The effect of information structure consistency on usability on cross-platform services

PAPER WITHIN Informatics
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JÖNKÖPING May 2019
This exam work has been carried out at the School of Engineering in Jönköping in the subject area of Informatics. The work is a part of the three-year Bachelor of Informatics in Engineering programme: New Media Design. The authors take full responsibility for opinions, conclusions and findings presented.

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**Scope:** 15 credits (first cycle)

**Date:** May 2019
Abstract

The purpose of this paper was to investigate and analyse the effect information structure consistency has on usability on cross-platform services. More precisely, it focused on evaluating consistency from the way information is structured and categorised. Current research on consistency is contradicting, therefore, this paper contributed to the field of research by conducting a study that investigated the effect consistency and inconsistency have on cross-platform services. The study was conducted using both qualitative and quantitative methods, gathering data from usability testing with Think Aloud Protocol and screen recordings, and post-test questionnaire. Two consistent and two inconsistent cross-platform services were chosen and tested by users who had to complete a task on a desktop and mobile versions of the service. The collected data was analysed, compared and the conclusions were drawn. The findings clearly show that consistency on cross-platform services is an important factor that strongly influences the user experience and enhances usability when done correctly.

Keywords

Cross-platform, user experience, usability, organisational system
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1 Introduction

The thesis was written as graduation work of Jönköping’s University Bachelor’s Degree in Informatics. The bachelor thesis is equal to 15 ECTS.

The following chapter describes the background within the subject of the research topic. Based on the problem statement, research questions were formulated. Finally, the delimitations and the outline of consecutive chapters was presented.

1.1 Background

The invention of the World Wide Web in 1989 by Tim Berners-Lee has irrevocably changed the way of human interaction, specifically, the shift from Web 1.0 to Web 2.0. The latter has made it possible for users to freely interact with websites, allowing them to not only retrieve the data but also share and interact with it. A new term, graphical user interface (GUI) was created in order to distinguish graphical interfaces from the text-based ones. Human-computer interaction (HCI) was controlled mainly with a mouse and a keyboard, which were designed based on WIMP (Windows, Icons, Menus, Pointers) interaction style. In consequence, developers started to put more focus on users rather than devices. Accordingly, the attention was directed to the experiences the users were having, resulting in User Experience (UX) that refers to all aspects of the end-user’s interaction with its services and products (Norman & Nielsen, n.d.).

With the release of the first iPhone device in 2007, smartphones became an essential part of humans’ daily life, which resulted in the growing number of smart media usage. Users started interacting with products and services, seeking information using various types of devices, ranging from traditional personal computers to smartphones.

The multiple device usage has led to a high demand of consistent systems across different platforms which has brought new challenges concerning web design. In order to satisfy users’ needs and to support different screen sizes, a responsive web design (RWD) was developed. RWD is an approach for designing flexible and adaptable layouts that automatically adjust to the screen size or the platform used (Moore, 2016).

With the increasing number of interconnected devices, there came a need of making the multi-device services inter-usable. The term inter-usability, also known as cross-platform usability, first coined by Karsenty and Denis (2005, p. 4) describes this phenomenon. They define it as the “ease with which users reuse their knowledge and skills for a given functionality when switching to other devices”. Therefore, for a better cross-platform usability, multi-device services need to support the continuity principle, which enhances the user experience throughout the devices (Majrashi, Hamilton & Uitdenbogerd, 2018). This brought the need for a usability evaluation of when users perform related tasks across platforms (Majrashi, Hamilton & Uitdenbogerd, 2016). In order for the users to reuse their previously acquired knowledge and skills on another platform, a consistent design on cross-platform services needs to be taken into consideration (Denis & Karsenty, 2005).
Concerning the existing methodologies for designing and evaluating cross-platform services, the problem is that they are usually limited to a single platform or device, and therefore, the aspects of cross-platform consistency and continuity are ignored (Antila & Lui, 2011). According to them the limitation comes from the challenge of considering the different platform capabilities in terms of display and user controls and the need to adjust the design to the target device on its own. Developers not only need to take into account different operating systems such as Apple and Android but also the constraints that are generated by these devices including screen size, resolution and interaction modalities (Nygen, Vanderdonckt & Seffah, 2016). What is more, Andrade & Albuquerque (2015) state that it is difficult to define the users’ behaviours on cross-platform services. According to Antila and Lui (2011), there is no easy way to meet this challenge since unified manner needs to be achieved when working with cross-platform services. Unified experience needs to be achieved not only design-wise but also the way information is structured and organised on cross-platform services. According to Antila & Lui (2011), consistency needs to be achieved not only design-wise but also the way information is structured and organised on cross-platform services (Antila & Lui, 2011; Rosenfeld, Morville & Arango, 2015). Information structure and organisation are part of an organisational system with the main purpose of supporting usability, findability and understanding, which plays an important role in creating and maintaining a positive user experience (Rosenfeld et al., 2015). With all this in mind, this research focused on assessing cross-platform usability from consistency perspective. More precisely, consistency from the organisational systems perspective, meaning the way the information is structured and organised.

