The Impact of User Interface on Recommender Systems

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ABSTRACT

Recommender systems are integral to the functioning of numerous digital platforms, helping users navigate vast information spaces by suggesting relevant content or products. This research investigates the critical role of user interfaces (UI) in enhancing the effectiveness and user experience of these systems. The primary objective is to explore how different UI elements, including graphical and tangible interfaces, influence user engagement, satisfaction, and trust in recommender systems across various domains such as e-commerce, healthcare, and smart environments.

Through an extensive literature review and analysis of case studies, this study examines key factors such as ease of use, transparency, personalization, and aesthetics in UI design. The research also addresses typical issues that recommender systems encounter, such as the cold start issue, scalability issues, and ethical concerns regarding user data and privacy. By highlighting the interplay between UI design and the underlying algorithms of recommender systems, the study aims to provide insights into how tailored UI features can mitigate these challenges and enhance the system's overall performance.

The findings suggest that well-designed UIs can significantly improve user interaction with recommender systems, leading to higher engagement rates and greater acceptance of the recommendations provided. Moreover, the study emphasizes the importance of user-centred design approaches that cater to diverse user needs and preferences, promoting a more inclusive and satisfactory user experience. The research concludes with recommendations for future UI design strategies that prioritize user trust and

ethical considerations, ensuring that recommender systems remain effective and user-friendly in increasingly complex digital environments.

Keywords: Recommender Systems, User Experience (UX), Personalization, Engagement, Transparency, Cold Start Problem, Scalability, Ethics in Recommender Systems, Digital Platforms, User-Centered Design, E-commerce, Healthcare Recommender Systems, Smart Environments, User Trust, Data Privacy, Interaction Design, Human-Computer Interaction (HCI)

ÖZ

Öneri sistemleri, kullanıcıların ilgili içerik veya ürünleri bulmalarına yardımcı olan dijital platformlar için kritik öneme sahiptir. Bu araştırma, bu sistemlerin etkinliğini ve kullanıcı deneyimini artırmada kullanıcı arayüzlerinin (UI) önemli rolünü incelemektedir. Grafiksel ve somut arayüzler dahil olmak üzere çeşitli UI öğelerinin e-ticaret, sağlık ve akıllı ortamlar gibi farklı alanlarda kullanıcı katılımı, memnuniyeti ve güveni üzerindeki etkilerini araştırmaktadır. Kapsamlı bir literatür incelemesi ve vaka çalışması analizi yoluyla, UI tasarımında kullanım kolaylığı, şeffaflık, kişiselleştirme ve estetik gibi faktörler incelenmiştir. Ayrıca, öneri sistemlerinin soğuk başlangıç problemi, ölçeklenebilirlik ve kullanıcı verilerinin gizliliği ile ilgili etik sorunlar gibi yaygın zorluklara da değinilmektedir. Bulgular, iyi tasarlanmış UI'ların kullanıcı etkileşimini artırabileceğini ve önerilerin kabul oranını yükseltebileceğini göstermektedir. Çalışma, çeşitli kullanıcı ihtiyaçlarına hitap eden kullanıcı merkezli tasarım yaklaşımlarını savunmakta ve genel kullanıcı deneyimini iyileştirmektedir. Gelecekteki UI tasarım stratejileri için kullanıcı güvenini ve etik hususları ön planda tutarak, karmaşık dijital ortamlarda öneri sistemlerinin etkinliğini ve kullanıcı dostu olmasını sağlama önerileri sunulmaktadır.

Anahtar Kelimeler: Öneri Sistemleri, Kullanıcı Deneyimi (UX), Kişiselleştirme, Katılım, Şeffaflık, Soğuk Başlangıç Problemi, Ölçeklenebilirlik, Öneri Sistemlerinde Etik, Dijital Platformlar, Kullanıcı Merkezli Tasarım, E-ticaret, Sağlık Öneri Sistemleri, Akıllı Ortamlar, Kullanıcı Güveni, Veri Gizliliği, Etkileşim Tasarımı, İnsan-Bilgisayar Etkileşimi (HCI)

DEDICATION

To My Father, Mother, Sister and love

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LIST OF ABBREVIATION

ALS	Alternating Least Squares
APIs	Application Programming Interfaces
BFT	Belief Function Theory
CF	Collaborative Filtering
CTR	Clickthrough Rate
FAVs	Fully Autonomous Vehicles
GUI	Graphical User Interface
HCI	Human-Computer Interaction
KPI	Key Performance Indicator
NDVI	Normalized Difference Vegetation Index
POIs	Points of Interest
RS	Recommender Systems
SVD	Singular Value Decomposition
TUI	Tangible User Interface
UI	User Interface
UX	User Experience

Chapter 1

INTRODUCTION

1.1 Introduction

Currently, recommender systems are analyzed as essential tools in different domains to help users to navigate in the unimaginable number of opportunities in the World Wide Web environment. They range from movie recommendations or Netflix users to product recommendations seen on e-commerce platforms such as Amazon. However, the effectiveness of these recommendations is not solely dependent on sophisticated algorithms; the design and functionality of the user interface (UI) through which these recommendations are presented here have a significant impact on user trust, satisfaction, and engagement.

This research focuses on the impact of user interfaces on the efficacy of recommender systems. Some of the back-end algorithms applied in these systems attract all the attention while the front-end: the UI mainly controls the user's way of engaging with and perceiving the recommendations. A good design of the UI would make the interaction with the application easy, fun, and straightforward to the point that the user can trust the application's recommendations. Conversely, a poorly designed UI can lead to user frustration, reduced engagement, and diminished trust in the system's recommendations.

This study's goal is to investigate the various UI design components, including graphical and tangible interfaces, and their influence on user interaction with recommender systems. It seeks to understand how the mentioned elements can be enhanced to solve problems like the cold-start problem that results from making wrong suggestions to initial users or items, and scalability problems in large systems. Furthermore, it will provide insight into the ethical concerns of the concept, more specifically, the approach taken to create recommendations and the management of the user data as this is very important for gaining the user's trust.

In doing so, this research seeks to offer a sharper understanding of the part played by UI in increasing the efficacy and usage approval of recommender systems based on the scrutiny of past literature and empirical evidence. In this way, it is to provide useful information and recommendations for further improving the interfaces of these systems and increasing their usability sufficient to meet the needs of patients in various digital contexts.

Thus, the purpose of the paper to provide a refined understanding of the impact of UI within the context of the current literature and case studies on the performance and user acceptance of recommender systems. Thus, it strives to provide relevant information and potential solutions for improving the interfaces of these systems with a focus on a user-centered approach and making these systems more suitable for the targeted audiences and the particular context of use.

1.2 Exploring the Influence of UI Design

The assessment of prior studies shows the systematic review of the literature providing an overview of the existing knowledge related to the role of user interfaces (UI) in recommender systems. It discusses approaches such as how UI design affects the use of systems, the forms of UI present in recommenders, and issues affecting the implementation of good UI with corresponding solutions.

1.3 UI Design and Its Effect on the User

This paper has highlighted that the aspects of the user interface considerably impact the performance of the given recommender systems. It has been found by previous studies that designing an interface in an appropriate way will have positive impacts on the interaction environment, the satisfaction level of the user, and the perceived relevance of the recommendations. For instance, influences of navigability, perceived graphics, and interactive devices might influence the process through which users find new materials in a positive way. Other work has stressed the need to offer users some control over the system, i.e., make adjustments or ask for their feedback, to increase their trust in the given recommendations.

A classification of recommendation UIs is used to address the various types of needs required by the users as well as the many circumstances under which recommendations are made. One of the most popular UI designs known as the graphics user interface that employs such elements as buttons, menus and icons to make interaction easier.

Whereas graphical interfaces are based on pictorial and visual elements to overcome the limitations of the command-based interface, Tangible User Interfaces (TUIs) use physical objects and environments to interact with the digital information and therefore

it will be more appealing for the users. It is found that every kind of UI has its own merits and demerits with respect to which has an impact on the interface of the system.

There are so many problems as to how a recommender system's recommendation interface can be presented and designed that it is difficult to cover them all.

As such coming up with the UI designer for these recommenders experiences the following challenges. One of the principal problems is the so-called 'cold start' problem when the system does not have enough data to make good recommendations for customers or items. The problem can be solved during the onboarding of an application or in the case of initial preference polls where such data could be obtained. Scalability is another issue, especially when an application has many and vastly different clients because the UI has to handle and display a large amount of data without overloading the client

1.4 Ethical and Transparency Considerations

A key concern that is growing in prominence in the formation of interfaces for recommender systems is ethics. Another important aspect concerning recommender systems is the openness regarding the formulation of the recommendations. Users have to know why certain items are suggested, which can be done with the help of additional comments/signs inside the UI. Also, there is also privacy and consent concerning the user data as important ethical considerations that must be taken to ensure users' trust as well as adhering to the required law. The literature review also indicates that despite there being a vast amount of studies on the more technical aspects of recommender systems, the influence of UI design is equally important but receives comparatively less attention. Therefore, this research seeks to answer this gap by disguisedly studying

the influence of UI design on the operation of the recommender system. The subsequent sections of this paper will provide further insight into these aspects, bringing over actual case studies and empirical evidence of the significance of the UI in the performance of recommender systems.

Chapter 2

LITERATURE REVIEW

Given the fact that in the modern context, we find ourselves in an era of information overabundance, RS has the task of helping the users make a decision. However, a number of these systems are largely dependent of the designs and flexibility of users interfaces. It is therefore crucial to comprehend the various settings in which the recommender systems are applied like healthcare, e-commerce, and smart homes.[1] There are numerous topics to review in recommendation systems' literature: as seen from the discussion above, the significance of certain themes could be relative to the context; the industry, and the advancement in the technological field. Literature reviews on recommendation systems cover a wide range of topics, and the importance of specific themes may vary depending on the context, industry, and technological advancements. Recommender systems, essential tools in today's digital landscape, leverage various filtering techniques to provide personalized recommendations. Collaborative Filtering (CF), Content-Based Filtering (CBF), and Matrix Factorization (MF) are among the most common methods employed.

2.1 Collaborative Filtering (CF)

Is a user-based approach that recommends items based on similarities between users. It assumes that users who have similar preferences in the past will likely share preferences in the future. CF techniques can be further divided into memory-based and model-based methods. Memory-based CF directly compares user-item ratings, while model-based CF constructs a model to predict future ratings.[23]

2.2 Content-Based Filtering (CBF)

recommends items based on their similarity to items a user has previously interacted with. This technique focuses on the content or attributes of the items themselves, such as keywords, genres, or features. By analyzing the user's preferences for specific characteristics, CBF can suggest items that align with their interests.[24]

2.3 Matrix Factorization

is a latent factor model that decomposes a user-item rating matrix into two lower-dimensional matrices. This technique assumes that both users and items can be represented by a set of latent features or factors. By identifying these latent factors, MF can predict missing ratings and provide recommendations.[23]

2.4 Evaluation Metrics

Evaluating the performance of a recommender system is crucial to understanding its effectiveness and identifying areas for improvement. Several metrics and techniques can be employed to assess recommendation quality.

2.4.1 Evaluation of Recommendation System

Precision The proportion of recommended items that are relevant to the user, recall The proportion of relevant items that are recommended to the user F1-score, The harmonic mean of precision and recall, etc., are the key parameters being used to measure the performance.

2.4.2 User-Oriented and Item-Oriented Perspective.

Recommender systems can be classified into two primary perspectives: user-oriented and item-oriented. These perspectives influence how recommendations are generated and the types of information used. In a user-oriented approach, recommendations are generated by focusing on the user's preferences and behavior. In an item-oriented approach, recommendations are generated by focusing on the characteristics or attributes of items.[23]

Research has proved that analyzing GUIs affects recommender systems differently and the highest of the GUI set up a 66% enhanced click-through rate and that operators can boost the Click Trough Rate CTR[1].

2.5 Cold Start Problem

Cold Start Problem in recommender systems refers to the challenge of providing accurate recommendations for new users or items with limited or no interaction data. The key challenge is When a new user joins a system, there's little or no data to understand their preferences and interests. This makes it difficult to generate personalized recommendations. When a new item is added to the system, it lacks historical ratings or user interactions, making it challenging to determine its relevance to users.[25]

2.6 Explainability and Interpretability

Measures or ways of how to make recommendations clearer and easier for the comprehension of users. This work benchmarks multiple models[26], the process of comparing the performance of different models or algorithms against a common standard or set of criteria. This helps to identify the most effective and efficient approaches for a given task, designs novel GUIs, and employs online studies to study

multi-supplier recommender systems. Using the dataset from the educational learning the paper highlights that supplying essential parameters for the recommendation models enhances the traceability and steers stakeholders' decisions. Transparency in multi-stakeholder RS is now under consideration, and simultaneous online research is also on the rise[2]. Some of them relate to addressing the "black box" problem seen in some recommendation models. A model or algorithm whose internal workings are not fully transparent. This means that it's difficult to understand how the system arrives at its recommendations based on the input data.[26]

The reports on the outcome of the controlled study have been conducted to apply the Relevance Tuner+ [3], which is an interactive hybrid social recommender system that aims to enhance the explainability and user control of recommendations which is interactive, a hybrid social recommender system that gains both visual explanation and user control for better performance compared to the other recommender systems which are traditional and complex by the design of the system[3].

2.7 Recommendations That Are Context-Aware

Such as information about the user's location, the time of day, and similar activities.

Dynamic and adaptive recommendation systems are those that attempt to constantly change and evolve in terms of their functionality or an attempt to adapt to the characteristics of the users.

2.8 Diversity in Recommendations

It is possible to guarantee the reception of numerous and surprising suggestions inspired by the multiplicity of interests and opinions.

Methods of achieving the right mix of popular and diverse subjects.

2.9 Scalability and Efficiency

Techniques to deal with voluminous data and real-time recommendations.

A technique of dispersed and parallel processing for recommender systems. The user interface serves as the gateway for users to discover, evaluate, and engage with recommendations. A well-designed interface enhances the reach and impact of a recommender system by creating a positive user experience at each stage of the funnel, from awareness to retention.[27]

Some of the more recent papers have focused on the interaction between the graphical user interface and the recommendation techniques in different contexts. For example, in the agriculture industry in India, the interfaces enhance farmers' efficiency by translating environmental factors [28]. In the context of the browsing and shopping domains, UIs are specially designed for solving the size-related mismatch, which as a problem, remains a constant in the field of online shopping. Moreover, the interfaces in clinical settings use data image analysis for diet planning, which proves the flexibility of recommender systems.

This process is expanded to include things like interaction with users in fully automated cars [29], where recommendations of news become important for smooth driving. Furthermore, in the process of recommending shoes, both 3D foot models and users' choices are applied; this addresses the issue of size differences[31].

It is also important to comprehend the effects of the user interfaces on the strategies of the recommendation system which are not just limited to the kinds of algorithms in use but als0o include the application of bearings toward change of behavior. Through

recommender interfaces, customized advice is provided; this paper discusses the impact this has on altering users' behavior and in matters concerning energy-saving behaviors However, by design good recommender systems aim at maintaining users' interest in the system over time[30].

The above introduction raises the tone for the subsequent assessment of recent studies and explores the myriad features and directions of user interfaces on the shifting terrain of recommendation systems.

2.10 Data Sparsity

Managing sparse interaction matrices between users and items. The ADN RS is a novel approach to improving the recommendation performance of fully autonomous vehicles (FAVs) (ANRS). It takes advantage of news representation learning and aspect-level user choices to produce fine-grained representations of users' preferences and new attributes. The likelihood that a reader will click on a news story is then estimated by entering this information into a click predictor.[4].

2.11 Long-Tail Recommendations

Improving recommendations for less popular items[5] presents ACUX Recommender (ACUX-R), an MRS that provides visitors with customized cultural points of interest (POIs) according to their travel interests. The method assigns cultural visitor profiles based on the ACUX typology. Through user research and questionnaires, the evaluation demonstrated ACUX-R's potential as a mediating factor between cultural content and visiting preferences. It also showed how well ACUX-R fulfills cultural visitors and captures their nonverbal demands.

2.12 Cold Start Challenges

Developing effective solutions for new users and items. In India, where farmers must make educated decisions based on projected crop yield and conditions, agricultural management is essential. Considerations include temperature, pressure, humidity, NDVI values, latitude, and longitude. To select the optimal crop, a crop recommender system takes into account the pH, rainfall, humidity, and soil characteristics. A machine learning technique similar to Xgboost for crop suggestions is described, coupled with a predictive approach utilizing deep neural networks and geographic data. To improve agricultural efficiency and productivity, a user interface known as CROPUP is being developed[6].

2.13 Ethical Considerations

Addressing biases and fairness in recommendation systems. Music and video streaming services frequently feature lists of recommended content based on predetermined standards. Researchers suggest an offline evaluation technique that gauges the model's improvement over current carousel sets to choose the best carousels. To take position bias into consideration, they also expand ranking to two-dimensional carousel situations. Two carousel ranking algorithms are assessed through trials conducted on publicly accessible movie datasets. The findings demonstrate that the algorithm's ranking greatly varies depending on the carousel settings, and that choosing the best carousel layout that takes into account the two-dimensional user interface results in varied choices.[7].

2.14 Ensuring Ethical Use of Personal Data in Recommendations

The technical industry boomed to a rise in startups, making it difficult to find suitable job openings. The research paper aims to automate job search in the tech industry by using Puppeteer and REST APIs for web crawling. It proposes a hybrid system of CBF

and CF, simplifying the process for job seekers. The system has demonstrated satisfactory results, outperforming existing systems.[8] .

2.15 User Engagement and Satisfaction

Understanding and enhancing user experience and satisfaction. discusses the adoption of diversity-enhanced interfaces in recommender systems, focusing on improving user satisfaction. Two visual interfaces were developed, offering recommendations beyond ranked lists. User studies showed that these interfaces reduced exploration efforts, enhanced recommendation diversity perception, and improved satisfaction, providing insights for future interface design.[3]. This paper proposes a hybrid evidential movie RS using the belief function theory (BFT) to represent users' preferences and interactions under uncertainty. Experiments show promising results in MAE, NMAE, RMSE, Precision, Recall, and F-measure values.[9].[15]

2.15.1 Robustness and Security

Protecting recommendation systems from adversarial attacks.Ensuring robustness against manipulated data.

2.15.2 Dynamic and Evolving Environments

Adapting to changes in user preferences and system dynamics over time. To increase crop productivity,[10] Analyze several areas' worth of temperature, precipitation, earth, plant material, harvesting, relative humidity, and speed of wind data. The MapReduce framework, preprocessed in Python, is employed for analysis. For accuracy, K-means clustering is employed. Crop relationships are studied through the use of bar graphs and scatter plots. Crop predictions are made by a self-designed recommender system and shown on a Flask interface. Cross-Domain Recommendations: Extending recommendations across different domains.

2.16 Awareness Stage

Users become aware of the existence of recommender systems during the awareness stage. This stage involves users finding out how recommender systems function, their objectives, and how users can manipulate them [11]. The transparency and visibility of RS play a vital part in this stage. For dealing with the concerns about bias, designers and engineers are encouraged to make the functioning and purpose of recommender systems more transparent It is also stated that providing informative and engaging content within the user interface such as articles, videos or an interactive feature about relevant topics would help to maintain users' interest [12].

Self-driving cars are employed in dense, harsh, and disaster areas frequently Nevertheless, there is a lack of research on context-aware systems. To highlight research concerns and prospects for further development, the literature on contextual awareness in-vehicle infrastructure is analyzed via the lens of human-AVS, with a particular focus on communication backbones, recommender systems, human-machine interaction, and activity detection technology.[13]

2.17 Interest

The user interface can generate interest by providing a visually appealing design and layout that captures the user's attention. A well-designed interface can attract users' attention, making them curious about the suggested items or content.

2.18 Consideration

Users who show interest move to the consideration stage, where they evaluate the recommended items. The user interface should provide detailed information, possibly using visual elements like images, ratings, and reviews to aid users in making informed

decisions. A framework for size recommendation based on user preference and 3D (foot and last) features jointly. Initially, [14][4] present measurements of the foot form.

2.19 Interaction

Using a service-oriented framework and a semantic web data-science ontology, a data-science recommendation system is suggested. The system aims to make it easy for users to interact with recommended resources, such as software programs, textbooks, online manuals, and specialists, based on student queries or exam scores. The user interface should be seamless, allowing users to click, explore, and engage with the recommended items.[15]. The study highlights the significance of personalized interaction in music recommender systems, highlighting how musical sophistication influences user control acceptance and perceived diversity in visualizations, thereby enhancing user experience.[16] The Personalized RS for Information Visual Methods via Extended Matrix Completion (PRIME) dynamically adjusts visual designs to users and settings for framework enhances human-computer interaction and helps extract insights from large, complicated datasets. PRIME covariates to predict recommendation scores, achieving satisfactory accuracy even with limited historical data, contributing to new-generation visualization systems.[17].

2.20 Engagement

Beyond initial interaction, engagement measures how deeply users interact with the recommended content. The user interface should encourage continued engagement, possibly through features like personalized content feeds, notifications, or dynamic updates based on user actions.

2.21 Conversion

The ultimate goal is to convert user interest into actions, such as a purchase, a subscription, or any desired outcome. The user interface should guide users toward conversion actions, making the process intuitive and straightforward.

2.22 Retention

A successful recommender system keeps users engaged by adapting to their preferences and providing fresh recommendations. A research study suggests a supplemental food menu recommendation system for infants between the ages of 6 and 24 months, taking into account the baby's and mother's preferences as well as the diet's balanced intake of fat, protein, and carbs. The system generates the best recommendations using TOPSIS, Naive Bayes, and ontology. Tested by mothers, it showed good user satisfaction is based on knowledge-based ontology and the TOPSIS method[32].

