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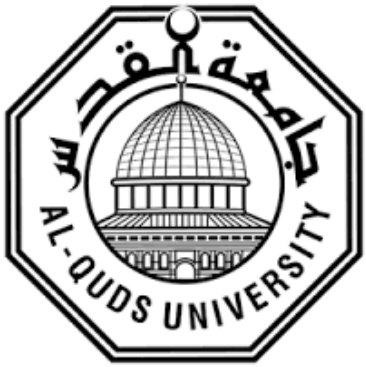

User Experience Framework of Arabic-English Websites Using Robotic Process Automation

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M.Sc. Thesis

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2- Internal Examiner: Dr. Raid Zaghal Signature .....
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Jerusalem – Palestine

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Dedication

إلى الروح التي ما زالت تسكن داخلي .. إلى الرجل المثالي المتفاني .. والدي الحبيب رحمه الله

إلى من من أفنت عمرها في تربيتي وراحتي .. أمي الفاضلة أطال الله عمرها

إلى من قدّم يد العون لي في كل وقت وحين .. زوجي الغالي

إلى سندي وقوتي في هذه الحياة.. أخوتي حفظهم الله

إلى نور عيوني وقلبي .. أطفالي فلذة كبدي

إليهم جميعاً ..أهدي هذا البحث

Declaration

I certify that this thesis submitted for the degree of Master, is the result of my research, except where otherwise acknowledged, and that this study (or any part of the same) has not been submitted for a higher degree to any other university or institution.

Signed: 

Heba Faiq Diab Sheeb

Date: 1/9/2022

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I would like to express my sincere gratitude to my advisor Dr. Radwan Qasrawi who made this work possible. Many thanks for his guidance, advice, patience, and knowledge.

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I would also like to thank my family for continuous support and understanding when undertaking my research. Your prayer for me was what sustained me so far.

Abstract

Testing the usability of the website is very important because it will indicate how much users can interact with web pages easily. There are many ways used to test the usability of the website whether based on users as empirical studies or experts who evaluate the usability based on guidelines or standard like heuristic evaluation but, most of the research focus more on three main factors that are effectiveness, efficiency, and satisfaction of end users. Moreover, available automated tools are incomplete tools because they usually test the usability of website by focusing on only one or limited usability variables like fonts, colors, accessibility, security or others variables. However, most of these tools and research focus more on English websites.

A usability testing platform that measure the usability of the webpage using the Robotic Process Automation (RPA) technique in term of layouts and design for the main common sections on the website that are header especially logo place, main navigation, carousel, body and footer based on Neilson's guidelines and principle was built to be used as comprehensive and general technique to measure the usability of Arabic and English website with least cost, effort and time without need to access the source code of the website.

The tool was used and validated on 15 webpage samples selected from three different categories that have high visitors and traffic in Palestine which are high education, governmental and media websites, the tool has ability to find the HCI violations on tested website then visualize the result in different ways like tabular, statistical, comparative, layouts and heatmap.

The results show all tested website have a usability violation on their logo with highest success rate 85.7% for U2 and highest fail rate 71.4% for 4 but, for navigation the results shows U1, U4, M2 and M4 get highest success rate of 90.9% while N3 gets the highest fail rate of 54.5%, for carousel, all news and media agencies don't have carousel on their homepages where all other samples get 100% success rate except U3, M1, M2 and M3 with success rate 75% but all news and media agencies show bad success rate up to 65% for footer while universities have the best success rate of 75% as lowest success rate

RPA usability testing tools result showed the tool is reliable and can be used to test the usability and improve the usability time and effort also, it is valid for both English and Arabic websites.

الملخص

نظام فحص سهولة إستخدام المواقع العربية و الإنجليزية باستخدام أتمتة العمليات الروبوتية

إعداد الطالبة: هبة فايق ذياب شيب

بإشراف: الدكتور رضوان قصراوي

إن عملية فحص سهولة إستخدام المواقع الالكترونية والأنظمة المطورة باستخدام تقنية الويب مهم وأساسي وذلك لأنه يعكس مدى قدرة المستخدم على إستخدام النظام أو الموقع الإلكتروني بسهولة ويسر. هناك العديد من الطرق المتبعة في فحص سهولة المواقع الإلكترونية سواء كانت عن طريق إجراء تجارب عملية على مستخدمين أو من خلال تقييم المواقع الإلكترونية من خلال خبراء مختصين في هذا المجال بالاعتماد على المبادئ والمعايير العالمية ولكن معظم الأبحاث التي أجريت تركز وبشكل رئيسي على ثلاثة متغيرات رئيسية وهي فعالية وكفاءة و رضا المستخدمين عن هذه المواقع.

بالرغم من التنوع الكبير في التقنيات والطرق المتبعة خصوصا بعد ظهور طرق آلية تساعد في فحص ميزات وأجزاء المواقع المختلفة،إلا أنه لا تزال الطرق التقليدية الأكثر إستخداماً وشيوعاً في الأبحاث العلمية مثل استخدام الاستبيانات والمقابلات وعمل قوائم بالمعايير المعتمدة ومطابقتها على المواقع المراد فحصها وغيرها من الطرق المختلفة ولكن جميع هذه الطرق تحتاج الكثير من الوقت والجهد بالإضافة إلى التكلفة المرتفعة. أما بالنسبة الى الطرق الالية الموجودة فهي تقدم فحص جزئية واحدة أو جزئيات وميزات محدودة في المواقع الإلكترونية مثل فحص الخطوط والألوان وسهولة الوصول ودرجة الأمان وغيرها من المتغيرات الأخرى وبالإضافة الى كونها تناسب المواقع الإنجليزية بشكل أكبر.

لذلك يقدم هذا البحث طريقة وأداة جديدة في قياس سهولة المواقع الإلكترونية سواء كانت باللغة العربية والانجليزية من خلال استعمال تقنية أتمتة العمليات الروبوتية بالرجوع إلى مبادئ نيلسون المعتمدة في مجال فحص سهولة المواقع؛ حيث تقدم هذه الأداة فحص لسهولة الموقع من ناحية تصميم الموقع وخصوصا الأجزاء الرئيسية الواجب توافرها وهي ترويسة الصفحة وبالتحديد شعار المؤسسة أو الشركة والقائمة الرئيسية وعارض الصور ومنطقية المحتوى وأخيرا جزئية ذيل الموقع. وأهم ما يميز هذه الطريق أنها لا تحتاج إلى وقت وجهد كبير في إجراء فحص سهولة الموقع بالإضافة الى التكلفة المنخفضة وأيضا عدم الحاجة للوصول الى النسخة الأصلية لبرمجة الموقع.

تم فحص هذه الأداة على خمسة عشر موقع مختلف تندرج تحت ثلاثة أقسام رئيسية وهي مواقع التعليم العالي (الجامعات) وعددها أربعة، ومؤسسات حكومية (وزارات) وعددها أربعة وأيضا مواقع إعلامية تختص بالأخبار وعددها ثلاثة؛ حيث تم فحص الصفحات الرئيسية لهذه المواقع بالإضافة الى صفحة عن الموقع للجامعات فقط.

أظهرت هذه الأداة قدرتها على إكتشاف مواقع الخلل في التصميم في جميع المواقع التي تم فحصها وأظهرت المواقع التي يجب على المبرمج تصحيحها ولا تطابق مع مبادئ تفاعل الإنسان مع الحاسوب حيث تم عرض النتائج بأكثر من طريقة سواء كانت من خلال جداول واحصاءات أو من خلال إعادة تصميم الموقع لمعرفة طريقة المتبعة وهل تتلائم مع التصميم الشائع للمواقع بالإضافة إلى رسم خريطة للموقع تبين مواقع الأخطاء وكما أثبتت هذه الأداة سهولتها وسرعتها وفعاليتها.

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List of acronyms

Acronym	Meaning
HCI	Human Computer Interaction
UX	User Experience
RPA	Robotic Process Automation
CSS	Cascade Style Sheet
HTML	Hyper Text Markup Language
PHP	Hypertext Preprocessor
DB	Database
UI	User Interface
PX	Pixel

Chapter 1: Introduction

1.1. Introduction

At the global level, there is a rapid increase of using web-based portals to provide services and information. The number of web-based applications increases around the world since cloud is used heavily by organizations, institutions and companies. Web usage statistics show that the Internet users have grown by more than 330 million during 2020, reaching a total of more than 4.7 billion at the start of April 2021, that means 60% of population is online [1], this reflects the importance of websites and web-based applications in delivering services and information. Furthermore, the number of users of digital devices and technologies has increased after COVID19 pandemic, while digital transformation has become a major requirement for the continuity of work of all institutions, regardless of the nature of their work.

In Palestine, similar to other countries in the world, Internet applications have become the main communication tool between end users and companies in different categories like education, government, businesses and others. The access to internet applications, such as websites, mobile applications and social media applications has increased at the country level due to the COVID 19 pandemic. Through the year 2020 and 2021, the country's businesses start transforming from traditional and physical access to customers into customers' online access and outreach. This rapid transformation improved to be cost-effective and efficient in delivering services and information. Furthermore, it became a tool of business sustainability and growth.

On the other hand, due to market needs, the multi-language websites mainly, Arabic-English websites" are commonly used in delivering services and information. These websites need to receive the user's satisfaction and acceptance at the local and global levels. However, following the Human Computer Interaction guidelines and standards while developing the websites, will help developers in achieve usability standards and user's satisfactions. Furthermore, using the traditional usability testing methods is time consuming and limited to user attitude, experience, and perception.

Recently, there have been several automatic testing tools that help developers on testing and evaluating the websites according to HCI checklists. However, these tools are limited to English contents, require access to source code, require quality assurance experts to set and validate the testing models, and most of them are commercial and expensive tools. With the robotic process automation technology, there is potential to fully automate the testing process, and to produce an intelligent and robotic user experience framework

1.2. Problem Statement

It is very important for any company to have a usable website especially after digital transformation due to the COVID 19 pandemic, so testing the usability of websites or designing new usable websites by developers become very essential.

There are many usability testing methods used abroad to check the usability of the website against HCI standards, these methods can be called traditional methods based on humans such as expert evaluation or conduct experimental test. Traditional methods usually used to check three main factors efficiency, effectiveness and satisfaction but sometimes used to check website design and layout by creating a measure checklist for HCI measures infer from standard or principles such as heuristic evaluation for Nielsen. But there are some automated tools that check the usability of websites either by making some integration with tested websites or directly without integration, but these tools usually focus on one aspect like user behavior during using the website or layout in term of one of User interface and style component such as colors matching, links broken and others.

But traditional tools have some limitation like time consuming, high effort and expensive because they need preparation especially if they are experimental, another limitation is human based so the result may have error margin, on another hand using traditional method need to repeat the testing for ever time user want to test new website so traditional method it is not practical and it is not fast. Also, automatic tools have some limitations for example there is no comprehensive tool to check the UI of the website from different aspects in different sections, usually check some features as mentioned before, or some tools need to be integrated with tested websites so there is a need to

access source code. Also, there is another challenge: that most of these tools are more suitable for English websites.

For these reasons, this research tries to represent new comprehensive automated tools that test the usability of bilingual websites in main sections of the website.

1.3. Research Questions

1. Does Robotic Process Automation RPA help improve the usability testing in terms of time and effort?
2. Can RPA be a good tool to check the usability of the webpage in terms of design and layout for the main section of the website?
3. Does having a tool for checking the usability of Arabic-English websites improve the quality of the UX of the website?

1.4. Objectives of the Study

This thesis investigates methods and techniques for checking the usability of the website in terms of website layout and design. Focusing on the main website sections header, navigation, carousel, body and footer for bilingual websites.

The purpose of this research is developing a robotic process automation framework for testing and validating user experience of Arabic-English websites that focus on the website's main sections. With this framework we will be able to highlight the issues related to Arabic-English websites usability and maybe it will be a reference HCI framework for testing and validating Arabic English websites at the national level.

The main objective of this study is to provide developers and people who are interested to check and test the usability of their website either in the early stage of designing and developing a website or launching a website. The specific objectives of this research summarized as the following:

1. Set a new automated method that checks the usability of the website based on HCI standard.

2. Provide reliable and fully automated usability tools using Robotic Process Automation RPA for developers and interested people to check the usability of the website for main website sections.
3. Provide a tool that checks the usability of bilingual websites mainly Arabic and English.
4. Improving the usability testing method's time and effort needed to do the test.

1.5. Thesis Contribution

1. Providing new tools using Robotic process Automation for developers and end users to test website user experience for Arabic English websites.
2. Enhance the time, cost and efforts needed to test the usability of the website.
3. Providing usability framework for automated testing based on HCI standard and principles.

1.6. Research Methodology

This research provides fully automated tool to test the usability of the website using RPA In order to check whether the website fit the HCI measures based on Nielsen's principles for Arabic-English websites then display the result of test using multiple method such as tabular view, heatmaps, comparing webpages result and web page layout structure.

The proposed tool was tested using 15 samples for 11 different websites in three different categories: universities, ministries, and media agencies, especially news agencies. These samples were selected due to the large number of users and these categories are the most important fields locally in Palestine. The testing was carried out in the platform that uploaded into Centos7 serve SSD with CPU 6 cores and memory 16 GB and bandwidth unlimited, the platforms integrated with RPA cloud version that provided by Automation Anywhere company where the Internet speed was 30 Mbps during testing.

The overall process carried out in four main steps

1. Set HCI standard

In this step HCI measures were set based on Nielsen's principle to be used as a reference for the bot later to check the actual result compared with it. These principles are extracted and transformed

to measures with cut off values that can be compared to then stored in a database to use later by bots.

2. Designing platform and bots

A platform was designed to collect data and preview results for later stages, the platform was developed using PHP, HTML, JavaScript, jQuery with connection to MySQL database.

Three main bots were designed which are the core of this tool and we can say that these bots have a brain that learns how and when to do things step by step. HTML and CSS bots designed to collect the data from website that will be used with third bot which is analysis bot that used to analyze the data collected and extract real value for HCI measures extracted in first step and compare the value with cut off standard value to assess whether the measure success or fail for each measure in each section of tested website.