1.2 Problem Statement

The previous studies in the field of cross-platform services have shown different findings on consistency influencing cross-platform usability. According to research carried out by Wäljas et al. (2010) and Denis and Karsenty (2005) consistency between platforms is overemphasized, as users are not too focused on consistency problems. They claimed that in terms of cross-platform usability, experiences and users’ feelings are more important than inter-device consistency when changing devices (Wäljas, Segerstahl, Väänänen-Vainio-Mattila & Oinas-Kukkonen, 2010; Denis & Karsenty, 2005). On the contrary, Majrashi (2016) in his research, found that inconsistency in terms of user interfaces was the main cause for cross-platform usability issues. Therefore, further studies and investigation are required in order to examine how consistency affects cross-platform usability.

1.3 Purpose and research questions

The previous research indicated the limitations in the process of evaluating cross-platform services in terms of usability. Therefore, the aim of the thesis is to evaluate cross-platform usability from consistency perspective. To address these limitations, an exploratory study was conducted. Due to the fact that consistency can be assessed using different components, this paper examined consistency from the way the information is structured and organised, which made the evaluation process more focused. After the problem was identified, the following questions were proposed:
1. How does consistent and inconsistent design on cross-platform services affect its usability?

1.1. How does inconsistent information structure and organisation affect users’ experience on a service?

1.2. How does consistent information structure and organisation affect users’ experience on a service?

1.4 Delimitations

It is beyond the scope of this study to examine all the aspects that affect usability on cross-platforms. Current usability metrics focus on measuring it from a single user interface, which sets certain challenges when evaluating cross-platform usability. Taking into consideration the difficulty in the different platform capabilities and design methods, limitations are met regarding the way they affect user experience. The reader should bear in mind that this study focuses on evaluating consistency from the way information is structured and organised, omitting the visual aspect of interface design on given platforms.

Due to practical constraints this study cannot provide comprehensive review on usability of all devices that cross-platform term encompasses. Therefore, the usability was tested on a smartphone and PC (personal computer).

1.5 Outline

The thesis work is structured in the following manner:

The first chapter “Introduction” includes the description of the background, the purpose of the study and research questions, that this study attempts to answer. Background consists of a brief amount of historical and theoretical background that helps the reader understand the basic concepts and definitions. The problem was described and supported with relevant references, indicating on the existing research gap within the field. The next paragraph describes the purpose of the work and the research questions that are the fundamental core and main focus of the research study.

The second chapter “Theoretical Background” demonstrates the concepts and theories that were used for the study. The third chapter “Methods and Implementation” chapter covers the methods and the tools used for the study, along with a detailed account on how the data was collected and processed. The following chapter “Findings and Analysis” addresses the gathered results of the study with their thorough analysis. The last chapter “Discussion and conclusions” consists of a further discussion and reflection on the choice of methods and its findings with regard to the purpose and research questions.
2 Theoretical background

The following chapter describes the references used throughout the work, along with the research that was previously carried out in the field. Based on theory, the ideas for the study were generated and refined in order to build up on existing knowledge and contribute to the field of research.

