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Semi-Automated System to Create User Scenarios, Mind Mapping, Prototyping, and HCI Best Practices

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***Abstract* - This paper introduces "SmartDesigner," a solution designed to address software product inconsistency by adhering to HCI best practices and ensuring compliance with HCI principles, all while requiring minimal supervisor guidance. The research approach encompasses a literature survey on existing automated UI generation tools and a user survey exploring the necessity of an automated user interface generation system. The survey investigates the underlying systems and software employed for automating the UI generation process. By integrating the design thinking process, including requirement gathering, user scenario generation, mind map creation, wireframing, and web UI development, along with evaluating the application of HCI concepts, SmartDesigner aims to streamline the UI design process. Additionally, the interview component of the research focuses on understanding the significance of artifact consistency, contributing further insights to the study.**

Keywords: HCI (Human Computer Interaction), Design Thinking, UI (User Interface).

I. INTRODUCTION

This Research Introduces "SmartDesigner," a comprehensive system aimed at enhancing productivity and simplifying software production while ensuring compliance with HCI (Human-Computer Interaction) best practices. This system integrates the stages of design thinking into a semi-automated tool, providing a streamlined workflow for university students and software developers. It offers a wide range of functionalities within a single tool, encompassing requirement gathering, user scenario creation, mind map development, wireframe and advanced UI design, and evaluation of the final output for adherence to HCI best practices. The goal is to optimize software development processes and facilitate the application of HCI principles throughout the design journey.

This tool emphasizes the importance of maintaining continuity and consistency throughout the design thinking process. Each input in the system depends on the previous output, ensuring a correct understanding of the requirements and facilitating task execution. The define phase utilizes interviews, surveys, and video conferencing technology to gather requirements, and the system automatically generates user scenarios based on the uploaded user requirements document.

The generation of mind maps in the process emphasizes the organization and association of ideas, with a simultaneous integration of HCI best practices such as color balance, alignments, icons, and layouts. During the wireframe and Advanced UI phases, the system facilitates the transformation of low-fidelity and high-fidelity prototypes into web user interfaces. Based on the uploaded mind map, the system provides recommendations and suggestions for prototype selection, enhancing the efficiency and effectiveness of the design process.

In the final stage, the system automatically examines the HCI best practices of the chosen wireframes and advanced UI. It conducts an assessment to identify any user issues and offers suggestions for further improvement, ensuring that the final product adheres to HCI standards. Additionally, the system features an editable mode that empowers users to modify test cases and facilitate future modifications, enhancing the flexibility and adaptability of the design process.

The primary objective of this research paper is to introduce a comprehensive tool that streamlines the design thinking process, reducing time and effort while promoting adherence to HCI best practices. The sub-objectives encompass various aspects, such as the efficient gathering of requirements, user scenario creation, generation of mind maps, evaluation of HCI best practices, ensuring consistency across mind maps, wireframes, and advanced UI, as well as automated verification of HCI standards. By addressing these sub- objectives, the research paper aims to provide a holistic solution that encompasses the entire design thinking process, empowering practitioners to create user-centric and high-quality software products while optimizing their workflow and ensuring compliance with essential HCI principles.

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II. RELATED WORK

To streamline the design process and create enhanced user scenarios, stakeholders representing diverse backgrounds such as students, users, vendors, and IT can be interviewed via video conferencing. This approach ensures the gathering of a broad set of interests. Once the basic requirements list is obtained, the next step is to create a requirements document. Tailoring requirements documents to the user's needs are possible, and the application of natural language processing techniques aids in identifying specific elements in specification sheets that directly contribute to the creation of user scenarios. By using automation tools, user scenarios can be generated automatically, bringing several benefits to the process[1].

First, using an automated tool increases efficiency by reducing the manual effort required to generate user scenarios. This allows the project team to focus on other important tasks. Second, it promotes consistency and standardization of the design process. Allows users to tailor generated user scenarios to meet their specific needs. This flexibility enables stakeholders to effectively address their unique needs and preferences[2].

