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Investigation into Carousel Interaction

Rashika Tasnim Keya

S329930

Department of Computer Science
Faculty of Technology, Art and Design

OSLOMET

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Abstract

This research is about the accessibility and usability of web carousel. There are several kinds of Carousel available that are being used in different parts of a website. But enough research is yet to be done to find out whether carousel is universally accessible & usable or not. This research is pushed three research questions and throughout the research it is tried to find out the answer of those questions.

Experimental quantitative method had been implemented for this study. Total of 40 users participated in this experiment. Two web site prototypes were designed for this purpose, only differing for the presence of carousel and without carousel to compare the accessibility and usability of a carousel. The experiment is divided into two sections, one is during the experiment and another is post-experimental questionnaires. The post-experimental questionnaires are designed on a Likert-type scale. By comparing task spent time, error & post-experimental questionnaire responses, the comparison between those two prototypes has been measured.

This study especially focused on desktop view of a carousel. The whole experiment was conducted from a laptop, it didn't consider the mobile view of a carousel. The overall result indicated that carousel might not the best way to present important contents of a website. Users mostly get confused when they use carousel prototype for the first time. Carousel has many accessibility and usability issues which suggested that it is better to avoid using carousel on any kind of website.

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1. Introduction

Carousel is becoming one of the most highly used web elements, especially for an e-commerce website or for home page decoration. Carousels are almost like a slider on a website where a designer can place multiple images on specific space to display visual content. Some carousel is automatically rotated with a range of seconds between highlighted content, whereas some are not, users have control to rotate those images. There is some mixed-format available out there where it has an automatic presentation of the content but, at the same time, allows a user to manipulate the content. Some carousels are used at the top of the homepage, and this is called homepage carousel. Some carousels are used in the business website to display products. Carousels are being used in different ways on different websites. There aren't any defined rules to use a web carousel. Some carousels have only images, while some have mixture of images and information. According to (Pernice K, 2013), carousel usually presents the following characteristics:

- Appear at the top of the main page of the website (homepage);
- Occupies a substantial part of the visible part of the website (page fold);
- There is a navigation option for some carousel. The navigation is typically done horizontally, although some navigation is done vertically via thumbnails in desktop versions.
- The contents presented in each frame with a large picture and a small amount of text.

The percentage of using web carousel indicates that designers use carousel very often on web pages and think this can increase the conversions rate (Baymard Institute , 2016) whereas from literature reviews it has been seen that researchers think that most of the time, carousels are not user-friendly. For that reason, it decreases conversions because they distract users, especially when it's placed on the top of the web pages. Enough research is yet to be done on this sector; few researches has been done regarding automatic carousel and manual carousel, but the usability of the carousel or how accessible it is to the user is still under discussion.

Therefore, research should be done to investigate the carousel interaction with the user as well as find out the accessibility of it.

1.1 Accessibility & usability

Tim Berners-Lee (W3C Director and inventor of the World Wide Web) has defined accessibility as "The power of the Web is in its universality. Access by everyone regardless of disability is an essential aspect" (w3org). Hence, A Web site can be said to be accessible if it can be used by everyone, including people with A ensures graceful transformation, and it makes content understandable and navigable (it should present its content in a clear and straightforward language, and should provide understandable mechanisms to navigate within and between pages) (Barbara Leporini, 2003).

Usability determined by user satisfaction. From ISO9242 standard, usability defines as "the effectiveness, efficiency and satisfaction with which specified users achieve specified goals in particular environments", where:

- Effectiveness means "the accuracy and completeness with which specified users can achieve specified goals in particular environments;
- Efficiency means "the resources expended concerning the accuracy and completeness of goals achieved";
- Satisfaction means "the comfort and acceptability of the work system to its users and other people affected by its use". (ISO, 2012)

1.2 ISO Based Analysis

ISO brings together experts to share knowledge, to make market-relevant international standards that support innovation and provide solutions to global challenges. They give world-class specifications, products, services, and systems. ISO has published 22631 international standards and related documents that cover almost every industry from technology to agriculture. They began their journey on 23 February 1947. ISO derived from the Greek ISOS, meaning equal, which means whatever the country or whatever the language, they are always ISO. (ISO, 1947)

“ISO is an independent, non-governmental international organization

With a membership of 164 national standard bodies". - (ISO, 1947)

In 2012, World Wide Web Consortium (W3C) and the joint technical committee JTC 1, ISO and the International Electrotechnical Commission (IEC) announced the approval of the web content accessibility guidelines (WCAG) 2.0 as an ISO/IEC international standard (ISO/IEC 40500:2012) (ISO, 2012).

ISO/IEC 40500:2012 covers a wide range of recommendations for making web content more accessible for everyone, including people with disabilities, blindness, low vision, deafness, hearing loss, learning disabilities, cognitive limitations, speech disabilities, photosensitivity and combination of these. Following WCAG 2.0 success criteria guidelines will make any web content more usable to users in general.

According to the World Wide Web Consortium (W3C), carousel should follow or implement some guidelines to make it accessible for everyone. Designers should provide a robust structure and user control. Those four concepts are: (w3org)

- **Structure:** semantic structure has to be used in carousel to support the proper function of assistive technology.
- **Functionality:** They have to add functionality to display carousel items.
- **Animations:** transition animation between items is important and make sure that users can stop or resume it.
- **Styling:** styling the carousel in such a way that it's usable and readable by everyone.

WCAG 2.0 has some success criteria and techniques from different levels. W3 organization provide guidance on how to make carousel accessible in different situations following WCAG 2.0 success criteria.

General structure: Carousels are typically best represented as unordered lists, using and ; other elements can also be used, and it depends on the context. Every carousel should be enclosed in a labeled region so that users can find carousel easily.

Functionality: Functionality should be provided to select carousel items and to inform users about the change within the carousel.

Animations: users must have control over animations in the carousel. Therefore, it is mandatory to provide control to the users, so that they can pause and control movements of the items of the carousel.

Styling: Always use appropriately sized buttons, links, and provide whitespace around them to allow users with reduced dexterity to handle the carousel easily. For touch screen and mobile device users, it will help a lot. Indicate buttons or navigation button to the carousel are typically small. However, it is essential to understand their presence both in color & shape way.

Also, ensure sufficient color contrast between foreground and the background of text, links, and buttons

1.3 Problem statement

Carousel is considered a good way to present information on the webpage as this allows publishing a variety of news in the same page space. However, it is not proved whether it is the best way to present information on the webpage or not. It can become inappropriate and distracting when the focus of the user is another content within the webpage because of continuous movement and dynamism (Burke, Hornof, Nilsen, & Gorman, 2005). Carousel is mostly used to highlight some visual content within the webpage. The trend of using carousel is mostly on a business website or media website (Ribeiro, Eduardo, 2018). Not so much research has been done to investigate the usability of carousel interaction. Is carousel universally design for everyone or not, is it easy to interact with the users? Is it really the best way of presenting information on the website? When and where is the best fit to use carousel on a website.

Carousel could be effective if Systematic review will be done to evaluate the carousel usability, find out the issues, and solved those issues properly. For instance, research should be occurred to investigate the usability of carousel and to know if it's accessible for everyone or not. The problem is that everyone is using carousel in their own way without maintaining any standard. Research has been shown that 52% of the top US e-commerce sites have a carousel

on the homepage on their desktop site, while 56% of mobile e-commerce sites have homepage carousel (Baymard institute , 2015). It clearly shows that the percentage of people using carousel is huge, but most of the time, homepage carousel doesn't work well because of the lack of interactive usability.

Very few user testing and research have occurred in carousel investigation over the last few years. Web site optimizer, a well-known usability testing organization, has done some research and usability testing regarding carousel investigation, and they published an article based on those real data. In 2011, the digital user experience team member of British mobile company called EE limited ran a usability test based on a carousel, and he described his observation from many usability tests (Adam Fellowes, 2012).

According to Adam "Almost all of the testing I've managed has proven that content delivered via carousels are missed by most users. Few interact with them and many comments that they look like adverts — we've witnessed the banner blindness concept in full effect."

Nielsen Norman Group is an international research organization; they always research users based on experience. After doing some user testing on auto-forwarding carousels, they have found that users mostly skip the carousel part of the homepage (jakob Nielsen, 2013).

Carousel is one of the few elements on the web which is randomly used by designers without proper guideline. According to some research, it is clear that the way it is being used nowadays is not the proper way. Baymard Institute conducted a usability test for the past seven years on both desktop and mobile e-commerce websites. The test shows that homepage carousel can perform decently to the end users if they implement 10 requirements (Baymard Institute , 2016). Therefore, universal design and usability investigation into carousel interaction is such kind of topic that should be researched more to find out the gap and resolve it with proper evidence.

1.4 Research question

Previous concerns on the issues of this system don't consider the universal design of it and how important it is to display information on a webpage. Although some of the research

has been done on user testing and has collected data, some found out few problems, whereas others proposed some points and mentioned that if designer implements those points properly carousel will be accessible, user-friendly, and effective to the users. Still, there is a lot to do in this sector to find out the gap between the system and the users. This paper will try to find out important answers to some specific questions. Because of the popularity and usage of this visual interactive tool on the webpage, this thesis pushed the following questions:

“Is carousel universally accessible & usable for everyone?”

“Are there any benefits to use carousel on a business website? Are they easy to interact with the users?”

“Is carousel the most appropriate system to show important content on the homepage of the website?”

2. Literature Review

In this chapter, so far, the research that has been done regarding carousel are explained on literature research. The main objective of this chapter is to provide how much research has been done, the type of things they consider and what is left to do. Creating a solid foundation for the problem statement and understanding the gap between the system and user for further practical assessment is the expected outcome of this chapter. As it is mentioned earlier that not so much research has been done in this sector, this paper will provide the literature review from some articles and journal paper.

2.1 Web site Optimizers analysis

Web site optimizers are well-known proponents of usability testing. They have done real-time usability testing when users perform some tasks using carousel website. Usability experts watching them and observes the kind of difficulties they face while using a website and how they perform the tasks. Does it increase the conversion rate or not (Tom Bowen, 2016).

Based on usability testing, observers shared their experience after they ran their tests. Different observers have different speech, but the most common view of them was that carousel doesn't increase conversion rate. They recommended not to use carousel in website. Craig Kistler is the user experience & information architect manager at signet jewelers and also the founder of CRO firm strategy & Design. He has been watching user tests for more than 15 years; therefore, he has seen plenty of user tests, including landing page carousel. Craig shared this observation regarding carousel in 2013 (Tom Bowen, 2016).

After observing user testing, Craig Kistler said "In all the testing I have done, home page carousels are completely ineffective. In test after test, the first thing the visitor did when coming to a page with a large carousel is scroll right past it and start looking for triggers that will move them forward with their task."(Tom Bowen, 2016).

Lee Duddell is the founder of the London-based remote usability testing tool whatUsersDo. He's been observing usability testing for many years, including rotating sliders. Back in 2011, he

points his comments, and perhaps his comment was the strongest among all of them (Tom Bowen, 2016).

Lee Duddell said “They are next to useless for users and often ‘skipped’ because they look like advertisements. Hence, they are a good technique for getting useless information on a home page. Use them to put content that users will ignore on your home page. Or, if you prefer, don’t use them ever.” (Tom Bowen, 2016).

2.2 Carousel interaction studies

Usability Experts comment about carousel interaction in the above, but they didn’t provide any exact data. Now in this section, some actual data which has been performed by different organizations will be shown.

Beaconfire red is a digital marketing agency in Arlington, VA. As a marketing agency, they do many works with non-profit clients (Tom Bowen, 2016). They also conducted a study on the carousel website of four of their non-profit clients. They found out that these carousels were rarely interacted. Users, most of the time, ignore carousel. The Click-Through-Rate (CTR) of carousels on these four sites was below 1% in aggregate. Though most of the time, interaction was left to do, but when there was a click, it was the first slide of the rotation majority of the time (Tom Bowen, 2016).

In 2013, Erik Runyon, web developer from Notre Dame University, posted much detail study result regarding user interaction with web sliders. He tracked the number of times users interact with the carousel features. He conducted a study on the main ND website, and the results showed that only 1% of the visitors clicked on the carousel. And 84% of them clicked the very first slide of the carousel (Erik Runyon, 2013).

Swedish conversion optimization firm ‘conversionista’ ran an image slider test for online pet store Grizzly Zoo in 2012 (Tom Bowen, 2016). In that case, the home page had a large carousel, but it was replaced by static image, and then they conducted the test two times, one with carousel and another with a static image. They observed the CTR of the slider as well as they also used eye-tracking technology to analyze where users were focusing their attention while on the page. Users who use the carousel with the website did not click on it and avoid

image slider. But when users use the website with static image website, the eye-tracking data revealed “a drastically improved interest for the top area, and a substantial number of users also chose to click on the new version.” It has been shown that the version with the static image got over 40% clicks of all the time. The slider version got 2% of the click of the time. Technical University of Ostrava presented a study using eye-tracking techniques to investigate user reactions for content sliders (Michal Radecky, Pavel Smutný, 2014). The study was about how users react to different kinds of navigation and layouts of the sliding banners. From eye-tracking results, it is recommended to avoid using reduced-size versions of pictures (thumbnails) as they decrease the quality of cognition of the main image. It is also suggested that the combination of navigation arrows and visualization of the direct links to all the contained images (bullets, numbers) in the sliding banners are more effective. Also, the number of slides used in content is also important because it is seen that users are directly proportional decreases by the number of images.

Institute of Baymard had done some research on user-friendly homepage carousel. They ran a test and found some point on e-commerce homepage & category and Mobile usability studies on homepage carousel (Baymard Institute , 2016) Their UX benchmarks said from their recent research that only 28% of the top US and European e-commerce desktop sites have a carousel, whereas it was 32% when they measured it in 2016, and it was 52% in 2013. Therefore, it clearly shows that the uses of homepage carousel decline popularity on e-commerce sites, especially on the homepage.