3. Data collection

In this step samples were selected then started collecting the data from tested samples using the bots designed in the second step, the data was stored in the database in the structure that will be easy to extract the data to be analyzed in the last step.

4. Data analysis and previewing result

Third bot was running to get the usability result and store them in a database to be visualized in different ways, mainly heatmaps and website layout structure. Heatmap was used to mark the position of failure in the website to give users an exact or approximate position for failure, layout rendering the website layout structure without content that means just re-draw the main blocks of the website to find out whether the website matches the common website layout or not.

1.7. Thesis Organization

Chapter 1 presents an introduction about this research, problem statement and the research question and objectives, also it presents research methodology, limitation and contribution.

Chapter 2 introduces background about different related topics and fields like HCI user experience, website user experience, RPA, HCI standard and testing methods then this chapter presents an analysis and review of the state-of-the-art user experience testing method and GUI usability measures, GUI user based and automated based methods.

Chapter 3 describes the methodology in this research, mainly describes framework development for the platform and bot designs then introduces framework testing and evaluation by introducing data samples, collection, analysis and visualization. The result of this research is introduced in chapter 4. Chapter 5 discusses the main outcomes and findings from this research, and summarizes the research and suggests future work.

Chapter 2: Background and Literature Review

2.1. Background

2.1.1. HCI User Experience

HCI is a field of study that focuses on the interaction between the end user and the computer. HCI is a design that should produce a fit between the user, the machine and the required services in order to achieve a certain performance both in quality and optimality of services [2].

User experience UX is defined by International Organization for Standardization (ISO) as “A person's perceptions and responses that result from the use or anticipated use of a product, system or service” [3]. Good user experience design guarantees that a user can use a webpage with minimal effort and maximum value, so, having good user experience design increases the satisfaction and decreases frustration of end users which reflect deeply on the usability of the website, however, bad user experience design may be very expensive because users may refuse using the website.

So, the interactivity of a website is very important because it will reflect the usability of the website; Usability as defined by Neilson is a quality attribute that assesses how easy a user interfaces are to use [4], usability evaluation by Alan Dix is to assess designs and test systems to ensure that they behave as expected and meet user requirements, also, evaluation should not be thought of as a single phase in the design process, instead, evaluation should occur throughout the design life cycle [5], another definition of Usability by the International Organization for Standardization (ISO) as “The extent to which a product can be used by specified users to achieve specific goals with effectiveness, efficiency, and satisfaction in a specified context of use” [6]. Effectiveness means to what extent a task, or a goal is achieved, and this can be assessed if a user succeeds or fails to perform a task. On the other hand, efficiency means the amount of effort a user needs to do the task and this is measured either by the number of errors the user caused during performing the task or the time is needed to finish the task, however, satisfaction is a subjective aspect which means how comfortable a user feels during the implementation of tasks [7].

There are a lot of design rules which designers must follow through designing a website or a system to make sure that this website fits the HCI standard.

These rules are classified into different categories, and they are the principles, guidelines and standards in which are demonstrated among section 2.1.2.

2.1.2. Website User Experience

Having a good website becomes an essential requirement and one of the main reasons for success. But when developers design and develop a website, they should follow the HCI standards and user experience guidelines to build it correctly with good usability measures. Following HCI is very important, because firstly, it will improve the productivity of technology applications secondly, it provides a right method which allows humans to interact correctly and effectively with web application, thirdly, it will help developers to create technologies that fits with user's compatibilities and easier for them, as a result HCI and user experience standards will improve the overall functionality, reliability, usability and understandability.

The main key elements of a good UX that should be taken into consideration during designing and developing web applications are great visual design, having a user-friendly design, good user research and good usability design.

Many of the published locally developed websites used free online templates that depend on developer's experience, rather than using a bilingual (Arabic-English) usability testing framework and this causes problems in usability because developers customize these templates to fit their needs in a way that may violate HCI standard.

There are many website usability methods that developers can use. Some of these methods are experimental which are used during development or after release and other methods are based on experience of expert's section 2.1.3 discuss these methods in detail.

2.1.3. User Experience Standards

There are many rules that websites should follow when designing in order to increase the usability of the website, these rules are classified based on two things: authority and generality. Authority means to what extent the rules must be applied or exist in websites, but generality means if the rules can be applied for many design situations or just for specific ones. Based on authority and generality, many designing rules are available, which are principles with high generality and low authority, guidelines that are low in authority and more general, but standards with high authority and specific for some situations. There are many principles in HCI that mainly categorized into many categories, firstly, learnability which means users should easily and quickly learn how to use a website or a system, so learnability lets the user to know how to use a website individually rather than teaching them through trainings and manuals, there are many principles under learnability such as predictability, consistency, familiarity, generalizability and synthesizability. Predictability is when the user guesses the future action based on a previous one, while consistency means the usage of the same rule for the same thing; for example, the same position for navigation is used in all web pages because if some pages has horizontal navigation while others have vertical navigation; this will make the user confused and uncomfortable during the time they spend on the website, familiarity is the ability of user to use new system or browsing new websites based on their experience of using other systems or websites, generalizability means extending the knowledge of using some feature in specific software to another system in the same case or situation. Synthesizability is the ability of the user to assess the effect of past operations on the current situation. Secondly, flexibility which means more than one way to perform the same task or the exchange of data, there are many principles in this category like customizability, task migratability and multi-threading, customizability means adaptivity that allow user to change the interface of website or system like changing theme, fonts and others, task migratability is passing the control of a task internally in the system but multithreading is when the system allows user to perform more than one task at the same time. Thirdly, robustness that guarantees successful achievement of tasks in a website or system. Principles that are categorized under robustness are observability, recoverability, responsiveness and task conformance, recoverability means the

ability of the user to take action when an error appears, responsiveness is the ability to interact and communicate with the system.

Task Conformance means to what extent the system allows the user to perform different tasks as the user wants and as the user understands them in the system, while observability means the ability of the user to evaluate the perceivable presentation of the website or system.

A standard is another designing rule that is set by international parties to conform the design fit rules; for example, the International Organization for Standardization (ISO), the draft standard ISO 14915 covers software ergonomics for multimedia user interfaces.

Guidelines are a set of recommendations for developers to follow and apply principles to provide a good user experience for the website; it acts as a bridge between principles and reality, guidelines usually include the style, layout, user interface, text, accessibility and design patterns [8], for example, the Heuristic Evaluation developed by Jakob Nielsen is an example of general guidelines.

2.1.4. User Experience Testing Methods

There are many methods that can be used to evaluate the usability of a website, some of these methods involve experts and others involve an end user. Usability evaluation based on experts; mainly human factor experts used to assess the design and find the difficulties that an end user may face while using the website, usually this type of evaluation is used at any stage in the development process, the main characteristics of this approach are cheap and it evaluates whether a system fit is complied with usability principles rather than actual use of the system, expert analysis has many approaches like cognitive walkthrough, heuristic evaluation and the use of previous work. Cognitive walkthrough approach focus to evaluate how much easy for user to use the system by learning through exploration rather than using manuals and training, in this approach evaluators have actions or steps for each part of the system that users should follow to achieve the mission or goal of using the website or system then walkthrough for each step and decide at the end whether this part is usable or not by answering some questions related to the usability as the

effect of the action is as the same as the user's goal at that point?, and will users see that the action is available?.

Heuristic Evaluation is a guideline or a general principle, or a rule developed by Jakob Nielsen that provide 10 principles to evaluate website these principles are [9,10,67] as published in the updated article in 2020:

1. Visibility of system status

2. Match between system and the real world

3. User control and freedom

4. Consistency and standards

5. Help users recognize, diagnose, and recover from errors

6. Error prevention

7. Recognition rather than recall

8. Flexibility and efficiency of use

9. Aesthetic and minimalist design

10. Help and documentation

In the Heuristic Evaluation approach, expert evaluators individually evaluate the website based on these principles by giving a scale from 0-4 for each principle then a main result for all evaluations will be calculated.

Using previous work, another approach based on experts is used to evaluate websites which deals with generic issues, for example the usability of different menu types and the choice of icons so evaluation based on previous work will be used as evidence to support aspects of the design.

There are many approaches based on users, such as the empirical or experimental methods, observational methods, query techniques, and methods that use physiological monitoring, like the eye tracking.

In empirical or experimental methods, the evaluator chooses a hypothesis to test, which can be determined by measuring some attribute of participant behavior but by using actual users for the website, this approach is expensive and may be conducted in labs or in the field. Observational method is an approach that requires participants to do tasks on a website while evaluators observe the behavior of participants using different techniques like asking participants to think aloud during the task, audio or video recording, make interviews with participants at the end or using questionnaires. Another method is using physiological monitoring that evaluates exactly what users do when they interact with computers and measure what they feel by tracking the participants eye or physiological measurement like heart rate, breathing or body heat.

All techniques stated above require a human intervention to do the usability, which means human is the main part of the usability testing whether human as participant, evaluator, or moderator. Participant will perform the tasks on tested website, evaluator who will judge the website usability based on their experience, moderator who will lead the test by giving participant the instructions to perform task, preparing the lab and testing environment, observe the interaction and impression of user. On another hand, the analysis of usability testing result will be done also by a human and all of that need time, effort and cost.

Some of the above approaches need a lot of preparation especially approaches based on participants that need a lab with some conditions and human mistakes during evaluation may happen. There are many tools or techniques that try to check some webpage's styles and user behavior like hotjar [11], mouseflow [12] and inspectlet [13] websites.

Hotjar provides many features like heat maps that display users clicks and scroll which gives an indication on how users behave while using the website. Another feature in hotjar is users' satisfaction using surveys and feedback, also recording videos for usage of websites by users to know what user tries to do a play back.

Inspect let is a website that tracks user behavior by using some features like clicks, scroll and mouse movement heatmaps, recording videos, surveys, AB testing, and user's satisfaction while filling surveys.

Mouse flow website provides heatmaps, video recording, form analytics and other features. There are another automated tools that checks the layout of a website from different aspects like the responsiveness of a web page, for example, we have the responsive design checker website [14] which is responsible for checking the representation of the website in different screens and devices, this website renders how it will look like while the user will interpret the result without giving a summary or a descriptive report. The responsive tool website [15] gives the same feature and is similar to responsive design checker; as it doesn't give summary for the responsive it just renders the website in different devices.

Color check is another aspect that some tools take in consideration to test like total website [16] that is color blind web page filter, this website checks how a website will look for color blind people, a11y website [17] is a color contrast accessibility validator tool that check the contrast between background and text color by listing all problems detected, there is another website that check the accessibility of webpage like wav tool [18] that check the accessibility in term of image alternative text, colors contrast, font sizes, links and others wave give summary and details for the problems found.

But as we notice there is no comprehensive automated tools that can check the usability of the website in term of layout without human intervention, that mean all tools focus only on one HCI principle or guideline for example colors, accessibility, fonts, etc and these website were developed using scripts and different popular programing language, so if users want to test their websites, they need to use multiple website to check the usability and get out the error. This research tries to provide new automated tools using RPA based on the Neilson heuristic evaluation that check the layout and design of the webpage from different aspects and for different sections of web page using the same tool without human intervention, so it is faster, more accurate and clearer.

2.1.5. Robotic Process Automation

Robotic Process Automation RPA is a software technology that is used to automate tasks by creating bots that can mimic human actions by teaching them how to do the actions step by step. RPA can interact with any application and system as a human also bots can adapt to any interface or workflow without any need to change business systems or applications.

RPA bots are the programs that are set up using automation anywhere technology to replace human action, usually RPA bot automate tasks with some specifications that are rule based and repetitive tasks, RPA usually used to automate common processes like HR, insurance, IT services, health fields and more.

There are many benefits for RPA such as increasing productivity rate because, the execution time much faster than manual process approach, high speed and accuracy because same task always done in the same way, high reliability which mean bots can work all the time effectively, error reduction, scalability because RPA can accommodate unexpected volumes or environment quickly and easily and reduce the size of manual work that cause to cutting cost.

There are many versions for RPA whether they are on-premise or cloud, but on this research cloud RPA was mainly used which provide the ability to automate tasks via a web-based interface accessed in the browser so users don't need to download or install any software or make any software update that mean cloud RPA is RPA as a service.

There are a lot of benefits for cloud RPA that are lower total cost that mean cloud automation eliminates maintenance, setup and infrastructure cost and take the advantage of cloud, so the only things users need to automate task are computer device and internet connection, cloud architecture is built and delivered using technologies and methods that are optimal for cloud environments. Other benefits are easy to use, enhance the security that mean cloud RPA designed for security and the data stored securely with full adherence to global privacy laws.

2.2. Literature Review

2.2.1. Websites User Experience Testing Methods

Different testing methods play important roles to assess the user experience and usability of web-based applications from different aspects.

Various research tried to test the usability of the website using different method, (Samrgandi, 2020) [19] used a heuristic evaluation to test the user experience of academic libraries in Saudi Arabia universities to find to what extent does result of evaluation correlate with result of task based and whether cultural and national origin impact student's assessment, the results of this research are the evaluation is correlate with task based and there is an impact of culture and origin of student on the assessment. Another research tests the effectiveness, efficiency and satisfaction by (Silva, M. A. L., & Wijayaratne, I., 2015) [20] using questionnaire to evaluate the usability of the library website of University of Colombo.

Usability testing for prototypes of a Web-based interactive tool in health field by (Verdaguer, Mateo, Wyka, Dennis-Tiwary & Leung, 2018) [21] based on observational method that based on user to evaluate the usability, survey and think aloud techniques were used in this research and it found specific usability issues that reported to finalize and make further development for this tool.

Another research used a survey to test educational bilingual websites and provide a guideline to build Arabic English websites, Ababtain & Khan (2017) [22] have shown some usability issues that should be taken into consideration to design a website with high usability rates.

From those issues were as follows; Layout; the layout of a page should be suitable for any website browser and change language option and color (Blue is preferable) indicates a better design, Loading time; it has been indicated that some of universities should increase loading time of pages to make students more satisfied, Navigation; as it offers the main tasks of websites and users better use it instead of using list options, Security and notification messages; receive notification messages before sessions' termination, downloading; preview doc.