Moreover, the reusability of user scenarios is enhanced with the incorporation of an automation tool. User scenarios can be stored, retrieved, and reused for future projects or improvements, saving time and effort in the long run. Collaboration between stakeholders is facilitated by the automation tool, as it provides a centralized platform for sharing and reviewing user scenarios. This fosters effective communication and collaboration, leading to a more comprehensive and accurate set of user scenarios.[3]

Software developers or academic students take on the responsibility of generating a mind map based on the user scenarios created in the previous step during the second stage of the process. This involves creating parent components and child components within the mind map structure[4] During the generation of the mind map, developers and students have the flexibility to customize it according to their specific requirements. To begin, the user scenario generated by the first team member is analyzed, and its keywords are extracted. By employing supervised learning techniques, the relevant keywords are identified, and a corresponding mind map is generated. Furthermore, the generated mind map can be customized based on the user's preferences, such as adjusting the color balance, utilizing icons, aligning elements, and selecting appropriate layouts[5], [6].

In the third stage of the process, software developers or academic students should generate a wireframe based on the mind map created in the previous step.[3] Developers and academic students are given the flexibility to customize the wireframes generated from mind maps according to their specific requirements. The process begins by obtaining the mind map created in the previous step. The mind maps are then analyzed using image-processing techniques to identify keywords. Using supervised learning methods, a wireframe is created based on the identified keywords. This approach allows for a more efficient and accurate translation of the mind map into a functional wireframe design.[7][8] Finally, a model is designed for typical wireframes like payments, registration, and log in. This involves feature extraction, model setup, and training a dataset. The system has the ability to identify an unknown diagram and generate personalized wireframes that correspond to it accurately, without any plagiarism.[9] After obtaining the low-fidelity prototypes from the preceding stage, the next step involves employing an image processing approach to transform them into fully functional web user interfaces.[9]

This involves transforming the prototypes into fully functional and interactive web interfaces.[9] Distributed data training and modeling methods such as TensorFlow, Keras, and NumPy are employed to identify common applications from the mind map generated in the initial stage of the interface design process. By recognizing specific keywords like "Login," the system can identify corresponding functions with the same encoding, facilitating efficient mapping between the mind map and functional elements. [10] So. the system can recognize the login button on the web interface and assign the corresponding coding to it. It utilizes different encodings for various common functions and ensures that generated web [11] functional web interfaces can be generated for the users.

In the final step of the process, software engineers or academic students are assigned the task of evaluating the user scenario, Mind Map, and Wireframe according to the standards of Human-Computer Interaction (HCI). HCI is a multidisciplinary field that focuses on designing and assessing interactive systems to improve usability, accessibility, and user experience. Within the domain of software development, HCI plays a vital role in ensuring the creation of interfaces that are user-friendly and intuitive[12]. By incorporating HCI standards and best practices throughout the design process, software developers can optimize their applications to meet the diverse needs and preferences of users. In this context, the system detects UI objects, allowing users to utilize a provided Rules form to assess the HCI standards and best practices of the advanced UI and wireframe. The proposed system includes a set of rules that typically pertain to HCI standards, verifying whether developers or academic students adhere to design best practices when creating Advanced UI or wireframes. This may involve aspects such as button sizes, font sizes, color, and

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more. During this stage, the system evaluates the HCI standards and best practices in advanced UIs and wireframes and provides feedback and suggestions. By assessing the efficacy of HCI standards and best practices during the software development process, this study aims to improve the quality of UIs and wireframes, ultimately enhancing the overall user experience and satisfaction[13].

III. METHODOLOGY

This research conducted a thorough literature review, focusing on identifying the current automated systems available for generating web user interfaces. Additionally, this research explored the significance of incorporating design thinking phases in both the software industry and academic settings. Furthermore, this research aimed to assess the extent to which users adhere to design best practices within the field of Human-Computer Interaction (HCI). To gather comprehensive insights, this research employed a user survey and interview methodology, soliciting input from both professionals and students.

3.1 User Survey

This research utilized Google Forms as the platform to design and distribute our survey. To reach a diverse audience, this research utilized popular social media platforms like WhatsApp, Viber, and Telegram to distribute the survey among academic students and professionals in the industry. This approach ensured broad participation and representation from different backgrounds. The survey questionnaire consisted of a total of 25 questions, with the first six questions focusing on gathering insights into the general process of the automated tool. The subsequent nineteen questions delved into each specific component of the tool, allowing for a comprehensive understanding of its various aspects.