In their study, they have researched on specifically 5 things and came out with a result. The test findings on:

- Whether having a homepage carousel is the right choice or not.
- Why auto-rotating carousel are problematic on mobile sites.
- 3 UX requirements for designing a user-friendly home page carousel for both desktop and mobile view.
- 3 additional UX requirements for desktop carousel auto-rotation.
- 3 additional UX requirements for mobile carousels.

According to their testing, they have found that rather than using carousel, the alternative is to simply use static content sections scattered throughout the homepage for featured categories. They said carousel is never better than its content. Content should be relevant, high-quality, and mobile optimized. Sometimes carousel content is not carefully chosen. Therefore, users mislead and misunderstand the type of site they've landed on.

This study showed that auto-rotating carousels are problematic on mobile sites. On desktop sites, auto-rotation of slides is a good idea to spread exposure across slides. On the other hand, on mobile sites, because the lack of hover state user intent can't be gleaned. During mobile testing, users viewing the content in an auto-rotating carousel were often distressed as sometimes slide change happen before they'd finished reading. Sometimes users attempted to tap a slide to learn more, and exactly the last second, the slide has been changed that resulting to a random landing page. This kind of thing makes an unnecessary frustration to the users. It is recommended that instead of auto-rotating carousels, it is better to provide manual carousels on mobile sites where users have control by swiping.

They have proposed 3 UX requirements if designers really want to use carousel rather than static content sections. It will work for both mobile and desktop sites. (Baymard Institute , 2016)

1. The slide sequence should be chosen carefully

The initial slide in a carousel is very much important as it will receive more exposure than the subsequent slides. Therefore, the first slide should be the most important content of the carousel. Most users don't see all the slides on the homepage, even if it auto-rotates. In general, they don't stick around the homepage for that long.

2. Carousel slides should never be the only route to features or content

Sometimes users completely ignore the homepage carousel section. During desktop testing, it has been found that many users immediately embarked on something before the page had been finished loading. Also, some users always skip the banner section as it resembles an ad. Therefore, product finders should never be only linked from carousel. It should also have a link in the navigation or a block on the homepage.

3. Manual controls should be clear

Most of the carousel has a poor navigation system on the sites as the visibility is crucial. Some carousel uses indicator dots, while others use arrow controls. Attention should be paid to both the size of the dots and the arrow. Also, it has to make sure that they are visible and not overlaid by the slide content. As carousel sliders are dynamic and will change over time, high color contrast between content and navigation tool is highly recommended.

Those 3 things are common for both mobile and desktop sites. But the baymard institute separately tested several points on carousel, from desktop and mobile view. After testing, they have summarized everything and came up with three separate points for desktop sites and mobile sites.

Baymard proposed 3 additional requirements for carousel autorotation on desktop sites

It was said that carousel slides should auto-rotate on desktop sites, but three implementation details must be considered to ensure well-performing auto-rotation. (Baymard Institute , 2016)

1. Carousel slides shouldn't rotate too quickly or too slowly

When slides auto-rotate too quickly, users feel they have very little time to evaluate the slides properly. And if slides change too slowly, users became impatient if the active slide doesn't grab their attention and move on. A good rotation time depends on the text slide. In general, 5-7 seconds for slide change is quite good for slides with a header and a few tags or labels. And for more text-heavy slides, it demands 10 seconds.

2. Auto-rotation should be paused on hover

During testing, it's observed that carousel slides were often changing milliseconds before a subject clicked, which directed to a wrong page. Obviously, this is a frustrating experience for users. When users hover the carousel with a mouse cursor, auto-rotation should pause so the user can focus on the slide for as long as they'd like, the slide shouldn't change automatically on mouse hover.

3. Auto-rotation should be stopped after any active user interaction with the carousel

When implementing carousel autorotation, the carousel slides change after a reasonable amount of time (around 7 seconds). There should be an option where the user can actively change the slide by clicking the “next” or “previous” buttons or slide indicators, even when it is autorotated carousel. carousel slide shouldn't be changed just because the user decides to check out the other parts of the homepage before returning to the selected slide. It is clear that whenever a user tries to check other parts of the homepage, the carousel slide should stop auto-rotating even though the slides don't mouse hovered.

In 2013, Nielsen Norman Group ran a study in the U.K for Siemens appliances. The test was run over an automatic carousel with 5000ms per slides. In conclusion, they have found out that automatic advance is not effective and it is not recommended to use this system. They mentioned the reasons behind this recommendation.

Banner blindness: carousels looks like an ad. People used to ignore ad and miss the whole carousel contents. Their eye-tracking research reveals that animated ads get 27% looked at a time.

Moving UI elements reduce accessibility: different people need different time duration to read all the content from carousel. If it's too fast, people get frustrated, and if it's too slow, users also feel unhappy, particularly users with motor skill issues who have difficulty clicking something before it's taken away.

International users read more slowly: if the site content is not their native language, users won't be able to understand panel if it's displayed briefly.

It causes loss of control: if things are automatically moving before they finish the reading content, it simply makes the user feel that they don't have control over it, and they mostly avoid such big-box section from the homepage.

According to the Nielsen group, they prefer to use 'hero image' rather than using multiple images of carousel. Users mostly look at just one image; even in the carousel, users click on the first image of the carousel. Therefore, it's better to use hero image on the homepage to show all the offers. Also, a static hero image may be less distractive to users than

a rotating element. They also mentioned that this static image doesn't seem like an ad, which is also a positive thing to get attention from users.

But if designers still want to use carousel on their website, they proposed some guidelines for doing them well (Burke, Hornof, Nilsen, & Gorman, 2005).

1. Include 5 or fewer frames within the carousel:

Users mostly interact with the first image of the carousel or highest 5 slides.

More than 5 slides are quite unusual to click by users. It also helps users discover the content, recognize topics.

2. Use crisp-looking text and images

It's difficult to read small text and small images, especially on mobile devices.

And it's not a good idea if anyone makes content for desktop version and for mobile users, it crams a large high-scale density image into a small region.

Definitely, clear text and images make the users have a feeling to get more engaged.

3. Indicate how many frames are present and user current position to understand their control

Use some dots or number so that users can understand the amount of slides on the carousel and make current position visible so that user can understand their current position in which stage they're in.

4. Use icons and links that are understandable and recognizable

In navigation control, designers should use recognizable icons and links to recall user after they have seen the content in the mainframe. A user cannot guess what a number or dot might reveal when clicked, for mobile device dots are poor cue because people often do not notice them. Use proper icons and links which help users or navigation.

5. Make links and buttons large enough to decipher

Buttons that are tiny, close together, or have poor background color-contrast are not easy to notice or click. According to Nielsen group, if designers want to use carousel on the website then they must follow that above guidelines.

In 2018 a new paper was published on rotating homepage carousel and its effects over news memorization. Eduardo Ribeiro, student of Universidade de Lisboa, Portugal, has done his master thesis on it and published a fresh paper. In that paper, he has done his research on the effects of two carousel variables over the evocation of news. Evocation was evaluated by an open-response questionnaire after the carousels exhibition to test participants. Two types of carousel were presented to the participants. One number of news in the carousel (7 or 14) and interaction mode with the carousel (automatic or manual scroll). This paper aims to understand which characteristics of a carousel is better for memorization, considering the number of news presented on the carousel, 7 and 14 news headlines; the possibility of user interaction, including an automatic scroll, and manual scroll. Total of 60 participants (33 male; 27 female) aged between 18 and 65 have participated in this testing. The level of education starts with primary education and college education. 60 participants were divided into four groups of 15 subjects each:

- Group 1: 7 news Headline into an automatic scroll;
- Group 2: 14 news Headline into an automatic scroll;
- Group 3: 7 news Headline into a manual scroll;
- Group 4: 14 news Headline into a manual scroll.

After the carousel exhibition, first, a number of news headlines were displayed to all the participants. The automatic scroll was parameterized to display a range of 5000ms between each news headline. The manual scroll was controlled with the mouse click. The experiment took place in different spots such as the classroom and meeting room. They maintained the place calm and prevented external disturbance. Each participant interacted with a computer device (laptop or tablet) individually. During the evaluation, each participant had to fill in the questionnaire according to the information from memory. Participants had to complete the

sentence with what they remembered about the headlines previously read. They are allowed to answer with 'I do not know' or 'I do not remember.'

A new memorization news index (IndexM) was created to understand the participant's response. The index had four rating layers which had been classified by them. For example: When there is no response at all, the score has zero value (0) points; when the headline express an idea, it is regarded as the reference to some terms with verb or noun feature, though it's not in the original news headline, the score has a value of 1 point; when the answer conveys the idea of the news headline, participants can recall some synonyms that represents the main content then the score has a value of 2 points; when the answer is a full transcript or reference, nothing is changed from the article, the score has a value of 3 points.

For result, the data of memorization index (IndexM) was converted for percentage, which means that the maximum score of 100% for 14 news is calculated 42 (3 maximum score of each individual news * 14 news). The maximum score for 7 news was calculated 21 (3 maximum score for each individual news * 7 news).

The results presented that, automatic carousel has an average percentage of 35.4, and the manual is 32.9%. It is clear that the difference is not so much, only 2.5%. Concerning the number of news, the average percentage of 7 news was 37.6, and for the 14 news, it was 30.7%. For the first hypothesis, memorization for 7 news is higher for an automatic scroll. In manual scroll, there is no difference in memorization of news between 7 and 14 news headlines in the carousel. The second hypothesis is not confirmed but it is said that in manual carousel, there is no better memorization than in the automatic.

With 7 news headlines, evocation was higher in an automatic carousel and little bit worst in a manual carousel. With 14 news headlines, evocation was worst in an automatic carousel and slightly better in manual. Therefore, it can be said that if the carousel is automated, there is better memorization of a few headline's news, and if carousel is manual, there is no difference in the number of news memorization. And it was confirmed that users have better memorization over news headlines when there are less slides on the carousel.

3 Methodology

Choosing an appropriate research method is very tricky as well as very much important for any kind of research. There are many research methods available out there where the researcher has to understand their research properly to find out the best suitable one for them. To pick the most appropriate research method is difficult, therefore one has to consider so many things at a time. Every research method has its own strength and weakness to offer. In that section, some research methods and their strength and weakness will be discussed briefly, and finally, the research method that was used will be disclosed.

Research has been described as a systematic (Burns, R.B., 1997) or inquiry whereby data are collected, analysed and interpreted in some way in an effort to “understand, describe, predict or control an educational or psychological phenomenon or to empower individuals in such contexts” (Mertens, Donna M, 2005).

There are several research methods out there where some of the methods are most common and mostly used by researchers. For example-

- Descriptive Research
- Correlational Research
- Experimental

3.1 Descriptive research

“Descriptive research is a study of status and is widely used in education, nutrition, epidemiology, and the behavioral sciences” (Eunsook T. Koh, Willis L. Owen, 2000). The primary purpose of this research is to find out what is going on. The most common kind of descriptive research method is survey. Apart from survey, case study, observation research, Questionnaires are also under the descriptive research method.

3.1.1 Case study

“A case study can be defined as an intensive study about a person, a group of people or a unit, which is aimed to generalize over several units” (Roberta Heale, Alison Twycross, 2017). A case study might be conducted in different situations, people, or any specific person who has

a unique characteristic. Therefore, a case study might be conducted on an individual who has a specific learning disability or in a particular environment that is engaging in a particular mode of instruction.

3.1.2 Observation research

This research mainly involves observing and watching how individuals interact in natural environments. A researcher might (with permission from the school and parents of the children, of course) watch a group of preschoolers through a 2-way mirror to see how the children interact with one another. There is also a special type of observation research called participatory observation. Sometimes it is very difficult or quite impossible to observe everything from a distance. Therefore, researcher also joins a group to learn about the group.

3.1.3 Survey research

In this research, the researcher compiles a set of questions and asks people to answer these questions. Some surveys might include people to rate their feelings or beliefs on a scale from 1-7 (also known as a "Likert" scale) or answer yes-no questions. Some surveys might ask more open-ended questions; then it might call the research an **interview** or a **focus group** if a few people are discussing a topic and answering questions in a group (Megan Sumeracki, 2018).

Strengths of Descriptive research

Descriptive research can provide an in-depth view of any topic to study. In this form of research, there is a possibility to find new information that the researcher might never even knew to look for! This type of research can be used to create new research questions or form hypotheses about cause and effect relationships. The strong side of descriptive research is that, it is effective to analyze non-quantified topics and issues. The possibility to observe the phenomenon in a completely natural way. Also, it requires less time-consuming than quantitative experiments (John Dudovskiy, 2018). Observation research has an added benefit of allowing researchers to see how things work in their natural environments.

Weaknesses of Descriptive research

It is not possible to determine a cause and effect relationship from descriptive research. One of the weakness of a descriptive studies that it cannot test or verify the research problem statistically, and due to the absence of this statistical data, research results may reflect a certain level of bias (John Dudovskiy, 2018). Therefore, it is required to be very careful in this type of research. Sometimes, people (and animals too) change their behavior if they know they're being observed.

3.2 Correlational Research

Correlational studies involve measuring two or more variables. For that reason, this research is inherently quantitative. Thus, researchers can then look at how related variables are to one another. If two variables are related or correlated, then it is possible to use one variable to predict the value of another variable. The greater accuracy of prediction will possible if the correlation is also greater. These factors might include things like eating a healthy breakfast, getting enough sleep, feeling safe, etc.

Strengths of Correlational Research

Correlational research can help understand the complex relationships between a lot of different variables. This type of research allows to make predictions and can demonstrate the presence or absence of a relationship between two factors. Therefore, it is good for indicating areas where experimental research could take place and could show further results (SharnaAbby, 2017).