2.1 Definition of Cross-Platform Service

As stated by Shin (2016), cross-platform services maintain similar or unified experiences across various devices, such as televisions, personal computers, tablets or smartphones. The definition of “cross-platform” refers to the ability of a product, software or service to adapt to various computing platforms (Majrashi, Hamilton & Uitdenbogerd, 2015). Cross-platform services, also referred to as multi-screen services, make it possible for the users to display the exact same content on different devices at any time (Wäljas et al., 2010). In this paper, cross-platform service is referred to as a service that is adaptable to and can be accessed on two or more devices.

2.2 Cross-Platform Usability and Task Continuity

Nielsen (2012) defines usability as a quality attribute, which helps to evaluate the ease of use of user interfaces. Moreover, usability is seen as a method for testing and improving the design process. As stated by Madan and Dubey (2012), usability is an essential factor when building successful, quality software. They refer to it as the ease of learning how to operate and handle a particular software by a user. In order to ensure that cross-platform services are user friendly, usability on platforms needs to be evaluated. According to Karsenty and Denis (2005), usability can also be measured across different platforms and devices and is therefore referred to as cross-platform usability. They define it as the ease of reusing the knowledge or a certain skill for a particular functionality. Thus, in order to be able to reuse the knowledge and support seamless transition between devices, it requires continuity in both knowledge and task (Seffah & Javahery, 2004). Knowledge continuity refers to the memory retrieval of a particular service functionality based on previous use of the device. Task continuity, however, refers to the ability of memorising the recently performed task, irrespective of the device and the belief of sharing it with the service (Seffah & Javahery, 2004). According to Wäljas et al. 2010, task continuity is an important cross-platform usability component and one of the key elements of cross-platform service user experience, which is achieved through cross-platforms consistency.
2.3 The difficulty of designing and evaluating Cross-Platform Services

The significance of consistency is perceived contradictory by different researchers. Findings of multiple studies have shown different attitudes towards consistency from users’ perspective and its importance in cross-platform services.

Majrashi (2016) in his paper examined multiple aspects of cross-platform user experience. He stated that despite of the significant growth of the cross-platform usage worldwide, there is still not enough research on that, resulting in the limited amount of assessment methods. Five different studies were carried out covering aspects such as usability, culture and context-related user experiences across platforms and users' behavioural patterns when toggling between devices. The analysis of the findings revealed that users were mostly sensitive to issues concerning the key cross-platform UX elements. Some of the most relevant ones were the consistency of user interface (UI) system components across platforms or the task continuity and the fluency in resuming a task on a different device. Inconsistencies, however, were perceived to be the main source of cross-platform usability problems. For instance, it was noticed that the inconsistent UI was affecting the fluency of the task continuity.

Similar research investigating user experience on cross-platforms was done by Wäljas et al. (2010). A field study was carried out along with interviews and diaries, evaluating user experience on three websites. Three common themes were identified in order for the analysis to support user experience as well as usability evaluation. Composition, continuity and consistency were the themes based on which the findings were discussed and analysed. The most relevant findings that contributed to this paper were on consistency theme. Wäljas et al. (2010) observed that users were not mentioning consistency in their interviews or diaries. Nevertheless, they justify it with two reasons. Namely, users simply do not think about it or consider evaluating it, on the other hand, the services they had to evaluate did not have any inconsistency issues for them to notice. However, consistency was described as a secondary factor that supported the other mentioned themes. For example, consistency might have had supported the ease with which users learned how to use the service on each of the platforms. Additionally, the questionnaire also investigated the aspects of consistency. The results showed that consistency of terminology was the one most noticed by participants, whereas the visual consistency and the overall impression had diversified responses. According to Wäljas et al. (2010), in order to implement consistency on cross-platform services three characteristics were taken into consideration: perceptual, semantic and syntactic consistency. Perceptual is about the consistent look and feel of the platforms, semantic covers the terminology and symbols and syntactic is achieved with similar interactions and functionalities.

Correspondingly, Denis and Karsenty (2005) define inter-device consistency, meaning coherency between services on different platforms, by four components. They claim that consistency in cross-platform services is achieved through coherency in perceptual, lexical and syntactic components, and that inconsistency to some extent in terms of semantic consistency in cross-platform services and products may bring an
added value to their use. Perceptual consistency refers to the way information and graphics are structured and presented, lexical means harmony of labels and user interface objects, syntactic is the availability of the same operations on each device for achieving a particular goal and semantic consistency concerns the redundancy of data and functionality between devices.