3.2 Interview of Users

As part of our research, this research conducted interviews with two individuals: an industry professional and a fourth-year undergraduate software engineering student from the same university as the authors. The chosen industry professional has a decade of experience in software development and is affiliated with a prestigious company in Sri Lanka. During the interview process, participants were asked to evaluate their computer literacy and provide self-assessments regarding artifact consistency as specific areas of focus. This approach allowed for a comprehensive understanding of the perspectives of both an experienced professional and a student in the software engineering domain.

IV. RESULTS AND ANALYSIS

4.1 Participants of the Survey

The survey was designed to be completed within an estimated time frame of 5-7 minutes. It remained open for a duration of one week and garnered a total of 63 responses. The majority of participants (90%) consisted of students enrolled in a software engineering and information technology degree program at our university. This selection was made because software engineering students are particularly invested in efficiently producing software products and are highly encouraged to grasp the underlying concepts. The remaining 10% of respondents were professional software developers working in the industry. It is illustrated in Figure 1.

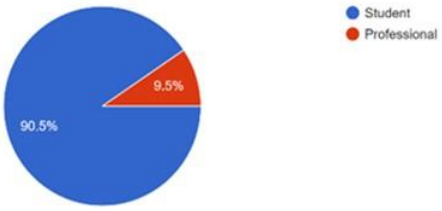

Figure 1: Are you a student or a professional

The survey encompassed participants with diverse levels of experience, including beginners in the software development field. Figure 2 provides a more detailed depiction of the participants' experience distribution, indicating that a significant majority falls under the category of beginners. By including participants with varying experience levels, the survey results become more comprehensive, reflecting a broader representation of the software development community, and enabling a more holistic understanding of the research topic.

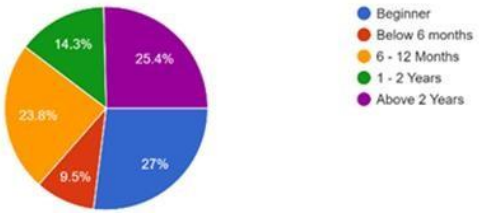

Figure 2: How long you Experienced?

During the survey, participants were asked to assess their self-rated proficiency in various areas, including computer literacy, knowledge of the design thinking process, familiarity with HCI principles, user scenario comprehension, and the process of generating mind maps. Furthermore, respondents were prompted to consider the factors influencing the proper generation of web user interfaces. Participants were requested to identify their preferred components of a well-executed

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wireframe and share any challenges encountered while utilizing the web UI generation tool.

4.3 Analysis of Survey Results

According to this survey, a higher percentage are beginners in this field, and that percentage is close to 30%. It seems that more than 75% of these participants use automated tools for professional and academic work. Among them, it can be concluded that nearly 90% follow design thinking phases. But it seems that only 70% of participants are concerned about HCI standards. Although the design thinking process and HCI standards are an important part of software production, only nearly 65% of participants pay attention to those two aspects.

Requirements gathering and Understanding user needs and wants can be shown as the first and most important step in the design thinking process. As shown by many survey participants, interviews and surveys are the main ways to gather the requirements. This survey shows that most people Fig. 1. Are you a student or a professional? Fig.2. How long have you experienced? create user scenarios in their design tasks. Most of them do not use any existing software to generate user scenarios automatically. According to this survey and the way this research monitored it, it seems that there is no tool to generate user scenarios automatically.

Creating a mind map can be considered an important step in the design thinking process. This method is mostly used for project planning, to-do list, and problem-solving. But according to this survey, it seems that only a small group of participants use mind mapping for software development. The reason is most of them are not using any existing software to generate mind maps automatically. According to the survey responses, most of them think creating a Low Fidelity Prototype is a mandatory step in the HCI design techniques. The results of the survey show that the tools Mind Mapper, Mind Manager, and Xmind are some of the popular tools available to generate mind maps. Most people spend a lot of time drawing mind maps by hand and do not pay attention to their accuracy. The biggest advantage of mind mapping software is better decision-making for its users. Mind mapping software seems to be more valued as a tool for organizing, gathering, and sharing information.