Weaknesses of Correlational Research

If two variables are related to one another, that does not mean it is certain how the cause and effect relationship works. "It's not certain that one variable caused another to happen, it could be one or the other, or it could even be an unknown variable that causes the correlation" (SharnaAbby, 2017). Another weakness of correlational analysis is that it can only be used when the variables are two measurable on a scale.

3.3 Experimental research

“Experimental research is a study that strictly adheres to a scientific research design. It includes a hypothesis, a variable that can be manipulated by the researcher, and variables that can be measured, calculated, and compared” (Darci J. Harland).

“This method of research is referred to as a hypothesis testing or a deductive research method” (Babbie, Earl R., 1997).

It is needed to randomly assign users into different groups. At least one of the groups serves as a control group or a group that serves as a comparison. Usually, it is repeating experiments with little changes to continue obtaining new information.

Experiments can also be conducted in a “within-subjects” design. In these experiments, each person participates in all of the conditions. The researcher then randomly assigns different participants to different versions of the experiment, with the conditions coming up in different orders.

Strengths of Experimental research

This type of experiment allows us to determine cause and effect relationships! It is possible to manipulate the variables when conducting the research. Researchers have almost full control when they conduct experimental research studies. Therefore, they analyze and determine what is best for the population. Another advantage of experimental research can be combined with other research methods for rigor (Steven M. Ross, Gary R. Morrison, 2003).

Weaknesses of Experimental research

Of course, true experiments also have its own weaknesses. True experiments require a lot of control, the more control, the better measurement is possible. However, it takes a lot of time and money. Apart from that, the effect might not be generalizable. There might also be human errors; for instance, the researchers may allow their personal biases to affect the study. Also, political pressure may skew results; sometimes human response can be difficult to measure (Steven M. Ross, Gary R. Morrison, 2003).

3.4 Chosen methods for this research

After considering all the methods and analysis of their strengths and weakness, experimental research is regarded as the most appropriate method for this research. Acknowledging that this approach has strengths and weaknesses, the experimental method was chosen because it aids in collecting more concrete data that is statistically analyzable. Users were involved in conducting some specific tasks on two prototypes that have been developed to experiment by the users. The total number of users are divided into two groups, and the research goes with the 'within-users' design. Some pre-define shopping tasks were given to the users to conduct. All the tasks are given as a document, and the tasks are the same for both sites. The reason for choosing "within-users" is the interest to have the participants see both user interfaces and then make a comparison of these. Time, Error variables were measured during the user testing, and after that, some personal information were collected from the users, at the end, Five (5) likert scale questionnaires were asked to the users to get more appropriate comparison about those two prototypes. Experimental research is under the quantitative method, and likert scale questionnaire is also under the quantitative method. Therefore, the whole research was followed by an experimental quantitative approach.

4. Prototype Design

The underlying architecture of this research is based on two website prototypes. Two e-commerce prototypes have been developed for conducting the research within users. One prototype is 'with carousel', and another one is 'without carousel' prototype. The architecture of those two prototypes is almost similar, and it contains the same information, images, and product; only the user interface is different based on carousel difference.

4.1 With carousel Prototype

Several pages of this e-commerce website are developed with different selling products where users can choose their desired product by full-filling some specific task. This site is an e-commerce site mostly for buying clothes. Different kinds of clothes for men & women are displayed here. In homepage it has four (4) sections. In the first section, four slides of manual option carousel have been displayed. Every slide represents a product item, for example- Denim jacket, Gown, Shirt & men suit. There are also some discounts, coupon code & information is given their user consideration. Users can click on the "add to cart" button to see all the related items of this product where they can choose their desired one from many others.

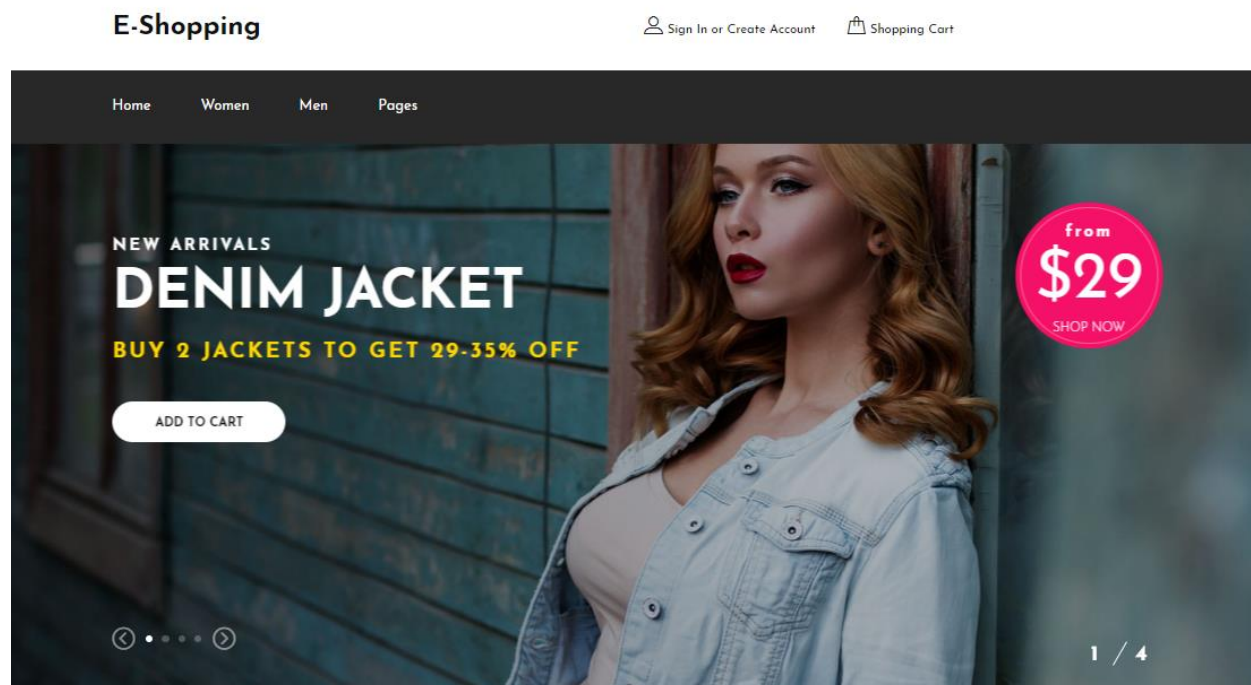


Figure 4.1: with-carousel prototype banner carousel section

From Figure 4.1, at the bottom left side, it is shown that it has four slides, and the current slide position is number one. At the bottom left side, two arrow button works as a navigator to see all the slides.

In the second section, it has shown all the latest products of different categories. In here, this prototype offers 9 different category clothes for men & women. Those are- top, striped dress, men suit, jacket, shirt, gown, overcoat, t-shirt, jeans. Those categories are displayed via carousel where the user has to click manually next arrow button to see the next category or to click the back-arrow button to see the previous category. At a time, users can see 4 categories on the display.

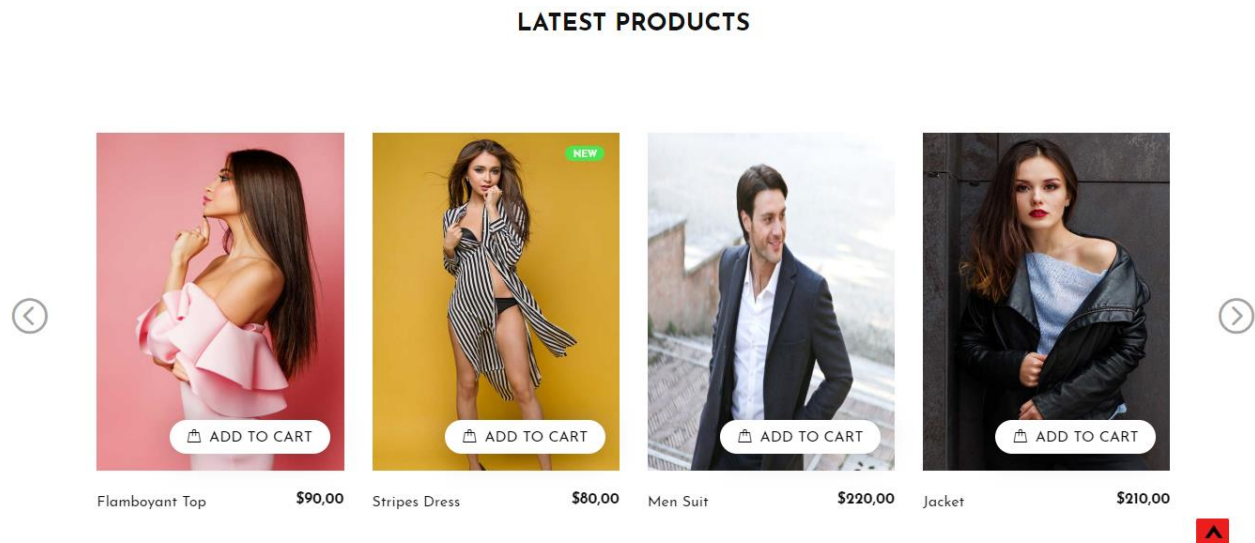


Figure 4.2: with carousel prototype latest product section

If user go to any specific category, for example- men suit, the user will be able to see different types of suit, for example- plain grey suit, double-breasted suit, dinner suit, wedding suit, summer suit, check suit, sports jacket, zoot suit via carousel.

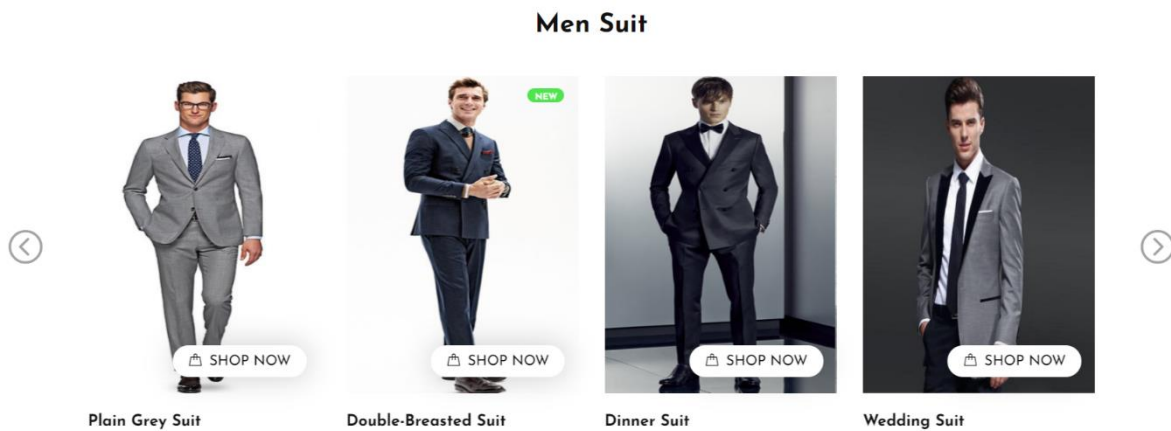


Figure 4.3: with carousel prototype different kind of men suit

There are total of eight types of men suit given there. If user choose any specific category, they will be able to see only that specific kind of men suit to choose from. For example- if user click summer suit, they will see different color's summer men suit in the next page.

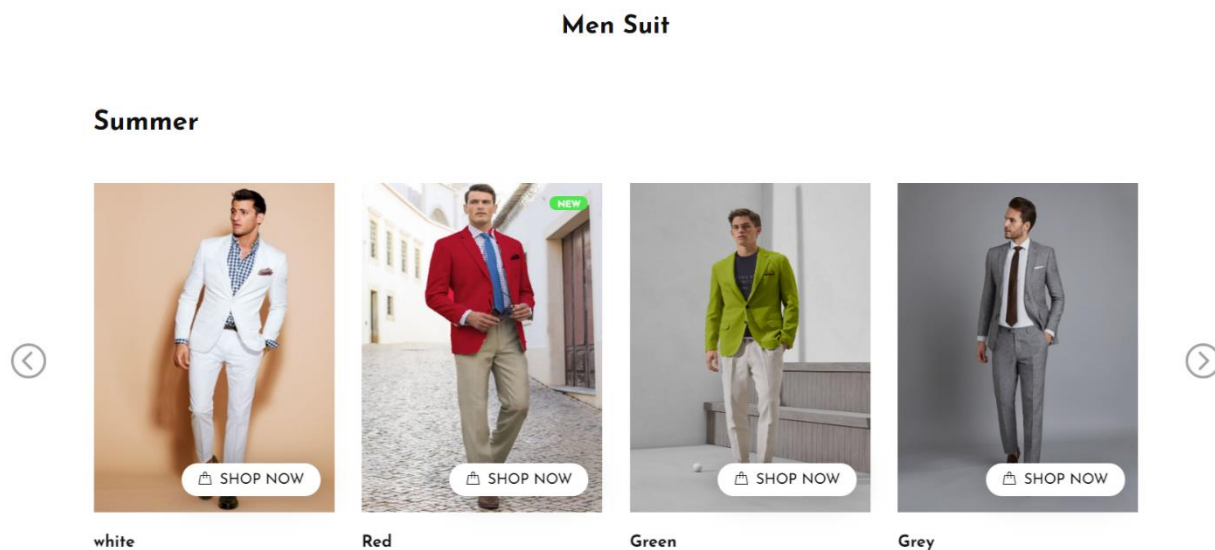


Figure 4.4: with carousel prototype different color summer men suit

Figure 4.4, in that section, user can see only different color's summer men suit. Whenever user selects any category suit, the next section is categorized by color. When users select any specific color, they can see only that particular color summer suit at different prices.