Consistency was referred in a similar way by Mendel (2012), who distinguished it in his paper as perceptual, defined as appearance and layout of the interface, and conceptual, meaning how the system works and responds. In his study he observed how those two dimensions of consistency affected users’ performance on different devices. The outcomes revealed that inconsistency of either of two dimensions affected the performance and had negative consequences. What is more, he found that the inconsistency of one of the dimensions, with the other dimension being consistent, was more unfavourable in comparison with inconsistency of two at the same time.

2.4 Information structure and organisational systems

Organisational system is one of the four systems of Information Architecture (IA). According to Rosenfeld, Morville and Arango (2015), information architecture is referred to as a discipline that concerns the design of information, with the main purpose of supporting usability, findability and understanding, all of which play an important role in creating and maintaining a positive user experience. They refer to organisation systems as the organisation and structure of the information, which influences the way users understand that information.

The way information is organised is closely related to navigation, labelling and indexing and plays an important role in the main navigation system (Rosenfeld et al., 2015). Rosenfeld et al. (2015) describe the different ways of categorising and grouping the information. They divided the system into organisation schemes and organisation structures. Organisation schemes concern the logical grouping of content items, which share similar characteristics. Organisation structures, however, relate to the kinds of relationships between the content items and groups (Rosenfeld et al., 2015).

There are different ways of grouping and organising the information. According to Rosenfeld et al. (2015) organisation schemes can either be exact or ambiguous. Exact schemes are used for information that can be easily assigned into groups by categorising them alphabetically, chronologically or geographically. Nevertheless, when the information is harder to define and group, the ambiguous scheme is used. On that occasion, the information can be grouped using task-oriented, audience-specific or metaphor-driven approach. Organisational structure consists of three primary structures. Top-down approach structures the information hierarchically, giving the overview of the information environment. Another way of structuring the information is with bottom-up approach, which enables to search, browse and filter through the tagged content. The third way concerns structuring the chunks of information and linking them to each other, which is mainly used as a complementary approach to the other two (Rosenfeld et al., 2015).
There are limited studies carried out on the importance of information architecture systems on cross-platform service consistency. Previous study carried out by Ali (2006), investigated one of the systems of information architecture - navigation system. He examined the consistency of navigation on cross-platform user interfaces. The outcomes of the study revealed that forcing consistent navigation might result in lower usability, arguing that it is not only desired to have different navigation styles, but they might even be a requirement. He supported it with a fact that user interfaces on different platforms have inherently different natures.

2.5 Conclusions

The previous work highlights the importance of consistency in cross-platform services. Researchers have different views on how consistency is achieved in cross-platform services, therefore it is still debatable to what extent it affects the usability. In order to get a better overview on the role consistency has on cross-platform services, this paper contributes by testing one of the components of consistency - semantic, meaning the way information is structured and organised. Furthermore, there are limited studies done on information architecture systems in cross-platform services. One of the previous studies evaluated the navigational system and its consistency on cross-platform user interfaces. Therefore, this paper focuses on testing the organisational system.
3 Method and implementation

This chapter introduces the methodological approach that was carried out in order to address the research questions. The choice and design of research model was described, followed with data gathering methods and the metrics that the usability was assessed with. Thereafter, the choice of population sample and description of data analysis was presented and described.

3.1 Research design

The aim of the study was to evaluate importance of consistent organisational systems on cross-platform services, namely on smartphones and PCs. Since there are limited studies done on cross-platform services, the field of evaluating those services is not fully explored. Therefore, the study was of an exploratory nature, as it intended to address and understand a problem that has not been clearly defined yet (Saunders, Lewis & Thornhill, 2009). The exploratory research pursued to collect both qualitative and quantitative data. The method through which qualitative data was collected was usability testing, whereas quantitative data was gathered through a post-test questionnaire. In order to generate new data and develop new theories that could contribute to the field, the data was analysed inductively (Saunders, Lewis & Thornhill, 2009).