Table 1:Survey response

Survey Questions	Yes	No
1. In your everyday tasks, have you? 2. utilized any automated tools that already exist?	76.2%	23.8%
2.When developing a software product as a student or professional, do you adhere to the phases of Design Thinking?	87.3%	12.7%
3.When designing a software product as a student or professional, do you adhere to HCI (Human-Computer Interaction) standards?	69.8%	30.2%
4.In your perspective, do you consider Design Thinking phases and HCI (Human-Computer Interaction) standards crucial for the design of software products?	66.7%	33.3%
5.As a student/professional, do you create user scenarios for your design tasks?	84.1%	15.9%
6.In your opinion, is the creation of prototypes (such as wireframes and advanced UI) an essential step within the design thinking phases?	92.1%	7.9%
7.Have you utilized any automated tools for generating prototypes that are already available?	36.5%	63.5%
8.As a student/professional, do you use HCI standards for prototype designing?	71.4%	28.6%
9.As a student or professional, have you employed any systems that automatically generate prototypes(wireframes and advanced UI) by utilizing mind maps?	55.6%	44.4%

Keeping wireframes simple and skipping the color makes a good wireframe according to the participants. This response received the highest percentage of agreement. Conversely, suggestions such as incorporating better sample data and being knowledgeable about the specific wireframe type received lower levels of endorsement from the respondents. Additionally, when creating wireframes or low-fidelity prototypes, participants expressed a lack of interest in certain elements. Analyzing the data derived from the survey responses, it was evident that the majority of participants do not utilize any existing automated UI generation tools. Participants cited issues with alignments, scales, and button sizes when employing such tools. These findings shed light on the challenges faced by users in achieving optimal outcomes when utilizing UI generation tools.

According to the participants, simplicity and absence of color contribute to a good wireframe, as they garnered the highest agreement percentage. On the other hand, suggestions such as utilizing better sample data and being knowledgeable about the specific wireframe type received lower levels of endorsement. Additionally, when creating wireframes or low-fidelity prototypes, participants expressed disinterest in certain elements. Analyzing the survey data, it was evident that the majority of participants do not utilize any existing automated

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UI generation tools. This finding indicates a lack of adoption in this area among the respondents. According to their feedback, challenges arise in terms of alignments, scales, and button sizes when utilizing UI generation tools.

Our research specifically addresses the significant challenges highlighted by the participants. A substantial number of respondents emphasized the importance of incorporating design best practices as a crucial stage within the design thinking process to achieve high-quality outputs. Interestingly, a considerable portion of participants revealed their lack of awareness regarding any existing HCI expert system capable of automating HCI principles by leveraging usability data to enhance design best practices. These findings underscore the need for our research to explore potential solutions to bridge this gap and provide a valuable contribution to the field.

V. DISCUSSIONS

To the best of the authors' knowledge, the results obtained from the survey present valuable and intriguing findings. This research paper stands as the first to propose an automated UI generation tool within a research context that incorporates both the design thinking process and HCI design best practices. The findings are reinforced by substantial evidence obtained through a user survey specifically tailored to the field of Human-Computer Interaction (HCI). These outcomes contribute to the existing body of knowledge in HCI by shedding light on the effectiveness of integrating design thinking and HCI principles into an automated UI generation tool. The research offers practical insights and guidance for professionals and researchers seeking to enhance the user experience and streamline the UI development process. The study's innovative approach, supported by empirical evidence, establishes a foundation for further exploration and advancements in automated UI generation and HCI practices.

The findings indicate that most professional developers and academic students adhere to the design thinking process when working on their software projects. Figure 3 presents a comparison between students and professional developers regarding their adherence to the Design Thinking Process when creating software products online. This suggests that both groups recognize the value and importance of incorporating design thinking principles in their development workflow. The results affirm the widespread adoption and application of the design thinking process within the software industry, highlighting its significance in guiding the creation of user-centric and innovative software solutions.