Option before download is important to be offered by the website, website structure; should be organized well to facilitate the process to the end user from finding information and update contents, News and site maps; it is required to be included as it helps users to scroll up and down on the page instead of opening new links.

Another study used empirical study to evaluate accessibility and usability on measuring the services of top Saudi e-government services and it has been showed that e-government services were well-designed and just a little work has been recommended to make user more friendly (Al-Faries, Al-Khalifa, Al-Razgan & Al-Duwais, 2013) [23].

Also Kılıç & Gökoğlu (2021) [24] use empirical study to explore the usability in virtual robotics programing for teaching, technology acceptance model has been developed to evaluate usability of VRP, this model consists of two determinants; perceived usefulness which the level of individuals believes to use technology that could enhance the performance, and perceived ease of use which the individual's believes that using technology would be free-efforts, then attitude will response to the use or technology as acceptance or rejection which leads to behavioral intention of use.

They have found that, the usability of VRP-C is compatible with curriculum used for robotic program teaching and can facilitate learning and allow teachers to use the learning time more efficiently, motivate students to learn through gamification, provide feedback on the outputs coding, and contributes to a positive attitude toward the programs of robotics for students' learning.

Anyaoku, E. N., & Akpojotor, L. O. (2020) [25] evaluate the usability of university library website using analytical survey to test set of measures that are usefulness, Efficiency, Effectiveness, Learnability, and Accessibility, this research found more than half of tested website have a total usability score 50% and above and most of these websites have violations in these measure that should be improved to enhance the usability.

Another research focuses on testing the usability and accessibility of library website to student with disabilities using empirical method with observational techniques like interviews, discussion and using surveys, this research found people with disabilities were excluded from access and use of library websites and (Kiruki, 2021) [26] gave recommendation to make usability testing for overall website and put policy for people with disabilities.

Soewardi & Ramadhan (2020) [27] test the usability of academic faulty websites by measuring learnability, efficiency, memorability, error and satisfaction using questionnaires. This study has led to a result that some features in this website should be improved such as; incomplete information, menu layout and empty content.

Uska, Wirasasmita & Fahrurrozi (2020) [28] have been revealed that Universities websites usability have been proven as technological development in the educational world and have been evaluated depended on many measurements. Website Usability should be taken into consideration. For example, the new student acceptance system (NSA) has been focused on registration processes and the selection methods to announce online elections results which reveal an execution of usability evaluation that determines users' satisfaction, the effectiveness and efficiency of the system, experimental by conducting an experiment and inquiry using questionnaires were used in this research.

2.2.2. Websites GUI usability measures (GUI)

Most of the research focuses more on testing user behavior during using the website or testing the usability of the website in terms of effectiveness, efficiency and satisfaction rather than website layout and structure.

There are some research measure layout and structure of websites (Saeed, S., & Amjad, 2013) [29] test the usability of university websites in Pakistan in term of layout, structure, navigation and functional modules based on Nielsen's heuristic evaluation using survey techniques to find how much user satisfied on the design of these measures, the result found the websites need improving the usability by designing them according to usability guideline.

There are many different methods used in evaluating educational websites such as; usability evaluation using Heuristics. This method gave a useful insight about the website problems that should be taken into consideration to improve, those problems were regarding standard design, navigation, content and user support. Design has been included; consistency in architecture and language, the use of images, the color's choice, selection criteria, menu design and the correct sequence of presentations. And finding the information has included; the forms of online admission, forms of feedback and domain names (Gul, Iqbal & Saqib, 2015) [30].

Agrawal, G., Kumar, D., & Singh, M. (2021) [31] investigate the usability of Indian government websites by measuring the usability, accessibility, HTML/CSS errors, navigation structure in term of broken links and mobile readiness using automatic testing tools like TAW, MobileOK and others, the result show that many governmental websites aren't usable, don't follow accessibility guideline, have HTML/CSS errors and warning, have many broken links and aren't mobile friendly.

2.2.3. GUI User Based Testing Methods

Some GUI users experience usability testing based on humans. That means based on experts who judge the websites based on their experience.

(Namoun, Abdallah, B. Alkhodre, A, 2019) [32] used inspections method that based in evaluators to inspect the usability of font type, font size and images in 73 Arabic websites to find what font type and size used in Arabic websites and what type of images used in Arabic website, this research found Arabic website suffer from mixed fonts type on the same web pages, Droid Arabic Kufi was dominant in formatting the titles and menus of the Arabic sites but Tahoma, Helvetica, Arial and Times New Roman, are used to format the Arabic paragraphs, images were used heavily in Arabic website that decrease loading time of website but images reflect the culture of Arab country.

An exploratory study by Doyle, S., Pavlos, R., Carlson, S. J., Barton, K., Bhuiyan, M., Boeing, B., Borland, M. L., Hoober, S., & Blyth, C. C. (2022) [33] to determine the efficacy and usability system interfaces of digital tools integrated into a pediatric patient registry for Acute respiratory infection ARI, the research found the usability score for the desktop interface get grad A.

Tahir (2015) [34] have revealed that, usability measures the usefulness of a website or application, a lot of educational Apps have been arose in our century which makes it more vital to measure the Apps usability, a measurement model for usability evaluation have been built depended on interface design guidelines and the usability evaluation includes usability characteristics, goals, questions and matrices to ensure the effectiveness and reliability of this model. Usability measurements models consist of performance measures, software usability measurements inventory, semi-automated interface designer and evaluator.

Kokil, U., & Scott, S. (2017) [35] did a usability study for school website in USA by conducting experiments and using observational method through discussion with participant, think aloud, and questionnaire, the result found of poor organization of information, and text labels not reflective of the contents, resulting in tedious navigation and unsuccessful searches also authors recommended to improve the site to be more effective and efficient.

Two empirical studies were conducted to evaluate two GUI prototypes usability for credibility assessment on COVID-19 news by assess the first prototype through conduction UX experiment with participant to assess interaction design (conforming to GUI conventions), navigation (orientation), visual design (affordance of GUI elements), and wording (user interface copy) then take in consideration the notes and usability issues to prepare the second prototype to conduct another experiment to test the usability of second prototype. Also, surveys used in this study to find the satisfaction of end users (Schulz, K., Rauenbusch, J., Fillies, J., Karvelas, D., & Rehm, G. ,2022) [36].

Al-Radaideh, Q. A., Abu-Shanab, E., Hamam, S., & Abu-Salem, H. (2011) [37] evaluated the usability of online newspaper websites using user perspective approach by measuring usability and web content, the result of this study were the usability is relatively good for all online newspapers tested but the web content factor is moderate.

Another research that assessed usability of agritourism farms website using a survey that was filled out by participants, the result of this study is lack of explicit updates or the presentation of outdated information, and problem in forms (Surveying, L., 2020) [38].

2.2.4. GUI Automated Testing Methods

There is some research that uses automated tools to test the usability of websites in different aspects.

Alhadreti (2021) [39] test the accessibility of the websites of top ranked hospitals in Saudi Arabia using AChecker automated tool, this research found out that, most accessibility errors happened due to information structure, non-text content, instructions, heading, labels and keyboard access which indicates weakness and a lack of the established legislation of a web accessibility.

Al-omar, K. (2017) [40] used three automated tools to test the usability of university e-learning website in KSA by measuring performance, reliability, accessibility, mobile friendly, SEO, usability, security and page analysis, this research found all websites are reliable but there is violations in usability guidelines in different websites.

Another research by Akgül, Y. (2020) [41] used to test the usability of the turkish university website using multiple automated tools like AChecker, PageSpeed and others to evaluate a set of measures that are accessibility, usability, quality performance, and readability, The results show the majority of website didn't meet WCAG 2.0 accessibility criteria also low usability, quality performance, and readability for Turkish websites.

Agrawal, G., Kumar, D., & Singh, M. (2021) [31] investigate the usability of Indian government websites by measuring the usability, accessibility, HTML/CSS errors, navigation structure in term of broken links and mobile readiness using automatic testing tools like TAW, MobileOK and others, the result show that many governmental websites aren't usable, don't follow accessibility guideline, have HTML/CSS errors and warning, have many broken links and aren't mobile friendly.

Agrawal, G., Dumka, A., Singh, M., & Bijalwan, A. (2022) [42] test the usability of official state tourism websites of India using automatic tools to measure the usability and accessibility especially HTML errors and warning, CSS errors and warning, broken links, image sizes, page

size and loading time. The result found tourism websites had low usability and accessibility status, and should be improved to make them accessible to people with special needs

Usability testing for e-commerce websites was conducted by Jain, S., & Purandare, P. (2021) [43] to test the usability of these website in term of Connectivity especially for loading time, page size and loading time, Readability, Accessibility by measuring URL, headings and links, and Functional Performance as enterprise, technology and marketing using automatic online tools like Nibbler and GT metrix, the result found websites need to improve in certain areas and must improve their usability to reach user expectations.

Another research used automatic tools used to test the usability of encyclopedia websites using Pingdom and GT metrix to measure the performance in terms of loading time, media size and overall web performance grades. The result of this research suggests improving performance, number of requests, time to load, size of the page, mobile, search engine optimization, user experience and security (Ismail, N. A., Jamaluddin, F. I., Hamidan, A. H., Ali, A. F., Mohamed, S. E., & Said, C. S. , 2021) [44].

Vlieger (2011) [45] This study has focused on using three different automated tools to evaluate the usability of e-learning websites. Those tools had the ability to analyze many factors such as; load time, performance, mobile friendly, navigation, security, satisfaction and accessibility.

The automated tools are as follows; the webpage analyzer 0.98 which has the ability to measure the speed and performance of a website, the Qualidator tool which has the ability to measure website against the website usability and accessibility, and the website grader which has the ability to grade website against the website security, mobile and performance. Those measurements have find out that, testing the download speed and webpage size impacts on the usability of a website, Qualidator tool measured against usability and accessibility as university website couldn’t be tested and the automatically returned error message indicates the operation has timed out, and the website grader tool has been shown that university website can’t be tested too.

2.2.5. Discussion

An overview of research studies regarding user experience testing methods, the measures usually measured in research, automated and user-based testing methods for GUI were outlined and presented.

Usability testing usually done in research either by users or using automation tools, in user-based research, researcher may conduct an experiment to check the functionality of the website or application and this type of methods usually used to measure effectiveness and efficiency like [20,28] but our research focus on new measures that affect the look and feel of the website, and they are main parts that outline the webpages. Experiments usually need time, efforts and high cost to perform them successfully, for example [21,23,36] uses experiment to test the usability of websites but, RPA tool improve the time and effort were needed to conduct the experiment. We note that when researchers used experiments in their study, other support techniques used to help them through experiment like think aloud, recording videos or using surveys that reflect user satisfactions.

Usability inspection is sometimes used to evaluate the usability of a website; this method is based on experts that can evaluate websites using their experience [32].

Most research as our research based on heuristic evaluations guidelines for Neilson like [29], but some research used WCAG 2.0 standard especially for accessibility

[41][46]. Heuristic evaluation is used heavily as a standard because it is general and abroad rules.

Researchers started focusing on another aspect of websites that affect deeply in websites like learnability, accessibility, security, memorability, readability, performance and more measures especially after there are automated tools that researchers can use in their study so, we note researches test these measures usually using automatic tools.

Regarding GUI usability, research test GUI either by usability inspection, surveys that reflect user satisfaction about the design or using automatic tools to check some aspect in design like HTML/CSS errors [41]. But researches for GUI usability using automatic tools didn’t test the

structure deeply and always use more than online tools to check multiple measures [31][40][41] but, our UX framework outperformed these studies by testing GUI more deep in the five main section using only one tool

There is some research that compares using automatic tools and traditional ones in the field of usability testing. Some research found that automatic tools are better than using traditional techniques in terms of time, budget and effort to be implemented. A systematic mapping study [47] identified automatic tools and found that it is a good idea to use automatic tools in usability testing. but some researchers found out the automated techniques have some issues such as contradictory results for same website using different automated tool, not easy to understand result for nontechnical users, focus on technical implementation of website rather than web usability issues and tools seems doesn’t match or based on usability standard and guideline [48].

Chapter 3: Methodology

3.1. Study Design

This research was designed as an analytical research project that provides a framework for testing the user experience website applications using Robotic Process Automation (Bot Programming) as a fully automated testing method. The system was designed and implemented in reference to the human computer interaction user experience standards and guidelines, mainly Nielsen's usability measures for Website applications. In which the websites Header, Navigation, Body, Carousel. Footer and page layout were considered in our testing framework. in terms of layout. The tool was designed to provide developers and users with an in-depth analysis of usability measures using the power of Bot programs, which will improve the development quality and efficiency.

The data set used in this research was extracted from locally produced Arabic and English website applications, including Higher Education Institutions, Governmental, Commercial and News and Media applications. with large audiences and from different fields mainly Universities, Ministries and media websites. The framework provides a visualized user experience measures using bots analytical tools.

3.2. User Experience Measures

The framework user experience measures were developed based on Neilson principles and standards for usability evaluations [9]. The Jackob Nielson usability measure is a heuristic evaluation method that has been tested and validated in several studies [9][49][50][51][52][53][54][55].

Table 3.1 shows the usability measure that has been used in our framework, including the usability variables and the accepted reference values.

Table 3.1: Framework User experience usability measures based on Nielson guidelines.