3.2 Usability testing

Usability testing is regarded as a core method for assessing and evaluating a service. According to Rubin and Chisnell (2008), the fundamental goal of usability testing is to gather data that would help to analyse and identify all the flaws in a service in order to improve it and implement adjustments. In other words, usability testing is a process that engages people as test participants who represent the target audience to evaluate the degree to which a service meets the usability criteria. Albert and Tullis (2010) identified ten most common usability study scenarios with respective metrics that they can be assessed with. According to them, the most valuable attributes for evaluating usability are performance metrics: task success, task time, errors, efficiency and learnability. Nevertheless, traditionally usability tests are conducted on single UI due to lack of assessment methods. In consequence, Majrashi (2016) for the purpose of his study developed an assessment model for evaluating the cross-platforms usability on multiple UIs through measuring efficiency, effectiveness, satisfaction, productivity and continuity.

Based on the relevant scenarios identified by Albert and Tullis (2010) and assessment models developed by Majarshi (2016), this study attempted to assess usability on cross-platforms by comprehending the traditional metrics used in usability testing with metrics that would allow to measure usability when users switch between devices. Correspondingly, four relevant metrics measuring users’ experience were chosen based
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on the design of usability test: task success, task time, efficiency and an additional metric, continuity, which is an essential component in cross-platform usability (Wäljas et al., 2010).

### 3.3 Assessment metrics

The metrics used in the study with respect to cross-platform tasks that were assigned to participants are described below (See Table 1). The descriptions of metrics and usability study scenarios are based on tables which were presented in the book by Albert and Tullis (2010) and in the research paper conducted by Majrashi (2016).

<table>
<thead>
<tr>
<th>Usability study scenario</th>
<th>Task time (Overall execution time)</th>
<th>Continuity (Task resuming time)</th>
<th>Efficiency (Number of actions)</th>
<th>Task success Completion of task</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Completing a task</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
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<tr>
<td>2. Comparing services</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Evaluating navigation and information architecture</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
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<tr>
<td>4. Maximizing service usability</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
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<tr>
<td>5. Comparing alternative design</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Measuring the time of resuming the task after switching the device</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

*x – metrics that measures the scenario*

**Task success**

Task success concerns completing the task and achieving the assigned goal. The metric can be used in usability study that requires accomplishing any task. Prior to measuring the success rate of the assigned tasks, the criteria for task completion were predefined.

**Task time**

Refers to the time spent on a task completion. The participants’ time is measured between the start and the on the task, measured in minutes and seconds. In this study it was recorded when screen recording the usability study.

**Efficiency**

Efficiency is the amount of effort needed in order to complete a task, which is usually done by measuring the actions the participants take while performing a task. There can be many forms of actions, such as clicking on a link, pressing the button on mobile or turning on the switch. Each one of the actions taken by the participant defines a certain amount of effort. The more actions taken means the more effort needs to be involved.
In this study efficiency was measured with the amount of actions taken to complete the task.

**Continuity**
Refers to the ability to seamlessly transition between devices. In this study, continuity was measured by the time it took for the participant to resume an interrupted task after transitioning to another device.

### 3.4 The design of usability test

Four cross-platform services offering the same service, online newspapers, were chosen for this comparative usability test. Online newspapers allowed to measure and evaluate organisational systems from the way information was structured, grouped and organised. For the purpose of assessing the importance of consistency, two of them were consistent in terms of structure and information organisation, whereas, the other two online newspapers were perceived as inconsistent. The bases on which the services were chosen are presented in section 3.5 which details the choice of websites for the usability test.

The study was designed to be as realistic as possible, based on the main purpose of that service. The test consisted of one horizontal task. Horizontal task is a task performed across multiple devices. For the purpose of this study it was performed on a desktop and mobile version of the same service. For comparison, a vertical task is fully performed on the same device (Majrashi, 2015). The task was performed on both devices with the aim of locating an article without using the search tab. The article was selected by moderators and belonged to the category in which inconsistency occurred. Having found the article on the first device the participant had to switch and find the same article on the second device.