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Chapter 3

METHODOLOGY

This systematic review was conducted under the PRISMA guidelines, focusing on articles from scholars in computer scientific organizations and written for some journals. A dataset was utilized in the study to evaluate the standard of systematic reviews in Artificial Intelligence and UI/UX design. Following the [19] and [20]'s methods, the study elaborates on and clarifies the reporting checklist items for systematic reviews in computer sciences.

Scopus and ScienceDirect were used as the data analysis path and inclusion criteria for a comprehensive dataset of papers published in 70 computer science journals, containing TITLE-ABS-KEY (user AND interfaces AND recommender AND systems) in their Titles, abstracts, or keywords. We limited the years to 2017-2023, document type to articles, and language to English, and narrowed down the numbers to make sure we had done it on time.

The search was performed on 28 Nov 2023, The data for the 378 documents selected has been exported to Mendeley. This study used an MS Excel spreadsheet to export the identified records' titles, abstracts, keywords, names of the authors, journal names, and year of publication.

Following the screening of the abstracts, and titles by different reviewers, the full texts of the remaining articles were assessed in compliance with the qualifying criteria. All of the reviews used an "explicit, reproducible, and without a priori assumption" approach to identify and choose publications. Reviewers' disagreements were settled by consensus, and reviews including only articles from a single publication were disqualified. The data management Excel file now includes the bibliographic information for the included studies as well as the necessary PRISMA checklist elements.

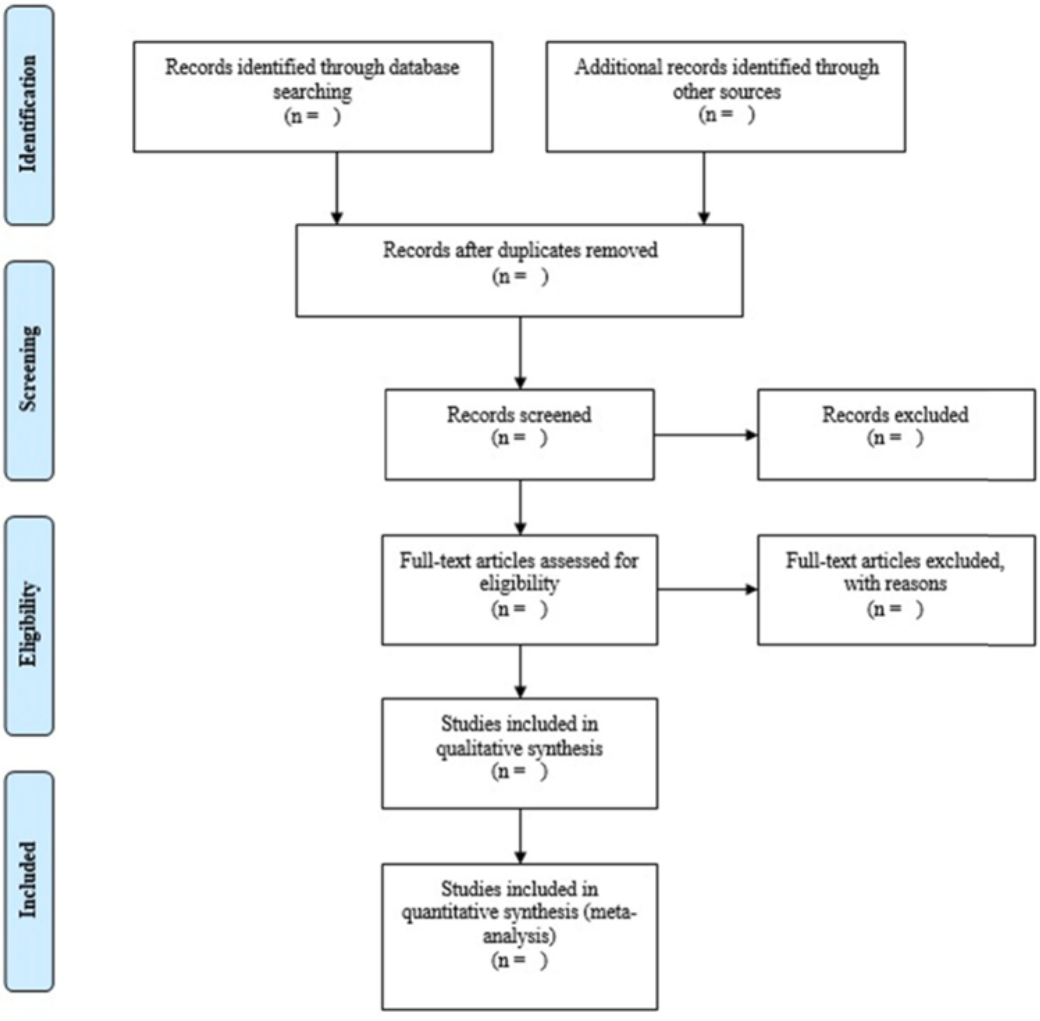

Figure 1: The PRISMA Flow Diagram

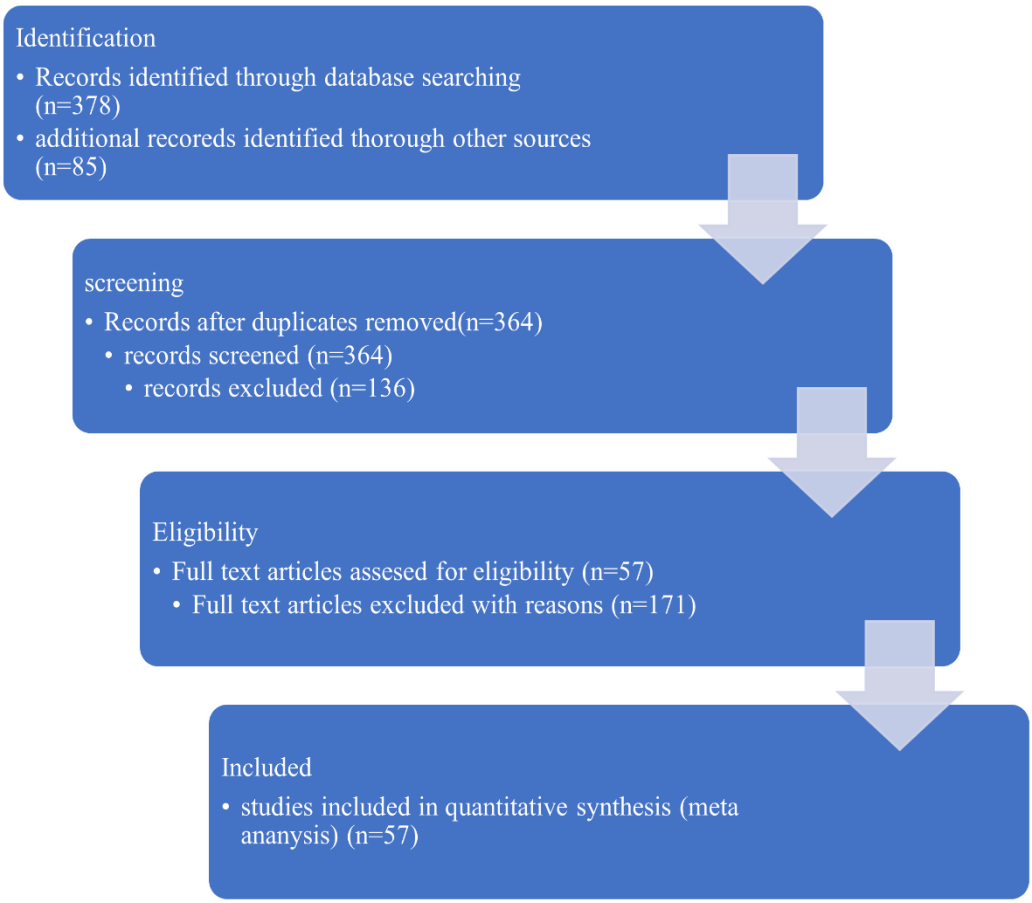

Figure 2: The PRISMA Flow Diagram

By using Mendeley as a bibliographic source we use Latex to write articles with codes and speed up the work. To improve the retrieved elements and code appropriately, a pilot test was carried out on 40 randomly chosen articles. Data extraction and coding were done after a thorough assessment of every included publication. Figure 1 illustrates the process of choosing studies.

3.1 Designing Platforms

We research different websites and applications like Adobe XD, Axure RP, Figma, InVision, Canva, Sketch, Marvel, Principle, Origami Studio, Zeplin, Framer, Proto.io, and Balsamiq.

3.1.1 Figma

Figma is a product of Figma Inc., a company that develops collaborative design software. It's known for its cloud-based platform that allows teams to work together on design projects in real-time. Figma has gained popularity among designers and developers for its features such as component libraries, prototyping capabilities, and integration with other design tools.[33]

3.1.2 Sketch

Sketch is a vector-based graphic design software primarily used for creating user interfaces and digital products. It's developed by Bohemian Coding and is particularly popular among designers working on macOS. Sketch offers features like vector drawing tools, layers, symbols, and plugins, making it a versatile tool for designing everything from logos to entire user interfaces. While it's primarily focused on UI design, it can also be used for other graphic design tasks.[34]

3.1.3 Adobe XD

Adobe XD is a popular design tool used primarily for creating user interfaces (UIs) and prototypes. It's part of the Adobe Creative Cloud suite and offers a range of features to streamline the design process suitable for both beginners and professionals.[35]

3.1.4 InVision

InVision is a collaborative design platform that enables teams to create, share, and collaborate on digital prototypes is often used by designers and developers to streamline the design process and improve communication within teams. It provides a centralized hub for creating, sharing, and iterating on digital designs.[36]

3.1.5 Axure RP

Is a rapid prototyping tool that allows designers and developers to create interactive prototypes for websites, mobile apps, and other digital products. It offers features such as Wireframing, Prototyping, Component libraries, and Collaboration.[37]

3.1.6 Marvel

A design and prototyping tool that also offers user testing features to validate your designs. These tools and platforms can provide inspiration, resources, and practical tools to enhance your UI/UX design projects[38].

3.1.7 Balsamiq

Balsamiq is a wireframing and prototyping tool that helps designers create low-fidelity mockups of user interfaces. It's designed to be simple and intuitive to use, even for those without extensive design experience. Balsamiq is often used in the early stages of the design process to quickly visualize and iterate on ideas before moving to more detailed design work. It's a popular choice for teams that need to create wireframes efficiently and collaboratively[39].

3.1.8 Proto.io

Is a web-based prototyping platform that allows designers and developers to create interactive prototypes for websites, mobile apps, and other digital products. It offers a range of features for creating realistic and engaging user experiences[40].

3.1.9 Framer

Framer is a prototyping tool that allows designers and developers to create interactive prototypes for websites, mobile apps, and other digital products. It offers a unique approach to prototyping by combining design, code, and interaction in a single environment. Framer is particularly popular among designers and developers who have a strong understanding of code and want more control over the interactions and behaviors in their prototypes. It's a powerful tool for creating highly customized and interactive prototypes.[41]

3.1.10 Zeplin

is a collaborative design platform that enables teams to share and manage design assets efficiently. It integrates with design tools like Figma, Sketch, and Adobe XD, making it a central hub for designers and developers to collaborate on projects.[42]

3.1.11 Origami Studio

is a prototyping tool developed by Facebook that allows designers to create interactive prototypes for mobile apps and websites. It focuses on rapid iteration and experimentation, making it a popular choice for designers who want to quickly explore different design concepts.[43]

3.1.12 Principle

is a prototyping tool that allows designers to create interactive prototypes without writing code. It offers a simple and intuitive interface, making it accessible to designers of all skill levels. We'll gather the necessary data about each platform, including pricing, free trials, and features. This information is based on typical offerings for these platforms, but actual prices and features can vary. Always check the latest details on each platform's official website.[44]

We evaluate and test each platform for creating designs and making interactive changes for websites and using their AI for creating samples separately then we use the better ones in our website.

Table 1: List of the development platforms and pricing

Platform	Monthly Price	Yearly Price	Free Trial Days
Adobe XD	$9.99	$99.99/year	7 days
Axure RP	$29/month	$495/year	30 days
Figma	Free, $12-$45/month	Variable	30 days
InVision	Free, $7.95/month	Variable	Limited free version
Canva	Free, $12.95/month	Variable	30 days
Sketch	$9/month	$99/year	30 days
Marvel	Free, $12/month	Variable	7 days
Principle	$19.99	$129.99	14 days
Origami Studio	Free	N/A	N/A
Zeplin	$8/month	$84/year	15 days
Framer	Free, $20/month	$180/year	14 days
Proto.io	$24/month	$228/year	15 days
Balsamiq	$9/month	$89/year	30 days

Most of the applications have a Trial version for testing and commissioning and they are Costly if a beginner intends to create an eye-catching design they have to pay a fee for using exclusive models or features. Undefined Free Options: Some of the tools mentioned above are partly free. More explicitly we can say that Figma, InVision, Canva, Marvel, Framer, and Origami Studio offer free versions with limited features or are available to a limited number of users.

3.2 Undefined Low-Cost Options

Balsamiq is more budget-friendly with pricing starting from $9/month while Sketch is more expensive, with its prices ranging from $89-$99 per year.

3.3 Undefined Higher Pricing

Axure RP and Proto are two of the most popular software used in Wireframing. It is at the higher end of the ladder with Axure RP, which is now available at $29/month while Proto. Undefined.

3.4 Undefined Free Trial Days

The free trial offer tends to come with different trial lengths, with most of the platforms providing about 14 to 30 days trial period. However, it is important to point out that Origami Studio is a free application – there is no trial version to test before designing.

3.5 Undefined Annual Savings

It is also more cost-effective to pay the fee in a single yearly amount than making monthly payments which are charged by the various platforms.
It also gives an overview of how much it costs to work with each of the UI/UX design platforms as well as the trial period it offers to any of the users and this is helpful when deciding based on the cost and specification needed.

Table 2: Platform Features

Platform	Site	Application	UX Design	UI Design	MAC	Windows	Real-time Collaboration
Adobe XD	✓	✓	✓	✓	✓	✓	✓
Axure RP	✓	✓	✓		✓	✓	
Figma	✓	✓	✓	✓	✓	✓	✓
InVision	✓	✓	✓	✓	✓	✓	✓
Canva	✓	✓		✓	✓	✓	✓
Sketch	✓	✓	✓	✓	✓		
Marvel	✓	✓	✓	✓	✓	✓	✓
Principle	✓	✓	✓	✓	✓		
Origami Studio	✓	✓	✓	✓	✓		
Zeplin	✓	✓			✓	✓	✓
Framer	✓	✓	✓	✓	✓		✓
Proto.io	✓	✓	✓	✓	✓	✓	✓
Balsamiq	✓	✓	✓		✓	✓	

Table 2 provides a high-level overview of different design tools. Adobe XD and Figma seem better for our project according to all criteria However princle, Origami Studio, and Balsamiq lack features also more research into each tool is recommended to determine which one best suits your specific design project requirements.

The platform lists the different design tools being compared. The site Indicates whether the tool offers a web-based platform or not (the checked mark signifies availability).

Application Indicates whether the tool has a dedicated desktop application or not (checked mark signifies availability).

UX Design Indicates whether the tool supports features specifically geared towards user experience design (checked mark signifies some level of support)

.UI Design Indicates whether the tool supports features for user interface design (checked mark signifies some level of support).

MAC Indicates whether the tool runs on Mac operating systems (checked mark signifies compatibility).

Windows: Indicates whether the tool runs on Windows operating systems (checked mark signifies compatibility).Real-time Collaboration: Indicates whether the tool allows multiple users to work on a project simultaneously (checked mark signifies support).

3.6 Cross-Platform Availability

The majority of the design tools are cross-platform; therefore, Adobe XD, Figma, InVision, Canva, Marvel, and Zeplin run on both macOS and Windows. Sketch, Principle, Origami Studio, and Framer are the ones that are Mac/OS only, which limits their availability to Windows users.

3.7 Design Focus

There are other similar tools like Adobe XD, Figma, InVision, Sketch, Marvel, and Framer which also address both the UI and UX design and come with full features in wireframing tools, prototyping, and interface design. Axure RP and Balsamiq are more oriented on UX design, which is more specialized in wireframing and prototyping activities. However, Canva mainly deals with UI design and graphic design, without stressing the specific tools for UX design.

3.8 Real-time Collaboration

The feature of real-time collaboration is implemented in modern similar tools, such as Adobe XD, Figma, InVision, Marvel, Framer, and Proto. Io, which makes them appropriate for team assignments and work-from-home scenarios. However, none of the tools such as Axure RP, Sketch, Principle, and Balsamiq mentioned above include real-time collaboration functions that may hamper the use of the tools in the collaborative context.

3.9 Application-Based Platforms

They all have site versions, but some present downloadable apps and give more opportunities and variants, especially if the user works offline.

3.10 Specialized Tools

Zeplin is centered on the exchange of work between designers and developers, it covers design details and resources but not the designing process.

Origami Studio and Principle are utilized for facilitating accurate, user-interaction, precise prototypes and are usually applied in intricate designs.

This consolidation assists in defining the advantages and disadvantages of each platform and their subsequent use depending on the required design specifications, cooperation with the team, and compatibility with the existing system.

To give detailed specifications of the design platform, I will present the data categorically in a tabular form that includes CPU, memory, price, and other additional features of each of the UI/UX design platforms. This will involve system requirements, cost based on the tier, and the characteristic or unique selling points.

Table 3: System Requirements and Pricing

Platform	CPU Requirements	Memory Requirements	Price for Application	Other Features
Adobe XD	**2 GHz or faster processor**	**4 GB RAM (8 GB recommended)**	**$9.99/month or $99/year**	**Supports vector graphics and wireframes**
Axure RP	**1 GHz or faster processor**	**2 GB RAM**	**$29/month or $495/year**	**Advanced prototyping and specifications**
Figma	**Web-based (low CPU usage)**	**2 GB RAM (4 GB recommended)**	**Free, $12-$45/month**	**Real-time collaboration, plugins**
InVision	**Web-based (low CPU usage)**	**2 GB RAM**	**Free, $7.95/month**	**Prototyping, user testing**
Canva	**Web-based (low CPU usage)**	**2 GB RAM**	**Free, $12.95/month**	**Graphic design, templates**
Sketch	**64-bit processor**	**4 GB RAM**	**$9/month or $99/year**	**Only available on macOS**
Marvel	**Web-based (low CPU usage)**	**2 GB RAM**	**Free, $12/month**	**Prototyping, user testing, integrations**
Principle	**macOS, 64-bit processor**	**4 GB RAM**	**$129.99**	**Animation-focused, easy to use**
Origami Studio	**macOS, 64-bit processor**	**4 GB RAM**	**Free**	**Built by Facebook, for high-fidelity prototypes**
Zeplin	**Web-based (low CPU usage)**	**2 GB RAM**	**$8/month or $84/year**	**Handoff tool for developers**
Framer	**macOS, 64-bit processor**	**4 GB RAM**	**$20/month or $180/year**	**Code and design integration**
Proto.io	**Web-based (low CPU usage)**	**2 GB RAM**	**$24/month or $228/year**	**A drag-and-drop interface, testing tools**
Balsamiq	**Web-based or desktop (low CPU usage)**	**4 GB RAM**	**$9/month or $89/year**	**Low-fidelity wireframing**

It comprises typical system requirements, the costs of the application, and certain other features that would be experienced when selecting a platform. Remember, that actual requirements and features can differ, so, to be precise, one should refer to the official sites of the platforms in question.

3.11 System Requirements

Web-based Platforms: Figma, InVision, Canva, Marvel, Zeplin, and Proto are a few among them. In general, Confluence, Google Drive, Trello, and MyCollab are lighter-weight applications at the core as they mimic web top work environments and do not have a large CPU or memory demand like an IDE or Photoshop, while Balsamiq, as a wireframing tool, is also less demanding.

MacOS-Exclusive Platforms: These are Mac-only applications such as Origami Studio, Framer and Sketch Require a 64-bit processor and at least 4GB of RAM for version 1.6, therefore limiting their use to only people who are using macOS because other operating systems have not been supported yet.

3.12 Pricing Models

Subscription-Based Pricing: Through a subscription plan that could be either monthly or yearly; all the platforms can be accessed through a subscription. Prominently, Adobe XD, Axure RP, Figma, InVision by Do: or Die Design Studio, Canva, Marvel, Zeplin, Framer, and Proto. Io offers their calculation in two major options: monthly and yearly prices.

One-Time Purchase: The principal also has an option of a one-time purchase at $ 129. 99, and anyone using a mobile phone for wealth creation might find it cheaper to make a one-time payment rather than paying monthly subscriptions.

Free Versions: Some of the design tools that are freely available include Figma, InVision, Canva, Marvel, and Origami Studio though they do have premium features that can be useful to the advanced users.

3.13 Specialized Features

Animation and Prototyping: Principle, Origami Studio, and Framer are the best tools for detailed interaction design because they are designed to have high-fidelity animation and interactive prototypes.

Handoff Tools: Zeplin specifically works in the context of design handoff where precise specifications like assets are handed over to the developers which could prove vital.

General graphic design: Canva has so many graphic templates and features that are useful for marketing. Content creators although it doesn't put much emphasis on UX/UI (User experience interface) design.

3.14 Flexibility and Integration

Marvel, Proto, and IO make these apps more flexible because they can be integrated with other applications as well as plugins in numerous processes. Hence, users can refer to the table for choosing the right tools depending on their hardware configurations, requirements, or budgetary constraints.