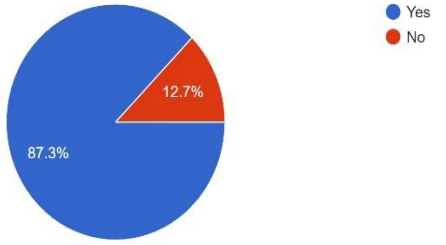

Figure 3: When creating a software product, whether as a student or a professional, it is essential to follow the Design thinking phases

Figure 4 demonstrates the significant emphasis placed on Human-Computer Interaction (HCI) principles by both professional developers and students during the software development process. It is evident that both groups recognize the importance of incorporating HCI best practices. This finding reinforces the notion that HCI principles hold great significance in ensuring the usability and user experience of software products. Given the recognition of HCI's importance, there is a clear need for a tool or software that facilitates the practical implementation of HCI principles in conjunction with the design thinking process. Such a tool would enable developers to effectively integrate HCI best practices into their software development workflows, ultimately resulting in enhanced user satisfaction and engagement.

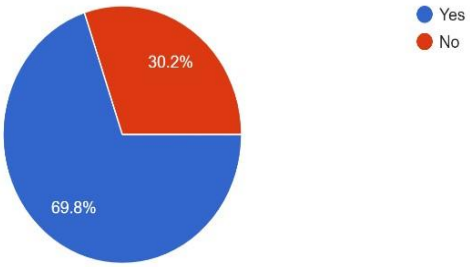

Figure 4: When creating a software product, whether as a student or a professional, it is crucial to adhere to HCI standards

The results highlight the significance of generating user scenarios as part of the design thinking process. The findings indicate that a considerable number of users consider gathering user requirements to be a crucial step. The primary methods employed for gathering user requirements include interviews, surveys, and video conferences. This is depicted in Figure 5, which illustrates the prevalence of these methods. These results underscore the importance of actively involving users in the early stages of development, as their insights and needs serve as valuable inputs for designing user-centered software solutions. By employing various techniques such as interviews, surveys, and video conferences, developers can effectively gather user requirements and shape their software products accordingly.

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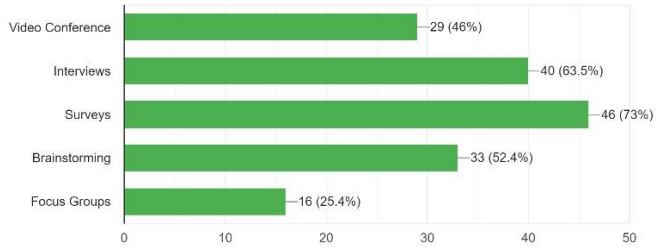

Figure 5: What are the main ways to gather requirements for software products?

The survey results depicted in Figure 6 indicate that most users engage in the creation of user scenarios during the design process. However, it is evident that there is currently no software or tools available for generating user scenarios automatically and efficiently. Consequently, users resort to manual creation, which may not always yield the desired output. The findings highlight the need for dedicated software or tool that can accurately and efficiently generate user scenarios. Such a solution would greatly enhance the design process by providing users with a more streamlined and effective approach to creating user scenarios, thereby improving the overall user experience.

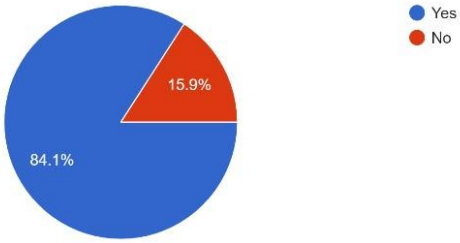

Figure 6: As a student/professional, do you create user scenarios for your designing tasks?

Our research findings highlight the significance of mind map generation as the second step in the design thinking process. Most users strongly expressed that creating a mind map is an essential and indispensable component when developing a software product, whether as an IT professional or an academic student. Mind maps are viewed as a valuable tool for gaining a clear understanding of the system being developed. However, it is worth noting that some academic students responded positively to the use of mind maps because they perceived it as a mandatory step in their projects, without fully comprehending its purpose and benefits.