The rotation of device order was dependent on the inconsistency factors. For the tests conducted on inconsistent online newspapers, the first tested device was the one that purely showed inconsistencies in structure and information organisation on the website. On the consistent newspapers, however, the order did not play a significant role as irrespective of the device, the websites showed no inconsistencies in structure and information organisation. Prior to the test, participants were acquainted with the course of the test process and received explanation about Think Aloud Protocol. Furthermore, participants had a chance to ask additional questions that did not influence the process and results of the study. The generally accepted and lowest number of participants for the qualitative method, stated by Nielsen (2000), is five people. In order to get more reliable data, the usability test was done by 12 participants. Six participants performed the tasks on two different consistent websites (three per website), whereas, the other six did the same tasks on two inconsistent websites. Prior to the study, a pilot test with two participants was carried out, which revealed the faults and weaknesses of the study and provided essential feedback for finalising the test. The devices used in the study were a MacBook Pro (15-inch) with MacOS operating system and an iPhone 10 with iOS operating system. In order to capture the interactions of the
users when performing the task on mentioned devices, the screen recording function was used as a supplementary method for gathering data.

3.5 The choice of websites for usability test

The choice of websites was based on the level of consistency in content structure and organisation. The main focus, when choosing websites, was aimed at the consistency or inconsistency of the menu items between the desktop and mobile versions of the service. The reasoning behind the selected consistent and inconsistent websites is given below with further explanation.

Consistent online newspapers

The desktop and mobile versions of online newspapers, “The Economist” and “Global News” were consistent in terms of organisational schemes and organisation structures. The content was organised logically into groups that share similar characteristics. For instance, on “Global News”, health related articles were organised under Health category and were labelled the same on both devices. Similarly, on ‘The Economist” website, the information was also grouped logically under the relevant headline. The visual presentation of the consistent websites design is demonstrated below.

Consistent website 1 “The Economist”

Smartphone (See Figure 1)

Figure 1
Findings and analysis

PC (See Figure 2)
Findings and analysis

Consistent website 2 “Global News”

**Smartphone** (See Figure 3)

![Smartphone screenshot](image1)

**PC** (See Figure 4)

![PC screenshot](image2)
Findings and analysis

Inconsistent online newspapers

The online newspapers of “The New York Times” and “SF Gate” showed inconsistencies between the desktop and mobile versions, in terms of how the information was grouped, organised and labelled. On “SF Gate” the content was organised illogically into groups that did not share similar characteristics. For instance, one of the menu items was labelled as A&E and consisted of topics such as Music & Nightlife, Art, Things to Do and Horoscope which could also be categorised under other menu items such as Living or Travel. Furthermore, the labelling of menu items showed hierarchical errors. Some of the categories were named more specifically than the others, which is where the main inconsistencies occurred. For instance, on the PC version of the website, Horoscope was put under A&E menu item, whereas on the smartphone version of the website it shared the same hierarchical level as the rest of the main menu items. Similarly, “The New York Times” showed inconsistencies in organisational schemes and structures. The weather-related news was labelled as Climate and Environment in smartphone and PC respectively. Moreover, the category was not on the same hierarchical level on both devices, meaning, on smartphone the Environment section was shown next to Science, whereas on PC version, the Climate was put under Science section. The visual presentation of the inconsistent websites design is demonstrated below.

Inconsistent website 1 “The New York Times”

Smartphone (See Figure 5)

![Figure 5]
Findings and analysis

PC (See Figure 6)
Findings and analysis

Inconsistent website 2 “SF Gate”

**Smartphone (See Figure 7)**

![Figure 7](Image)

**PC (See Figure 8 and 9)**

![Figure 8](Image)
3.6 Data gathering methods during the usability test

In usability studies, data collection often relies on multiple data sources (Majrashi, 2016). In order to collect as much valuable data as possible, two data gathering methods were combined consisting of Think-Aloud Protocol and screen recording. The explanations of used methods are described in the following sections.