Table 4: Additional Features

Platform	Offline Mode	Export Options	Plugins/Integrations	Cloud Storage	User Testing Tools
Adobe XD	Yes	PNG, SVG, PDF, JPG	Yes	Yes	Yes
Axure RP	Yes	HTML, PNG, PDF	Limited	Yes	No
Figma	No	PNG, JPG, SVG, PDF	Yes	Yes	Yes
InVision	Yes	PNG, PDF	Yes	Yes	Yes
Canva	Yes	PNG, JPG, PDF, MP4	Yes	Yes	No
Sketch	Yes	PNG, JPG, SVG, PDF, TIFF	Yes	No	No
Marvel	No	PNG, JPG, PDF	Yes	Yes	Yes
Principle	Yes	Video, GIF	Limited	No	No
Origami Studio	Yes	PNG, JPG	Yes	No	No
Zeplin	No	Assets export for developers	Yes	Yes	No
Framer	Yes	PNG, JPG, HTML	Yes	Yes	Yes
Proto.io	Yes	PNG, PDF, HTML	Yes	Yes	Yes
Balsamiq	Yes	PNG, PDF	Yes	Yes	No

Design tools comparison is made in this table according to their design and functionalities. Functional attributes cover offline mode, export support, resources plugin integrations, support for tracking cloud storage, and testing tools. Many of the tools provide offline mode, support for many document types, and have additional plugins and integrations. A few other tools provide cloud support, which eases the process of asset management and cooperating with much bigger teams. A few tools comprise options for in-house user testing. The selection of appropriate logical tools, which exactly befits the practical usages revolves around the workflow, collaboration, type of exports, user testing, and the cost involved. For a better value-wise expenditure,

take into consideration the interdependence of the different aspects example workflow, collaboration, familiar file formats, user testing, and pricing policy.

3.15 Platform Availability and Compatibility

3.15.1 Cross-Platform Support

Most platforms are available on Mac OS and Windows, but Sketch, Principle, Origami Studio, and Framer are only operational on macOS.

3.15.2 Web-Based vs. Desktop Applications

Platforms like Figma, InVision, Canva, Marvel, Zeplin, Proto.io, and Balsamiq have web-based versions, that don't need much computer resources leaving for any device you use.

3.16 System Requirements (Memory and CPU)

System requirements in web-based tools generally range from low to moderate.

For desktop applications like Sketch ($99), Principle version 4 ($129), Origami Studio ($149), and Framer ($14) a 64-bit processor is required which should be with at least 4 GB of RAM for more complex projects that require more powerful hardware.

3.17 Pricing Models

3.17.1 Subscription-Based Pricing

Most platforms offer monthly and yearly subscriptions. Notable examples include Adobe XD ($9.99/month), Axure RP ($29/month), and Figma (Free, $12-45/month).

3.17.2 One-Time Purchase

The principle offers a one-time purchase option at $129.99, providing long-term cost savings compared to subscription models.

3.17.3 Free Versions and Trials

Several platforms, such as Figma, InVision, Canva, Marvel, and Origami Studio, offer free versions or free trials (ranging from 7 to 30 days), allowing users to explore features before committing financially.

3.18 Feature Set and Specialization

3.18.1 UI and UX Design Capabilities

Platforms like Adobe XD, Figma, InVision, and Marvel provide robust tools for both UI and UX design, including wireframing, prototyping, and user testing.

3.18.2 Animation and Interactions

Principle and Origami Studio are known for high-fidelity animations and interaction design.

3.18.3 Handoff Tools

Zeplin specializes in facilitating the handoff between designers and developers, offering detailed specifications and asset management.

3.18.4 Graphic Design: Canva focuses more on general graphic design, suitable for marketing and content creation for different platforms.

3.18.5 Real-Time Collaboration

Essential for team projects, platforms like Figma, Adobe XD, InVision, Marvel, and Proto.io offer real-time collaboration features.

3.19 User Accessibility and Usability

3.19.1 Beginner-Friendly

Canva and Balsamiq are noted for their simplicity, making them accessible for beginners or non-designers.

3.19.2 Advanced Features for Professionals

Tools like Axure RP, Principle, and Framer cater to advanced users needing detailed prototyping and interaction design.

3.20 Integration and Ecosystem

Many platforms, including Figma, InVision, Marvel, and Proto.io, offer extensive plugins and integrations with other design and productivity tools, enhancing workflow efficiency.

3.21 Cost-Effectiveness and Value for Money

3.21.1 Free Tiers and Trial Periods

Platforms offering free tiers or generous trial periods provide opportunities to evaluate their utility without upfront costs.

3.21.2 Annual Savings

Opting for yearly subscriptions typically offers savings over monthly payments, making them more economical for long-term use.

In connection with this, the use of Canva can help enhance the User Interfaces of websites. Considering the nuances of the utilization of Canva in the framework of the mentioned problem, it is possible to underline that there are a large number of opportunities that can help make UI much better in terms of both quality and user experience. Here's how:

3.22 Intuitive Design Tools

Canva still operates with a simple interface that uses the drag-and-drop function. Budget parameters, thus, offering a convenient interface for persons who are new to the software and professionals in the field of graphics design. This means that there are more opportunities as well as easy testing and redesigning of products.

3.22.1 Diverse Templates

There are thousands of templates in Canva that are available for choice when it comes to UI components such as buttons, icons, or backgrounds. Such templates can easily be modified to the needs of a particular project and the look and feel is always professional.

3.22.2 Collaborative Features

Canva also brings the feature of real-time collaboration hence allowing designers, developers, and stakeholders to work simultaneously. This can enhance the speed of approvals of the design of the product and the final product is more Harmonized.

3.22.3 High-Quality Visuals

Canva offers a way of getting access to a wide variety of very high-quality images, illustrations, and graphic arts. This can be helpful when it comes to the design of interfaces since people are more drawn to an object mainly because of its outer appearance.

3.224 Customizable Elements

Users are also able to develop their icon designs, buttons, and banners which tend to be more appropriate to the brand and may be used to boost the UI.

3.22.5 Brand Kit

Brand Kit in Canva assists in brand management as you can save and apply the brand colors, logos, and typefaces. In this way, UI elements correspond in terms of the general branding concept and emphasize it if necessary.

3.22.6 Animation and Motion Graphics

Canva has simple animation and motion graphic features that can be used to design fancy UI components such as an animation for transitions, loading animation, or any other animation that can be integrated into the project.

3.22.7 Responsive Design

To top it up, Canva has the functionality of creating objects that are suitable to be used on other devices and screens thus improving the usability of the item.

3.22.8 Ease of Exporting

Users' practical capabilities and shared designs can be downloaded easily in a short time in different formats to facilitate the integration of designs into web applications or to share with web developers for application.

3.22.9 Learning Resources

Canva has a variety of tutorials and design courses that help individuals always improve their design skills and stay in touch with the latest UI trends.You can come up with a visually attractive, useful, and customer-friendly interface on Canva that will increase users' commitment and satisfaction.

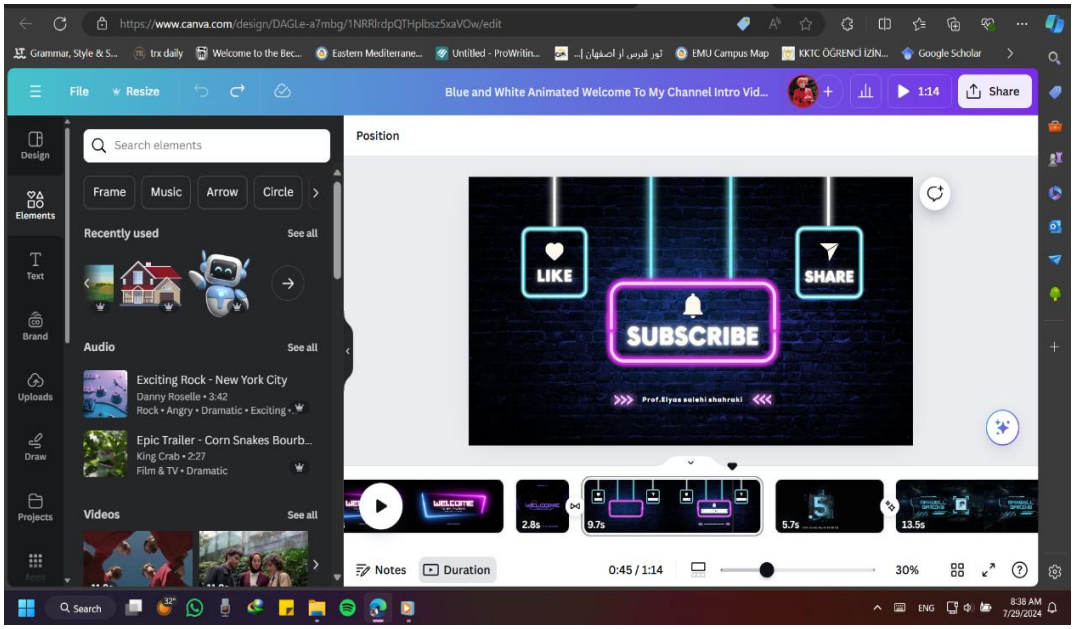

Figure 3: Canva Outro Design 1

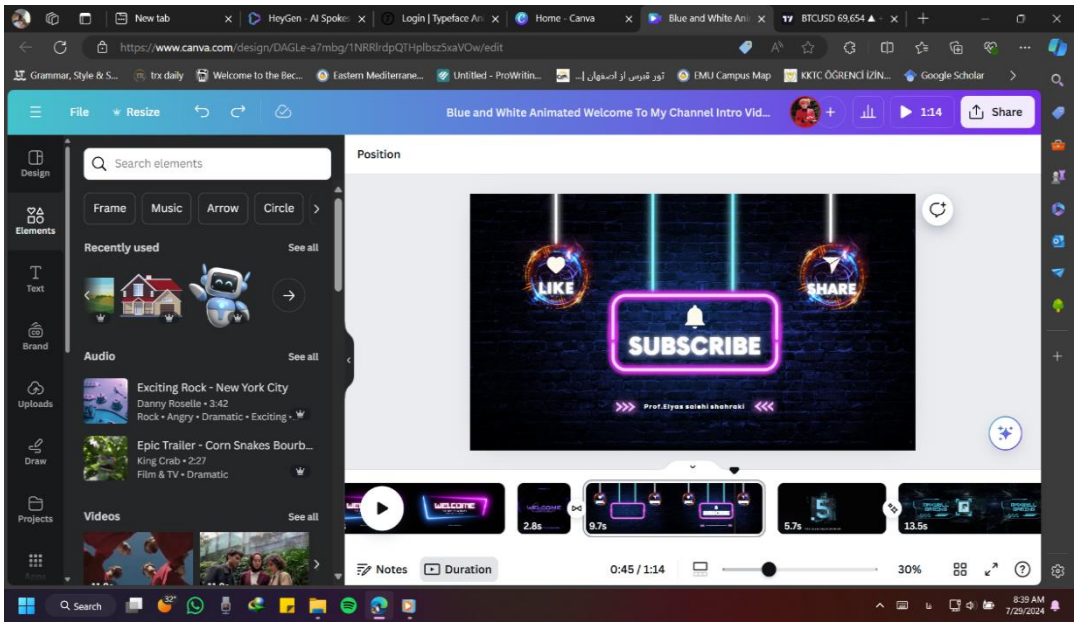

Figure 4: Canva Outro Design 2

3.23 The Heat Map

With a heatmap, you can monitor exactly how people are using your website and what they are actually clicking. It is here that the ‘hot’ part of your website – the points at

which readers are spending more time – will be shown in more red or orange shades, and areas where readers are spending less time visualized in cooler blues or greens.

Altogether they can help to supplement the usual Website indicators that Web analysts check, and, therefore, offer some extra information that can be used to identify the aspects that need refining in order to increase the conversion rates and to improve user satisfaction. Thus, heatmaps help to sort out information that may exist in large amounts, enabling it to be viewed almost immediately. Thus, they are effective for those who would like to advertise their merchandise in visual techniques.

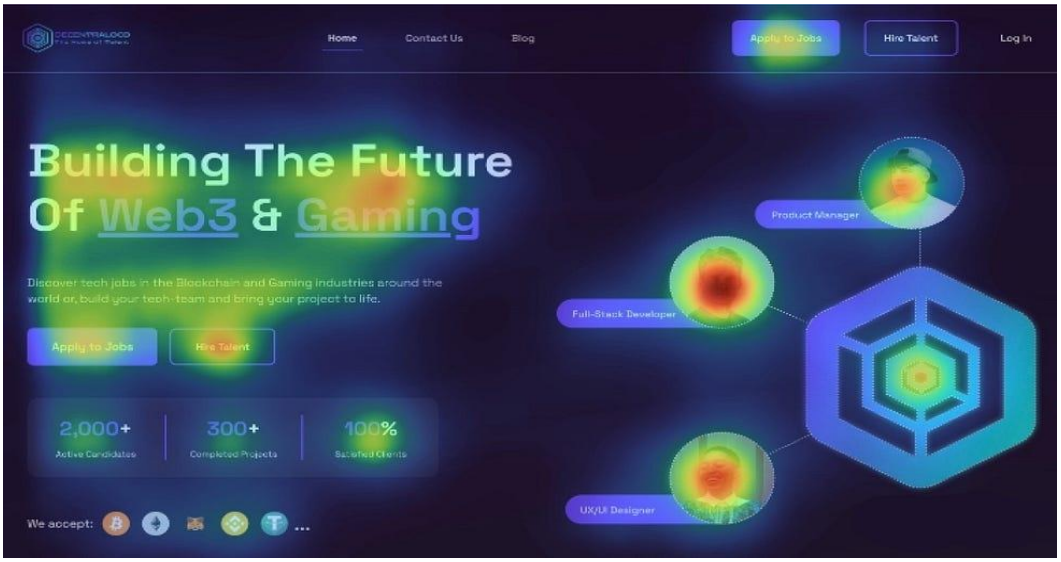

Figure 5: Sample of The Most User-Eye-Catching Areas

How Heat Maps Can Assist You with the Better Understanding of Your User Experience?

It helps you identify if users are experiencing issues based on mobile devices or if users are having a hard time finding anything on your website. The possible issues

faced by the visitor can be as follows By knowing these issues you can tweak them and give your visitors a positive user experience.

Helps you understand the perspective of your website visitors so that you can change it in such a manner to contain your most important material and discover what piques their interest.

Its ‘soundness’ can be scrutinized; your website performance can be reviewed. Heatmaps help you find whether the users are clicking more on the crucial part of your website or are moving their attention to the other parts. This data can be used to replace the given element by informing the crucial element. To help you identify the performance level of distinct KPIs, several heatmaps should be employed. For instance, while using the scroll map you can know how far the users scroll down a certain page and while using the click map, it shows you the areas that are generally clicked most by the users on your website.

3.24 Types of Heat Maps

It can reveal the actual percentage of users that have scrolled at any point in the website with scroll maps: the more red a point is – the more people have seen it.

3.24.1 Scroll Map

A scroll map is a form of heat map that indicates how fast the users are scrolling on a webpage. Using scroll maps, you can receive information about which elements of a website are sectional on, for example, a laptop, smartphone, tablet, or screen starting with the highest ranking – hot and ending with the lowest one – cold.

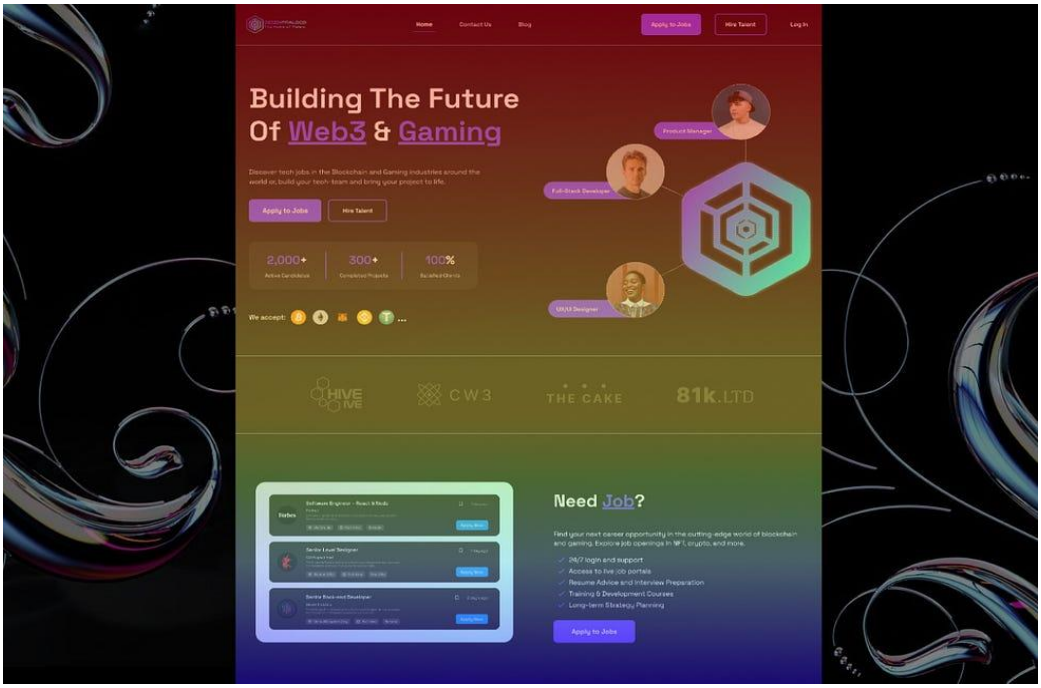

Figure 6: Scroll Heat Maps

Figure 7: Movement Heat Map (Decentraloco. xyz)

3.24.2 Movement Heatmaps

Continuing to the next topic. This one paints out for you all areas on the screen that your user has moved the mouse to; whether the click was made or not.

3.24.3 Eye Tracking Heatmap

Heatmaps are used in eye tracking and they are of two main types, which are drastically different from each other. Other common types of maps include heat map that shows the volume of focus around which there was a high fixation among the viewers. The circles around patients represent the area location and the colors represent how long time they were fixated on that particular area. For example, a fixation length heat map will provide more details on what people visually looked at and, therefore will be more useful than a fixation volume heat map to understand which material in a design is most attracting the viewer's eyes.

And finally, the crucial click data. Indeed, Google Analytics is certainly a good place to obtain the most of this information, but the website's click heatmaps make it easier to see which parts are functioning properly and which aren't. You can also obtain the precise number of clicks and their percentage of the total sample size for each location that has been clicked.

The click map can also be used to pinpoint locations that might be frustrating users, such as a text headline that they are clicking on but isn't connected to anything else. It also helps you to observe clearly if users are clicking on your most important call to action (CTA).

Website Click Heatmap (Decentraloco. xyz)In what concerns Heat Maps, the following metrics can be obtained:

Following the identification of an informational goal of a page, the next step is to find a way to measure it. Without a doubt, compared to other heatmap software providers, Mouseflow gives you more measurements.

Among our important metrics are:

Clicks: The gross number of clicks on this element and its click-through rate on the page level as well as the raw count.

Hovers: The total of users that have passed the mouse pointer over this element, expressed as a percentage and totaled raw count of page hovers for the month.

The ratio of patients who initially positioned the pointer on an item before clicking it is referred to as the hover-to-click ratio. This helps determine hesitancy because, presumably, each user who takes time to hover to show interest would click to complete.

Hover->click time: The average amount of time of user, within which he/she stays in the proximity of an element before clicking on it. This helps determine the time that a user spends to analyze an element—but only if this user follows the element and clicks on it.

Hover time: The total average of time that hoverers spend on this element at any one time. It never really matters to a researcher whether or not a specific piece is clicked on by a user; it is more important to be able to measure how long a user will take to decide on the piece.

Hover Order: The following is the order through which a typical user will search for and place the cursor on this element. This element, for example, if the hover order is 3, will take the average user between two hover elements before arriving at this element. 2. In other words, they have over-clicked this about the third of the other items they come across on the page that hovers between the underline and the text.

Hotjar: User feedback, scroll maps, click, and tap.

Hotjar Website Mouseflow: Form analytics functionality, tracking funnel, user session recording, click, scroll, attentiveness, and movement heatmaps.

Mouseflow (Website)

Dragonfly AI: Instantaneous website analysis, real-time heatmaps of attention, and user session recording.

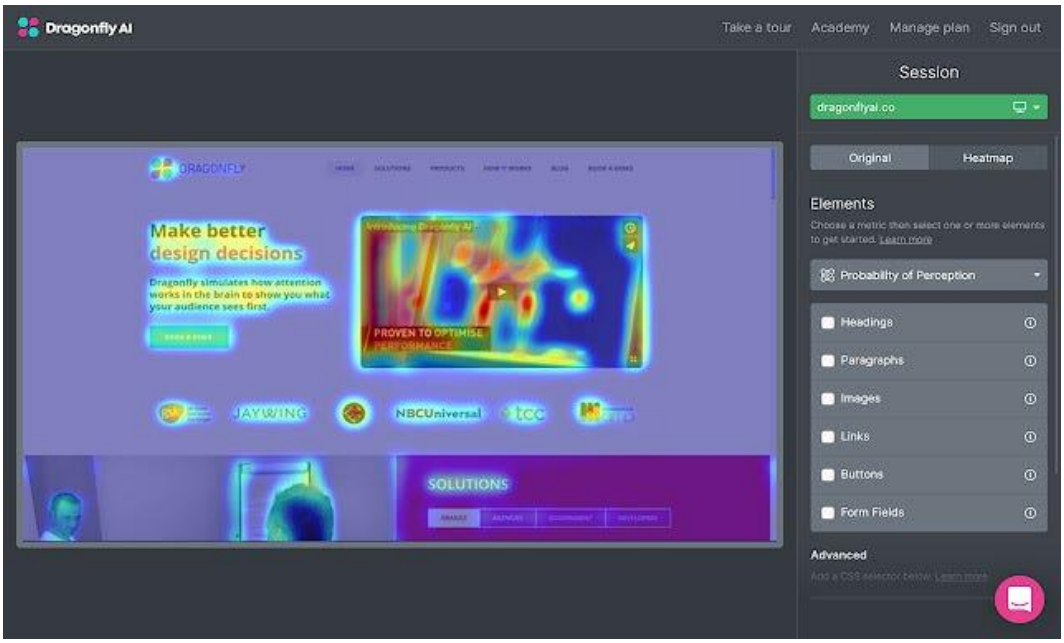

Figure 8: Dragonfly AI (Website)

Segmentation and analysis of segments, click, scroll, and other heatmap kinds.