Section	Variable	Measures (HCI-Ref.)	Cut off values	Scale
Logo	Position	Top of webpage	600	Less than and less than carousel
	Caption	Should have caption	alt	should exist
	Link	Logo should be a link to homepage	Href	Not equal (not empty #,'')
	Font family	Some webpages logo followed by text so should be same font	All values	Equal
	Background color/ font color	As info to know the background and font colors	-	-
	Margins	Shouldn't be 0px	0px	Not equal
Navigation	Position	Horizontal on Top of webpage or left /right side	600	Less than
	Item (total tabs)	7-2 or 7+2 (5-9 items)	5-9	Range (less than or equal 9 and more than or equal 5)
	Content	Should contain home tab whether Home as text or icon Should contain about tab to help user know about the institution/company	Home, about	Should exist

	Paddings (left, top, right, bottom)	Should not be 0px	0px	Not equal
	Margins (left, top, right, bottom)	Should not be 0px	0px	Not equal
	Font family	Should be same	All values	Not equal
	Font size	Should be same for all items	All values	equal
	Number of images	5 images or fewer	5	Less than or equal
Carousel	Position	Top of homepage Should appear above fold area	600 px	Less than More than navigation top
	Appearance	Indication how many images are there	<li	Should exist
	Navigation	Arrows inside the carousel or buttons	Prev, next	Should exist
Body	Content / images	If contain image should have caption be	img	Should exist

	Content / text		Span, strong, text,	equal
	Content /Links	If contain link should be not broken	Href !=’’ or href !=’#’	equal
	Margins	Should not be 0px	0px	Not equal
	Paddings	Should not be 0px	0px	Not equal
	Font family	Should be same	All values	Same
	Font size			
	Background / font color			
	Position	The bottom of every web	900 px	More than
Footer	Content / logo	Should exist	<img	Should exist
	Content /social media	Should exist	Facebook, twitter, Instagram, YouTube	At least one exist
	content / sitemap	Should exist	<a	Should exist

content / newsletter	Should exist	Newsletter	Should exist
content / jobs	Should exist	Job, career, join us	Should exist
content / copyright	Should exist	Copyright, copyright icon	Should exist
background color and font color		-	-
font family	Should be Same	All values	equal
font size	Should be same	All values	equal

3.2.1. Logo

The Logo is one of the website's main components that indicates the institution identification sign of the website owner. In our framework, the logo position, position, caption, links, margins, font type and colors were considered as user experience indicators in reference to Nielson guidelines and standards as shown in table 1. The HCI logo reference indicated that it should be located on the top of the webpage with a caption description, and clickable link directed to the home page. Furthermore, when the logo has a text then the font type, color, and size should be matched with the webpage colors and contents. The logo position should not exceed 600px, and the image caption should not have empty spaces, while the logo should have clickable reference value.

3.2.2. Navigation

The website navigation usability measures include variables related to the position, total number of menu items (tabs), margins, paddings, content, depth, and menu direction and orientation (Horizontal or Vertical). As indicated in table 1, the menu could be horizontal on the top, or vertical on the left or right side of the webpage with an average number of tabs (5-9 tabs). Padding was measured as the space between the element border and its content and should equal 0px, the position should be around 600px, while margin measured the spaces around element borders from all sides (top, right, bottom and left) because both will affect appearance and readability for the tab item.

In reference to HCI guidelines the navigation menu should contain a home tab that will be used as the main page reference menu and help users to manage the navigation process. The average number of navigation tabs should not be less than 5 tabs and not exceed 9 tabs in most websites. The menu should have an About tab for providing information about the website owners. Furthermore, the font size, type, position, and image sizes should be stable and consistent in all pages.

3.2.3. Carousel

The website carousel usability was measured based on the number of images used, position, appearance, and navigation. In reference to HCI standards, the number of images should be less than 5 images located on the top of the pages (webpage fold: the portion of the webpage that appears without scrolling (around 600px)) and under the navigation menu [56]. However, this measure could be changed based on the screen size, in our framework, computer screens greater than 11 inch were used in testing the carousel usability. Appearance and navigation are other variables measured in the carousel section, the appearance of the carousel means the carousel should give indication of how many images are available with ability to direct transition between images by clicking on these indicators but, navigation allow user to navigate carousel using next and previous buttons.

3.2.4. Body

The webpage body section was measured based on the content type of body blocks that users want to check whether it is text, links, or a mix of content type. The paddings and margins of the body block, the font size, type, and background color, were measured and compared with the HCI standards listed in table 1. The HTML and CSS tags were used as a reference keyword for identifying the measure variables from the website source code. sour

3.2.5. Footer

The webpage footer section was measured based on the position, content, colors, and fonts. According to HCI standards, the footers are usually located at the bottom of the web page and contains the identification information such as: Contact Information, job link, site map, newsletter, copyrights, and social media links, in addition to fonts info and colors whether font or background colors. Table 1 shows the Nielson user experience measures, the footer contents are located at the bottom of the webpage under the page fold with a maximum average height of 9px.

3.3. Framework Development

3.3.1. User Experience Platform Development

A user experience testing framework was developed that used robotic process automation (Bot programing) for testing websites application user experience. The framework was developed based on HTML CSS, Java script and PHP programming language. The platform database was developed using MySQL databases. Figure 3.1 shows the general architecture of the user experience framework.

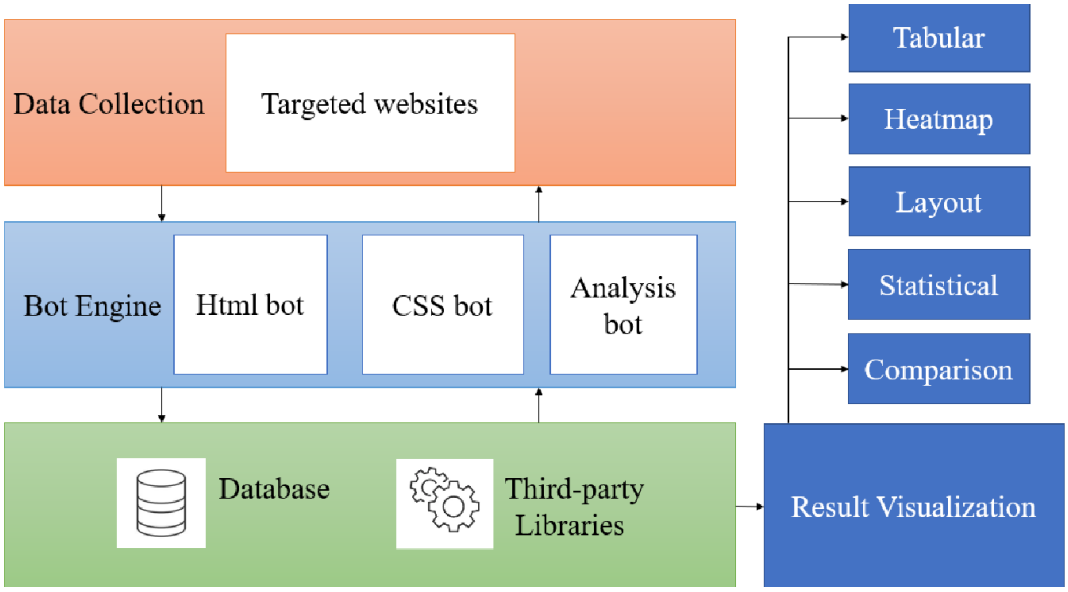


Figure 3.1: General architecture for user experience platform

The framework composed of four main components: The platform development layer based on Html, CSS and PHP programing language; The Bot engine layer that contains the Bot programs based on automation anywhere cloud platform and the MySQL database layer, in which the usability measures variables were stored and analyzed using the Bot analytical tools.

The Bot engine layer used the web automation package [57] provided by automation anywhere, in which the bots were developed to extract the website source code. The source code will be classified and analyzed using Bots programs. Furthermore, additional Bot was designed to run object cloning that capture the HTML tags and all associated data such as position (left and top), height, width and the inner html that mean object cloning give us the ability to have the design of a web page as text that is formed and used as it is requested. The data visualization layer was used to visualize the user experience results, it provides graphical, tabular and heatmap data visualization approaches. The heat map was developed using heatmap.js [58] which is a java script library that builds a heatmap from a given dataset.

3.3.2. Robotic Process Automation (Bot) Design

The bots flow architecture is illustrated in Figure 3.2. The design is composed of three main Bots: Two bots for source code cloning and classifications, and one bot for data analysis and visualization. The source code cloning and analysis bots provide detailed source code classifications of HTML and CSS tags. The tags and classes provide information about the usability measures variables, such as: position, font, test, images, navigation menu, padding, margins, etc. While the CSS source code provides information about the website's applications styles, formats and the display of HTML documents.

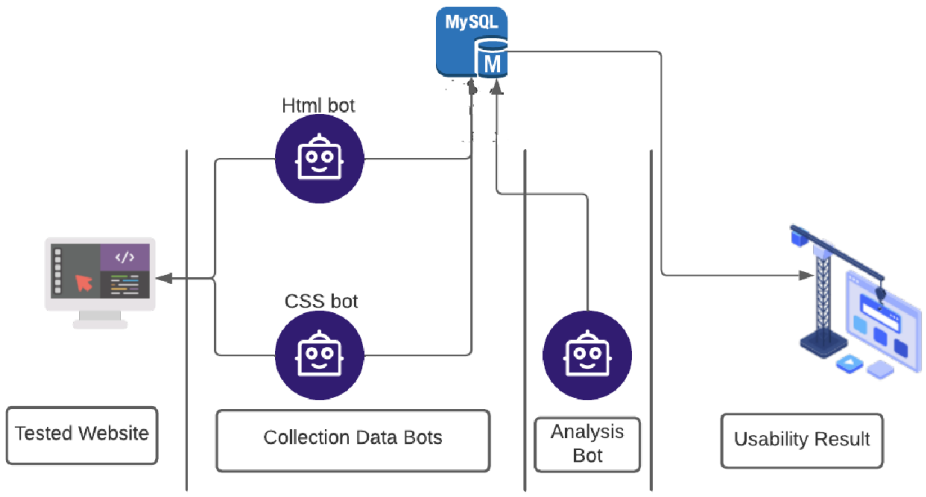


Figure 3.2: Bots process flow architecture

3.3.2.1. HyperText Markup Language (HTML) Bot

The HTML bot was designed to read and analyze the website html code. The Bot used the object cloning technique for extracting the html source code, including html tags and elements. In object cloning, all the object properties and associated data was copied and re-created in its clone [59], which provides us with detailed information about the website design and functionalities. Figure 3.3 shows the html bot process flow architecture.

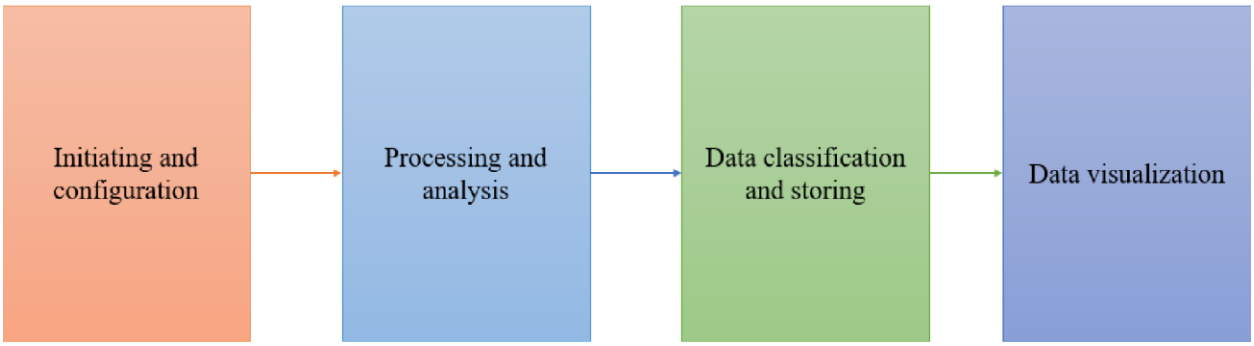


Figure 3.3: Bots source code cloning and storing process

At the initiation and configuration stage, the bot extracted the html code from the website source code using the object cloning technique. In the processing and analysis stage the html tags (start and end tags), elements, values, names, images, ...etc., and all webpage properties were processed and analyzed and stored on the framework database. The data storing stage concerns with organization and storage of html code analysis in framework database, in which three main tables were created: The first table used to store the top (vertical position), element width, element height, left (horizontal position), name, section and section part (navigation, news, highlights, videos or textual information). The second table stores the attributes properties (name, value, id of html tag, while the third table used to store the classes names and properties related to webpage ID. The bot used an iterative processing and analysis approach for code analysis and data storing for avoiding duplication and replacement (example: bot class extraction requires checking whether the class name is already stored or replaced, if yes, the bot will stop the transaction to the class table).

3.3.2.2. Cascade Style Sheet (CSS) Bot

The CSS Bot was used to extract and store the CSS code from the website source code. In overall about 234 CSS attributes were extracted and stored on the framework database, from which the usability elements were analyzed and compared with user experience standards and guidelines. The CSS attributes provide the bots with the required data such as font properties, positions, background, images, and many others, the bot compares these data with the predefined usability measure and provides a graphical visualization for the analysis results through the framework dashboard.

3.3.2.3. Data Analysis Bot

The data analysis bot was designed to provide a user experience analysis for the website's application by conducting comparative and statistical analysis of usability measures parameters. The bot connects to the framework database to access the usability variables data and runs the predefined analysis functions. The analysis functions were developed in reference to Nielson usability standards and guidelines. In this research, the website GUI was assessed in terms of navigation menu, contents, and overall graphical interface. The bot analysis workflow is illustrated in Figure 3.4.

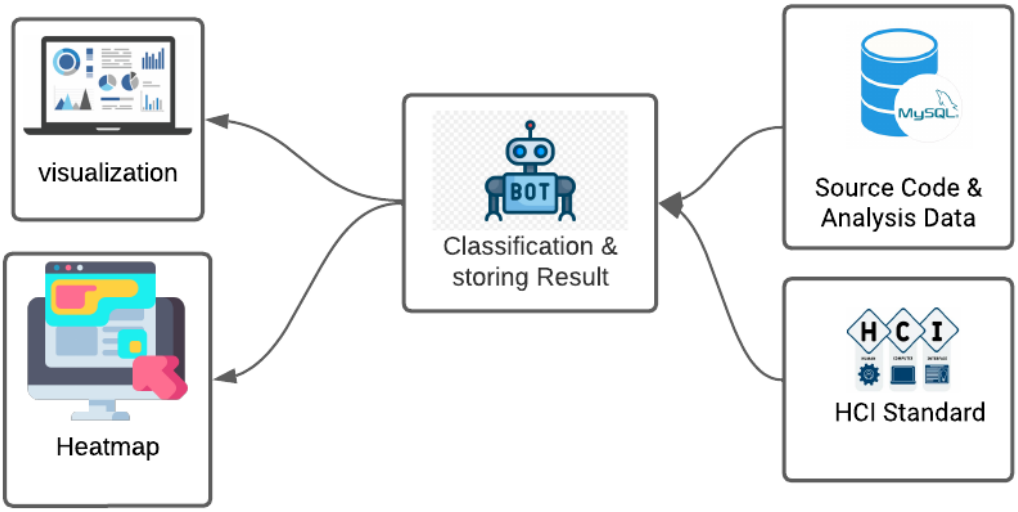


Figure 3.4: The user experience analysis bot process flow

As indicated in figure 3.4 the bot accessed the usability measures data and started the data processing, in which, the GUI usability categories were classified according to the HCI standards. The classifications include different scales (Acceptable or not acceptable; bad, good or very good; greater than, less than or equal; severe and non-severe). The bot analyzed the data in a tabular and graphical visualization form. In which the predefined indicators and the analysis results will be

demonstrated on the framework user experience dashboard. Furthermore, the heatmap analysis, also included in our framework, where the high threat and unacceptable points will be mapped using the heatmap technique.