3.6.1 Think Aloud Protocol

According to Nielsen (1994), Think Aloud Protocol is one of most valuable practical evaluation methods of human-computer interfaces. Moreover, the method can provide a rich amount of qualitative data from a small number of participants. The data gathering method is widely used by usability professionals since it helps to identify usability issues that occurred on a service or website and gives suggestions for improvements (Olmsted-Hawala, Murphy, Hawala & Ashenfelter, 2010). The method involves the participant interacting with the service and completing a set of tasks while continuously verbalising their thoughts and saying out loud things that come to their mind (Rosenzweig, 2015). The two of the most used Think Aloud protocols today are Concurrent Think Aloud (CTA) and Retrospective Think Aloud (RTA). CTA refers to the method where participant is asked to verbalise their thoughts while completing a task. RTA on the other hand refers to the method where participant shares their thoughts after completing a task, generally while watching a video replay of their actions (Olmsted-Hawala & Romano Bergstrom, 2012). Various research contributions have pointed out both benefits and drawbacks of using one protocol over the other. In this study, participants were asked to think aloud retrospectively after completing each task, which let them to execute the given tasks in their own pace and...
Findings and analysis

manner without any interruptions. This made it possible to measure one of the main usability metrics - task execution time. Furthermore, since all participants in this study were verbalising their thoughts not in their native language, RTA makes it easier to verbalise and formulate thoughts after task performance (Haak et al., 2003). Moreover, Haak et al. (2003) in their study found that participants who were tested with CTA approach, made more errors in the process of task performance and were less successful in completion. The screen recording of the entire process was immediately showed to the participants after completion of the task, which helped to avoid the occurrence of biased and modified thoughts. The purpose of RTA was to gather information on the cognitive behaviour of participants performing the tasks and measure the cross-platform usability by previously mentioned metrics. In this study, the data from Think Aloud Protocol was transcribed using audio recording and stored for further analysis.

3.6.2 Screen recordings

Screen recordings were acquired during the usability test. The recording was started with the first action taken by the participant until achieving the goal of the task. The data was gathered from both smartphone and PC. The data gathered through this method allowed to measure all of the assessment metrics: task time, continuity, efficiency and task success.

3.7 Questionnaire

According to Maguire (2001), the post-test questionnaire is considered to be a valuable method for supporting human-centred design and obtaining quick subjective feedback from participants, based on their experience of a service. Since the design of questionnaire can affect the reliability and validity of the data that is collected, it is pivotal that the questionnaire is carefully planned and formulated in regard to set research questions. The are several standardised usability questionnaires designed for the assessment of perceived usability, typically used at the end of a task or a study. As there are no standardised usability questionnaires designed for evaluating cross-platform services, the question formulation in this study for post-test questionnaire was based on the standard usability questionnaires such as SUS (System Usability Scale) and on cross-platform system usability scale designed by Majrashi (2016).

In this study, post-test questionnaire was selected as a complementary data collecting method, which measured users’ satisfaction and gathered information about usability issues that occurred when switching devices. Blomkvist and Hallin (2015) distinguish between three different types of data variables that can be measured through questionnaire: nominal, ordinal and ratio or interval variable. The post-test questionnaire was designed to consist of ranking questions, which often is ordinal variable. The first two questions measured continuity when switching devices, whereas the other four concerned measuring users’ satisfaction. The questions were conducted using the Likert rating scale. The participants were asked to show their level of agreement and attitude towards the given statements, which was measured with a five-
Findings and analysis

point metric scale (from strongly disagree to strongly agree). The method was conducted after usability test was completed. The post-test questionnaire can be found under appendices (see Appendix 1).

3.8 Selection of participants

In order to prevent biased data, the choice of participants for the usability testing was dictated by fundamental criteria. To begin with, the participants should have never used or seen the examined websites. They should have had little or no knowledge of web design, or concepts such as Information Architecture or User Experience. They had to be familiar with multiple device usage, namely, switching between PCs and smartphones and performing similar or identical tasks on them. Since the test was conducted in English, participants needed to be comfortable with expressing themselves in that language. Concerning the software used for the tests, the participants had to be comfortable with using devices with macOS and iOS operating systems. In order to find suitable participants, a short survey based on the mentioned criteria was prepared and distributed via Facebook. In the time frame of three days, 18 people answered the survey, 12 out of which met the criteria and were asked to take part in the test (see Appendix 1).