Figure 9: Bitcurrent website

Although heat maps can provide valuable insights into user behavior, they should not be relied upon as the sole source of information for your website decisions. It's important to supplement heat map analysis with other reliable user testing methods to make well-informed and data-driven design choices.

Chapter 4

DESIGN, DEVELOPMENT, AND MEASURING UI/UX

4.1 The Purpose and Target Objectives Of Web Building

Website creation primarily aimed at improving the teaching of languages developed quite rapidly. Processes aimed at achieving desirable or target objectives such as increasing website traffic and interaction with resources contained within the site were compromised. The target audience for the website was adolescents and grownups where it was crafted in such a way that they do not just offer the available products but rather create and fair relationship with the site.

4.2 Development from Scratch

As a learning activity, there was an effort to build websites in Windows starting from scratch without any management applications. Certain websites had some constraints for example in giving embed codes or using some iframes. First, the basic pages were designed the directory page, the bio page, the useful links page, the main page, and the final project page as illustrated in figures 10 to 14.

Custom wireframes were created through specified programs, after which the embed code was uploaded to GitHub to utilize the free website for trial purposes. Some programs, however, had limitations that rendered the production of the embed codes unsuccessful, making the heatmap tests and analysis impossible. These challenges increased the complexity of comparing different application processes, discouraging best workflow practices.

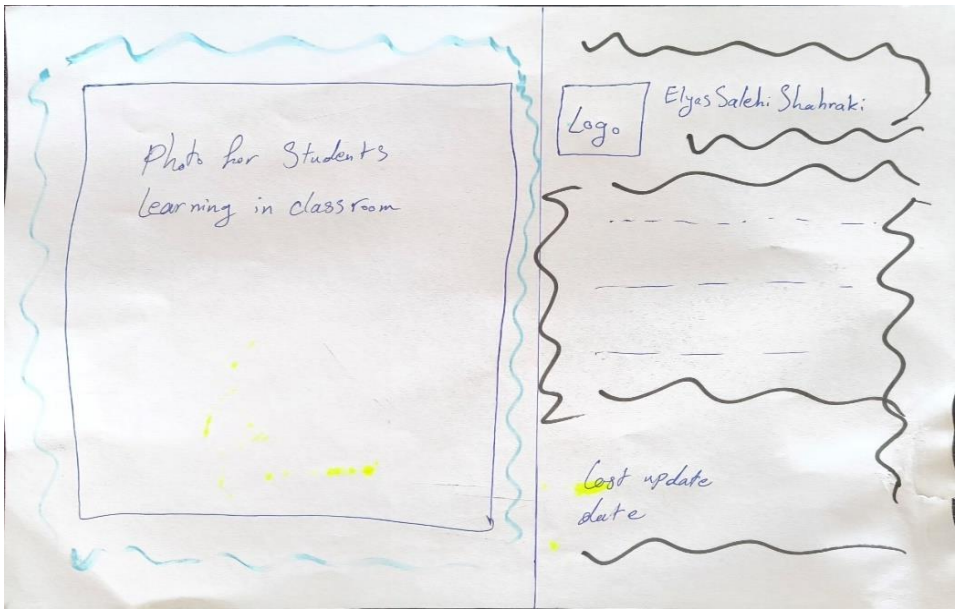

Figure 10: Hand-Drawn Wireframe Home Page

The first drawing for the home page was created independently and consists of a logo, picture, and title. The second bio page was also designed and includes biographical information about the teacher.

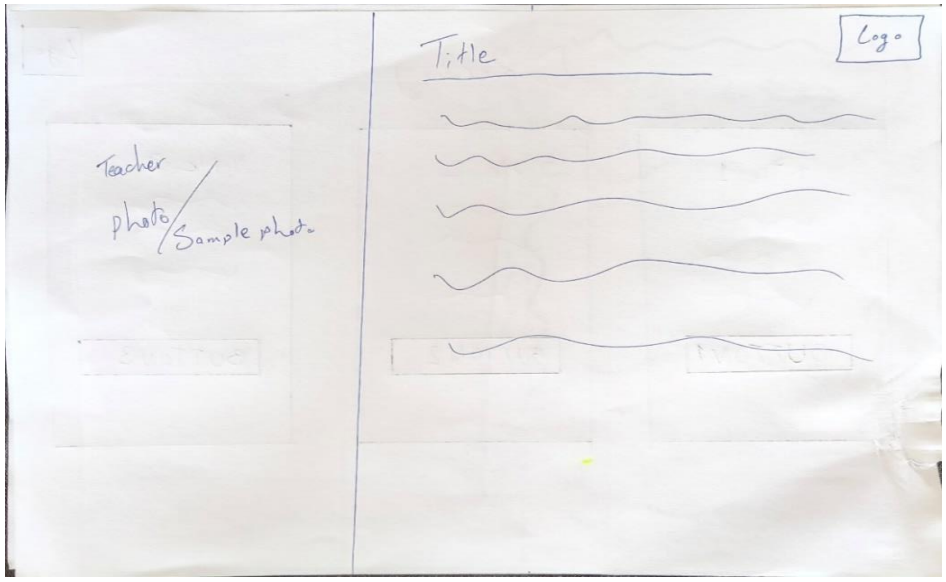

Figure 11: Hand-Drawn Wireframe Bio Page

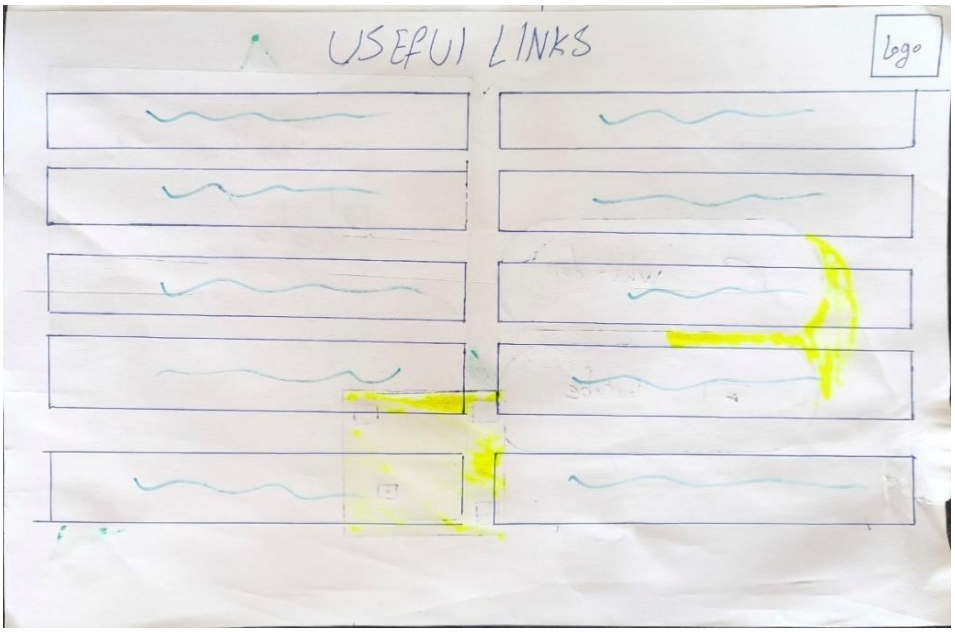

Figure 12: Hand-Drawn Wireframe Useful Links

The useful links in hand-drawing parts consist of logo and text boxes including the linked text to different parts of websites and wireframes. The Directory page consists of 3 parts and the logo and buttons link users to various pages or other sites.

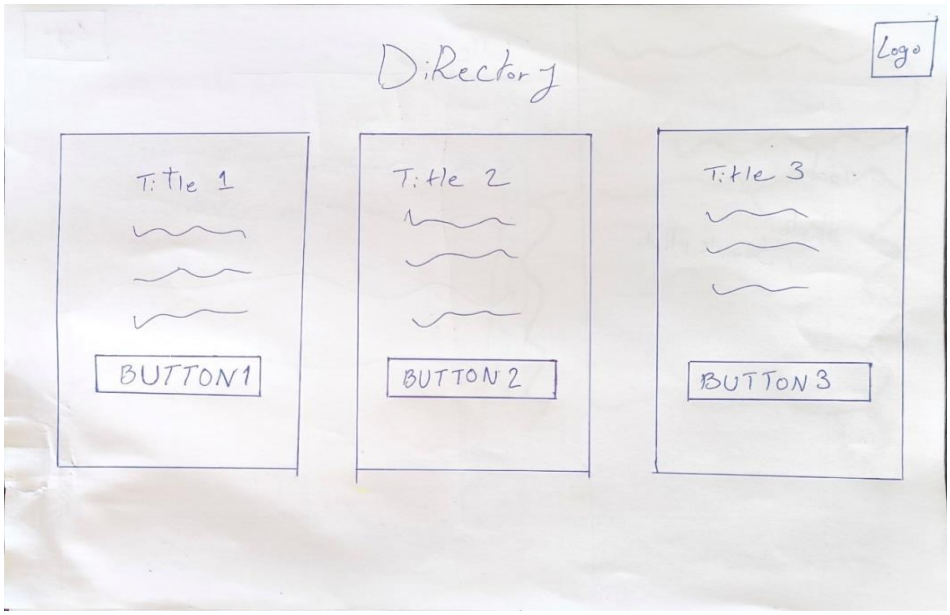

Figure 13: Hand-Drawn Wireframe Directory

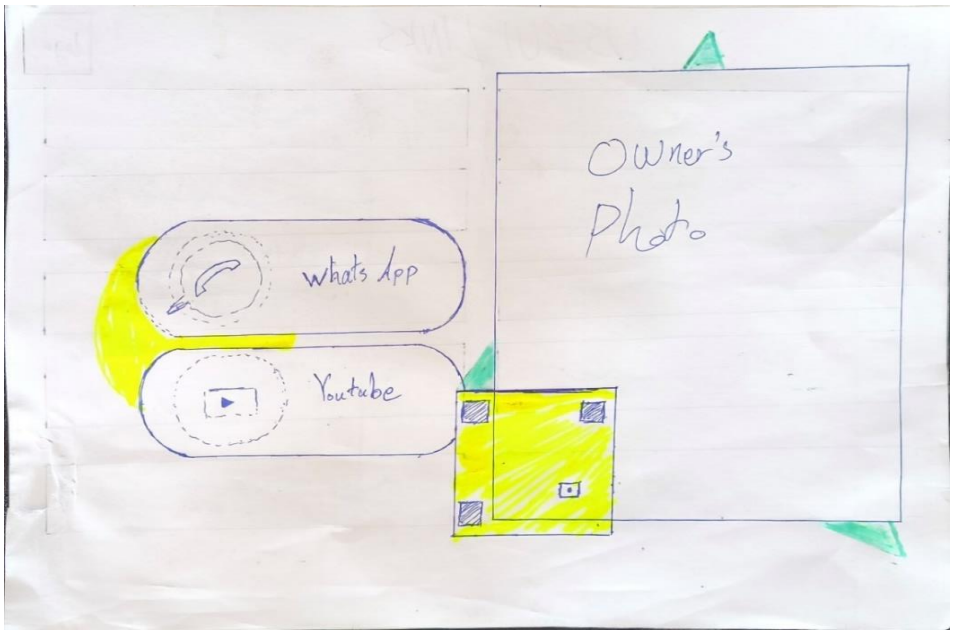

Figure 14: Hand-Drawn Wireframe Last Page

The last page is designed for users including the WhatsApp and YouTube links and has a QR code that links to https://app.qrcode-tiger.com/ and shows a bio-information of the website for ease of contacting and registrations for courses.

4.3 Developing pages in design platforms

Company websites can be constructed without too much effort mainly due to the development of design platforms that have simplified the work. With such platforms, drag-and-drop functionalities, premade sections, and many other editing functions are common. Electronic pages can be effortlessly created by simply dragging in the appropriate elements, including text and images, and defining actions for them. It also contains such functions as testing and optimization, making such activities efficient even for non-designers.

4.3.1 Canva designing

Canva is a versatile design platform that offers a user-friendly interface and a vast library of templates and elements. To create a design with Canva, you simply choose a template, customize it with your desired colors, fonts, and images, and add your content. Canva provides a wide range of design options, from social media graphics to presentations and branding materials. With its intuitive tools and extensive resources, Canva makes it easy for anyone to create professional-looking designs, even without prior design experience.

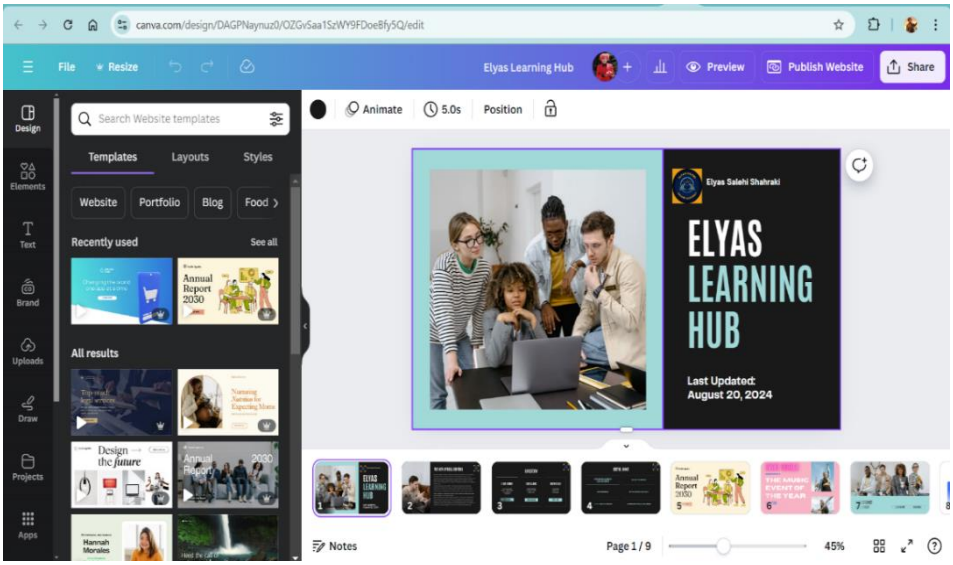

Figure 15: Canva Home Page Design

The Logo on the middle part is created in the Canva application Figure 20 and used on all platforms mentioned before in Chapter 7 the other parts of the design were designed based on the hand drawing pictures and the colors were picked as a sample. In this design, I used the Canva stock images that were provided on the site, and the other parts have been designed like the templates.

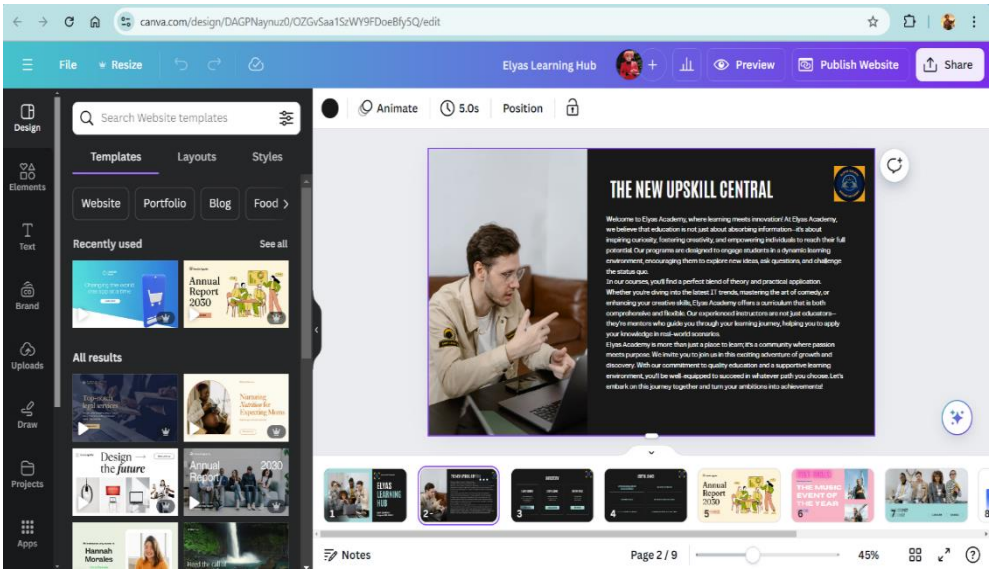

Figure 16: Canva Bio Page Design

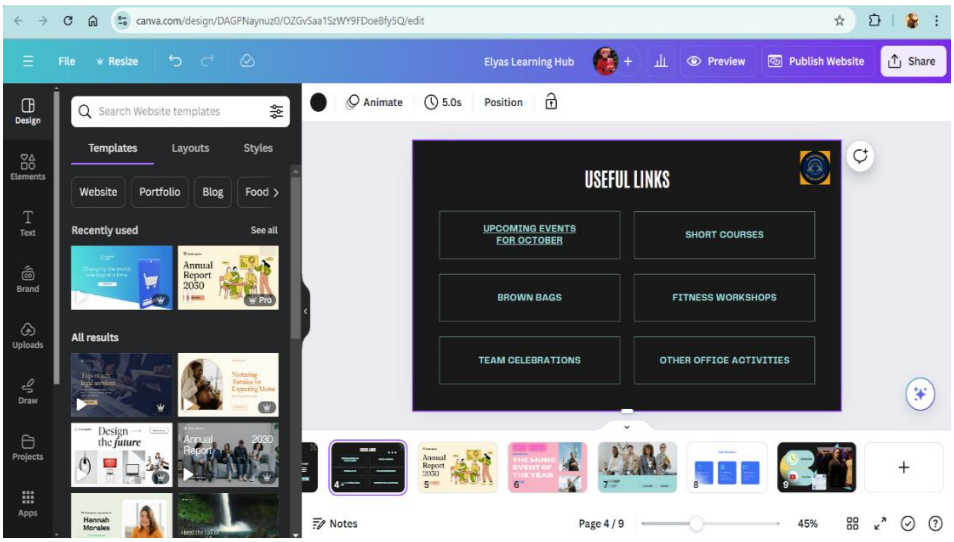

Figure 17: Canva Useful Page Design

For useful and directory pages I used the same color Plat and the design was based on the hand drawing wireframes including the same logo and related information to guide the user to crucial parts of the website in Figures 17 and 18.

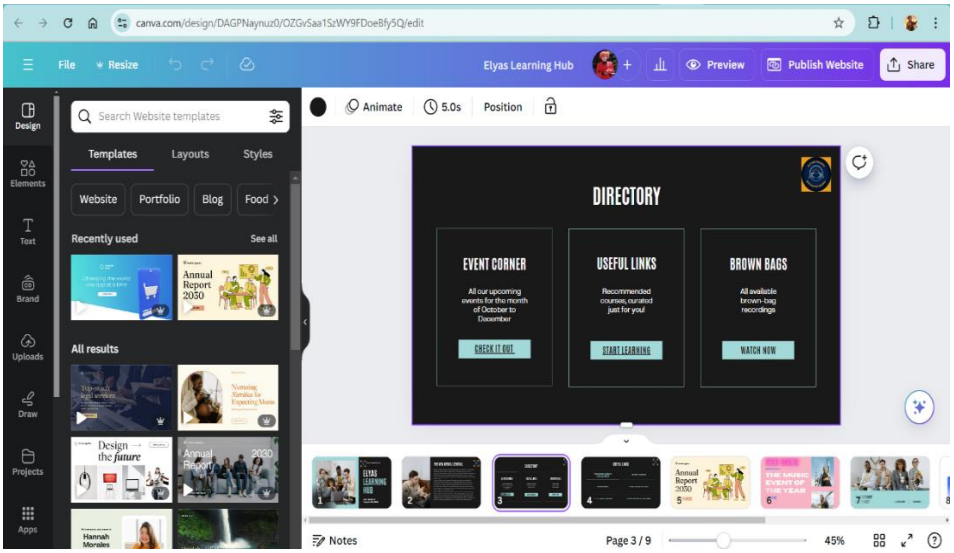

Figure 18: Canva Directory Page Design

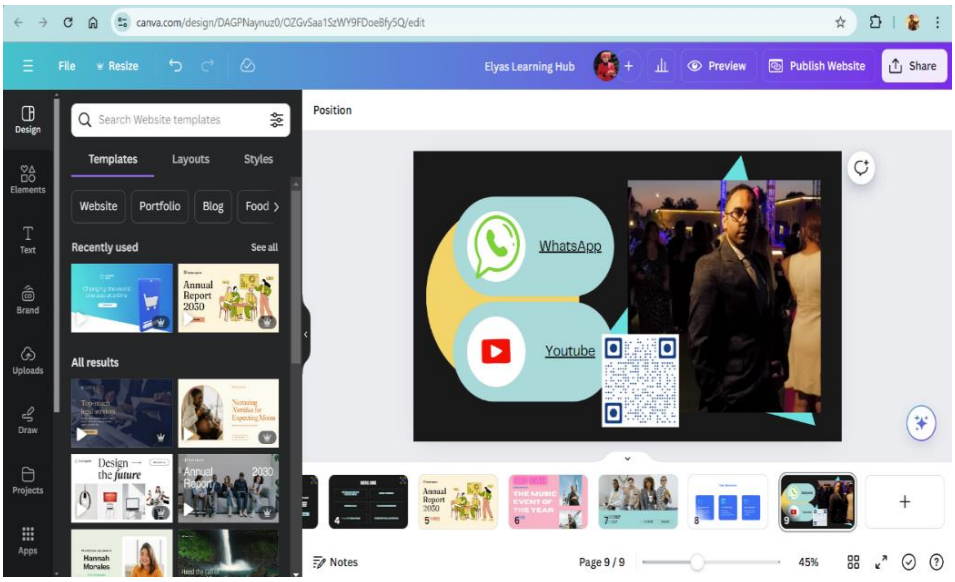

Figure 19:: Canva Last Page Design

Figure 19 illustrates the last design of the website and includes the 2 links to social media and a QR code with a big picture and basic shapes on the background to create contrasts and attention to the links and areas.