Summer Men Suit

Khaki

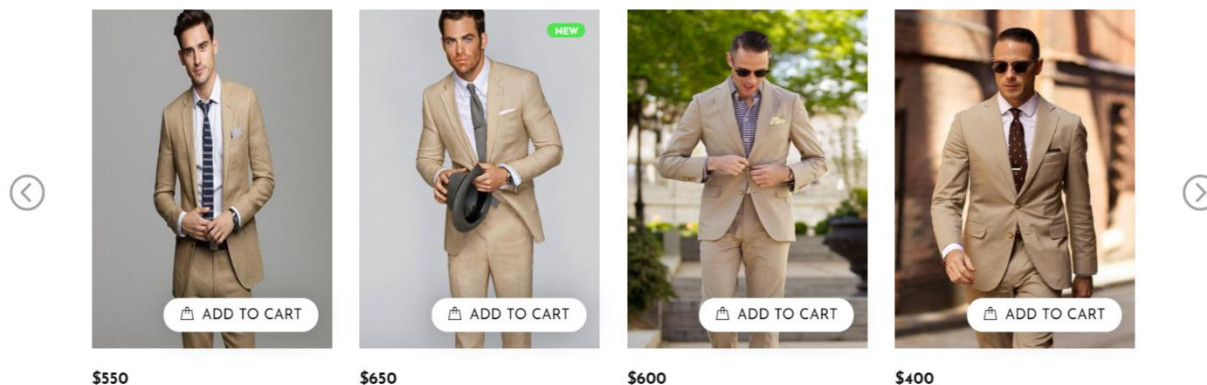


Figure 4.5: with carousel prototype only khaki color summer men suit

This section is presenting only khaki color summer men suit. When users choose any specific color section, they can see only that color product at different prices.

Responsiveness is very much important for modern web applications. The e-commerce prototype is completely responsive in any kind of device. Users can use this app on pc, laptop, tablet, or mobile device.

Color contrast: The Interface has designed a high contrast, highly visible, and tactilely discernible symbol that can be easily understood by the website users. According to WCAG 2.1, High color contrast is mandatory for low vision users.

Screen-reader accessibility is very much important for any kind of ICT system. When it comes to web accessibility, screen-reader accessibility is mandatory according to WCAG 2.1. The web app is screen reader supportive; therefore, blind people also can use this app with the help of a keyboard or braille.

HTML: Hypertext Markup Language (HTML) 5 has been used to construct the structure of this web app. Html5 is being used to mainly build a structure of the website. Every bit of information and text is displayed through html5.

CSS: Cascading Style Sheets (CSS) version 3 has been used to make the interface colorful. High contrast color has been implemented using CSS for low vision users. This prototype is mainly

based on black and red color combination. The color contrast was one of the main concerns here when the CSS was being used. All the colors and styles have been made using CSS.

Bootstrap: Bootstrap is framework based on html & CSS. Bootstrap 4 has been used to make the layout of this application. It has been mainly used to design row and columns of the website. Bootstrap buttons are used to make multi-modal interaction to the users. Bootstrap has been used here to make the interface responsive so that Prototype is accessible for different kind of device including tablet, pc, Mobile etc. different pages are divided into three or four columns where products are being displayed into different categories. For example- latest product section is divided into four columns. To make it like this bootstrap 4 has been used.

```
<div class="container">
    <div class="row">
        <div class="col-lg-4 col-sm-6">
            </>
        </>
    </>
```

For container the whole product section is contain and col-lg-4 means for large screen, it is displayed as 4 columns and for small screen, it will be divided into two columns; 6 for each as bootstrap always work with 12 columns.

Font- Awesome: Font-awesome is world's most popular and easiest toolkit to use icons. It was made with CSS & LESS to create some pre-designed icons. Currently, version 5 is going on and it is being used to make universal icons of the interface. For making all the icons including social media icons, font-awesome is being used.

```
<i class="fa fa-instagram">
<i class="fa fa-google-plus">
<i class="fa fa-facebook">
<i class="fa fa-twitter">
<i class="fa fa-youtube">
```

Javascript: Javascript has been used here to make the web app dynamic. The carousel function both the homepage carousel and product carousel, and it is running on the website by using javascript. Several products are displaying in a single row where products are rotating by clicking next or previous button. To make this functionality javascript framework called jquery is being used here more specifically 'owl carousel' which is made by javascript is linked to the html code to make this happen.

```
<link rel="stylesheet" href="css/owl.carousel.min.css"/>
```

First the owl carousel plugin is included in the beginning of the html code and then called it separately in every specific div the carousel is used.

```
<div class="product-slider owl-carousel">
    <div class="product-item"></div>
</div>
```

In the above example latest product section, the owl carousel plugin is being called, and inside the div the product items are displayed.

A "bottom to top" button is implemented here by using javascript. Also, user can choose multiple products at a time. If user choose multiple products, it will multiple by its price. Product and price multiplication function is also implemented by javascript.

```
<script>
function calcTotal() {
var total = 0;
for (var i = 0; document.getElementById('quantity'+i); i++) {
var quantity = document.getElementById('quantity'+i).value,
price = document.getElementById('pprice'+i).value;
total += (quantity * price);
}
}
```

```

document.getElementById('total').value = (total).toFixed(2);
}
</script>

```

4.2 Without carousel Prototype

Second Prototype is developed based on the same concept, except it is without carousel. Therefore, this website has four sections as well. In the first section, four slides are displayed at a time in two columns.

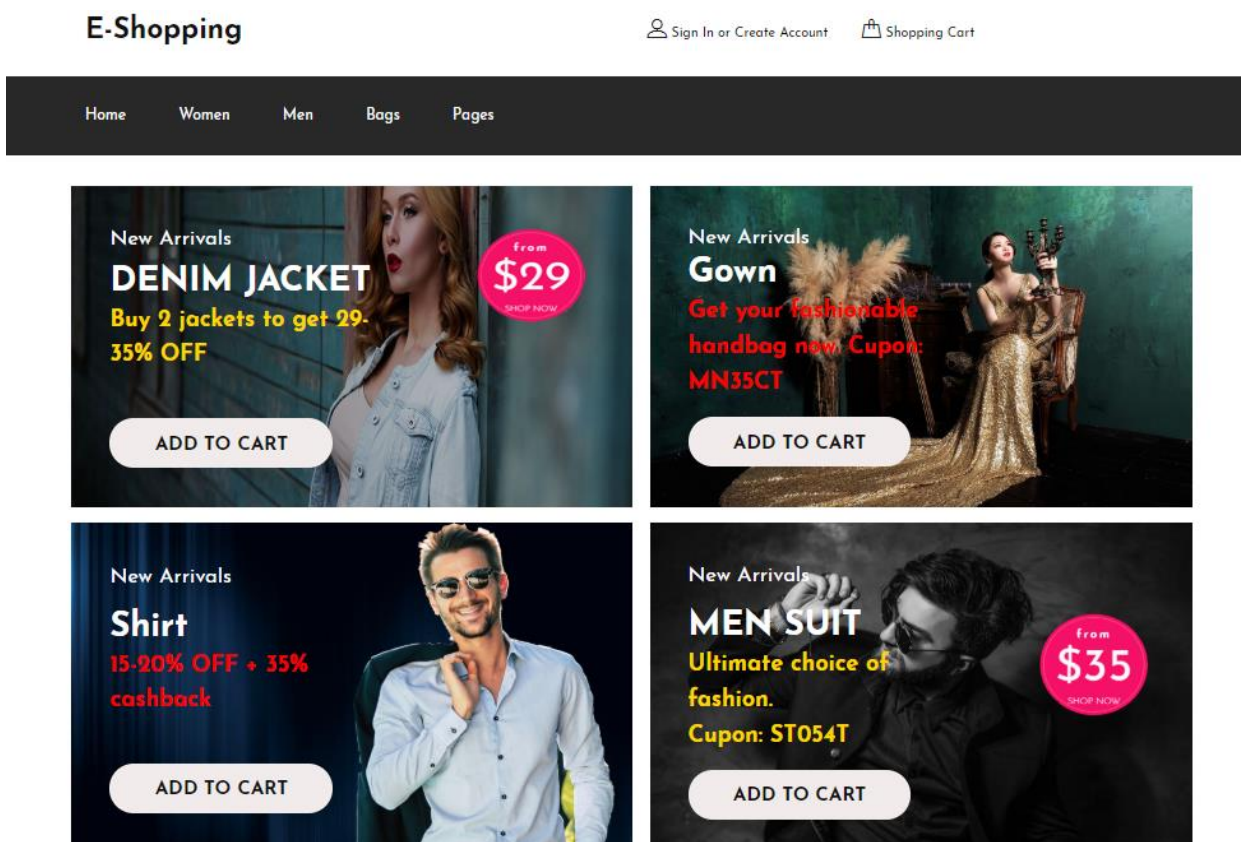


Figure 4.6: without-carousel prototype banner section

The second section also has nine categories of different clothes for men & women, which are displayed without carousel. The categories are displayed in three separate columns in three different row positions at a time.

LATEST PRODUCTS

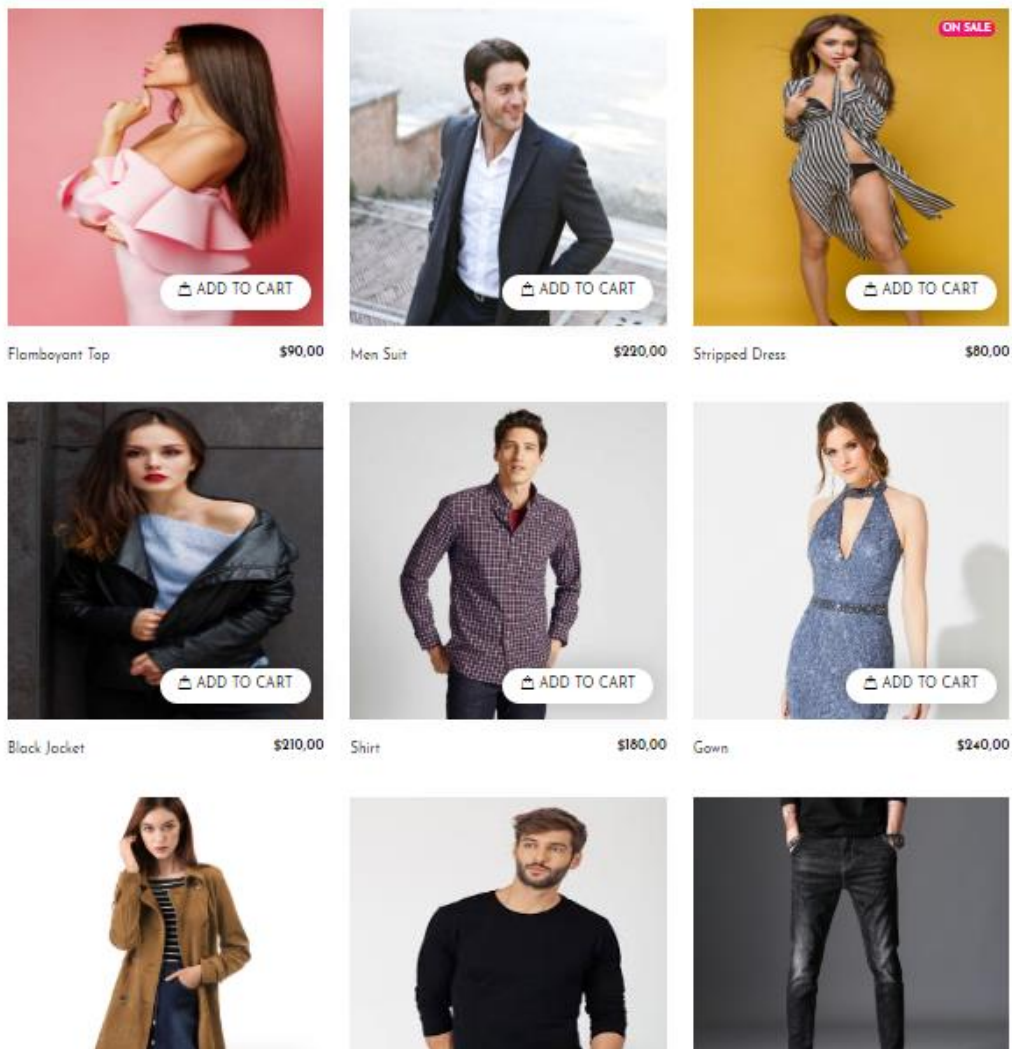


Figure 4.7: without carousel prototype latest product section

As like with carousel prototype, if user click any specific section, they will see only that category product in the next page but without carousel. All Products are displayed at a time in three columns.