3.4. Arabic-English Framework Development

User experience framework was developed to match Arabic and English by allowing end user or developer to set some settings like alignment whether is right to left or left to right since languages are different mainly in alignment and alphabets text but, in our case, alphabets text don't affect the testing since the bot based on source code which is always in English language more than Arabic or English text and paragraph.

Bots collect data whether HTML tags or CSS based on their syntax by extracting and saving the main HTML tag part which is property's keys and values separated by spaces in database. Bots just need to know the alignment of the language to prepare data for visualization like heatmap and layout structure that redraw the website blocks.

3.5. Framework Testing and Evaluation

3.5.1. Study Sample

The user experience framework was tested on a sample of 11 locally developed websites including 4 higher education institutes, 4 governmental, 3 media and news websites. For each higher education institute two pages were evaluated, the HOME and ABOUT US pages. In overall 15 pages were tested and evaluated. The websites were selected based on websites ranking using a similar website ranking platform, in terms of number of visitors, pages per visit and institution ranking in Palestine. Table 3.2 shows the selected websites by number of visitors, rank and pages per visit [60].

Table 3.2: Total visit, pages per visit and ranking for selected samples

Institution	Total visits	Pages per Visit	Rank in Palestine
U1	166.7K	4.87	364
U2	681.6K	6.98	43

U3	339.5K	6.48	84
U4	287.9K	6.42	198
M1	331.8K	5.03	67
M2	5K	2.01	6214
M3	83.3K	6.33	387
M4	265.8K	2.39	293
N1	3.9M	3.24	10
N2	2.0M	6.14	11
N3	2.1M	2.91	60

For institutions' privacy protection and ethical considerations, the selected websites were coded into anonymous codes. Table 3.3 shows the coding distribution by business type.

Table 3.3 Website coding by business type

Business Type	**Code**	**Tested Pages**
Higher Education Institution	U1, U2, U3, U4	Home, About
Governmental	M1, M2, M3, M4	Home, About
News and Media	N1, N2 , N3	Home, About

3.5.2. Data collection

The data collection was completely conducted and stored in the databases automatically using the robotic process automation (Bot programs). The bots were activated via the user experience framework, in which users type the website URL and run bot. The data was collected in three levels: The HTML tags and elements; the CSS keys and values; and the JavaScript commands and functions. Figure 3.5 shows the general architecture of the data collection process using the user experience framework.

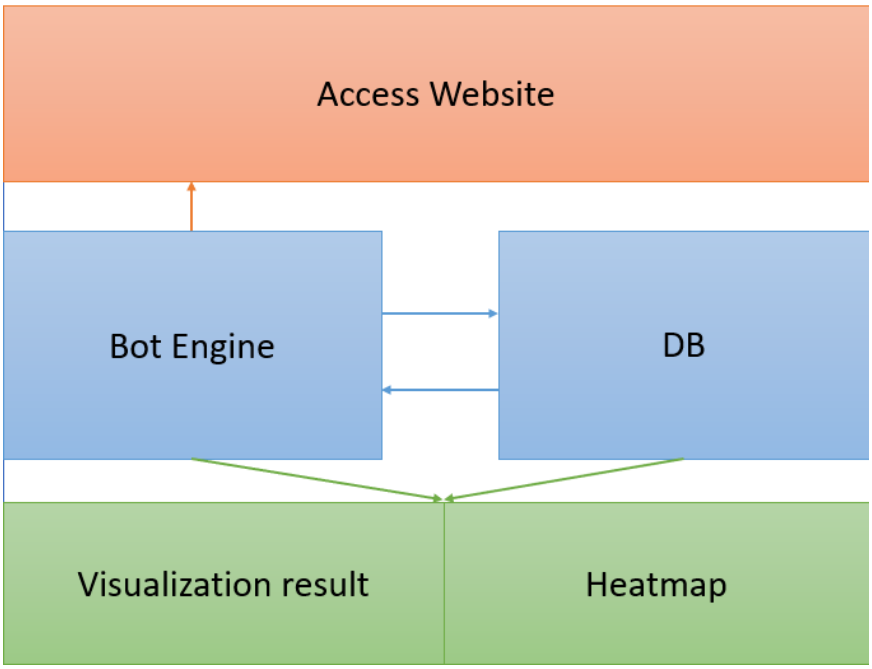


Figure 3.5: General architecture for data collection

In addition to the user experience parameters, the data collection time and status (success or Fail) were recorded for evaluating the robotic process automation efficiency compared with other common testing methods.

3.5.3. Data Analysis and Visualization

The user experience analysis was conducted using the analysis bot, while the results were presented using tabular and graphical visualization methods. A results presentation dashboard was added on the framework and connected with the system database. Furthermore, a descriptive statistical analysis was used to present the general statistics such: Average, percentages, and frequencies.

The usability measure success and fail percentage were calculated as indicated in equations 3.1 and 3.2. The success or failure rates were calculated by dividing the total number of successes by the total number of trails, multiplied by 100.

$$Success\ Rate = \frac{number\ of\ measure\ success}{total\ number\ of\ measures} \times 100\% \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ 3.1$$

$$Failure\ Rate\ = 1 + \frac{Number\ of\ measure\ fail}{Total\ number\ of\ measures} \times 100\% \qquad \text{……..3.2}$$

The results compared with the HCI standards and guidelines. According to the usability measures, the website should always preserve a consistent navigation menu, footer, header, logo and web page structure across the whole website pages. The inconsistency in these elements or graphical interface elements will lead to usability violation. The usability parameters standards used in our framework were listed in table 3.1, which was used as a reference for the bot to analyze the user experience results.

3.5.4. Layout

A website is often divided into header, navigation menu, content and footer, however there are many different types of layouts that developers can choose to design the website, but the most common layout is the 2-3 columns pages as it is more suitable for responsive design [61]. Figure 3.6 illustrates the common page layout design.

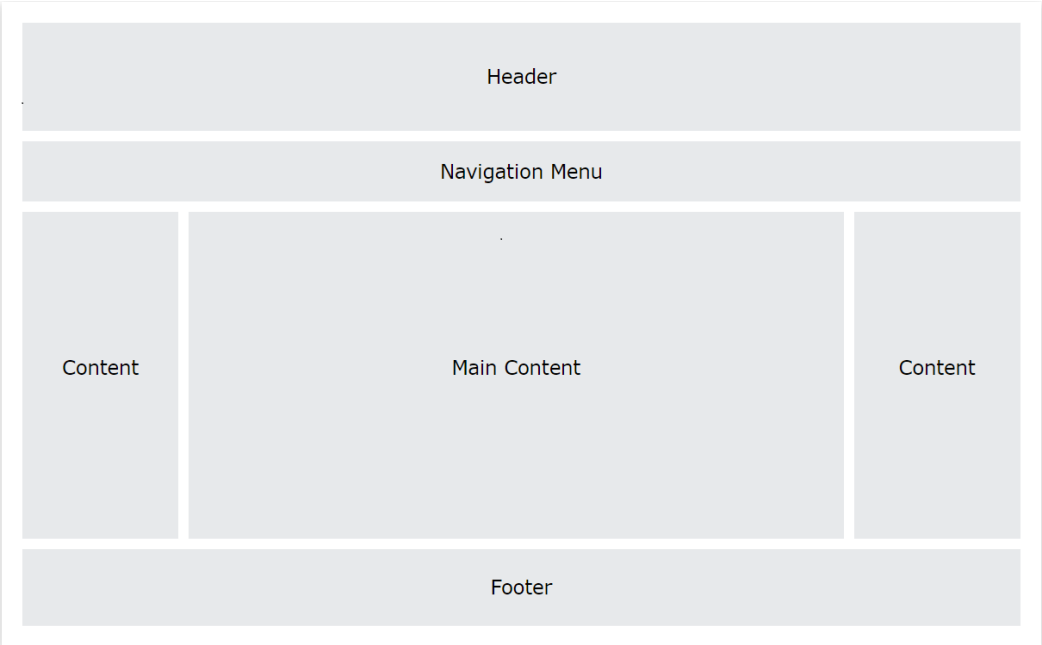


Figure 3.6: The common layout for web page [61]

Generally, there are three common methods are used to design multi column layouts: the bootstrap, the CSS float property using float and clear properties, in which the CSS flexbox in this layout elements that behaves predictably when the page layout must accommodate different screen sizes and different display devices, and the CSS grid layout that offers a webpage in form of rows and columns [62].

In our framework, we used a reconstruction approach for redesigning the page layout from the cloned source code in order to validate the bot functions. The reconstruction approach provides us with detailed information whether the original design followed the common layout design, and whether the other design elements (position, content, divisions, width, height, right left margins, ..etc.) were designed according to the HCI standards for user experience validation.

3.5.5. Heatmap

Heatmap is a data visualization technique that shows the magnitude of a phenomenon using the color mapping technique [63]. Heatmap method was used in website usability testing for tracking the user activities by users clicks and scrolls intensity [64]. Figure 3.7 shows an example for user clicks heatmap. In our framework design the JavaScript heatmap library was used to map the failure positions and inconsistent design elements [58]. The framework displays the user experience issues on the reconstructed webpage using color mapping, which provides developers with feedback on the vulnerable usability issues.

The bot used the exact or approximated points marking approach for mapping the failures issues. The padding or margins used the exact position marking, while the images or navigation tabs used an approximated approach as it is difficult to reconstruct the same position, especially when the tabs and image sizes are different and unbalanced.

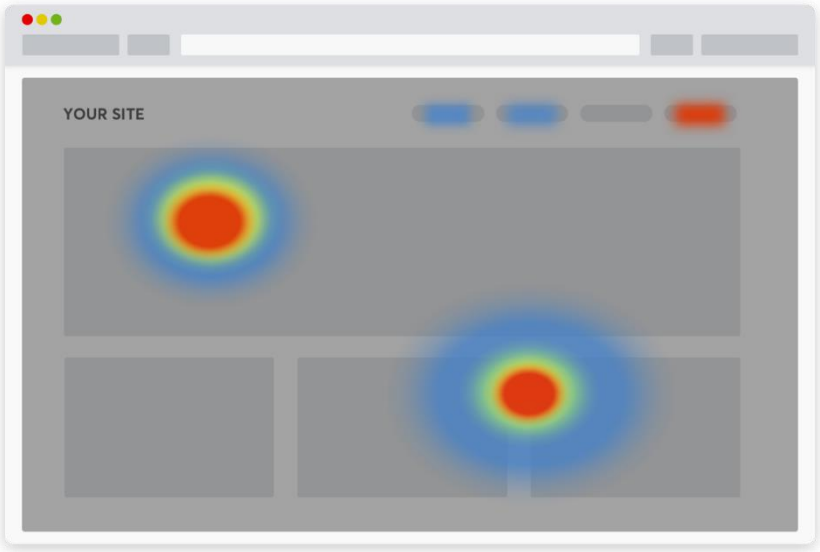


Figure 3.7: An example for user clicks heatmap

Chapter 4: Results and Analysis

4.1. Usability testing using bot

The Robotic Process Automation (Bot Programming) user experience framework was tested and evaluated on locally developed websites. The framework examined the user experience of web pages design for 11 websites, including higher education institutions, governmental and news and media businesses. For each website, the home and about pages were tested and evaluated.

4.1.1. Web Page Structure Testing and Analysis

Results in table 4.1 shows the Bot analysis results of universities webpages header (Logo) analysis. Table 4.1 indicates a success rate ranging from 28.6% to 85.7% and a failure rate ranging from 14.3% to 71.4%. U1, and U4 reported the highest failure rates (57.1% and 74.1%) respectively,

while the U2 and U3 reported the highest success rates (85.7 and 71.4%) respectively. The main header issues were found in the logo position and margin settings.

Table 4.1: Frequencies of User Experience Websites Logo Analysis for Higher Education Institutions

	Header (Logo)							
Parameters (PX)	**U1**		**U2**		**U3**		**U4**	
	Home	**About**	**Home**	**About**	**Home**	**About**	**Home**	**About**
Caption	Exist	Exist	Exist	Exist	Exist	Exist	Exist	Exist
Has a Link	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Position	56	56	42	42	0	0	16	16
Top Margin	0	0	6	6	6	6	0	0
Bottom Margin	0	0	6	6	30	30	0	0
Left Margin	0	0	110	110	-5	2	0	0
Right Margin	0	0	0	0	0	0	0	0
Success rate (%)	**42.9**	**42.9**	**85.7**	**85.7**	**71.4**	**71.4**	**28.6**	**28.6**
Fail rate (%)	**57.1**	**57.1**	**14.3**	**14.3**	**28.6**	**28.6**	**71.4**	**71.4**

Results in table 4.2 shows the navigation menu Bot analysis report, results indicated that U1 and U4 reported the highest success rates of Menu design 90.9%, while the U3 reported the lowest success rate of 63.6%. All the navigation menus don't exceed the number of menu items allowed. While most of the vulnerable issues are padding and margin settings.