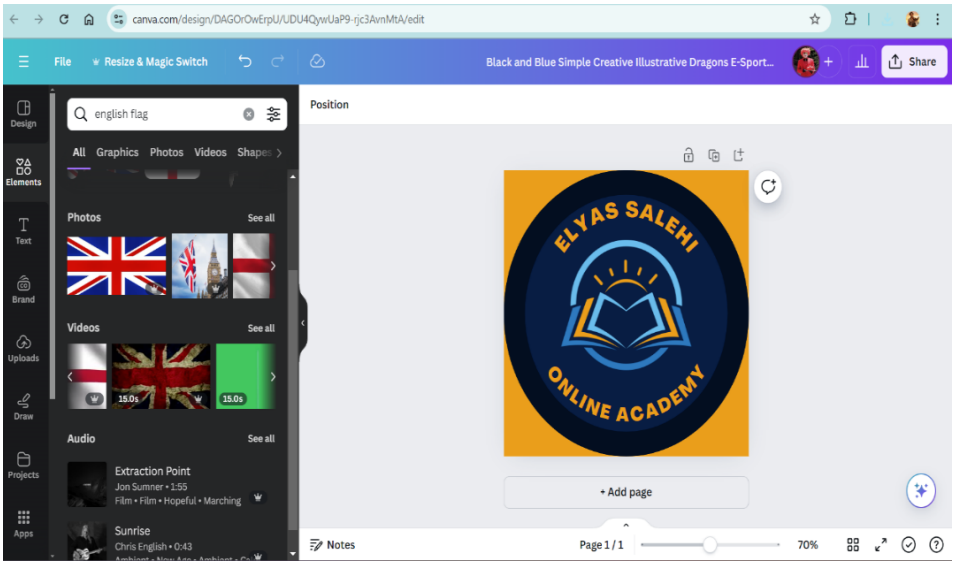

Figure 20: Canva Logo Design

4.3.2 Adobe XD Designing

Using Adobe XD a powerful design tool that allows to make stunning user interfaces for websites, mobile apps, and other digital products. The same design has been created and implemented in Figure 21.

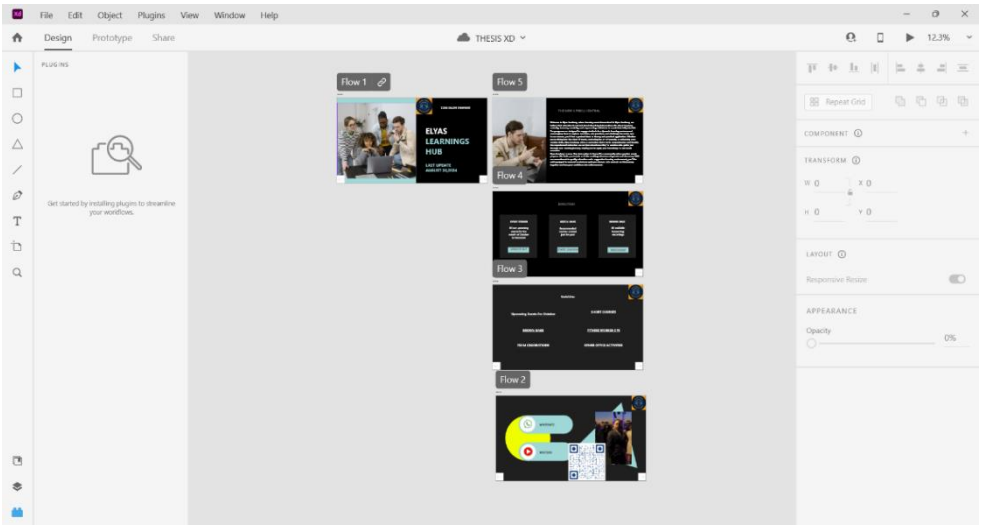

Figure 21: Adobe Xd Platform And Design

With its intuitive drag-and-drop interface and rich feature set, Adobe XD offers a wide range of features, including vector drawing tools, component libraries, and interactive prototyping capabilities. Whether you're a professional designer or just starting out, Adobe XD can help you bring your ideas to life.

4.3.3 proto.io

With a Cloud-based prototyping platform that enables designers to create interactive prototypes for websites, mobile apps, and other digital products. With its intuitive drag-and-drop interface and extensive library of components, we can quickly and

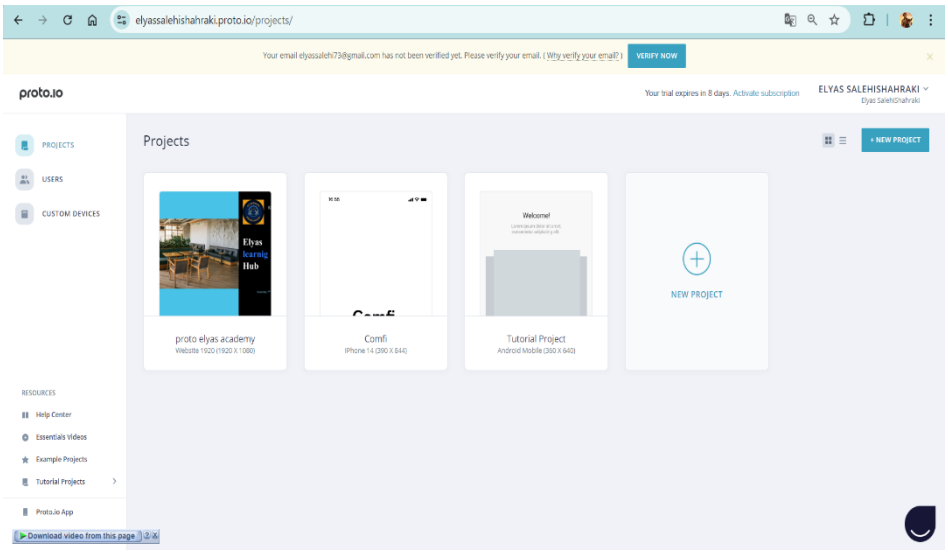

Figure 22: Proto.Io Platform And Design

Easily build prototypes that simulate the user experience. Proto.io offers features such as real-time collaboration, version control, and integration with other design tools, making it a valuable asset for teams working on complex projects. Figures 22 and 23 illustrate the design of the proto.io website and use the same method for designing with this platform.

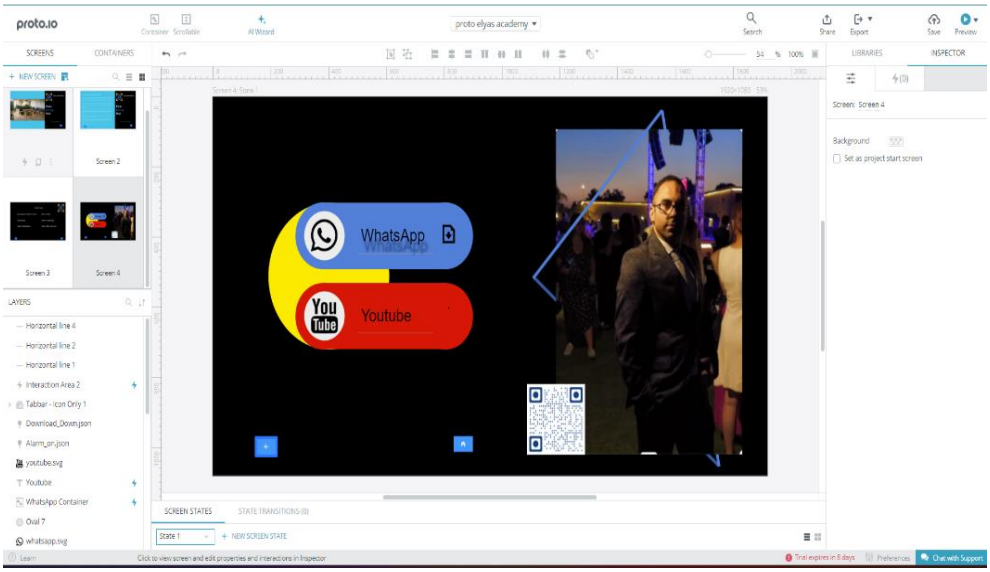

Figure 23: Proto.Io Platform And Design 2

4.4 Measuring the UX with Heat Maps

We used mouse-flow, hotjar, and the self-application to gather data and compare them for the usage of users and see which platforms they using how much time they engage with applications how much time it takes to render the page and bounce rate the percentage of sessions where users viewed only one page.

4.4.1 Testing the Canva Design with Mouseflow

After the design was completed, the embed code was obtained from the Canva export section and inserted into the HTML code within the GitHub repository. The mouse flow tracking code was then added to the head of the HTML code to enable user interaction tracking on the site.

In Figure 24, the interaction, location, duration, and devices were measured by the Mouseflow website, showing that 92 percent of users accessed the website via phone, while 8 percent used desktop devices.

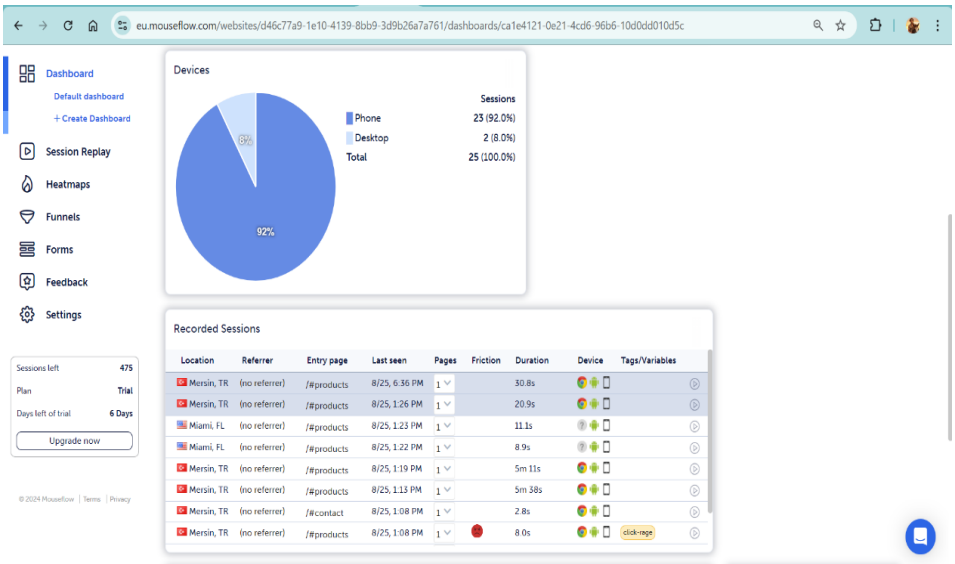

Figure 24: Mouse Flow Interaction Of The Users

Some websites were found to be too expensive for this research, necessitating the use of only trial and free versions to achieve the intended goals.

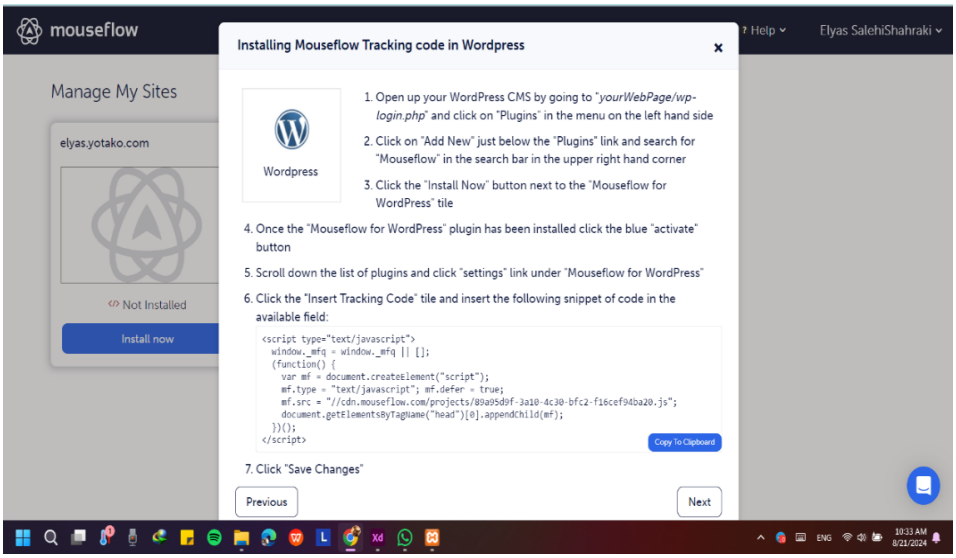

Figure 27: Mouse Flow Tracking Code For WordPress

The behavior of the user and their actions on the website are dependent on the quality and quantity of the website provided. Visibility and ease of using the platform are measured by Mouseflow and Hotjar.

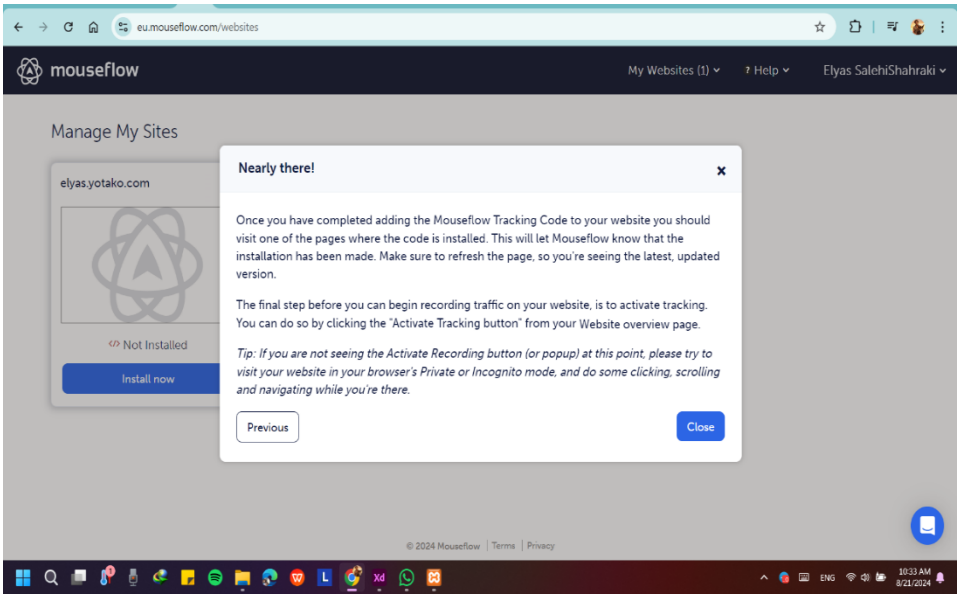

Figure 28: Step-By-Step Mouse Flow Guide

Figure 28 mouse-flow explains how to add tracking code to your website and begin recording traffic on the website. Also, Hotjar has the same method and uses a unique tracking code to add the head of the HTML site illustrated in Figure 29.

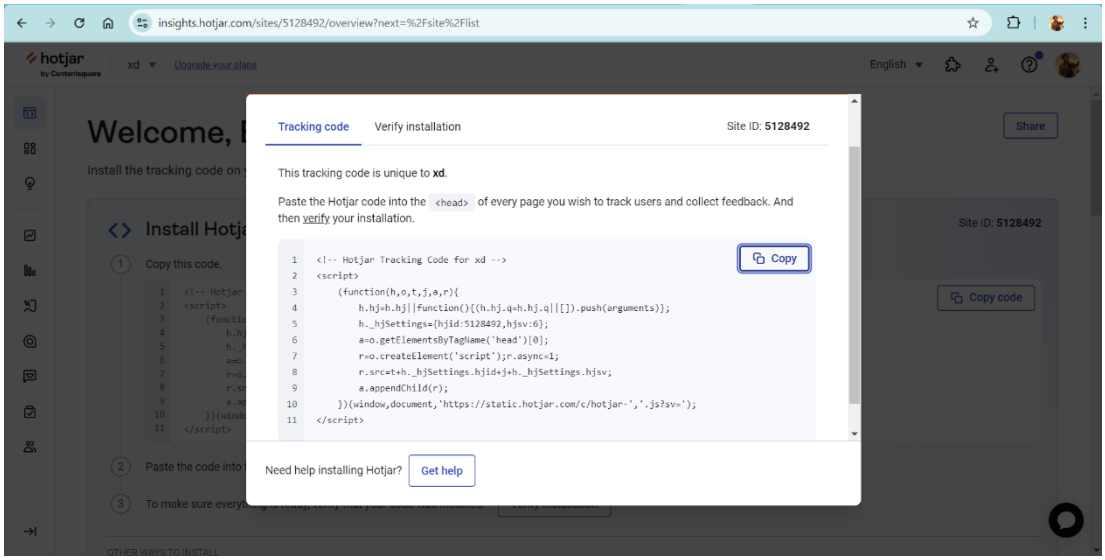

Figure 29: Step By Step Hotjar Guide

After 24 hours the website shows the users from around the world like Figure 30 and the device they use to connect to the specified site we have used and on the left menu bar we can watch the session replay of each user separately or heatmaps of them.

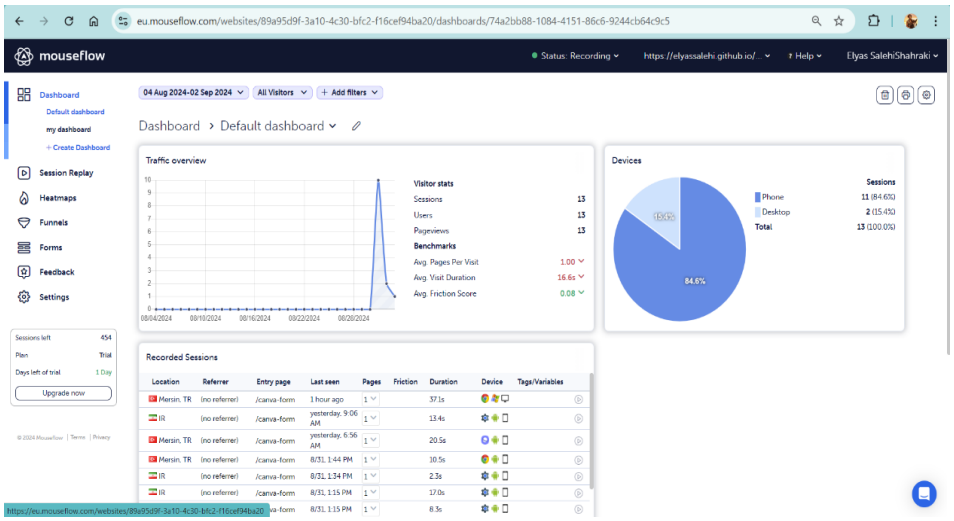

Figure 30: Mouseflow Geo Heatmap For Xd Design

The most popular user countries are displayed in the Geo heatmap section Figure 31 And the top countries are Turkey 72.7%, Iran 21.2 % and the United States 6.15%.

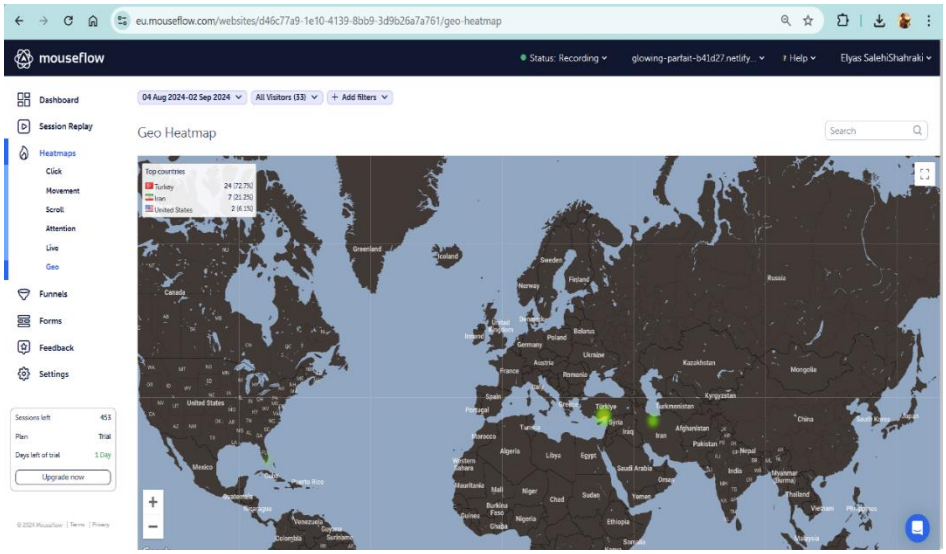

Figure 31: Mouseflow Geo Heatmap

The website also creates click heatmaps for us related to Figure 32 and we can see buttons have clicked 19,16,16,13 from left to right.

4.4.2 Testing the XD Design with Mouseflow

After the design was completed, the embed code was obtained from the Adobe XD and export section and inserted into the HTML code within the GitHub repository. The mouse flow tracking code was then added to the head of the HTML code to enable user interaction tracking on the site for the other platform Hotjar same way used and all the tracking codes were added in the header of the HTML of the website in GitHub for testing.