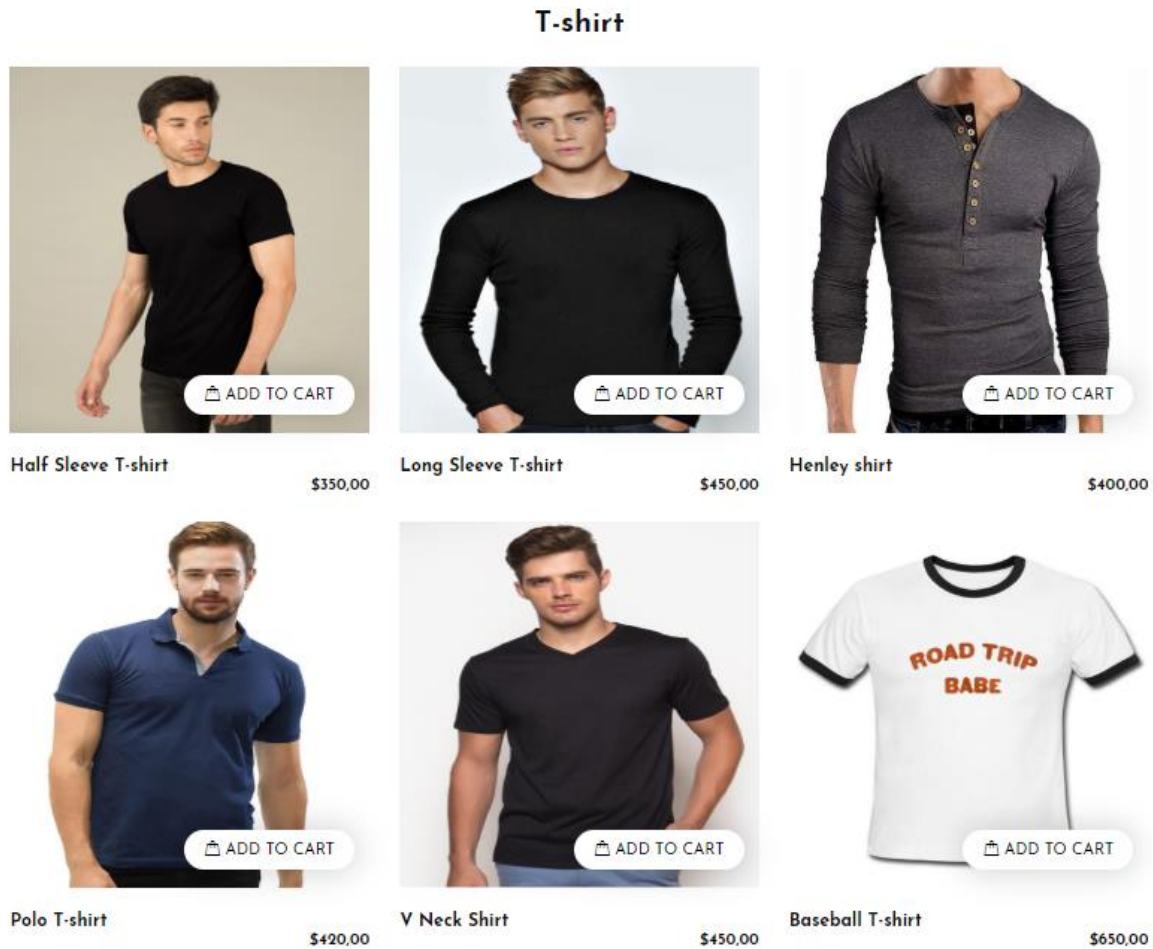


Figure 4.8: without carousel prototype t-shirt category

In Figure 4.8, it is shown that different kind of t-shirt is being displayed. If users click on the t-shirt category, then they will see different kinds of t-shirt in the next page, and all the items are displayed via three columns rather than carousel.

4.3 Experimental Design

An effective research design/experiment design constitutes for collection, measurement, and analysis of data to ensure the research is conducted within conceptual structure. Therefore, a clear experimental design is needed before starting the thesis. In that section, how the user testing was being conducted throughout the research, which things were considered to evaluate the result, and how the result was evaluated will be described.

Users

A sample of participants were recruited from different parts of the world where participants need to have experience in computer and internet use. The experiment was conducted with total of 40 people with different age groups and diverse professional background. The main concern is to include different age groups, gender, diverse cultural background. The users were from total of 15 different countries with different professional backgrounds- either students or employed or both with minimum 2 years of online shopping experiences. Initially, it was planned to recruit some user who has disability, for example, blind or color blind, but because of the present covid-19 situation, it was tough to reach all the people. Therefore, it wasn't possible to recruit any disable person.

Variables

The Independent Variables are the two user interfaces and the tasks associated with the interfaces. The Dependent Variables are performance and user satisfaction/opinion. The Dependent variables were measured based on overall task time, errors, and users' opinions elicited by means of a post-experiment questionnaire. Errors were measured to observe how often user do mistake according to the tasks in different interfaces. In that way, error indicates which interface is easier to follow along with the tasks. Total six (6) questions were asked to understand the user's opinion about those two interfaces. The questionnaires were focused on both homepage carousel in the banner section & product display section. The focus of this thesis is to analyze carousel interaction in both banner section & product display section from the web view.

Apparatus and Materials

For this experiment, the following systems and materials were used to conduct the experiment:

- Lenovo laptop with windows 10 OS, 12GB RAM, intel corei7 processor, 15.5" screen;
- Chrome web browser;
- A stopwatch;
- Debut screen recorder software;
- Information sheet

- Consent form;
- Google form;
- Tasks document for the experiment;
- Post experiment questionnaire

Task Design

A task is an activity performed to reach a goal (Paternò, Fabio, 1999). Task models describe how activities can be performed to reach the user's goals when interacting with the application considered (Barbara Leporini, 2003). Two task groups were designed for the experiment. All the tasks are goal-driven, finding specific items from website. The tasks were designed to achieve four specific goals in two different interfaces. Therefore, all the participants experienced both user interfaces, but in a different order, e.g., participant1 would experience and use the with-carousel prototype first and then the without-carousel second. Participants 2 then experienced the user interfaces in the opposite order etc. Total of 40 participants attended that experiment. The tasks and group patterns are explained in Table 1:

Tasks description:

- Task-1 Find a summer Men suit-khaki color with exactly \$500 price from the Latest product section
- Task-2 Find a Choker Top-Floral color with less than \$300 price from the latest product section.
- Task-3 Find a men's v-neck Black color t-shirt with more than \$150 price from the latest product section.
- Task-4 Buy a men suit with coupon code from the new arrival section.

Group Name	Number of participants	Interface order	Tasks performed
Group A	40	<ul style="list-style-type: none"> ➤ 1st with-carousel ➤ 2nd without-carousel 	Task-1,2,3,4
Group B	40	<ul style="list-style-type: none"> ➤ 1st without-carousel ➤ 2nd with-carousel 	Tasks-1,2,3,4

Table 4.1: experimental table

Procedure

The experiment was carried out in three different stages. Before starting the actual user experiment with the selected participants, pilot testing was conducted with two different participants to identify possible problems in advance. After completion of the pilot experiment, the following issues were identified and changes were made in the actual experiment-

- While doing the testing, it had been noticed that the website was quite slow and every-time it was taking a longer time when loading pages. Therefore, the speed of loading pages was increased a little bit.
- Participants faced some difficulties with the category name and how the categories are displayed in the product section. Further, the category level & button name have been changed to fix some confusions.

The whole experiment was conducted in three different stages including some pre-experiment brief, after that, the actual experiment, and then post-experiment questionnaires. The recruitment questionnaire asked participants to state their age group, gender, nationality, year of online shopping experiences, and year of internet using experiences. The post-experiment questionnaire asked a series of questions using a Likert-type scale covering the satisfaction of the carousel interface & without carousel interface. The questionnaires are attached to the appendix section of the paper.

First, an information sheet was given to each participant that contained details of the study and expectation of this experiment. An ethical consent form was also used where the outlined of the participant rights and understandings for the experiment was described briefly. Initial contact with the participants was established by sending an email with the consent form. If they agree, a suitable appointment was fixed to conduct the user testing. The tasks were to achieve some specific goal more specifically to find out some products from both shopping interfaces. During the experiment, the following aspects were manually recorded on paper: task times, errors, and any particularly noticeable behavioral aspects on the part of the user (e.g., joy or frustration etc.). During the participation, if users mistakenly clicked the wrong section in the interfaces to find out the proper shopping item under specific requirements, it will be count as an error. For example, it is mentioned to find the item from the new arrival section, but if the user clicks the latest section to find out, the item is counted as an error.

A screen recording software was used to record the whole experiment & a stopwatch was used to count the exact time of the experiment. When participants asked any questions regarding any issues they faced, some hints were provided to complete the tasks. Those hints were the same for every participant to reduce biases.

In the end, post-experiment questionnaires were given in the google forms, which dealt with the aspects of participant's preferences & opinions about those two interfaces. Some questions covered how do they feel about those interfaces and their usability? At the end of the experiment, the participants were thanked for their participation.

5. Results

The data for participant opinions were collected by google forms and were analyzed by SPSS. As discussed before, from the are goal-driven tasks, overall task time & errors were measured, and after that the post-experiment questionnaires was analyzed.

First, users performing tasks was screen recorded & time was measured by a stopwatch. After that, six (6) questionnaires were given to them to evaluate the result.

From the google form analytics the following characteristics were found from the participants-

- Total of 40 users participated in this experiment, where 40% are female, and 60% are male. 24 male and 16 female participants conducted the experiment from around the world.
- 20% has the highest 5 years online shopping experience, while 12% has the second-highest 10 years of online shopping experiences. Others are either 1 or 3 to 8 years' experience of online shopping.
- 23% has the highest 10 Years of computer & internet experience. The rest of the 77% has 12 to 15 years' experience.
- The experiment was conducted with users from different nationalities around the world. From the google analysis data, it has been seen that users are from total of 15 different countries participated in this experiment. Countries are- Norway, Bangladesh, Albania, Netherland, France, India, Philippines, China, Mexico, Russia, Pakistan, Poland, North Macedonia, Denmark, Indonesia.
- 62% are age groups between 20-29 years. 23% are between 30-39, 15% are in 40-49 years old.
- 35% of the users are students, 45% are employed, while the rest of the 20% are both.

Error has also been noticed for every experiment; There was no significant difference in the carousel ($M= 1.6, SD=0.86$), and without-carousel ($M=1.5, SD=0.782$) interfaces; $t(78)=4.0$, $p=.68$, which means that the null hypothesis is true, the error between those two interfaces is not significantly different.

All the experiments were screen recorded and were also observed in a person during the experiment. In summary, the participant's experience in using with-carousel interface and without-carousel interfaces showed the following commonalities:

- 32 participants out of 40 didn't read the tasks properly. They only read what to find out but didn't notice from which section of the interface it is needed to find out the item. Therefore, most of them randomly search for the product without noticing the section. Users didn't understand that they need to go to different category sections and have to follow the steps in with-carousel. Whereas in without-carousel, they were able to see all the products while scrolling down; therefore, they understand the pattern comparatively faster.
- 6 participants out of 40 did look at the banner section while they were asked to find items from banner section. The Rest of them were searching below and consider the banner carousel section as an advertisement. Therefore, most of them didn't find the new arrival section from the task requirement in the with-carousel interface. But when it comes to the with-out carousel banner section, it was more visible to them to find out. Thus, participants found a new arrival section comparatively faster way in the without-carousel interface.
- From screen-recorded video, it has been seen that except for one participant, everyone was searching the first item randomly on the homepage without noticing from which section of the product needs to find out. Therefore, few hints were provided to avoid unnecessary error & time wastage.
- From their facial expression & activities it has been found that 20 participants were got lost when they first saw the with-carousel interface and didn't understand that they have to swap/click to see the next product. But when users experienced. From the google analytics, the following results have been found from six questionnaires.

As discussed before, the questions were likert- type scale for the responses. The questions used Likert-type scale ranging from 1 to 5 and for each question a 5 response was the most positive response one could allocate.

The bar chart results for each question is put in the appendix for better understanding.

- The first question concerned whether it was easy for them to find out the items from the interfaces. For with-carousel, 11 people agreed, whereas 9 users disagreed with that. On the other hand, 22 people strongly agreed, 14 people agreed in with-out carousel interface. Clearly, more people strongly agreed in the without-carousel interface.
- Second question was asked do they like with-carousel or without-carousel interface in the banner section. In with-carousel, 14 people agreed Whereas for without-carousel interface, 18 people strongly agreed, 9 people said agreed. Therefore, it has been seen that more people strongly agreed with the without-carousel interface.
- The third question was whether they like with-carousel or without carousel to display product section. Like before, the majority (21) people strongly agreed with the without-carousel. Only 5 people strongly agreed with the with-carousel interface.
- On the 4th question, it was asked if the website interface is user friendly to them or not? Again, the majority (19) of the user strongly agreed on without-carousel interface, whereas only 7 people strongly agreed on with-carousel interface.
- 5th question was if navigations were easy for them to follow. Again, it has been seen that most of them strongly agreed that navigation was easy in without-carousel interface. 18 people strongly agreed & 17 agreed for without-carousel interfaces, while 9 people strongly agreed for with-carousel interface.
- The final and 6th question was about color contrast. Were contents clear enough for them to follow and understand? The results showed that 22 people strongly agreed in without-carousel, whereas 19 people strongly agreed in with-carousel interface. On the other hand, more people disagreed in with-carousel interfaces, only 2 persons disagreed in without-carousel.

The above result showed that the without-carousel interface has more 'strongly agreed' opinion in each question. But one person's satisfaction rating of 5 may be very different from someone else's rating of 5. In those circumstances, it might be more appropriate to compare groups on how those ratings are ranked by using a non-parametric test. That way the absolute value of the rating has less impact. A t-test examines differences in the mean scores of a parametric dependent variable across two groups or conditions. There are mainly two types of t-test, independent t-test (for between-group analyses) and related t-test for within-group studies. An independent t-test measures differences between two distinct groups. The task of the independent t-test is to establish whether that difference is statistically significant or not, if it is then null hypothesis is being rejected. How is it possible to decide when a difference is large enough to be significant? The answer is it is needed to run an independent t-test to find out. If the probability is less than 5% ($p < .05$), it is confirmed that the outcome did not happen by chance (Andrew Mayers, 2013). The independent variable must be categorical and must be represented by two distinct, exclusive, groups (it can only be possible to be a member of one group at a time). To get a clear comparison between those two groups, an independent student t.test was run for each question. It was allocated 'numbers' to represent groups when creating variables in SPSS (such as 1 = with-carousel; 2 = without-carousel).

```
T-TEST GROUPS=group (1 2)
/MISSING=ANALYSIS
/VARIABLES=score
/CRITERIA=CI (.95) .
```

→ **T-Test**

Group Statistics					
	group	N	Mean	Std. Deviation	Std. Error Mean
score	with-carousel	40	3.1500	.83359	.13180
	without-carousel	40	4.4500	.67748	.10712

Independent Samples Test										
		Levene's Test for Equality of Variances			t-test for Equality of Means					
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
score	Equal variances assumed	.264	.609	-7.654	78	.000	-1.30000	.16984	-1.63813	-.96187
	Equal variances not assumed			-7.654	74.871	.000	-1.30000	.16984	-1.63835	-.96165

Figure 5.1: t.test SPSS result for question one

From the above table, for question one, there was a significant difference in the scores for carousel interface (M=3.2, SD=0.83) and without-carousel interface (M=4.5, SD=0.67) conditions; $t(78) = -7.7$, $p < .001$, which indicates that the result is significant, and the null hypothesis is rejected. The result suggests that finding items from without-carousel interface is easier than carousel interface.