Based on the survey results, it was found that a significant number of users continue to rely on manual processes and techniques for designing mind maps, rather than utilizing available software tools to generate mind maps more effectively and efficiently. Consequently, there is a need for software or tools that can automate the mind map generation process and provide users with accurate guidance on how to create mind maps correctly for different user scenarios. This would greatly enhance the productivity and accuracy of mind Fig.3. When creating a software product, whether as a student or a professional, it is essential to follow the Design thinking phases. Fig.4. When creating a software product, whether as a student or a professional, it is crucial to adhere to HCI standards. Fig.6. As a student/professional, do you create user scenarios for your design tasks? Fig.5. What are the main ways to gather requirements for software products? map creation, allowing users to gain a comprehensive understanding of their projects. Professional developers need to ensure that their projects are completed on time and generated in accordance with HCI best practices. Finally, it should be mentioned that the generation of mind maps varies according to the participants and the occasion.

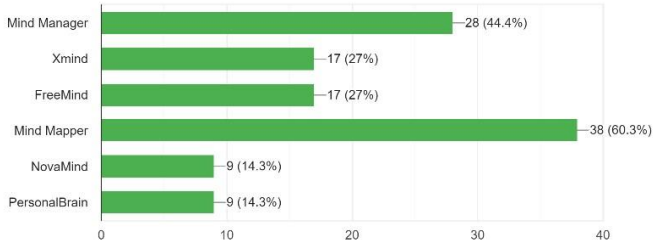

Figure 7: What is the primary mind mapping program you use in your work?

Third, our findings demonstrate wireframe creation. A low-fidelity prototype's (wireframe) creation is seen by many consumers as an important step in the design thinking process.

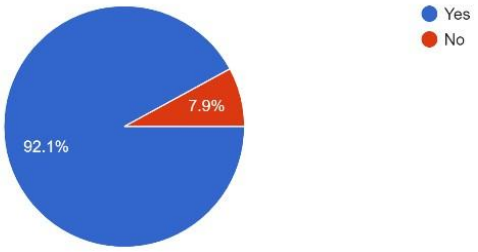

Figure 8: Do you think creating prototype (creating Wireframes, Advanced UI) are mandatory step in design thinking phases?

Draw.io and Mock Flow are two of the most popular programs for manually designing wireframes. Many people claim this since no technology has been developed to automatically produce low-fidelity prototypes using mind maps. The best practice for creating better wireframes is to keep them simple and avoid color. To create a better wireframe, it is crucial to utilize relevant sample data and have a clear understanding of the wireframe's purpose and type.

In the next section of our study, this research presents the findings related to the creation of the Web UI. The results indicate that a significant number of users have not had the

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opportunity to utilize automated UI generation tools. Despite the existence of tools such as UIzard and Sketch2Code, it was observed that these tools do not provide an automated approach for generating UI directly from wireframes while incorporating design thinking principles. This highlights the need for improved solutions that offer automated UI generation while aligning with design thinking methodologies.

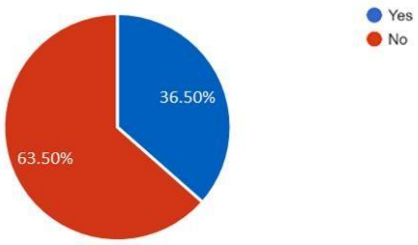

Figure 9: Have you used any existing automated prototype generation tools?

The findings from our research emphasize the importance of incorporating HCI standards and best practices in the fourth step. It is evident that most users consider design best practices as a mandatory component in the Software Development Life Cycle Process to ensure highquality output. Specifically, when designing advanced UI and wireframes for web applications, adhering to design best practices and HCI standards holds significant importance. However, our survey revealed that some IT professionals and academic students lack a precise understanding of HCI standards and design best practices. Additionally, the survey results indicate the absence of an exactly automated system for automatically checking adherence to HCI standards and best practices. As a result, some students and developers have not been utilizing HCI best practices during the creation of advanced UI or wireframes. These findings highlight the need to address the knowledge gap and develop automated systems to promote the application of HCI standards and best practices, ultimately improving the quality and user experience of software interfaces.