Table 4.2: Frequencies of User Experience Websites Navigation Analysis Higher Education Institutions

Navigation								
	U1		**U2**		**U3**		**U4**	
Parameters (PX)	**Home**	**About**	**Home**	**About**	**Home**	**About**	**Home**	**About**
Position	166	166	154	154	130	130	36	36
Items	9	9	7	7	9	9	6	6
Main Content	Found	Found	Found	Found	Found	Found	Found	Found
Margin-bottom	0	0	0	0	0	0	0	0
Margin-left	8	8	3	3	-10	2	99.6	99.6
Margin-right	8	8	3	3	0	0	99.6	99.6
Margin-top	1	1	0	0	19	19	6	6
Padding-bottom	6	6	5	12	8	8	6.4	8
Padding-left	30	30	12	12	0	0	5	5
Padding-right	47	47	12	12	0	0	5	5
Padding-top	7.8	7.8	5	12	12	12	38.4	8
Success rate (%)	**90.9**	**90.9**	**81.8**	**81.8**	**63.6**	**63.6**	**90.9**	**90.9**
Fail rate (%)	**9.1**	**9.1**	**18.2**	**18.2**	**36.4**	**36.4**	**9.1**	**9.1**

Table 4.3 indicates a success rate range from 75% to 100% and a failure rate ranging from 0% to 25%. Only the universities' homepages' carousels were analyzed because carousels usually exist only on the home page. The Carousel analysis includes the webpage appearance, position, number of images and Navigation menu, all websites carousel design was consistent with the HCI standards, except the U3 website that uses images more than the allowed number of images as indicated in table 3.1.

Table 4.3: Frequencies of User Experience Websites Carousel Analysis Higher Education Institutions

Carousel								
	U1		**U2**		**U3**		**U4**	
Carousel (PX)	**Home**	**About**	**Home**	**About**	**Home**	**About**	**Home**	**About**
Appearance	Exist	-	Exist	-	Exist	-	Exist	-
Position	205	-	154	-	199	-	64	-
Number of images	3	-	2	-	13	-	2	-
Navigation	Exist	-	Exist	-	Exist	-	Exist	-
Success Rate (%)	**100**		**100**		**75**		**100**	
Fail rate (%)	**0**		**0**		**25**		**0**	

Table 4.4 shows the web pages footer analysis, results indicated that U1 and U3 reported the highest success rates (100% and 87.5%), while U2 and U4 reported lower success rates of 75%. The highest failure rate was found in U3 and U4 (25%). The results indicated that the position, content, and navigation links are the most vulnerable issues in the web pages design.

results in table 4.5 shows the header bot analysis results of governmental web pages. The header analysis indicated that the M1, M2 and M3 reported a success rate of 71.4%, while M2 reported the highest failure rate of 42.9%. The webpages user experience issues were found in the caption., position and margin design settings.

Table 4.4: Frequencies of User Experience Websites Footer Analysis Higher Education Institutions

Footer								
	U1		**U2**		**U3**		**U4**	
Parameters	**Home**	**About**	**Home**	**About**	**Home**	**About**	**Home**	**About**

Content / contacts	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Content / copyright	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Content / jobs	Yes	Yes	No	No	No	No	No	No
Content / newsletter	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Content /logo	Yes	Yes	No	No	Yes	Yes	No	No
Content /social media	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Position (PX)	507	1451	3330	982	2190	1874	5680	5006
Content / navigation (links)	12	12	12 l	12	8	8	23	23
Success Rate (%)	**100**	**100**	**75**	**75**	**87.5**	**87.5**	**75**	**75**
Fail Rate (%)	**0**	**0**	**25**	**25**	**12.5**	**12.5**	**25**	**25**

Table 4.5: Frequencies of User Experience Websites Logo Analysis for Governmental Institution

Header (Logo)				
Logo Parameters (PX)	**M1**	**M2**	**M3**	**M4**
Caption	Not exist	Not exist	Exist	Exist
Has a link	Yes	Yes	Yes	Yes
Position	0	20	0	20
Top Margin	9	12	10	10
Bottom Margin	9	0	0	0
Left Margin	8	0	-1	0
Right Margin	174.6	105	15	10
Success rate (%)	**71.4**	**57.1**	**71.4**	**71.4**
Fail rate (%)	**28.6**	**42.9**	**28.6**	**28.6**

Results in table 4.6 shows the navigation menu Bot analysis report, results indicated that M2 and M4 reported the highest success rates of Menu design 90.9%, while the M1 and M3 reported the lowest success rate of 63.6% and 72.7% respectively. M1 exceeded the allowed number of items, while the margin and padding settings were the most vulnerable user experience issues found in web pages design.

Table 4.6: Frequencies of User Experience Websites Navigation Analysis for Governmental Institution

Navigation				
Navigation Parameters (PX)	**M1**	**M2**	**M3**	**M4**
Position	100	19	61	102
Items	10	5	6	9
Main Content	Found	Found	Found	Found
Bottom Margin	0	0	0	10
Left Margin	0	2	-1	5
Right Margin	0	7	10	5
Top Margin	2	29	-1	8
Bottom Margin	7	6	8	20
Left Padding	15	20	6	30
Right Padding	15	20	35	3
Top Padding	7	5	0	20
Success rate (%)	**63.6**	**90.9**	**72.7**	**90.9**
Fail rate (%)	**36.4**	**9.1**	**27.3**	**9.1**

Table 4.7: Frequencies of User Experience Websites Carousel Analysis for Governmental Institution

Carousel				
Carousel Parameters	**M1**	**M2**	**M3**	**M4**
Appearance	Exist	Exist	Exist	Exist
Position (px)	136	200	142	162
Number of images	8	8	6	4
Navigation	Exist	Exist	Exist	Exist
Success rate (%)	**75**	**75**	**75**	**100**
Fail rate (%)	**25**	**25**	**25**	**0**

Table 4.7 indicates a success rate range from 75% to 100% and a failure rate ranging from 0% to 25%. Only the governmental' homepages' carousels were analyzed because carousels usually exist only on the home page. The Carousel analysis includes the webpage appearance, position, number of images and Navigation menu. Only the M4 website carousel design was consistent with the HCI standards, while the M1, M2 and M3 reported vulnerable usability issues.

Table 4.8 shows the web pages footer analysis, results indicated that M1 and M3 reported the highest success rates (75% and 87.5%), while M2 reported the lower success rates of 62.5%. The highest failure rate was found in M2 (37.5%). The results indicated that the content (job, newsletter and logo),position, and navigation links are the most vulnerable issues in the web pages design.

Table 4.8: Frequencies of User Experience Websites Footer Analysis for Governmental Institution

Footer				
Parameters	**M1**	**M2**	**M3**	**M4**

(PX)				
Content / contacts	Yes	Yes	Yes	Yes
Content / copyright	No	Yes	Yes	Yes
Content / jobs	No	No	No	No
Content / newsletter	Yes	No	Yes	Yes
Content /logo	Yes	No	Yes	No
Content /social media	Yes	Yes	Yes	Yes
Position	1152	2601	1790	1823
Content / navigation (links)	16	4	29	8
Success rate	**75**	**62.5**	**87.5**	**75**
Fail rate	**25**	**37.5**	**12.5**	**25**

Finally, three media agencies were tested by collecting results for the web pages' main section. Although in all samples, no website has a carousel on the homepage, tables 4.9, 4.10, and 4.11 present the result for the website's logo, navigation, and footer sections. All media -news agencies have no carousel on their home pages.

Table 4.9: Frequencies of User Experience Websites Logo Analysis for Media

Header (Logo)			
Parameters (PX)	**N1**	**N2**	**N3**
Caption	Exist	Exist	Exist
Has a link	Yes	Yes	Yes
Position	55	111	107
Top Margin	-110	0	38
Bottom Margin	0	0	0
Left Margin	0	41.1	46

Right Margin	0	41.1	0
Success rate (%)	**57.1**	**71.4**	**71.4**
Fail rate (%)	**42.9**	**28.6**	**28.6**

Results indicate a success rate ranging from 57.1% to 71.4%. The News agencies' homepages reported high failure rates ranging from 28.6 to 42.9%, which is considered very critical in web pages design. The position and margins were the main vulnerable issues found in the media pages.

Table 4.10: Frequencies of User Experience Websites Navigation Analysis for Media

Navigation			
Parameters (PX)	**N1**	**N2**	**N3**
Position	0px	111px	531
Items	6	20	8
Main Content	Exist	Exist	Exist
Bottom Margin	auto	0	0
Left Margin	0	41.1	0
RightMargin	0	5	0
Top Margin	auto	7.5	0
Bottom Padding	6	10	0
left Padding	6	6.6	46
Right Padding	6	6.6	259.6
Top Padding	6	0	38
Success rate (%)	**81.8**	**63.6**	**45.5**
Fai rate (%)	**18.2**	**36.4**	**54.5**

Table 4.10 indicates a success rate ranging from 45.5% to 81.8% and a failure rate ranging from 18.8% to 54.5%. N1 and N2 had the highest success rates, while N3 reported the highest failure rate of 54.2%. The position, number of items, margin and padding settings were the most vulnerable usability issues found in the media web pages.

Table 4.11 shows the footer bot analysis results. The analysis reported footer design low success rates ranging from 12.5% to 62.5% and high failure rates ranging from 37.5% to 87.5%. N3 reported the highest failure rate (87.5%), in which most of the HCI usability issues were not found. The media websites footer design had vulnerable issues in position, margin and content design.

Table 4.11: Frequencies of User Experience Media Websites Footer Analysis

Footer			
Footer Parameters	**N1**	**N2**	**N3**
Content / Contact	No	No	No
Content / Copyright	Yes	Yes	Yes
Content / Jobs	No	No	No
Content / Newsletter	No	No	No
Content / Logo	Yes	Yes	No
Content / Social Media	Yes	Yes	No
Position	8225px	8866px	No
Content / Navigation	0	13	0
Success rate (%)	**50**	**62.5**	**12.5**
Fail rate (%)	**50**	**37.5**	**87.5**

4.1.2. Web Page Body Testing and Analysis

Web pages body sections were tested and analyzed using the Bot analysis framework. The results in table 4.12 shows the body blocks analysis on a sample of selected websites. The body analysis included the font size and color, background, content padding, margins, images and links. The results showed that the governmental and media website had vulnerable usability issues in the page body design, while the university webpages are more consistent with HCI standards.

Table 4.12: Samples of Frequencies of User Experience Websites Body Analysis –U2 (Home page), M2, N1

Body			
Parameters	**Samples**		
(PX)	**U2**	**M2**	**N1**
Font size	14, 16, 26	10, 12, 14, 25	14, 15
Background color	RGBA (0, 0, 0, 0)	RGB (242, 242, 242) / RGB (255, 255, 255)	RGB (0, 0, 0) / RGB (255, 255, 255)
Font color	RGB (51, 51, 51)	RGB (51, 51, 51) for both background colors	RGB (255, 255, 255) / RGB (0, 0, 0)
Top Padding	6	17	9
Left Padding	8	15	9
Bottom Padding	6	15	9
Right Padding	5	15	9
Content /image	No	Yes	Yes
Content /links	Yes	Yes	Yes
Top Margin	15	14	10
Left Margin	179.6	5	0

Bottom Margin	7	15	9
Right Margin	179.6	126.6	0

4.1.3. GUI Testing and Analysis

A comparison for all samples in terms of logo, navigation, carousel, and footer was made. Figure 4.1 shows frequencies of UX logo analysis for all tested samples, figure 4.1 indicates all tested samples have a problem in logo section but, U2 reported the highest success frequency while, U4 reported the highest failure frequency.

Figure 4.2 shows frequencies of UX navigation analysis for all samples. It indicates U1, U4, M2, and M4 have the highest success frequencies but, N3 reported the highest failure frequency in navigation. In general, figure 4.2 indicates universities and ministries match UX rules more than news agencies.