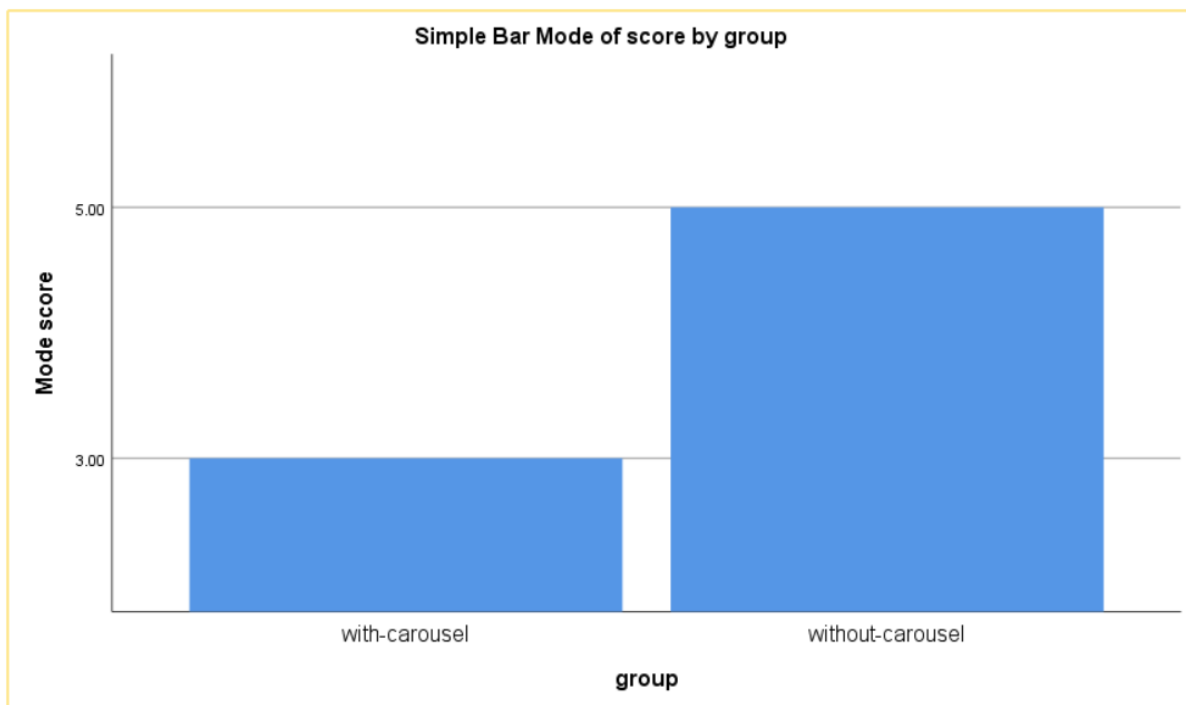
GGraph

Figure 5.2: bar chart result from SPSS for question one

Using bar chart from SPSS, the result is even more clearly visual. From the below mode bar chart, it is seen that mode score for without carousel is far higher than with-carousel score.

```
T-TEST GROUPS=group(1 2)
/MISSING=ANALYSIS
/VARIABLES=score
/CRITERIA=CI (.95) .
```

► **T-Test**

Group Statistics					
group	N	Mean	Std. Deviation	Std. Error Mean	
score	with-carousel	40	3.3750	1.21291	.19178
	without-carousel	40	4.0000	1.08604	.17172

Independent Samples Test										
		Levene's Test for Equality of Variances			t-test for Equality of Means					
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
score	Equal variances assumed	.578	.449	-2.428	78	.017	-.62500	.25742	-1.13749	-.11251
	Equal variances not assumed			-2.428	77.067	.018	-.62500	.25742	-1.13759	-.11241

Figure 5.3: t.test SPSS result for question two

For 2nd question, using an independent t-test, it was confirmed that users like without-carousel interface in banner section more than carousel interface, $t(78) = -2.4$, $p < .001$ This represents a very strong effect.

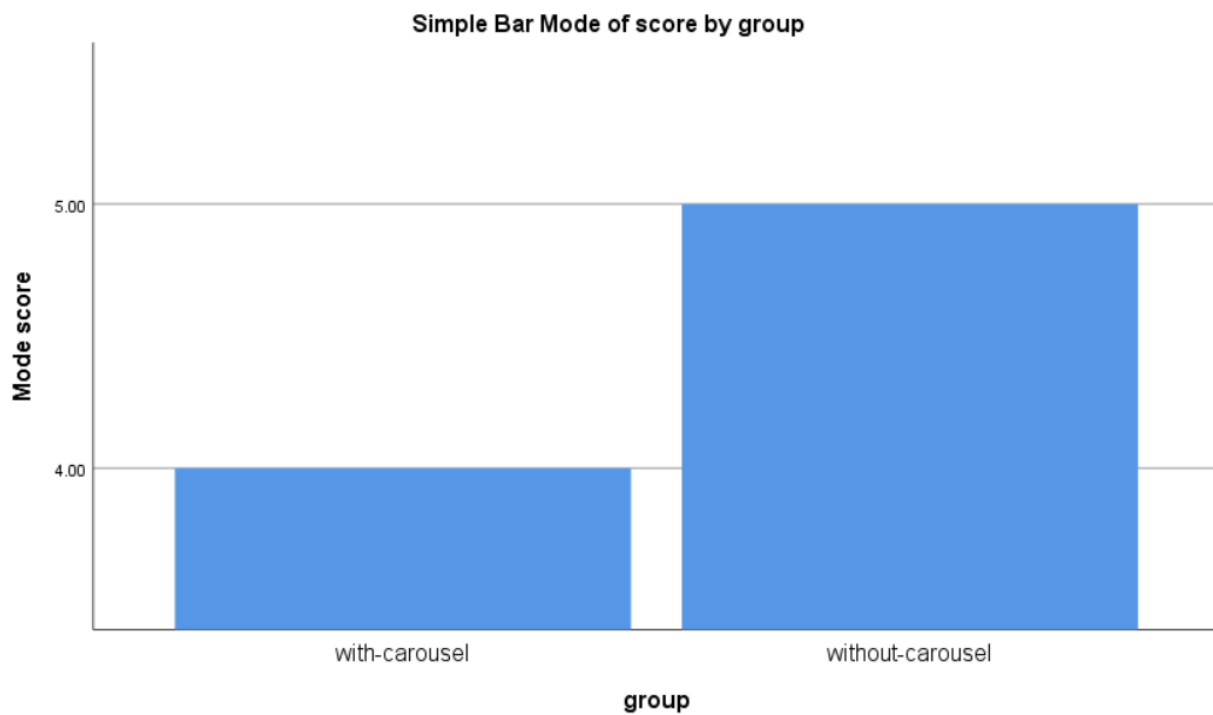
GGraph

Figure 5.4: bar chart SPSS result for question two

From the above bar chart, it can be seen that the mode score for 'without-carousel' is higher than with-carousel. The difference between those two values is clearly visible.

```
T-TEST GROUPS=group(1 2)
/MISSING=ANALYSIS
/VARIABLES=score
/CRITERIA=CI(.95).
```

► **T-Test**

Group Statistics				
group	N	Mean	Std. Deviation	Std. Error Mean
score with-carousel	40	2.9750	1.22971	.19443
without-carousel	40	4.2750	.90547	.14317

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
score	Equal variances assumed	2.581	.112	-5.384	78	.000	-1.30000	.24146	-1.78070	-.81930
	Equal variances not assumed			-5.384	71.683	.000	-1.30000	.24146	-1.78137	-.81863

Figure 5.5: t.test SPSS result for question three

For 3rd question, using an independent-samples, t-test confirmed that users like without-carousel interface in display product section compares to the carousel interface. There was a significant difference in the scores for carousel interface (M=3.7, SD=1.2.) and without-carousel interface (M=4.2, SD=.90) conditions; $t(78) = -5.3$, $p < .001$. this presents a very strong effect; the results are significantly different to each other.

GGraph

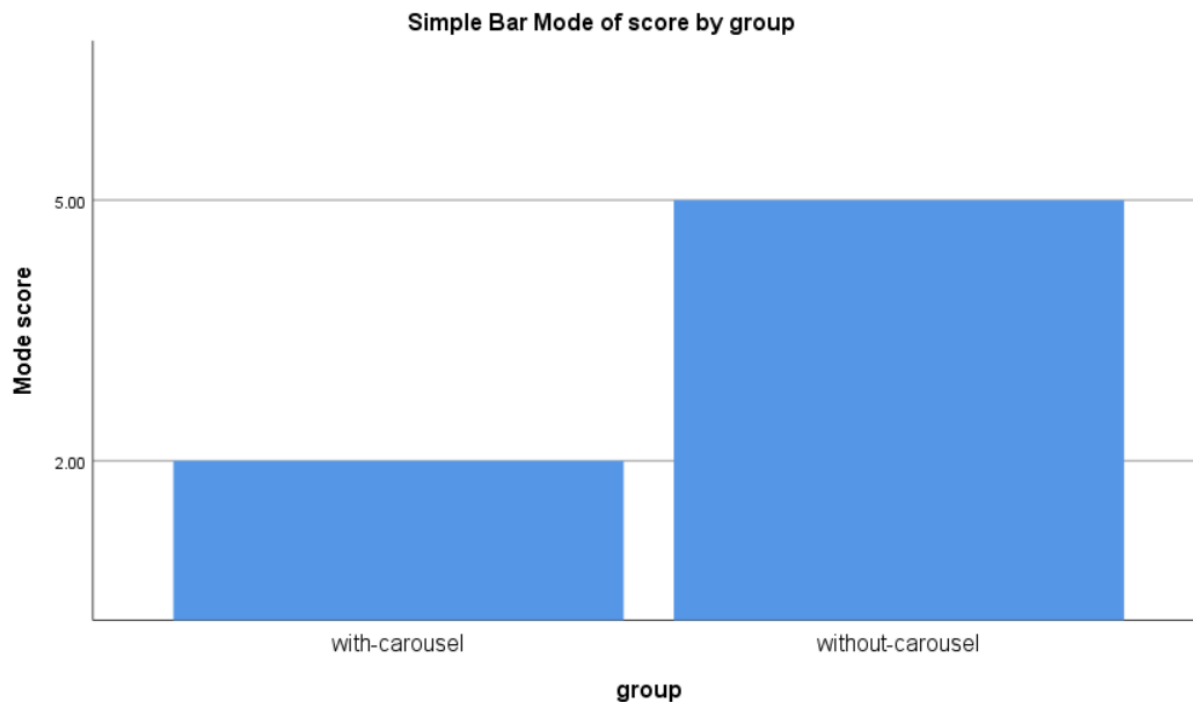


Figure 5.6: bar chart result from SPSS for question three

Mode score for without-carousel(M=5.00) is far higher than with-carousel (2.00) in bar graph.

The difference between them is significant is also proven visually.

```
T-TEST GROUPS=group(1 2)
/MISSING=ANALYSIS
/VARIABLES=score
/CRITERIA=CI(.95).
```

► **T-Test**

Group Statistics				
group	N	Mean	Std. Deviation	Std. Error Mean
score with-carousel	40	3.5500	1.06096	.16775
without-carousel	40	4.3250	.76418	.12083

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
score	Equal variances assumed	3.968	.050	-3.749	78	.000	-.77500	.20674	-1.18658	-.36342
	Equal variances not assumed			-3.749	70.884	.000	-.77500	.20674	-1.18723	-.36277

Figure 5.7: t.test SPSS result for question four

For 4th question, independent-samples t-test confirmed that users find without-carousel interface more user-friendly compare to the carousel interface. There was a significant difference in the scores for carousel interface (M=4.5, SD=1.1.) and without-carousel interface (M=4.3, SD=0.76) conditions; $t(78) = -3.7, p < .001$. The results suggest that users find without-carousel interface more user friendly when they were performing the tasks.