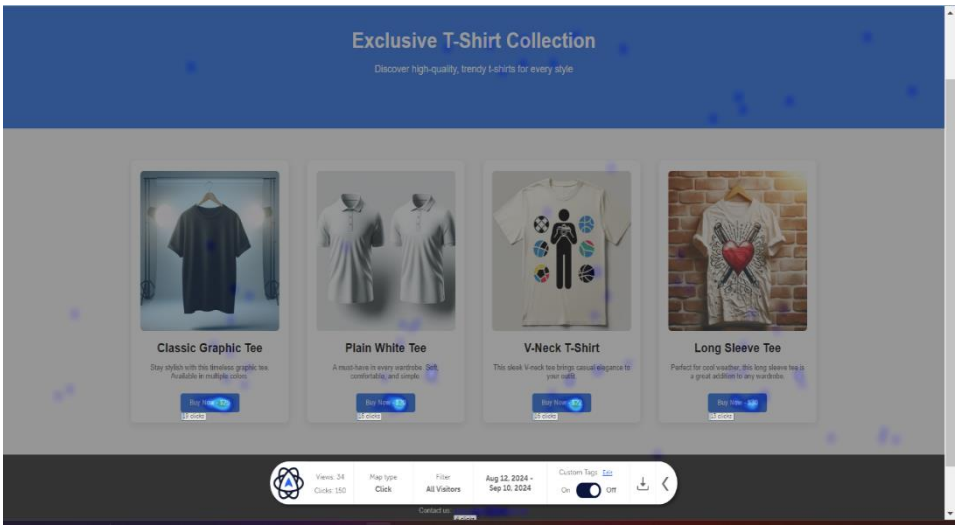

Figure 32: Mouseflow Click Heatmap For Xd Design

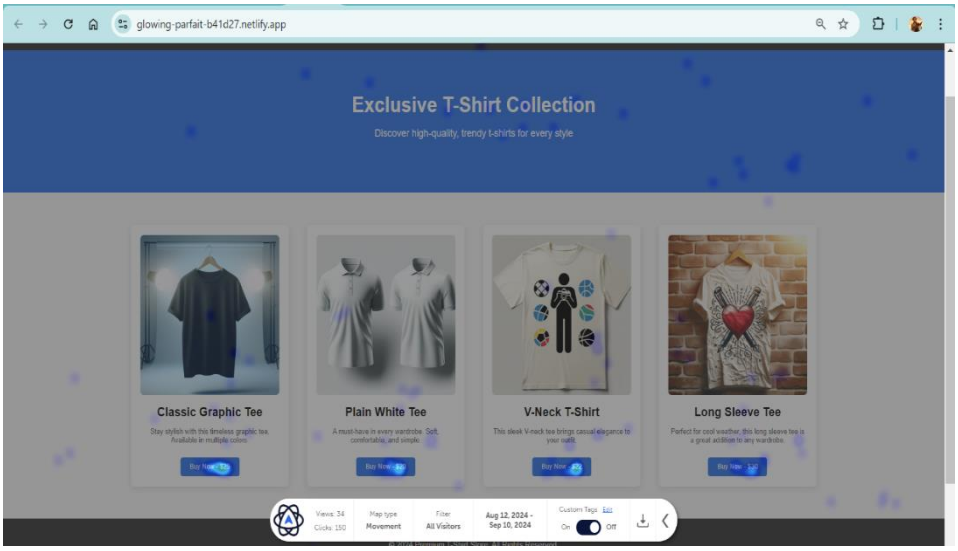

Figure 33: Mouseflow Geo Heatmap For Xd Design

Figure 33 illustrates the movement of all visitors from 12 Aug until 10 Sep 2024 and the website has 34 views and 150 clicks the blue areas are the most touching area and it seems the user clicked the bottom right side of the button more.

Figure 34: The Heat Maps Of The Mouse-Flow For Canva

The website shows the percentage of average time users spend on the page and user engagement the red areas are seen more by users than the blue areas. It also mentions that the page has been viewed by 10%, the average time is 3.2 s and the engagement is 1.6 seconds.

Figure 35: The Scroll Heat Maps Of The First Page Canva

In Figure 35 the most attention is to the point of the upper level of the picture and the lowest is at the bottom of the picture with 19% of views and 3.7 seconds average time spent on the page and the average engagement is 1.9 seconds which is more than figure 34 all the links for heatmaps are available in the Pdf version in reference section.

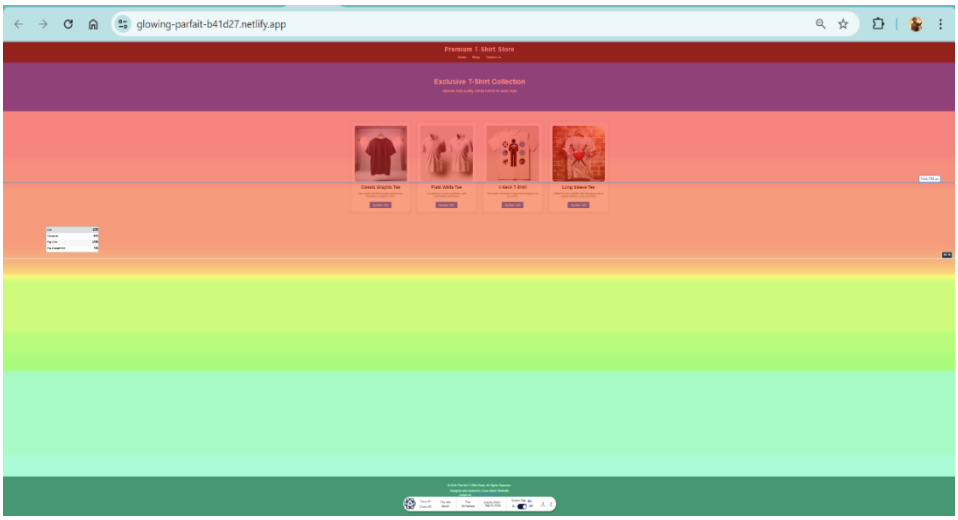

Figure 36: Scroll The Heat Map Of The Market Page In Mouse-Flow

In Figure 36 we have the attention section which is very interesting and shows the engagement part of the market and the product's picture hereو shirts are in the center of attention and the rest of the website is naturally working out of attention.

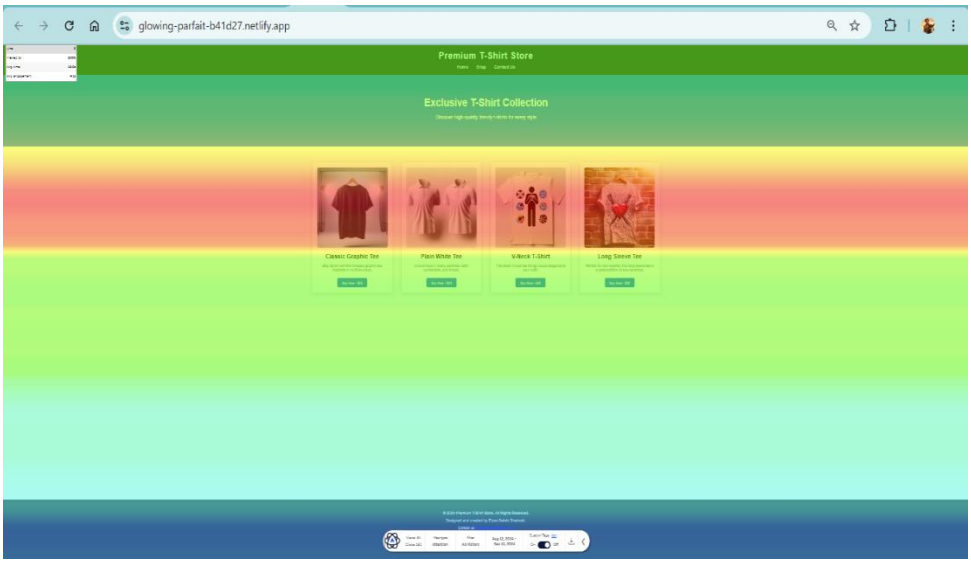

Figure 37: Attention Mouseflow Heatmap For Market Page

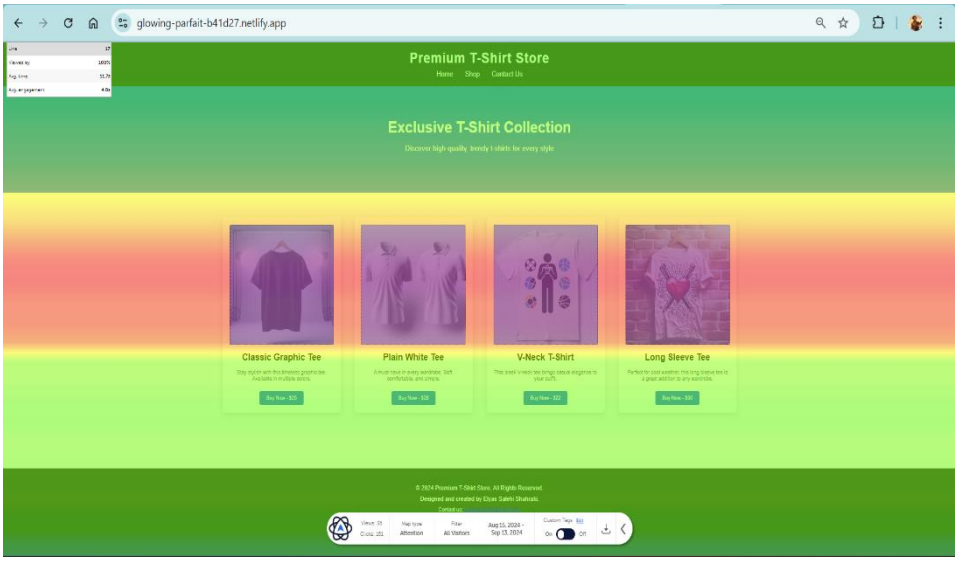

Figure 38: Attention Mouseflow Heatmap For Market Page With Tags On

Figure 38 specifies tags that may be switched on or off to provide additional data for customers and company owners. The tags are colored purple. The summary page displays all of the historical data for all of the situations that occurred within the last day or earlier.

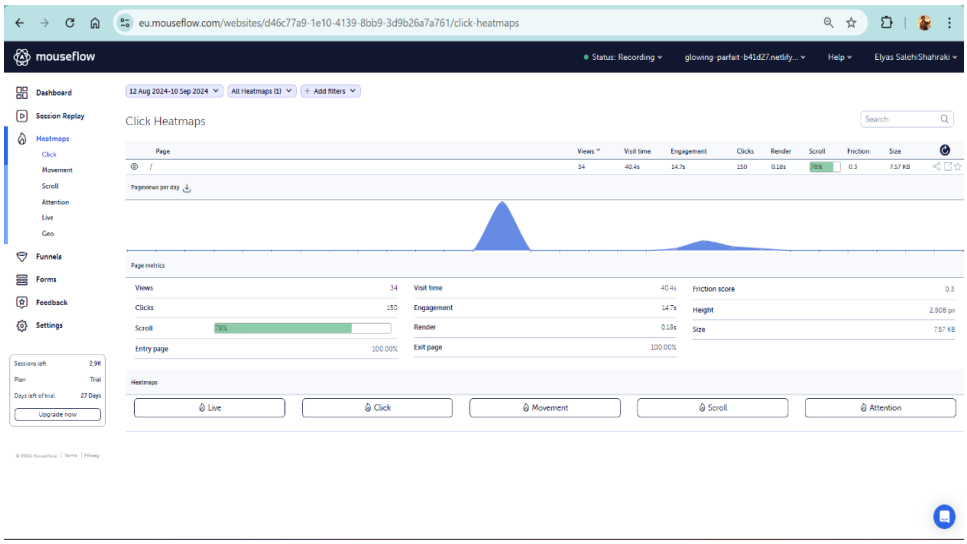

Figure 39: Mouseflow Summary For Market Page Design

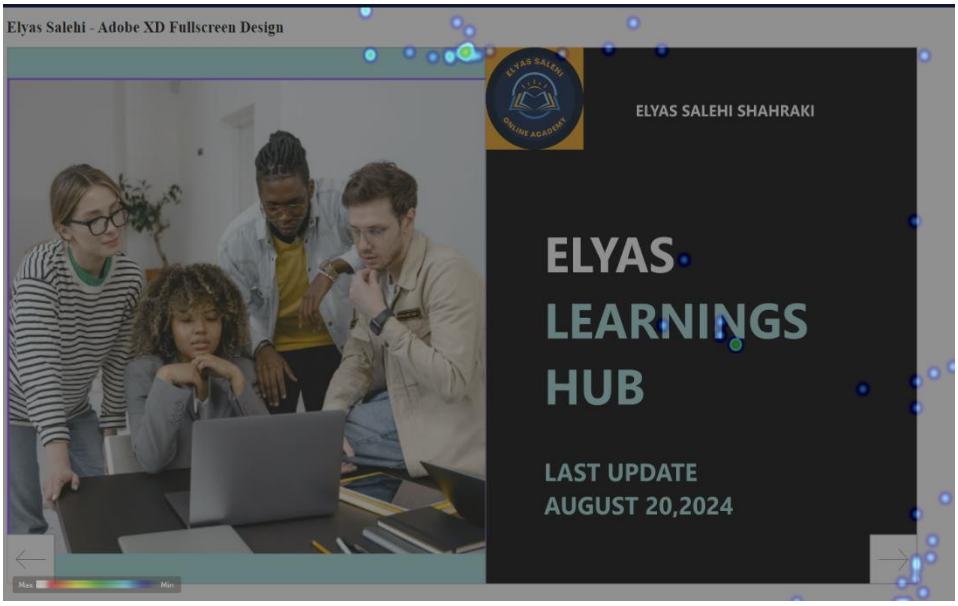

Figure 40: Mouseflow click Heatmap For Xd Design

Figure 39 shows a summary of the market page and The Xd design shown in Figure 40 has some interactions on the right bottom on the white arrow and some on the title for linking to the related pages, figure 40.[45]

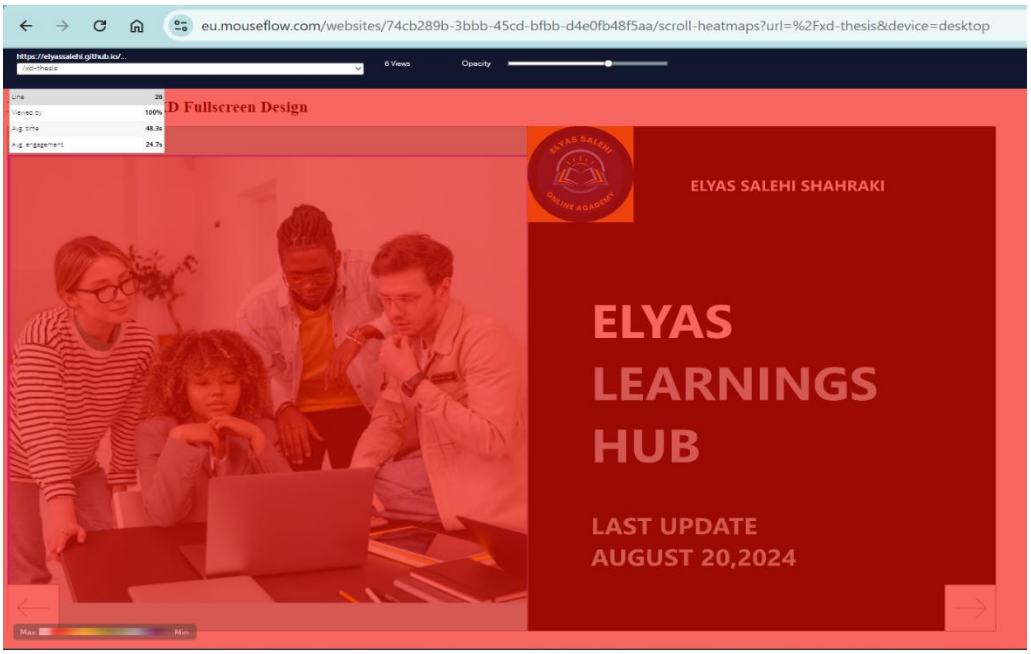

Figure 41: Mouseflow Movement Heatmap For Xd Design

Figure 40 Has a red heatmap that indicates more attention to the page and the whole page with 100% view and great engagement.[45]

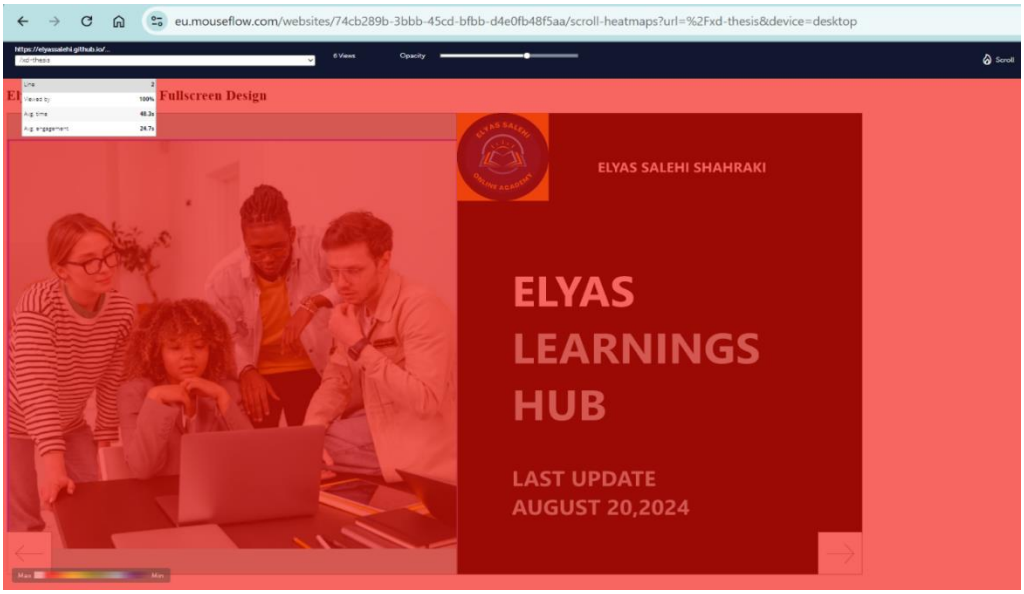

Figure 42: Mouseflow Attention Heatmap For Xd Design

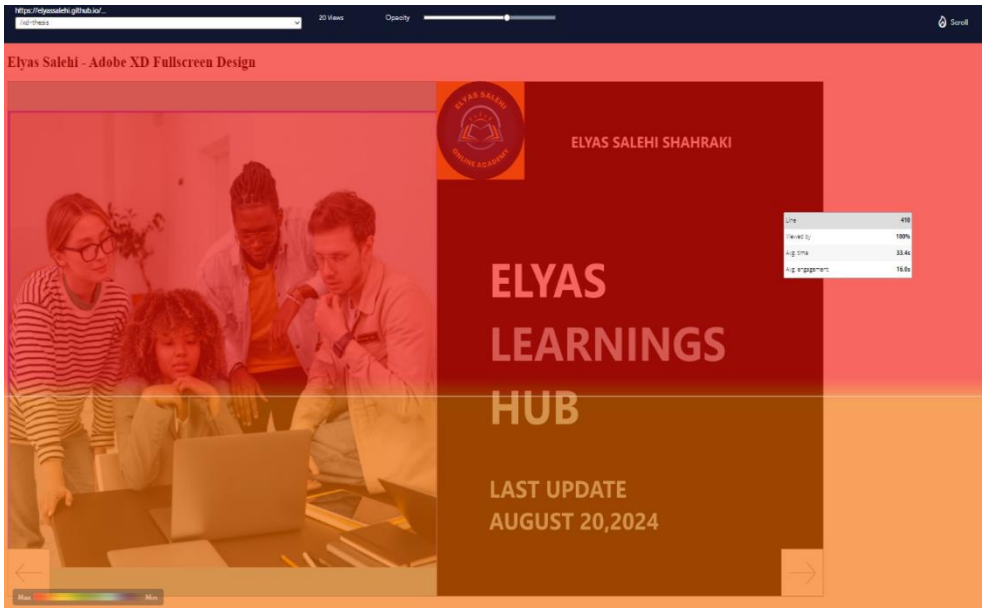

Figure 43: Mouseflow Heatmap For Xd Design

Figure 43 illustrates the Adobe Xd Heat maps across mouse flow and the difference between the 2 areas is clear the upper side of the page has more attention by 33.4 seconds engagement on average time.