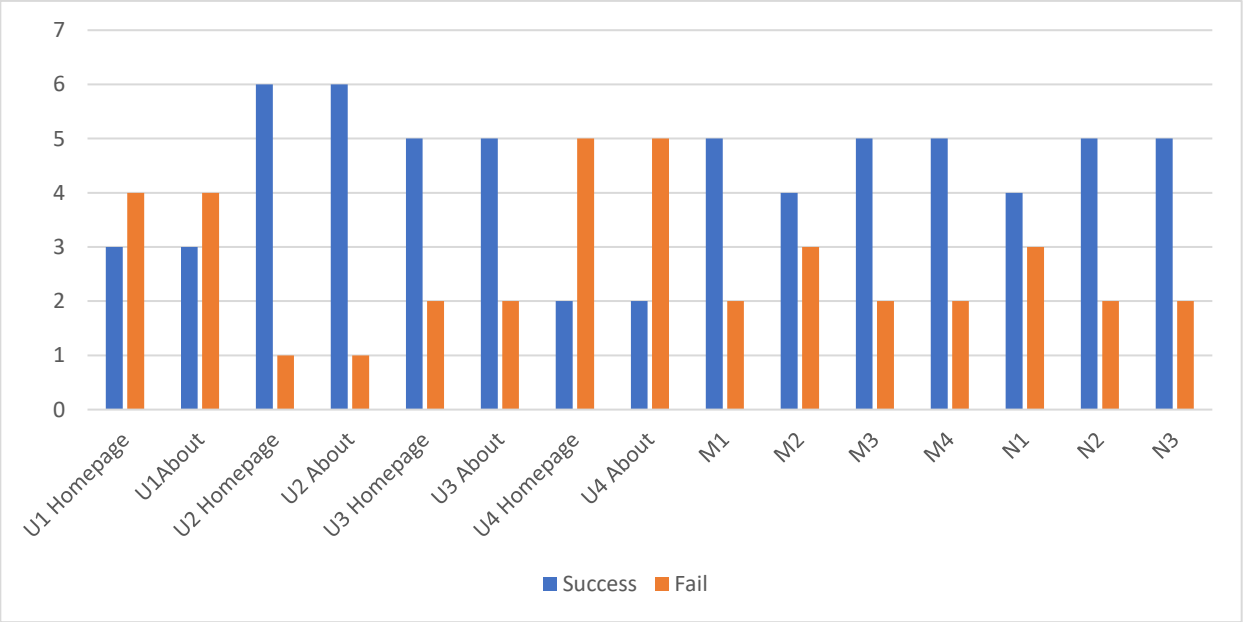


Figure 4.1:Frequencies of UX logo analysis for all samples

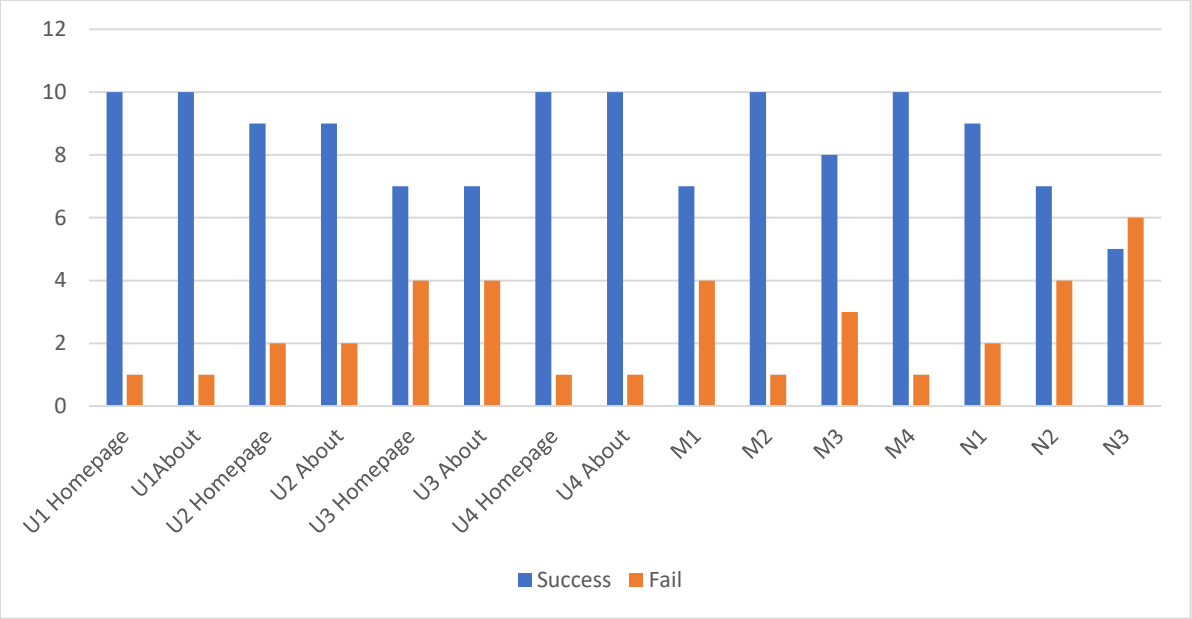


Figure 4.2:Frequency of UX navigation analysis for all samples

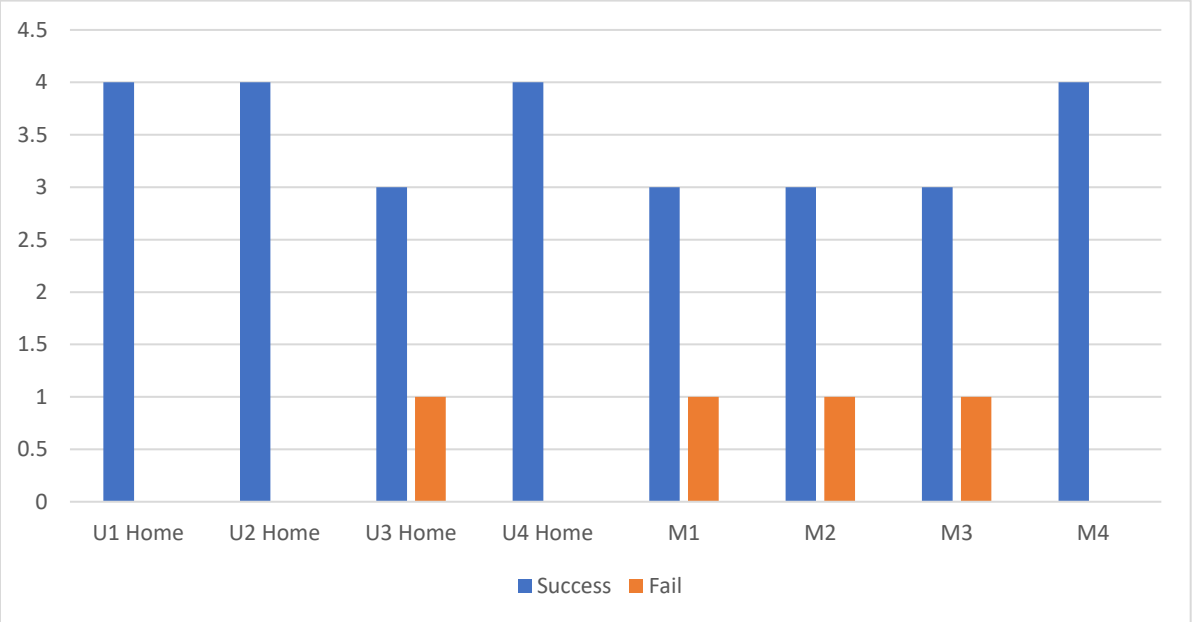


Figure 4.3: Frequencies of UX carousel for all samples

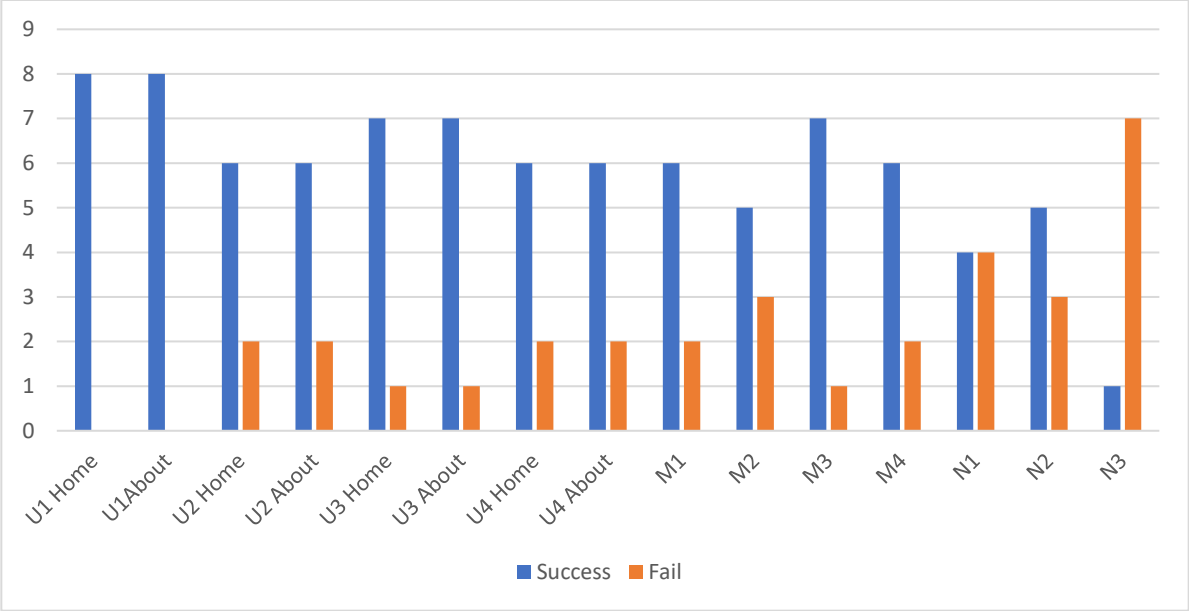


Figure 4.4: Frequencies of UX footer for all samples

Figure 4.3 shows the frequencies of UX carousel for all samples and shows that carousel appears only in homepages of websites, while media – news agencies have no carousel on their homepages. Also, it illustrates that all ministries except M4 and U3 have HCI violations in the carousel due to low fail frequencies.

Figure 4.4 depicts frequencies of UX footer measures for all samples. Figure 4.4 shows all news agencies have problems in their footer designs due to high fail frequencies, while universities and ministries are more consistent with HCI standard due to low fail frequencies.

4.2. Layout

In this research, we display the general layout of the webpage to find whether the tested website is following the general layout of a webpage or not. More details about this feature are available in section 3.4.3.4. Table 4.13 describes each webpage, whether it follows the common layout, and which content layout the webpage follows 1, 2, or 3 columns.

Table 4.13: Layout classification for tested webpage.

Website	Webpage	Common layout?	Content layout type (Column/s)	Notes
U1	Home	Yes	1	
	About	Yes	2	
U2	Home	Yes	1	
	About	Yes	2	
U3	Home	Yes	1	
	About	Yes	2	
U4	Home	No	1	Logo and navigation at
	About	No	1	same level
M1	Home	Yes	2	
M2	Home	Yes	1	
M3	Home	Yes	2	Some columns also contain 2 columns layout
M4	Home	Yes	1	Each column has multiple column content block (3 to 4 columns)
N1	Home	No	Mixed (1 & 2)	Navigation on top of logo
N2	Home	No	Mixed (1,2 & 4)	Logo besides navigation
N3	Home	Yes	Mixed (2 & 3)	

Table 4.13 indicates all universities' websites follow the common page layout with content layout type 1 column for home page and 2 columns for about page. All ministries follow the common layout with content type 1 and 2 columns but, there is mixed content type in some ministries as M4 which has 1 columns layout multiple body block but some of these blocks have 3 to 4 columns content layout.

Figures 4.5 and 4.6 depict the layout for U2 about page and M3 respectively. Figure 4.5 depicts U2 follows the common layout structure with body content 2 columns type, while figure 4.6 indicates M3 follows the common general layout but it has mixed body content type especially in column 2 body content that has one and two columns content structure.

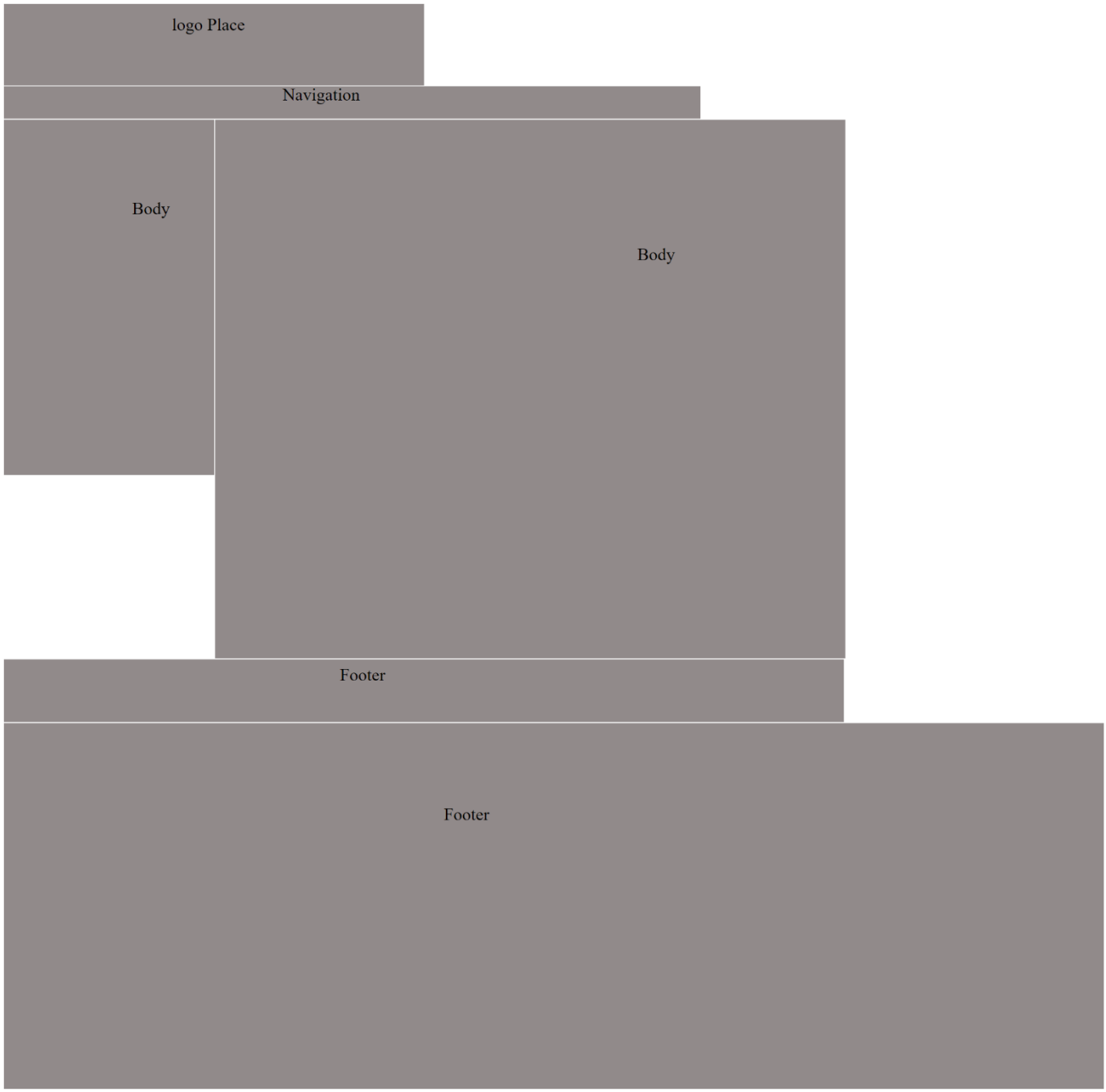


Figure 4.5: Layout structure for U2 about page

Figure 4.6: Layout structure for M3

4.3. User Experience Results Comparison Using Bot Framework

This feature is used to compare the result of two web pages on the same website to compare whether the website is consistent or not regarding a specific section. For example, figure 4.7 depicts the results of U1 home and about pages regarding navigation that show the website is consistent regarding navigation.