GGraph

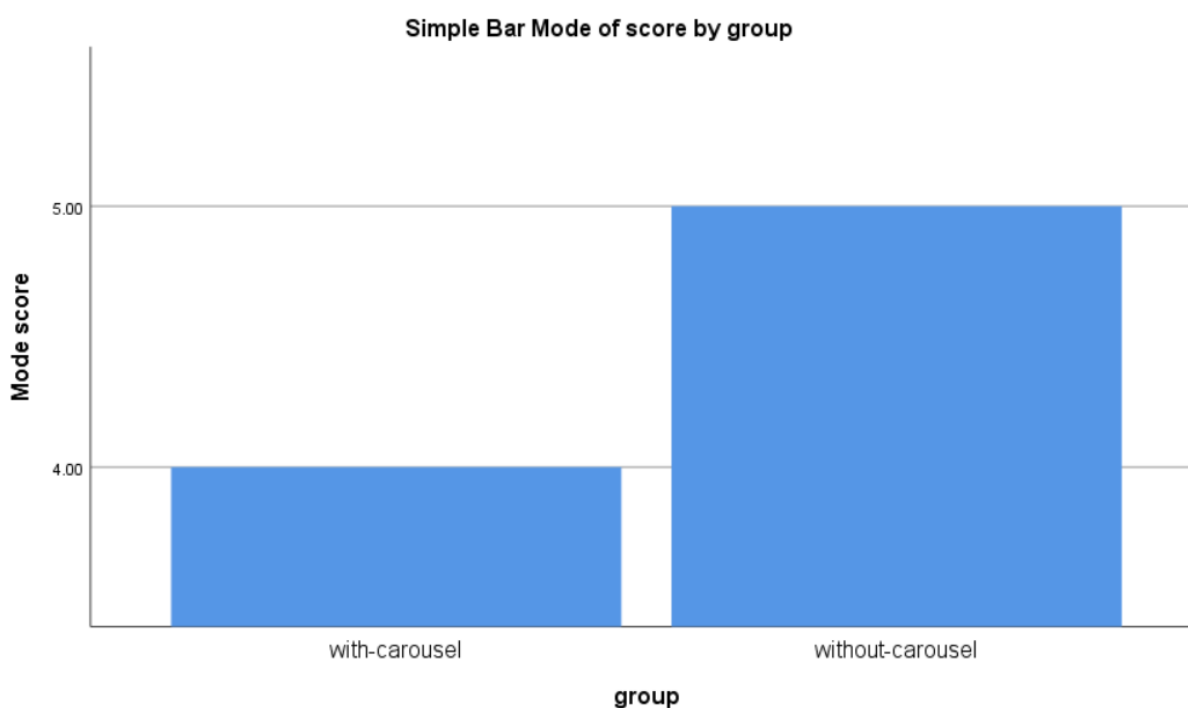


Figure 5.8: bar chart result from SPSS for question four

From the graph, with-carousel mode score is 4.00, while without-carousel, mode score is 5.00. therefore, it is visually evident that With-carousel and without-carousel mode score is significantly different.

```
T-TEST GROUPS=group(1 2)
/MISSING=ANALYSIS
/VARIABLES=score
/CRITERIA=CI(.95).
```

◆ T-Test

Group Statistics				
group	N	Mean	Std. Deviation	Std. Error Mean
score with-carousel	40	3.4250	1.19588	.18909
without-carousel	40	4.2750	.84694	.13391

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
score	Equal variances assumed	6.822	.011	-3.669	78	.000	-.85000	.23170	-1.31128	-.38872
	Equal variances not assumed			-3.669	70.259	.000	-.85000	.23170	-1.31209	-.38791

Figure 5.9: t.test result from SPSS for question five

From independent-samples t-test result for question 5 confirmed that users find navigation is easier in without-carousel interface compared to with carousel interface $t(78) = -3.6$, $p < 0.001$. This represents a very strong effect; navigation was easier in without-carousel interface than carousel interface, and the difference is significantly different.

GGraph

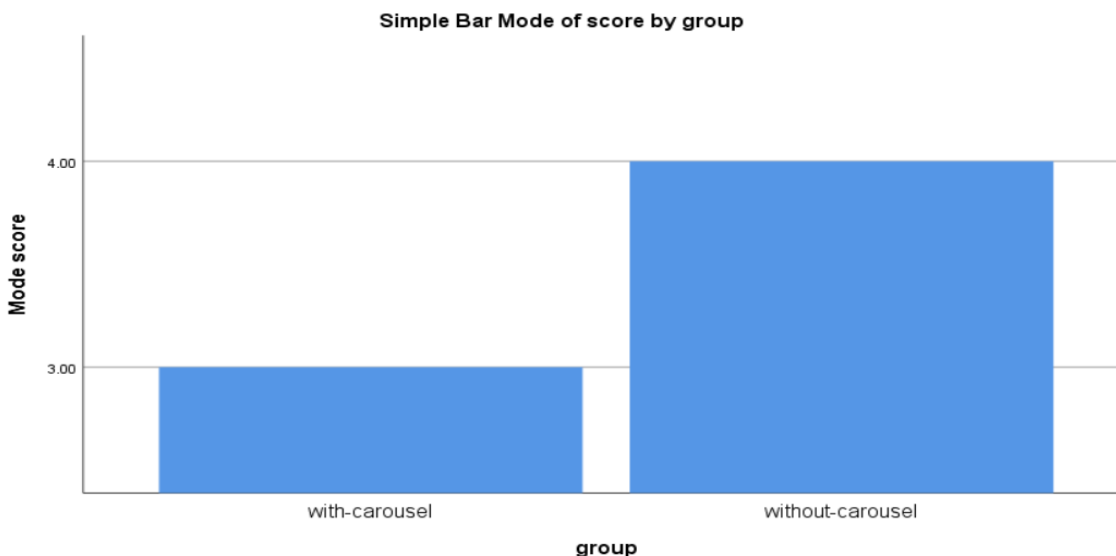


Figure 5.10: bar chart result from SPSS for question five

From the mode bar chart, it is clear that the difference between them is also different. More score for with-carousel and without-carousel is 3.00 and 4.00 respectively. The difference between them is noticeable.

```
T-TEST GROUPS=group(1 2)
/MISSING=ANALYSIS
/VARIABLES=score
/CRITERIA=CI(.95).
```

→ **T-Test**

Group Statistics					
score	group	N	Mean	Std. Deviation	Std. Error Mean
	with-carousel	40	4.0250	1.14326	.18077
	without-carousel	40	4.3250	.88831	.14045

Independent Samples Test										
		Levene's Test for Equality of Variances			t-test for Equality of Means					
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
score	Equal variances assumed	2.075	.154	-1.311	78	.194	-.30000	.22892	-.75574	.15574
	Equal variances not assumed			-1.311	73.512	.194	-.30000	.22892	-.75618	.15618

Figure 5.11: t.test result from SPSS for question six

For final 6th question, independent-samples t-test confirmed that there is no significant difference between without-carousel interface and the carousel interface when it comes to the contents of the website. Users find out that contents were clear enough on both interfaces; $t(78) = -1.31$, $p = .194$ which certainly means $p > 0.5$. thus, there is no significant difference in here.

GGraph

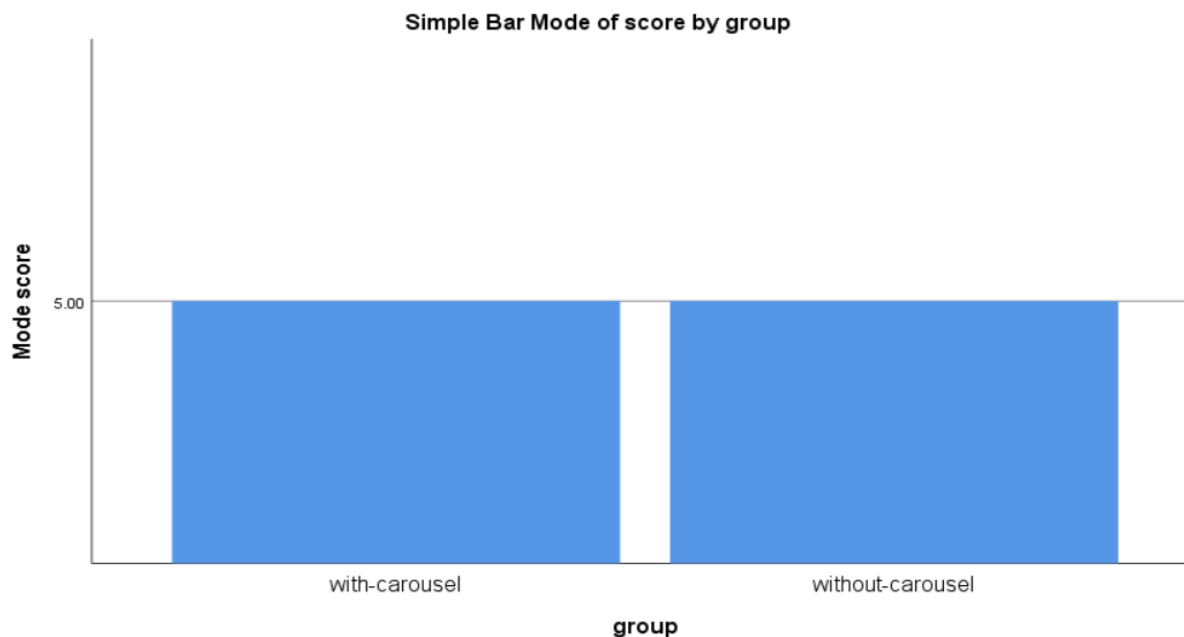


Figure 5.12: bar chart result from SPSS for question six

From the above graph, it is seen that both with-carousel and without-carousel mode score is same (5.00). there is no significant difference between them.

Overall, questions one to five result is significant, whereas the question six result is not significant. Question six was asked about the contents (ex- color contrast between text & photo) of the website. Where the result of two interface data are almost similar, users do not find significant difference between them as both interfaces share the same contents. Question one was asked whether items were easy to find out from interfaces or not. The result showed that finding items from those two interfaces gave users different experiences.

On the other hand, Question two asked explicitly about the banner section of the website. It was asked which interface users like to display in banner section on a website; the result showed that most users preferred without-carousel interface in the banner section of a website. The third question were asked about the product section of interfaces, which one user like to see to display product items in the product section of a website. From bar chart, it has been seen that participants mostly strongly agreed on the without-carousel interface, and p-value

also indicated that the difference between those two data are significant. Users like without-carousel interface in the product section. For fourth question, users find without-carousel interface is more user friendly to them while performing tasks. 5th question was asked about the navigation of those two interfaces. Was it easy for them to navigate throughout the website? From t.test result, it is seen that users find without-carousel interface was more comfortable to navigate. Total one (1) out of 6 results is not significant, and the rest of the five results is significant, and they rejected the null hypothesis.

6. Discussion and Conclusion

This study aimed to understand the accessibility of carousel interaction and usability of it. Therefore, this thesis compared the with-carousel interface and without-carousel interface, which one is more usable & accessible for users. The main goal of this research is to find out the gap between the accessibility of the carousel and how important it is to use it in a website. Is it really the best way to show information on the website?

The result showed that users like without-carousel interface more compared to with-carousel interface both in banner and product section of a website. Though some participants said it's almost the same for them, they didn't find so much difference between them to interact with. Six questions had been asked as a post-experiment questionnaire. The responses from users were presented in a bar chart using google analytics.

Overall, the first three questions were about to understand the user's preference of with-carousel or without-carousel interfaces. From the analytics, it has been seen that most of them said without-carousel interface was better understandable than with carousel interface. They have found out that without-carousel interface is more accessible. For that reason, they can recognize the category pattern from the product section easily. This thesis focused on only the web view; how accessible carousel is on a website from web view; it doesn't observe the mobile view of a carousel. Investigate the accessibility and usability of carousel interaction of users is the main concern of this thesis. From the tasks result, at first time and error were measured. By comparing task spent time by users on the two interfaces estimated the quality of navigation. When the web usability is being evaluated, it is needed to consider the user satisfaction, the interaction of web sites, the efficiency and the likelihood of errors while performing the tasks the site has been designed for (Turk, A.G, 2001). Therefore, the task spent time and error was measured to evaluate which interfaces is more user friendly to the users. By measuring the mean value for both task killing time & error, without-carousel interface took less time & users did less error on it. From the SPSS result, it is confirmed that the difference between those two data is significant, which means with-carousel & without carousel interface gave significantly different experiences to the users. In the context of web site design, accessibility is a measure of

how easy it is to access, read, and understand the content of the website (Barbara Leporini, 2003). From the above data, it is clear that without-carousel interface is more accessible compared to the with-carousel interface as it took less time to perform the goal driven task and users did less error on it, which indicates participants understanding the content of the website comparatively easily. Task time & error analysis data indicates that without-carousel interface is more accessible and usable.

Post-experiment questionnaires were designed to get the opinion of the users and to understand their experience during the experiment. Total of six questions were asked to the users, and from google analytics result, it has been seen that most of the users find without-carousel interface more user friendly when they performed goal driven tasks. Both the banner section and product display section were comparatively easier for them to find out the items from the interfaces. From SPSS result, total five (5) out of 6 questionnaires result showed that the data between them are significantly different. Thus, it can be said, from the post-experiment questionnaires result, without-carousel interface is more accessible and usable from the user's opinion.

Both during the experiment and post-experiment, questionnaires result support without-carousel interface more accessible and usable compare to with-carousel interface, which indicates perhaps carousel interface is not completely accessible and usable for everyone. Some of the users have more online shopping experiences, and they understand that the carousel interface and without-carousel are almost similar for them. They didn't find so much difficulties while performing the tasks, whereas the majority of the users said without-carousel interface is easier for them to understand. Without prior experience of the with-carousel interface website, it is quite complicated for users to understand the behaviour of carousel interface. Therefore, from the result, it can be said that carousel interface is not accessible for everyone. Even though both prototypes have been designed following WCAG guideline, therefore, both interface pass accessibility guideline, but the actual usability can be understood by user experience. Three research questions were asked in this thesis. The first one was, is it universally accessible & usable for everyone? From the result, it can be seen that carousel is not entirely accessible for everyone especially if users don't have much previous experience on it. The 2nd question was,

“Are there any benefits to use carousel on a business website? Are they easy to interact with the users?” from the whole experiment, no benefit has been found to use carousel on a website, rather users sometimes get confused on the carousel interface and especially when it comes to the banner section users entirely skip the banner part. Users do not even bother to know what is in the banner part and do not bother to click the next slide to see.

The final third question was “Is carousel the most appropriate system to show important content on the homepage of the website?” From the result it doesn’t support that carousel is the most appropriate system to show relevant content on the homepage because most of the time, most of the information is hidden, and users do not bother to check it. Relevant contents should be clearly visible whenever users come to a website.