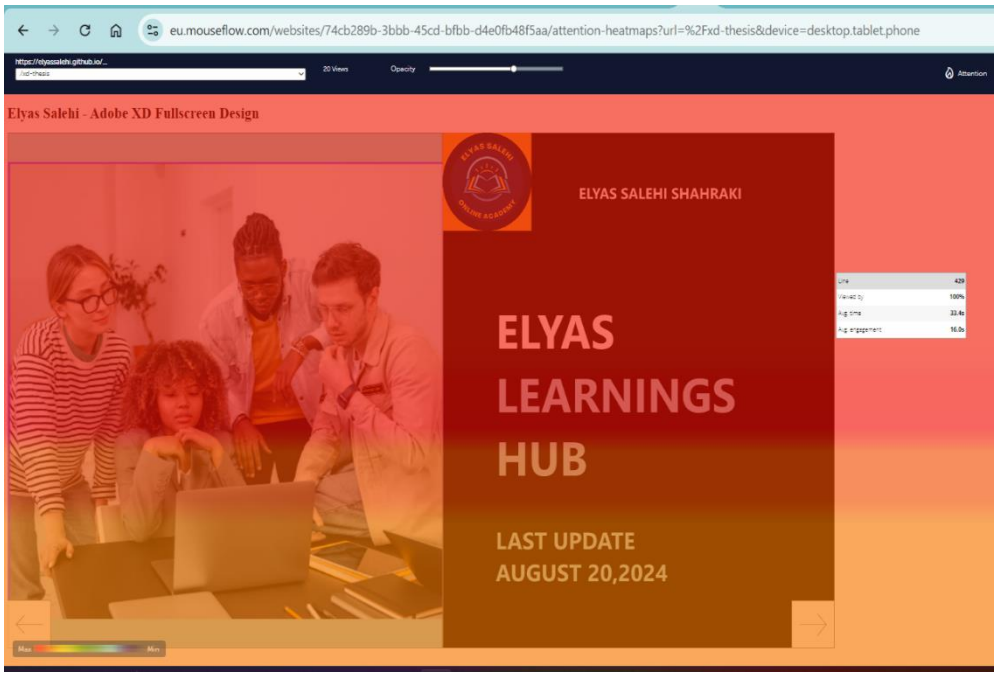

Figure 44: Mouseflow Heatmap For Xd Design

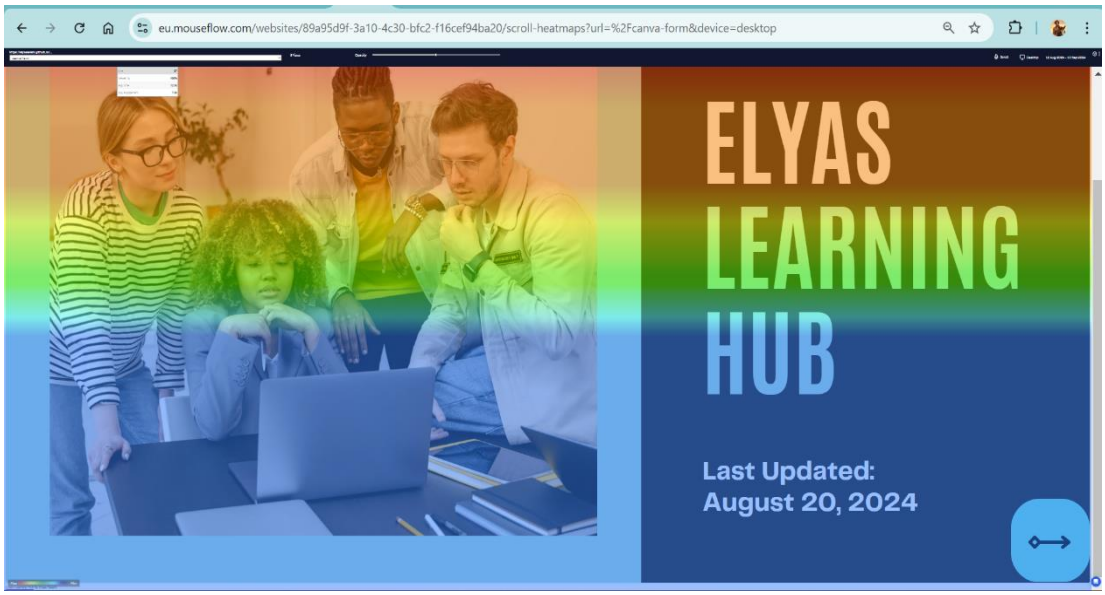

Figure 45: Mouseflow Heatmap For proto.io

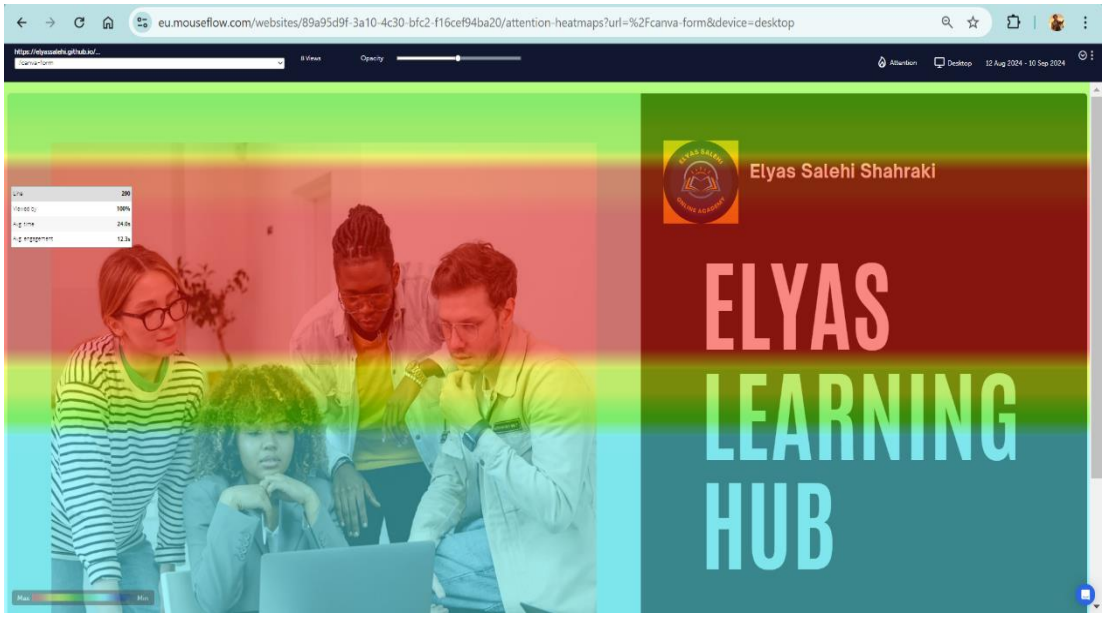

Figure 46: Mouseflow Heatmap For Canva Design

All the related figures have the same results almost all of them have more concentration emphasising the pictures and links with more attention and engagement.

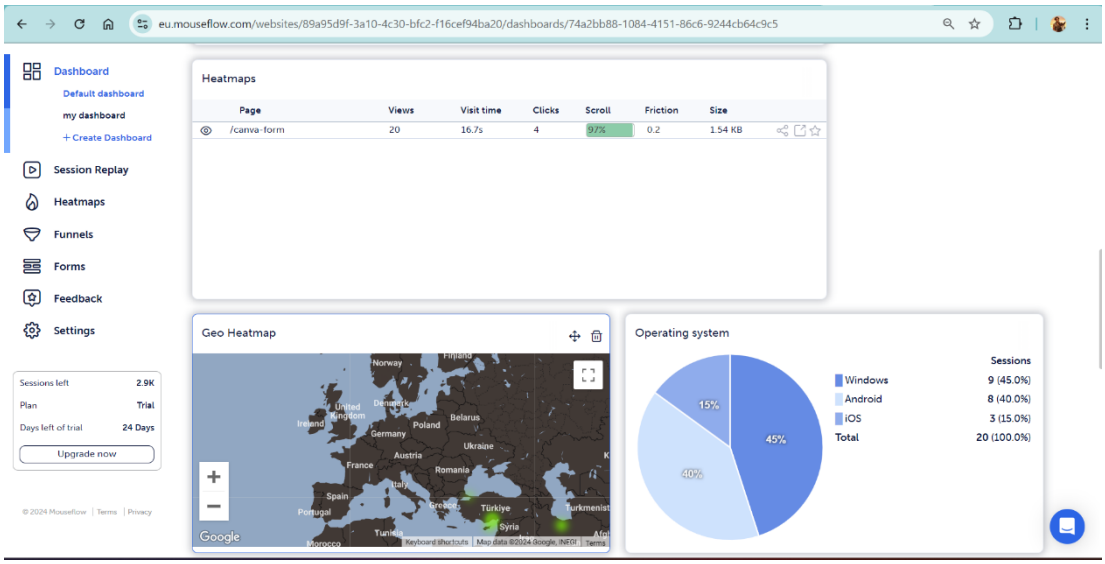

Figure 47: Mouseflow basic Summary Home Page For Canva Design

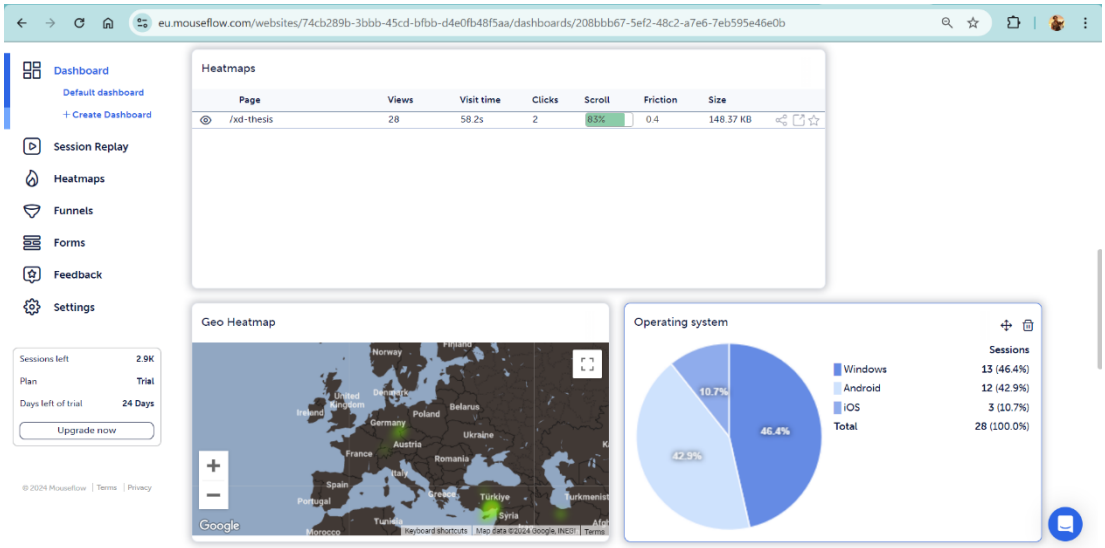

Figure 48: Mouseflow basic Summary Home Page For XD Design

In Figure 47, 48 we have available report areas to create more related data analysis according to the tracked websites here only we have the geo heat maps and operation systems that can be expanded to show the browser of the user traffic source screen resolution country and page in and page out data.

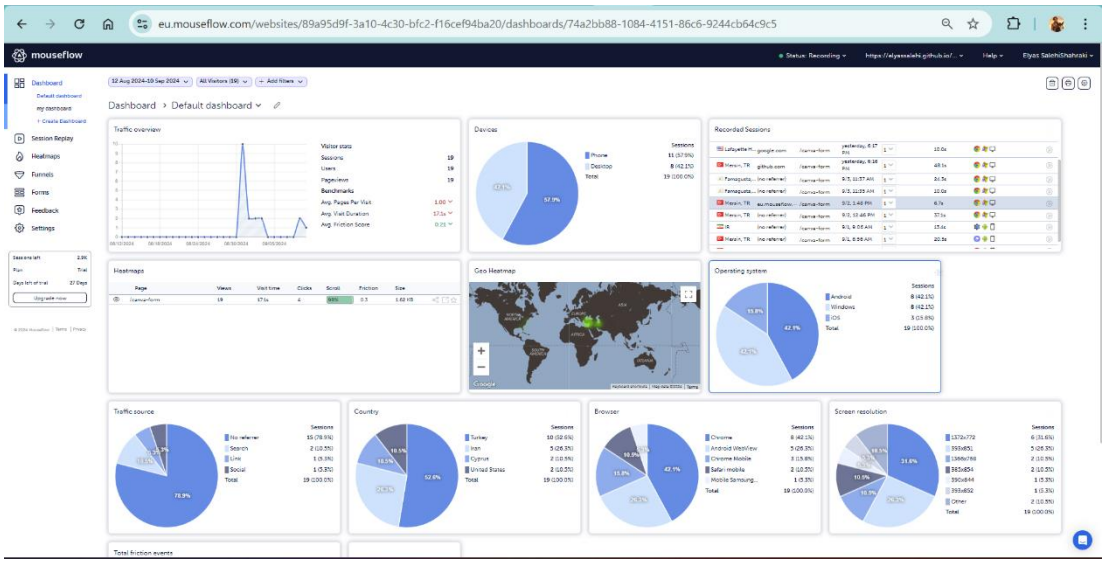

Figure 49: Mouseflow Summary Home Page For XD Design

In Figure 49 we can see the desired reports generated by the website including the operation systems consisting of 45% Windows 40% Android and 15% Ios users in traffic sources, 75% come from social links 15 % come from search engines and 5 % come from direct links.

Users are 50% from Turkey 25% from Iran 15 % from the United States and 10% from Cyprus. Also, Screen resolutions vary from 1372*772 by 30% of users to 1366*768 by 15% and 393*851 by 25% of users among the most.

However, the Friction events show The session has 80/20 % which indicates the number of times users encounter obstacles or difficulties while interacting with a website or application. These events can range from simple errors or confusing elements to major roadblocks that prevent users from completing their tasks.

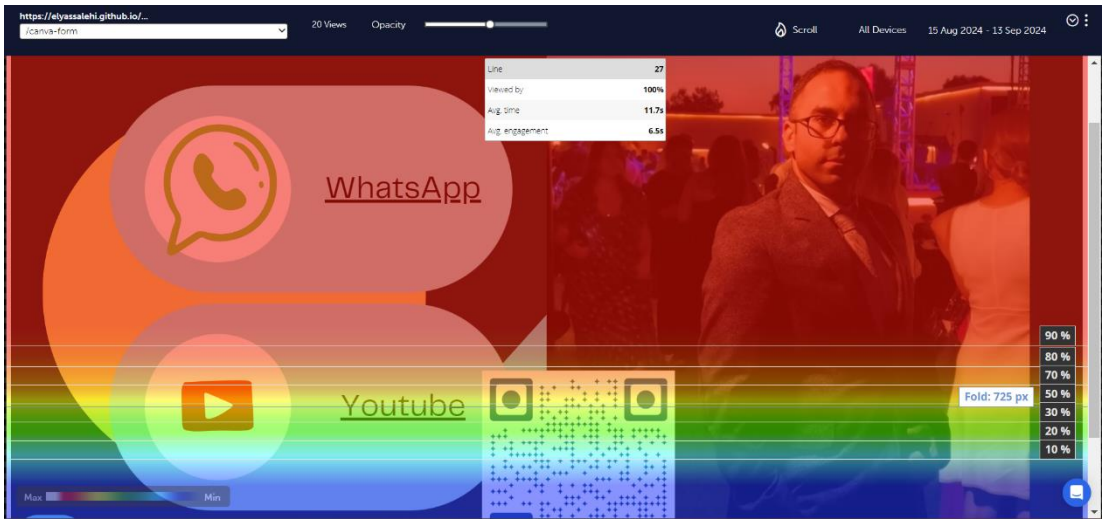

Figure 50: The Last Page Of Heat Maps

This page is at the end of the website for advertising and getting the attention of clients to contact with a QR code watch YouTube videos through the link or send Direct messages via the WhatsApp link.

Table 5 compares user behavior collected by mouse flow and hotjar for 3 applications of Canva, Adobe Xd, and Proto.io, the views are the Number of times a page/design is viewed, height is measured by pixel, and total size as KB. Proto.io designs tend to be larger (size) but have a higher scroll percentage and lower visit time, suggesting users might be quickly finding what they need (higher scroll) despite a slower loading time (larger size).

Engagement Variations: There are some discrepancies between Mouseflow and Hotjar data, particularly in "engagement" and potentially "render." This could be due to differences in how each tool calculates these metrics.

Table 5: Comparison Table of measured platforms

	views	height	size	scroll	visit time SEC	engagement	render
mouse flow canva	20	793PX	1.54 KB	97%	16.7	9	1.64
mouse flow XD	28	1576px	148 KB	83%	58.2	21.3	3.04
mouse flow PROTO.IO	35	1614	7.57 KB	83%	15.2	12.3	5.27
hotjar CANVA	11	793	1.54	27.30%	17.4	10.3	1.75
hotjar XD	30	1576	148	33.30%	59.5	22.7	3.22
hotjar PROTO.IO	12	1614	7.57	83%	14.5	11.1	6.13

Chapter 5

CONCLUSION

Constantly, this thesis describes the methodology for evaluating user interface (UI) and Ui/UX design on recommender systems. The goal was to achieve satisfactory engagement, and the results showed that 80% of web surfers continued to use the offered products after they left the site.

As a result, this thesis describes the methodology for evaluating user interface (UI) and UX design on recommender systems. The goal was to achieve satisfactory engagement, and the results showed that 80% of web surfers continued to use the offered products after they left the site.

In addition to the research, recent discoveries have been made, such as geo-heatmaps that show the nation having the most influence on a website. These results may be vital for marketers and website owners to prepare for the relevant client in advance. The study produced a smooth design and verification process before extensive programming and website deployment, which will make the process of creating websites easier for designer-only users.

Find in shaping the effectiveness and user interaction with recommendation systems. A well-designed interface not only improves the user experience but also ensures a smoother interaction with the underlying recommendation algorithms. Expertise in IT and project tracking tools like Mouseflow and Hotjar have shown how user interface

improvements can create meaningful interactions and increase user satisfaction. Furthermore, the balance between an intuitive user interface and a robust recommendation system can significantly contribute to better decision-making and ensure that users find value and relevance in the recommendations provided.

This study provides a comprehensive comparison of various UI/UX design platforms, evaluating their system requirements, pricing, features, and usability. It serves as a guide to help users select the most suitable tools based on their specific design needs, technical setup, and budget considerations.

For the Future part, it's suggested a need to investigate the evolution of personalization in interfaces and how it can blend into different users' behavior without making recommendation systems ineffective. Including AI into UI: This involves assessing the level of integration of artificial intelligence (AI) into the UI as it gives room for changing the UI following how users interact with it.

Consistency Across Multiple Platforms: Maintaining the UI on various devices and platforms without compromising user experience or the functionality of the recommendation system Rehabilitation in UI Design: More needs to be done regarding the UI design so that users with disabilities are taken care of, if the recommendation system is to be usable by all users.

Better Data Representation in UI: Users of the recommendation systems should be able to interact with the system more intuitively and feedback from the system should be presented more effectively to facilitate Button interactions.

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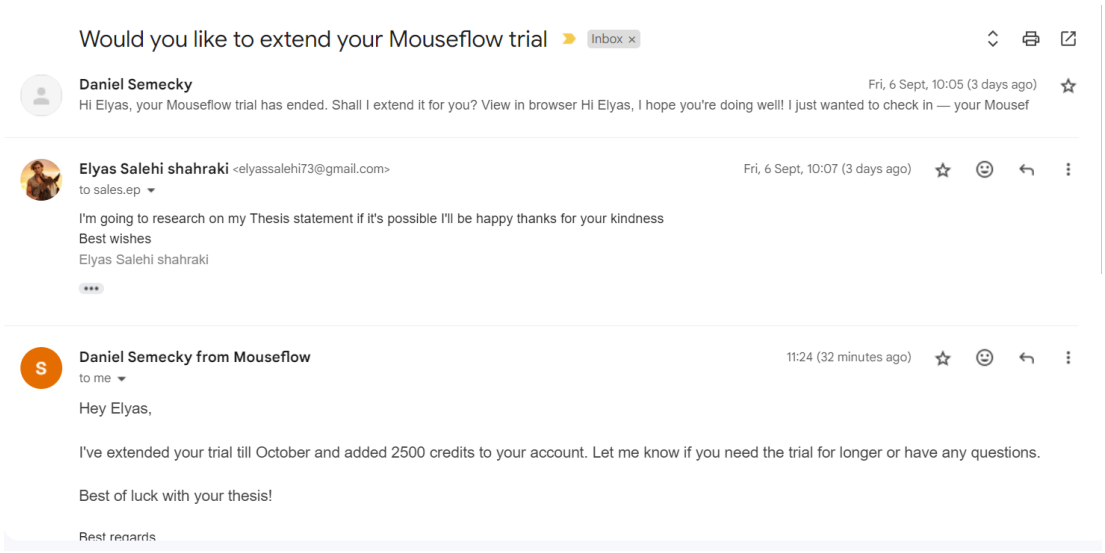
APPENDICES

Appendix A: Colors in User Experience Design

Appendix B: Credits From Mouseflow



Would you like to extend your Mouseflow trial Inbox ×

Daniel Semecky Fri, 6 Sept, 10:05 (3 days ago)
Hi Elyas, your Mouseflow trial has ended. Shall I extend it for you? View in browser Hi Elyas, I hope you're doing well! I just wanted to check in — your Mousef

Elyas Salehi shahraki <elyassalehi73@gmail.com> Fri, 6 Sept, 10:07 (3 days ago)
to sales.ep

I'm going to research on my Thesis statement if it's possible I'll be happy thanks for your kindness
Best wishes
Elyas Salehi shahraki

Daniel Semecky from Mouseflow 11:24 (32 minutes ago)
to me

Hey Elyas,

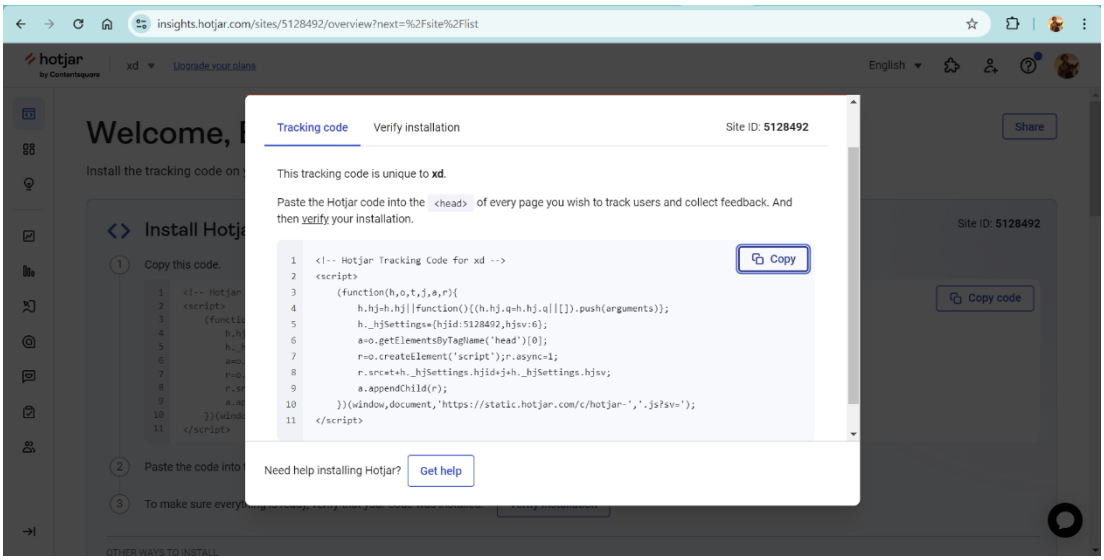
I've extended your trial till October and added 2500 credits to your account. Let me know if you need the trial for longer or have any questions.