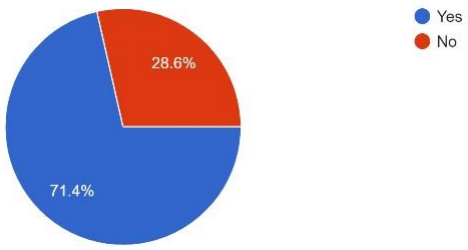

Figure 10: As a student/professional, do you use HCI standards for prototype designing?

Maintaining consistency in software projects poses a significant challenge for academic students[7][9]. Currently, there is no established approach for ensuring artifact consistency, often leading to decisions made through team discussions or input from IT professionals. Academic students greatly benefit from upholding artifact consistency as it enables them to learn industry best practices and meet project deadlines. Professional developers, in turn, benefit from the reliability that comes with consistency, allowing them to complete projects within the designated timeframe. Failure to maintain artifact consistency can result in missed deadlines, disregard for best practices, reduced customer satisfaction, and a decline in the company's reputation. The ongoing pandemic has further exacerbated the challenges faced by both academic students and professional developers, making consistency maintenance even more demanding. Despite the existence of accurate procedures, achieving and sustaining consistency remains a formidable task.

VI. RECOMMENDATION

Concluding the results of the discussion, the research findings indicate that university students generally have a lesser understanding of HCI best practices compared to IT professionals, particularly in the university setting. However, incorporating these best practices can greatly benefit students in completing projects within deadlines and provide them an advantage when transitioning to the industry. IT professionals can also benefit from following HCI best practices, as it enables efficient project completion within allocated timeframes. Adhering to HCI best practices can help supervisors in companies or academic instructors reduce their guidance and supervision workload during projects. Design best practices serve as guidelines for applying design principles and ensuring a positive user experience. Unfortunately, many students and even some IT professionals tend to prioritize the backend process while neglecting the crucial steps in the Design Thinking process. Emphasizing the essential steps such as gathering requirements, creating user scenarios, developing mind maps, designing wireframes and advanced UI, and testing the application of HCI principles is crucial. Automation of these processes saves time and costs, promotes adherence to best practices, and imparts knowledge about the Design Thinking process. This automation minimizes inconsistencies in projects for students and developers, resulting in high-quality software products that meet market demand.

VII. LIMITATION AND FUTURE WORKS

This research was initially undertaken by undergraduate students with a specific focus on academic students and professional developers in the software industry.

However, there are plans to expand the user base to include individuals with an interest in software product development, such as project managers and quality assurance professionals. Additionally, the tool aims to cater to college

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students and a wide range of users, making it accessible to a larger audience. It serves as a valuable resource for gaining knowledge in software product development, regardless of the user's background or expertise. With technology constantly evolving, there is ample room for continuous improvement and the addition of new features to enhance the application further. To provide users with more control over their designs, an editorial board can be implemented, allowing for customization and modifications to the generated wireframes and UIs. This flexibility enables users to refine their designs according to their specific requirements. In order to enhance usability and user experience, necessary changes will be made to the application based on user feedback. Moreover, efforts will be made to improve the accuracy of the outcomes generated by the tool, ensuring reliable and precise results.

VIII. CONCLUSION

In this research, the primary focus is on bridging the gap between manual and automated UI production through an extensive literature review of existing UI generation tools. The aim is to explore the features, tools, procedures, and methods utilized in previous studies and initiatives that aim to automate the creation of user interfaces. The study delves into examining the supporting systems and their application in automating UI creation. With the growing significance of Human-Computer Interaction (HCI) best practices in modern software development, both academic students and software engineers prefer employing semi-automated tools or software that aligns with HCI principles and incorporates design thinking phases. To assess artifact compatibility, an interview was conducted involving a professional developer and a student. This step allows for a deeper understanding of how the generated UIs align with the needs and expectations of users in real-world scenarios. The findings from the survey and literature review will contribute to an improved understanding of UI generation and aid in the development of more innovative UIs. By incorporating design thinking phases and HCI best practices, the resulting UIs will be usercentric, intuitive, and effective in meeting user requirements. Ultimately, this research aims to facilitate the integration of automation into the UI production process, streamlining the design workflow, improving efficiency, and enhancing the overall user experience.

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