In future work, larger participation could be conducted. Future work should also address the possibility that the prototypes and tasks used perhaps were simple, thus potentially making it more challenging to achieve a goal. It could have been improved by having more complex information and, in turn, more complex tasks that could have highlighted differences. Also, the questionnaire could have been a semi-structured interview of the participants to get more in-depth information about their perceptions and how they felt about the whole experience. And this thesis is only focused on desktop view of a carousel, to get the idea of how carousel work on mobile view, future research could be conducted on the mobile view of a carousel.

Until more work is done, this study results suggested that without-carousel interface should be used on websites because of its’ simplicity. It appears to be a more accessible & usable option when compared to the with-carousel interface.

Web designers should consider usability & accessibility more than only the look of a web site. The aim of this research is to help the web designers to understand the user’s need and their expectation while using a website. From my personal experience, this research is a big journey for me. Throughout the study I have learnt a lot starting from writing to practical user testing. As a web designer, I was always focused on the look of a website, used a lot of animations while designing webpages. Majority of the clients prefer carousel, animation and different color contrast on websites, they weren’t so much aware of the accessibility of a website; they didn’t

consider that any disable person could also visit their website. Practically I have seen how users behave while using a website and what type of problems they've faced while using it. I hope this research would help web designers to think more about the accessibility of webpages and they will re-consider using carousel on webpages especially from web view. Apart from that, I have learnt a lot about research methodology and how to conduct an actual user testing during this study. To know something theoretically and to implement that practically is quite different and for that reason this research is create a big impact on my research career. Throughout the journey it helps me to grow as a researcher as well as helps me to think more about accessibility and usability while designing web pages.

7. Appendix

Tasks

Task-1 Find a summer Men suit-khaki color with exactly \$500 price from the Latest product section.

Task-2 Find a Choker Top-Floral color with less than \$300 price from the latest product section.

Task-3 Find a men's v-neck Black color t-shirt with more than \$150 price from the latest product section.

Task-4 Buy a men suit with coupon code from the new arrival section.

Questionnaires

1. it is easy for you to find out the items from the website.

	1	2	3	4	5
a. carousel?	strongly Disagree,	Disagree,	Moderate,	Agree,	strongly Agree

b. without-carousel?	strongly Disagree,	Disagree,	Moderate,	Agree,	strongly Agree
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2. You like with-carousel/without-carousel in the banner section?

3. You like with-carousel/ without-carousel to display products in the Product section.

4. website interface seems user-friendly to you?

5. navigations were easy for you to follow?

6. contents were clear enough for you to follow (Ex- the color contrast between text & photo).

Bar charts results

1. it is easy for you to find out the items from the website.

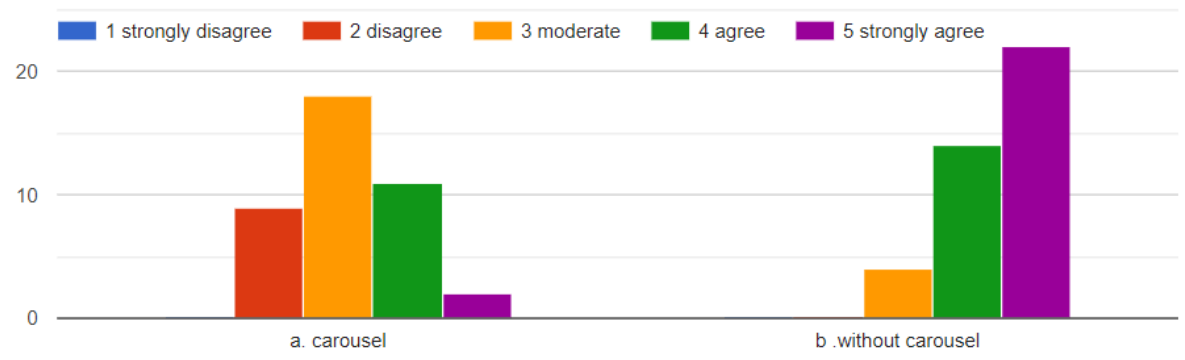


Figure A.1: bar chart result for likert-scale response for question one.

2. You like with-carousel/without-carousel in the banner section?

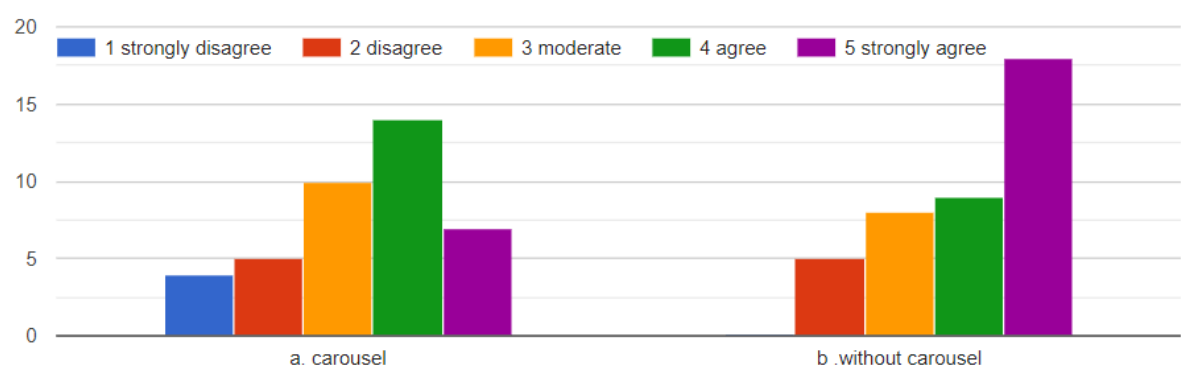


Figure A.2: bar chart result for likert-scale response for question two

3. You like with-carousel/ without-carousel to display products in the Product section.

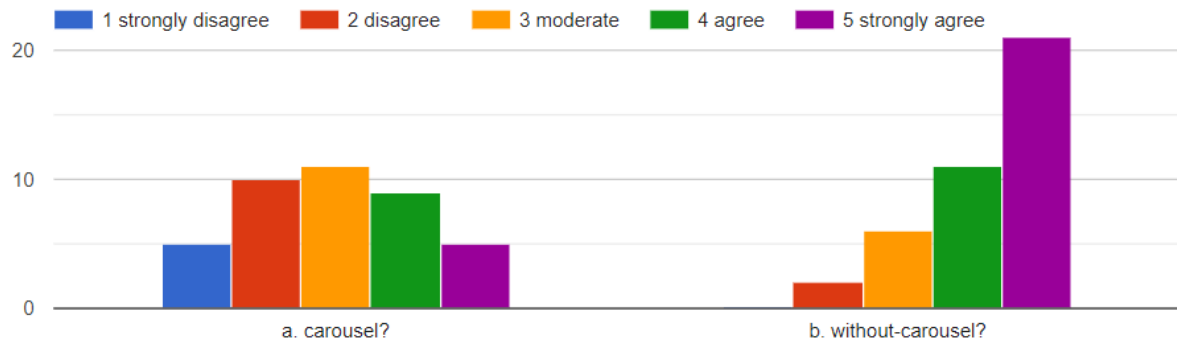


Figure A.3: bar chart result for likert-scale response for question three.

4. website interface seems user-friendly to you?

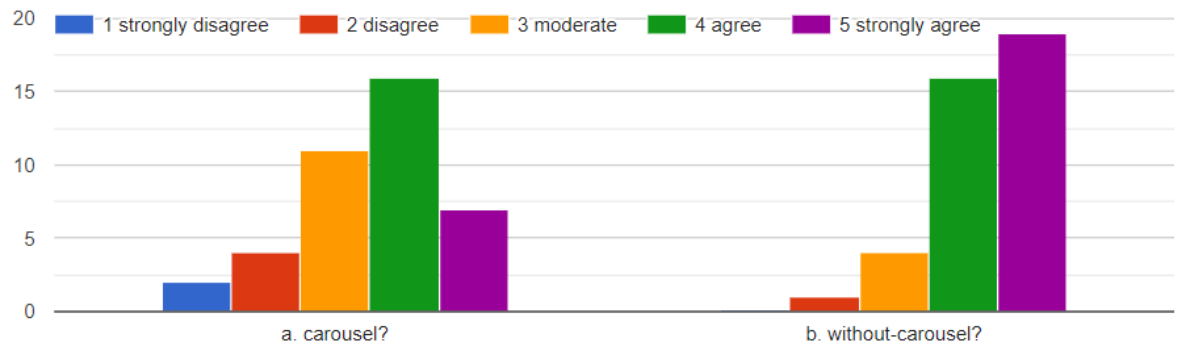


Figure A.4: bar chart result for likert-scale response for question four.

5. navigations were easy for you to follow?

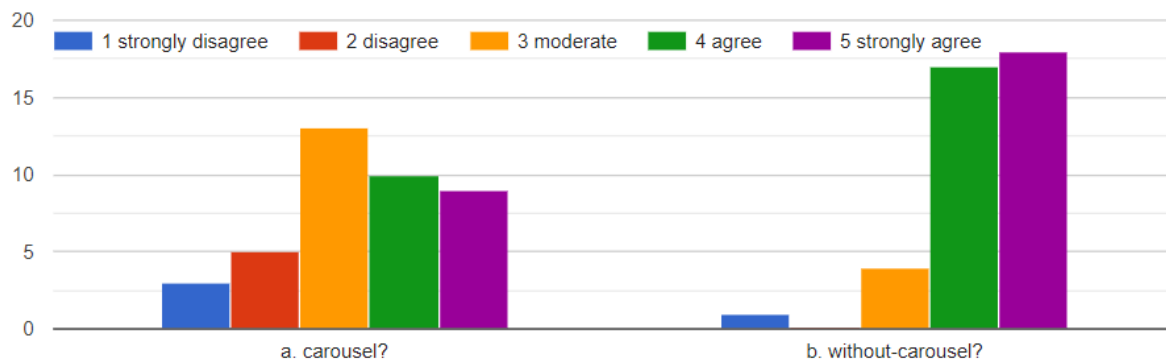


Figure A.5: bar chart result for likert-scale response for question five.

6. contents were clear enough for you to follow.(Ex- color contrast between text & photo)

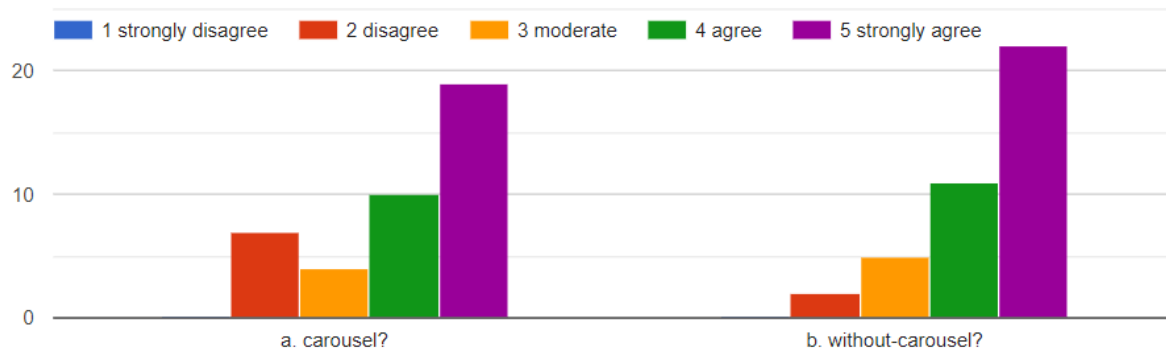


Figure A.6: bar chart result for likert-scale response for question six.

Information sheet

Informed consent

Title of the Research: Universal Design and Usability Investigation into Carousel Interaction.

Introduction and Purpose of the Study:

This is a request for your participation in a research project regarding web Carousel. The study is in the field of universal design of ICT and to understand the importance of using web carousel. The purpose of the research is to find out whether carousel universally design for everyone or not, is it easy to interact with the users? The result of the experiment will be used in the master thesis of Rashika Tasnim from Oslo metropolitan university.

In order not to influence the results, it is not possible to give exact information on what is being studied. Debriefing and a short description of your result will be given after the experiment has been completed.

Procedures

The procedure is to perform some online dummy shopping. There are four tasks that are described in the tasks form; participants have to follow those requirements and have to perform those tasks. The tasks are related to finding out four product items from two different online shops with certain requirements. Participants need to find out those four items separately on two different online shops. At the end of the tasks, on the post-experiment questionnaire, users give their opinions about those two interfaces and make a comparison between them.

Duration

The whole process is divided into three sections. First, understand the concept and perform certain tasks. After that, fill up some personal information that will be collected anonymously. Finally, the post-experiment questionnaire where users need to give their feedback based on their task experiences. The total time will take approximately 20-25 minutes.

Who to Contact

If you have any question, arise in the future and wanted to contact about the research. You're welcome to contact me. As it is my master's thesis program, you have to contact me in the following email address-

Rashika Tasnim Keya

Master's student in universal design of ICT

Oslo metropolitan university

S329930@oslomet.no

Consent Form

- I voluntarily agree to participate in this research study
- I understand that even if I agree to participate now, I can withdraw at any time or refuse to answer any question without any consequences of any kind.
- I understand that I can withdraw permission to use data from my interview within two weeks after the interview, in which case the material will be deleted.
- I have had the purpose and nature of the study explained to me in writing, and I have had the opportunity to ask questions about the study.
- I understand that participation involves some online dummy shopping, and there is nothing personal judgment here about the performance.
- I understand that I will not benefit directly from participating in this research.
- I agree with my interview being screen-recorded.
- I understand that in any report on the results of this research, my identity will remain anonymous. This will be done by changing my name and disguising any details of my interview, which may reveal my identity or the identity of people I speak about.
- I understand that I am free to contact the person involved in the research to seek further clarification and information.

Signature of the research participant

Signature of participant

Date

Thank you for participating!

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