Best of luck with your thesis!

Best regards

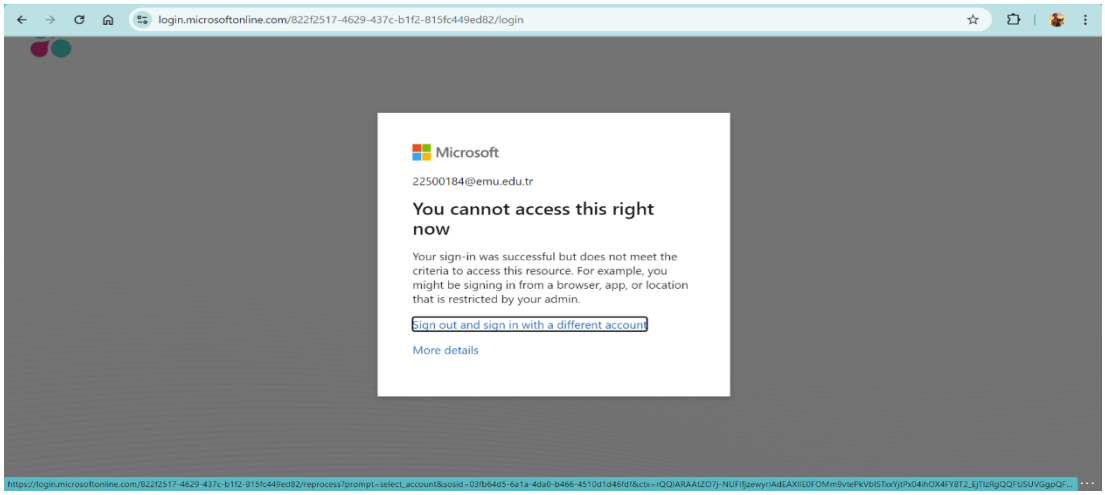
This is the email i appreciate the 2500 credits Mouse Flow give me for my thesis defense

Appendix C: Tracing Codes

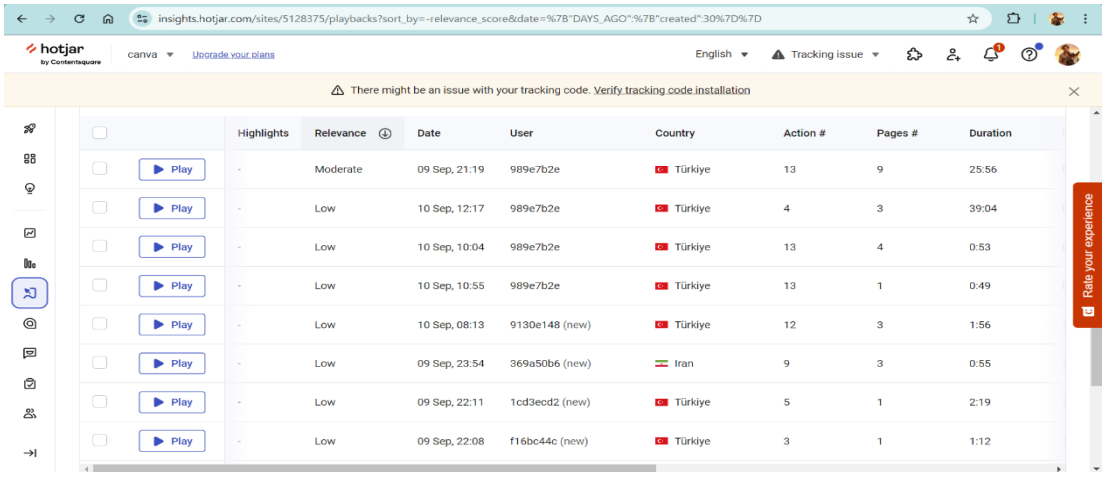


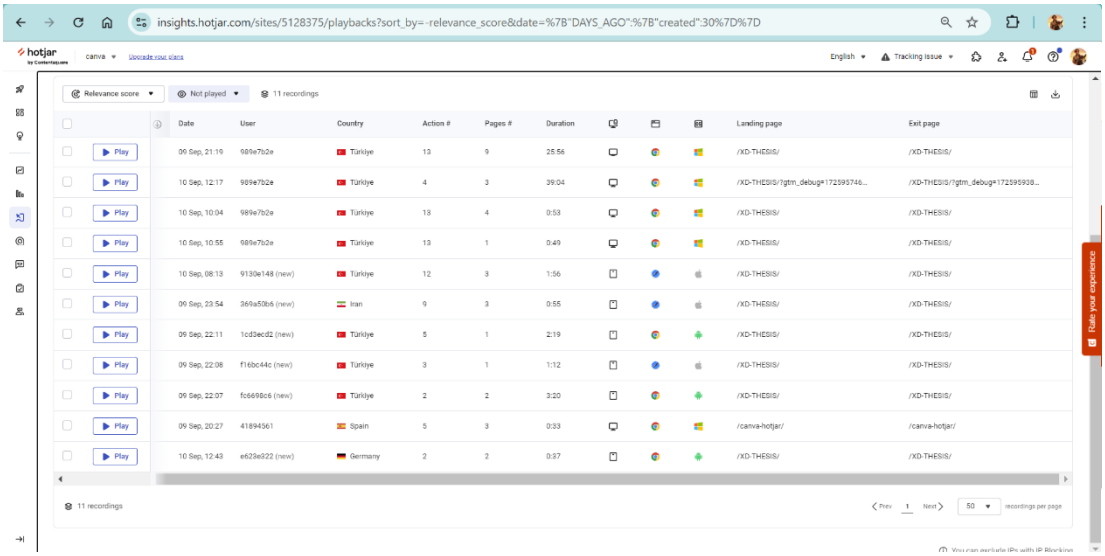
Related tracking code for adding to website in Hotjar guide

The Dragonfly tracking website does not permit access to a free or trial version for experimenting.

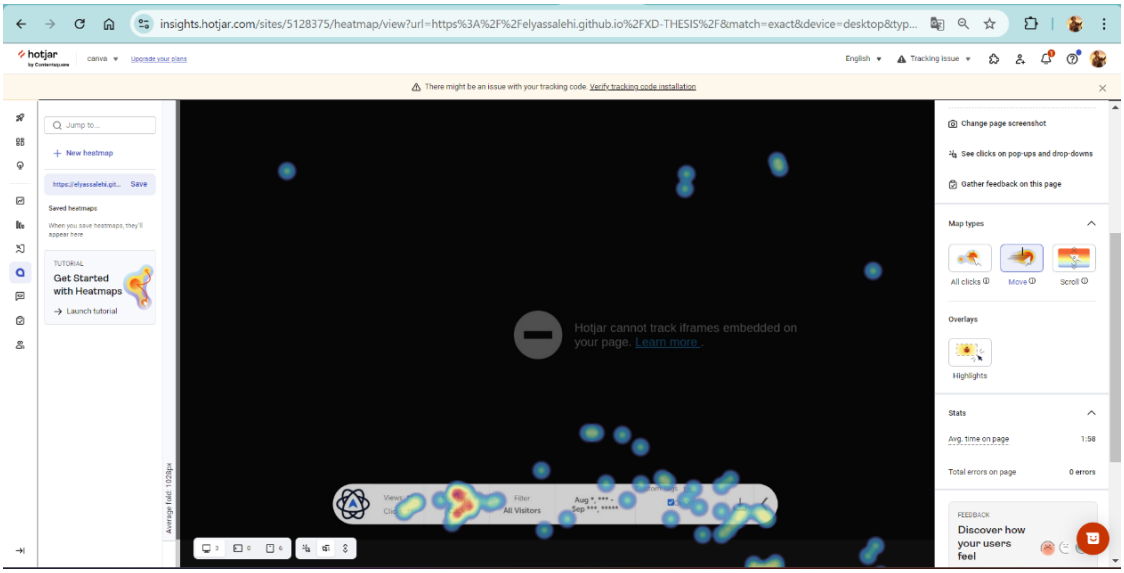


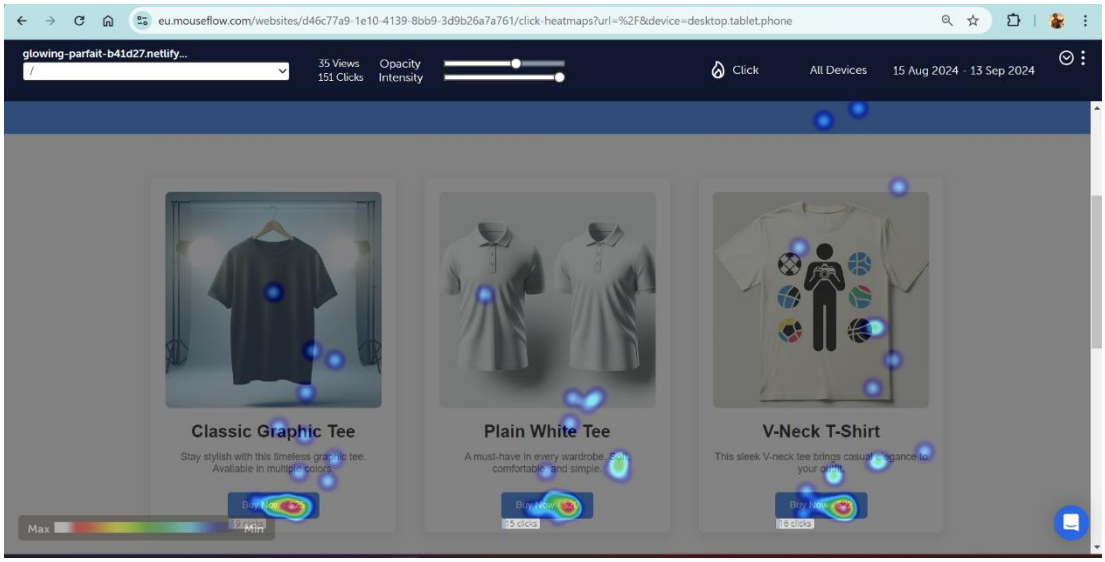
Appendix D: Hot jar heat maps website and session replays

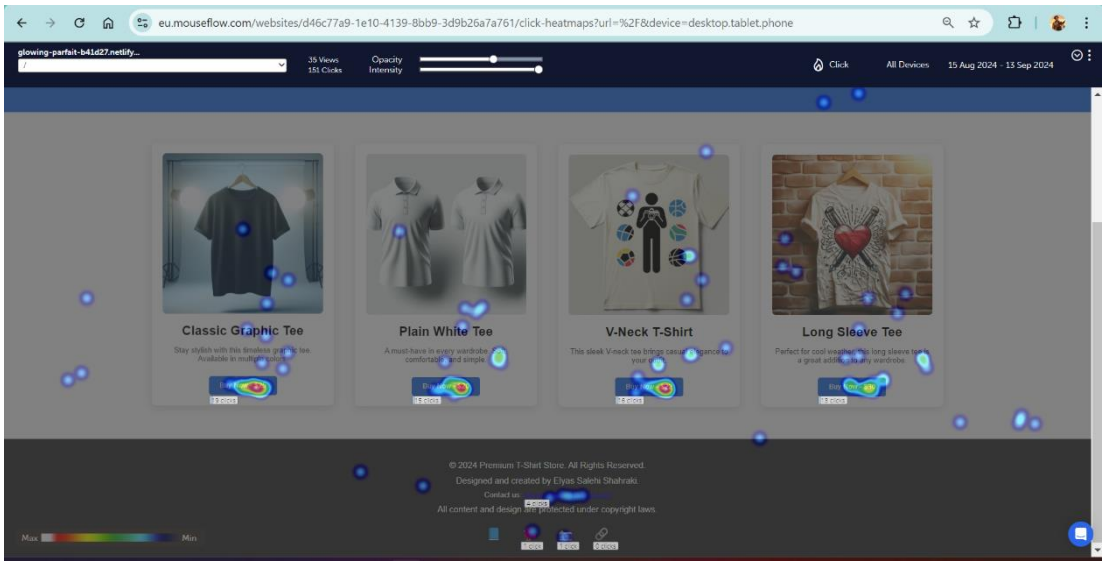




Appendix E: Heatmaps and Click rates



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glowing-parfait-b41d27.netlify...
35 Views
151 Clicks
Opacity
Intensity
Click
All Devices
15 Aug 2024 - 13 Sep 2024
Classic Graphic Tee
Plain White Tee
V-Neck T-Shirt
Long Sleeve Tee
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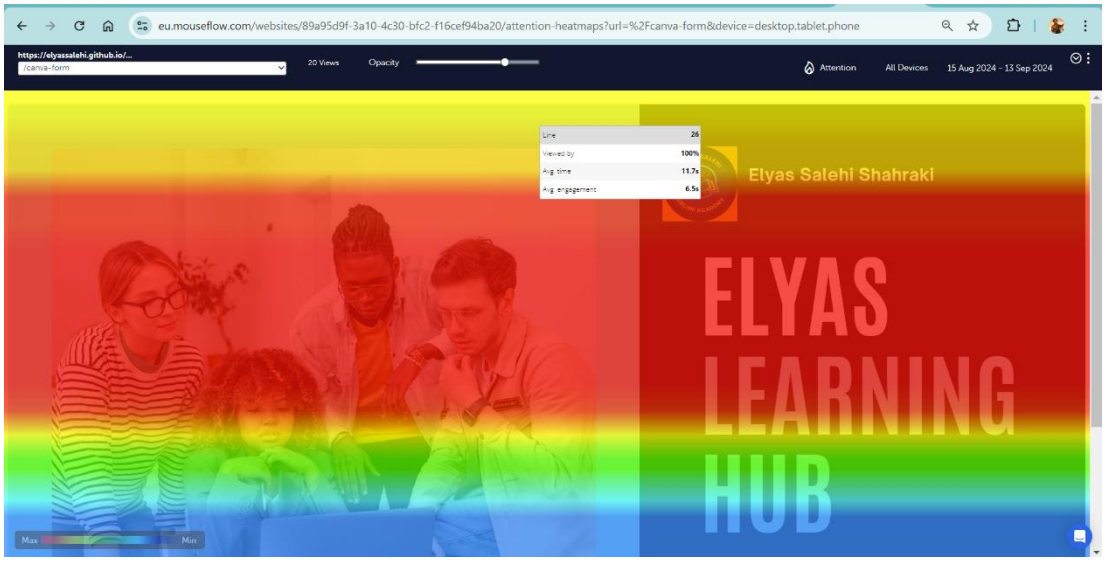
Max
Min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11.7s
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hotjar
canva
Upgrade your plans
English
Maximum traffic coverage
Jump to...
New heatmap
Saved heatmaps
When you save heatmaps, they'll appear here
TUTORIAL
Get Started with Heatmaps
Launch tutorial
Page screenshot
Date of screenshot
Sep 13, 2024
Change page screenshot
See clicks on pop-ups and drop-downs
Gather feedback on this page
Map types
All clicks
Move
Scroll
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Total errors on page
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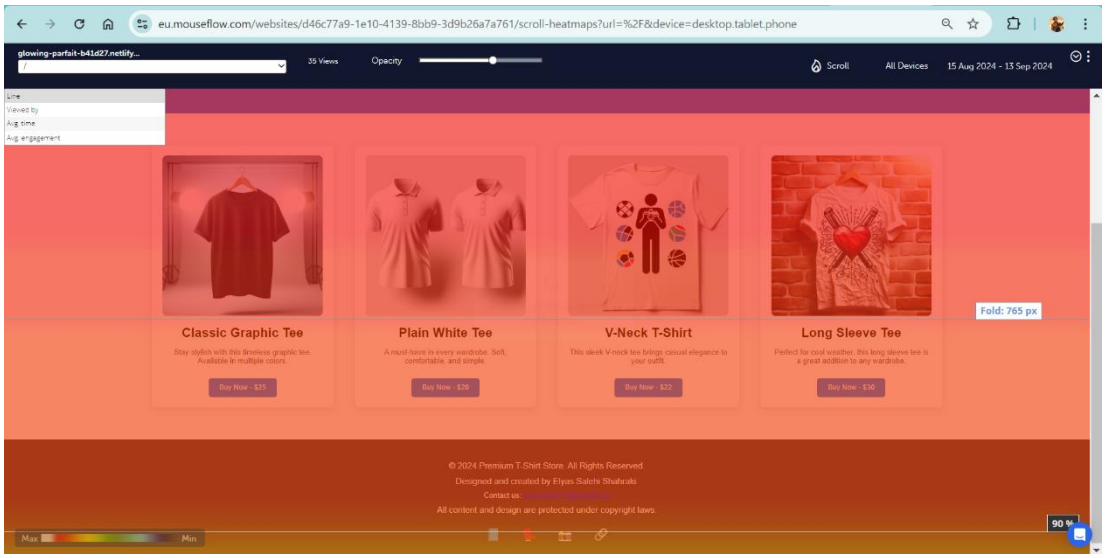
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35 Views
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Classic Graphic Tee
Plain White Tee
V-Neck T-Shirt
Long Sleeve Tee
Fold: 765 px
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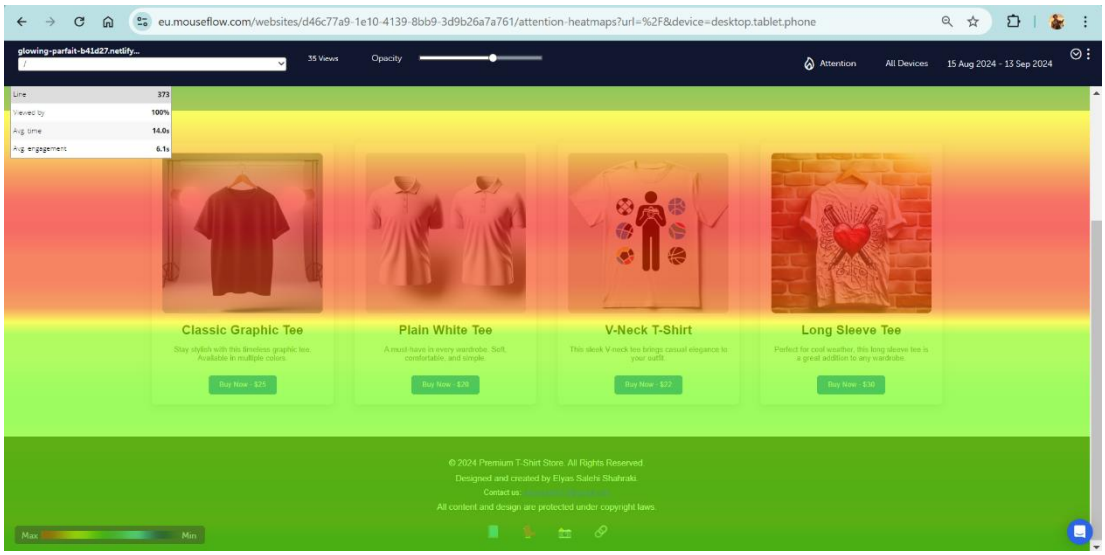
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Viewed by 100%
Avg. time 14.0s
Avg. engagement 6.1s
Classic Graphic Tee
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V-Neck T-Shirt
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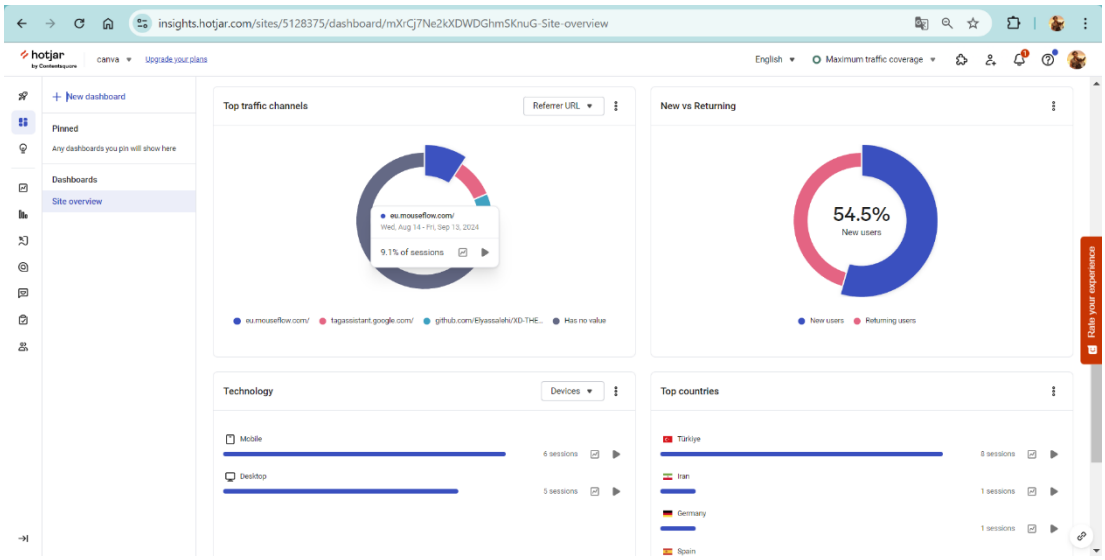
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Pinned
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Dashboards
Site overview
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Desktop
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Iran
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Germany
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Spain
Rate your experience