U1 Navigation Results			
U1 Homepage	**U1 About Page**	**Final result**	
Position	166	166	Success
total tabs	9	9	Success
content	found	found	Success
padding-top	7.8px	7.8px	Success
padding-bottom	6px	6px	Success
padding-left	30px	30px	Success
padding-right	47px	47px	Success
font family	font found: Lato, "Helvetica Neue", Arial, sans-serif	font found: Lato, "Helvetica Neue", Arial, sans-serif	Success
margin-top	1px	1px	Success
margin-bottom	0px	0px	Success
margin-left	8px	8px	Success
margin-right	8px	8px	Success

Figure 4.7: Comparison result between U1 home and about pages in term of navigation

This feature represents the UX result in the form of statistical values that indicate the success and fail rates for each section of the website. For example, figure 4.8 depicts the result for the U3 home page.

4.4. Statistical Result

This feature represents the UX result in the form of statistical values that indicate the success and fail rates for each section of the website. For example, figure 4.8 depicts the result for U4 home page.

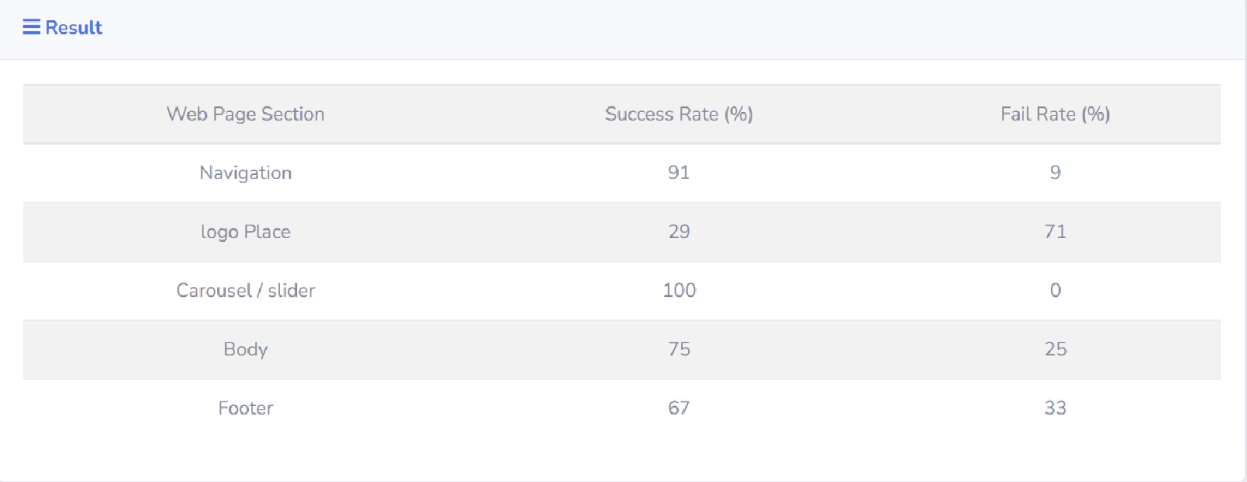


Figure 4.8: Statistical result for U4 homepage as presented in the framework

4.5. Heatmap

Heatmap represents the usability measures that have usability issues in the web page by drawing a mark in the position of the problem. Heatmap was generated for each tested webpage. Figure 4.9 depicts the heatmap for U2 about page. Figure 4.9 shows the fault position marked in red based on failures position.

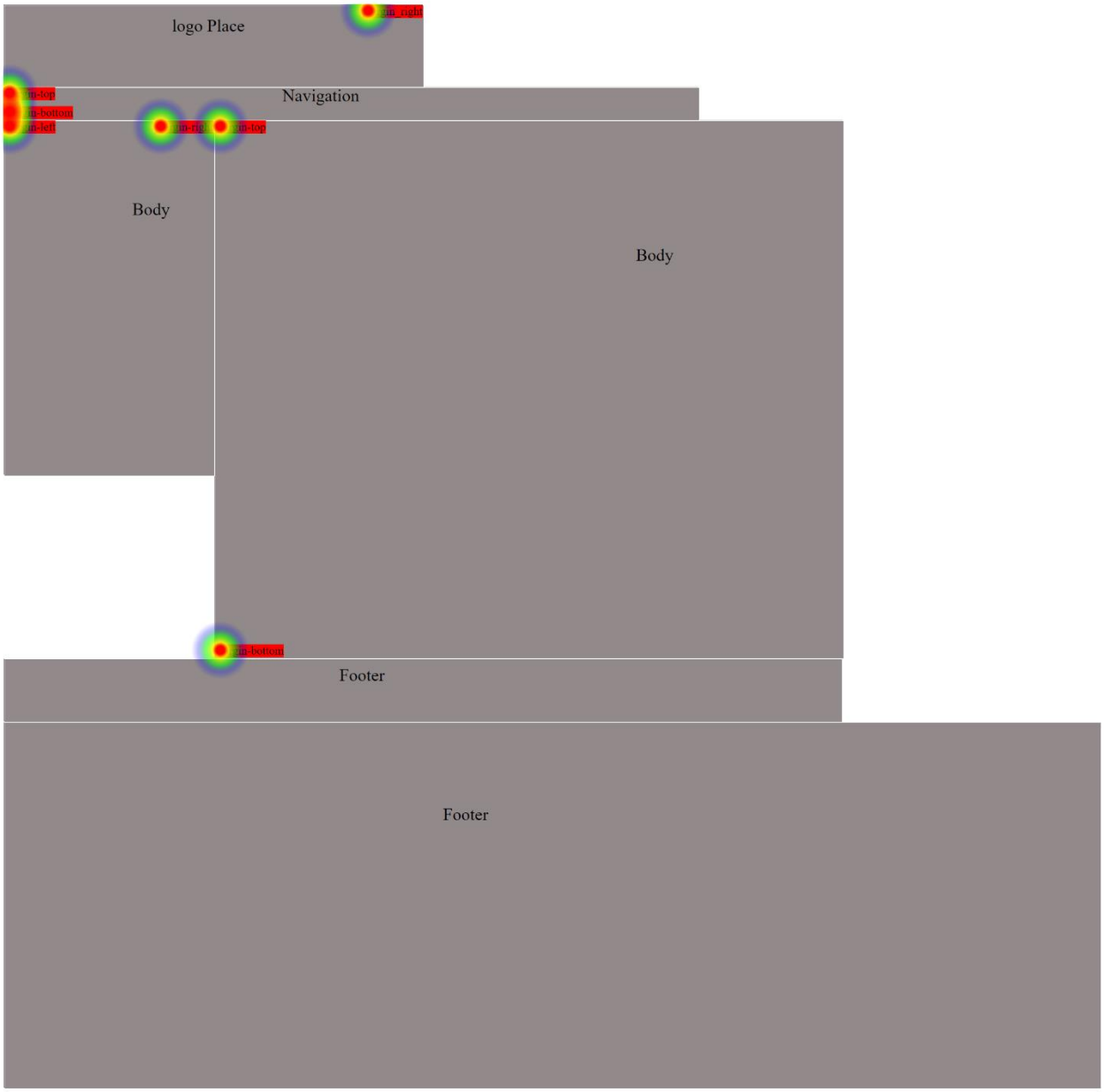
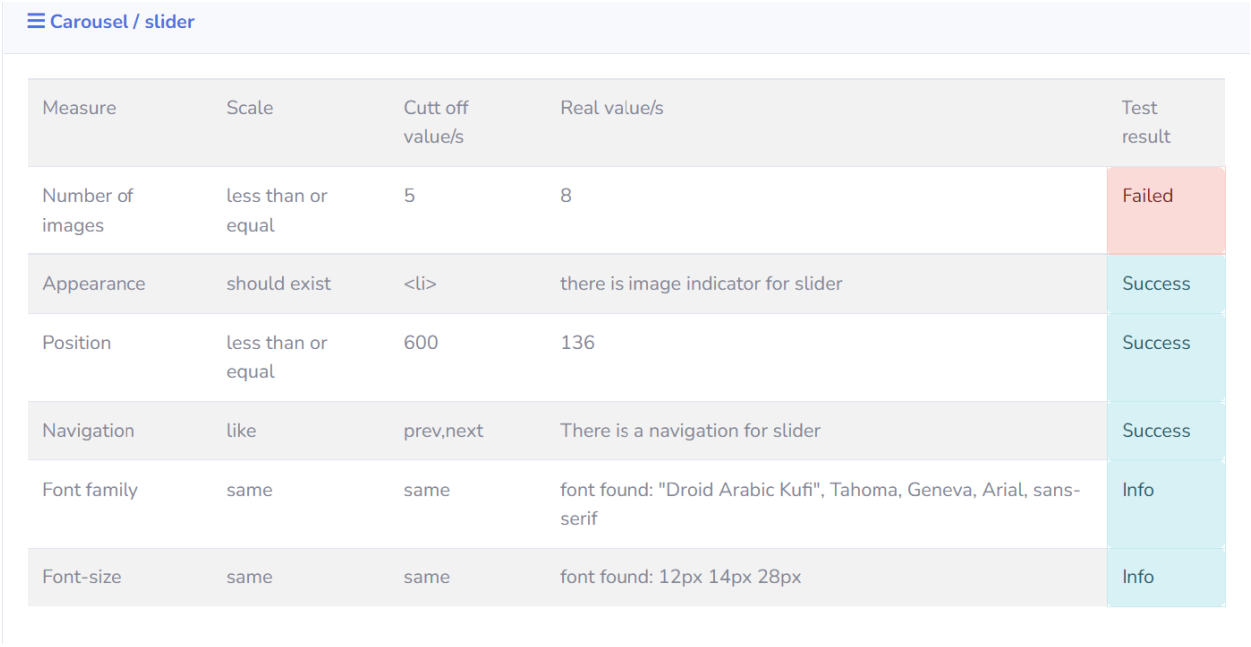


Figure 4.9: Heatmap for U2 about page

4.6. Tabular view

Platform displays result in tabular form that displays the result and marks success and failed measures that help the user find the usability violation. For example, figure 4.10 depicts the result as a tabular report for the M1 carousel.



☰ Carousel / slider

Measure	Scale	Cutt off value/s	Real value/s	Test result
Number of images	less than or equal	5	8	Failed
Appearance	should exist		there is image indicator for slider	Success
Position	less than or equal	600	136	Success
Navigation	like	prev,next	There is a navigation for slider	Success
Font family	same	same	font found: "Droid Arabic Kufi", Tahoma, Geneva, Arial, sans-serif	Info
Font-size	same	same	font found: 12px 14px 28px	Info

Figure 4.10: M1 carousel result in tabular form

Chapter 5: Discussion and Conclusion

5.1. Discussion

An automated UX platform was developed using RPA to check the website's usability for the five main sections: logo, navigation, carousel, body, and footer, which corresponds with our objectives. The platform is suitable for Arabic and English websites and was developed based on Nielsen guidelines.

Many studies use different techniques, whether user-based or automated, to discover the extent that the website meets HCI standards. However, as discussed in Chapter 2 literature, the challenge of user-based techniques is the time, effort, and cost needed to perform the testing. Moreover, automated processes usually focus on one UX measure, such as accessibility, performance, or others. Currently, researchers use more than one tool to check the usability, creating a lack of comprehensive automated tools that check the usability from different aspects. Additionally, automated tools don't focus on measuring the usability of websites in terms of design and layout, unlike this research.

We found that the usability of websites in Palestine of the three main categories tested in this research needs to be enhanced. Furthermore, the results of this research match the result found by Chow, A. S., Bridges, M., & Commander [65], which tested the usability of a library website based on Nielsen guidelines utilizing a usability checklist and survey. This study matches our research regarding the navigation position horizontally on top, in other words, with the logo position on top of the webpage with the contact information and sitemap at the bottom of the webpage. Contrary to current research on overall usability for logos, in this research, the logo on all websites has an unfavorable success rate due to missing alternative text for logo or margins and paddings zero values. Our results also match another search for navigation, logo, and footer content like contact and sitemap [66]. Another study [22] highlights websites' usability issues that should be considered when designing a usability framework for an Arabic-English website, and this differs from our study, which concluded that there are no specific styles or main categories in the

navigation menu of the websites. Still, in contrast, it matches the recommended framework that advises top horizontal navigation.

We found mixed font sizes on the same body block for font size and color. In general, more than one font size may be available since the block may have a heading and body but based on standard practice, it is not acceptable to have four or more font sizes in the same body block. This result matches another search result that found a mixed font size on a tested university website [30].

5.2. Conclusion

This thesis has presented new usability testing techniques using Robotic Process Automation based on Nielsen HCI guidelines that discover the usability violation in terms of website layout in five main sections: logo place, navigation, carousel, body, and footer.

The main focus of this research is to decrease the time, cost, and effort needed to test the usability of websites and to automate usability testing instead of standard techniques like human experts or experimental methods.

The proposed tool has significantly contributed to HCI usability testing by using RPA. Chapter 3 describes the structure and method used in this tool to test the usability of web pages. In addition, this tool proves the ability to explore the usability violations and visualize the usability results in different techniques. On the other hand, this tool has proven successful in testing Arabic and English websites, especially since there is a lack of tools suitable for languages other than English.

Based on the results in Chapter 4, Palestinian websites, especially in the three main fields tested, educational (universities), governmental (ministries), and media (news agencies), require enhancement in their usability from different aspects. They should also follow the common website layout users expect when browsing the website.

5.3. Research Limitation

At the beginning of research, on prem automation anywhere 360 used to design the bot but at some point, we needed some packages that exist only in the advanced version which is cloud RPA so we were forced to migrate to cloud version with re-built some features in bots.

In some websites, we couldn’t collect computed styles for all CSS properties, so we decreased the number of CSS attributes to minimum essential attributes that we need in this research.

In sample selection, we prefer to select websites with front end developed using bootstrap because bots support this type of design better because it is easier to learn Bot how to extract UI with bootstrap from other methods.

5.4. Future work

Different tests for other websites are intended to be conducted considering new measures like color matching and new sections like utility navigation, search, and others until a comprehensive tool is reached using RPA.

We seek to expand the scope of this tool to test the usability of websites in terms of efficiency and effectiveness by mimicking human interaction to accomplish tasks on a website or web-based systems using RPA bots which decrease the cost, time, and effort of conducting usability experiments.

Getting an optimal layout for a tested website also can be obtained using RPA by learning how to match the actual layout structure and how it should be to have an optimal usable website.

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