3.9 Ethics

In order to conduct a study in humanities and social science, it is necessary to consider and follow the ethical principles. According to Blomkvist and Hallin (2015), there are four requirements that need to be met. Information requirement entails that participants are informed about the purpose and the process of the study. Consent requirement demands the participants’ agreement prior to the study. Furthermore, the collected data needs to be treated confidentially, meaning, it must not be freely shared or exposed. The last requirement entails that the collected material is exclusively used for the purpose of this study. In this study, all of the above-mentioned requirements were followed and respected.

3.10 Validity and reliability

In order to ensure that the chosen methods are as reliable and as valid as possible, a pilot test was planned and conducted before the actual study. Two participants took part in the test, providing feedback about the weaknesses which were later addressed and adjusted in a proper way.

3.11 Data analysis

The empirical data gathered in this study was both qualitative and quantitative. Since there are many ways through which the data can be analysed, the material needs to be
Findings and analysis

processed in critical manner using an appropriate approach. Therefore, the collected data was analysed inductively, which is frequently used in exploratory studies. In this study the inductive analysis was done by organising raw data, transcribing it and grouping it to relevant categories. Through this process new knowledge was generated.

The qualitative data from Think Aloud Protocol was stored and organised in separate files for each participant. Then, the collected data was analysed thematically by grouping the data into different categories. The categories resulted in revealing the aspects, that were particularly noticed by participants and influenced the usability of the websites.

The quantitative data from questionnaires was analysed with univariate analysis, that looked at one variation at a time and estimated the median of all responses (Blomkvist & Hallin, 2015; Saunders, Lewis & Thornhill, 2009). The data from screen recordings was analysed by estimating the mean of the overall time on each device, time it took to resume the interrupted task on the second device and the number of actions.
4 Findings and analysis

The following chapter presents the findings and analysis of the data gathered with the various methods used in the research. The Think Aloud protocol was analysed using the thematic analysis approach. The screen recordings were analysed by calculating the mean of the task success, overall task time, task resuming time and the number of actions. The questionnaire was analysed by calculating the median from the data gathered from the Likert scale. In order to ensure that all participants stay anonymous, they were referred to as Participant 1 - 12.

4.1 Think Aloud Protocol Analysis

The collected data from Think Aloud Protocol was analysed thematically, meaning the interpreted answers were written down and related answers were grouped and quoted directly into relevant categories and descriptions. The analysis of the findings concerning the websites was separated into the independent analysis of consistent and inconsistent online newspapers (See Table 2) and supported with a complementary explanation.
Findings and analysis

Table 2: Analysis of consistent and inconsistent online newspapers

<table>
<thead>
<tr>
<th>Category and description</th>
<th>Participants’ responses</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ease of use</strong>&lt;br&gt;Whether the participant completed the task easily, without any major problems</td>
<td>Consistent websites: - “It was easy to complete the task on both devices.”&lt;br&gt;- “It was easy to use the website.”&lt;br&gt;- “It was easy to navigate on the website, since sections were nicely structured.”&lt;br&gt;- “It went pretty smoothly.”&lt;br&gt;- “Super easy on the phone, went to the menu right away,”</td>
</tr>
<tr>
<td><strong>Findability</strong>&lt;br&gt;The ease with which information can be found on a website</td>
<td>Inconsistent websites: - “I found the article logically since the keyword that I had in mind matched the category.”&lt;br&gt;- “I was looking for the category to which the article could be relevant to, and found it without any problems.”&lt;br&gt;- “I looked for the title on the main page and found it easily.”&lt;br&gt;- “I looked for the relevant menu item and found it directly there.”</td>
</tr>
<tr>
<td><strong>Learnability</strong>&lt;br&gt;The ease with which the information can be memorised and reused</td>
<td>- “On the second device I recognised the same menu item as on the smartphone, so I assumed it would be in the same place.”&lt;br&gt;- “It was easier to find the article on the second device, as I already recognised the same section.”&lt;br&gt;- “I knew where it was, so I took the same path on the second device.”&lt;br&gt;- “It was basically the same, I went to the menu again, and saw the same topics.”&lt;br&gt;- “I took exactly the same path.”</td>
</tr>
<tr>
<td><strong>Ease of use</strong>&lt;br&gt;Whether the participant completed the task easily, without any major problems</td>
<td>Consistent websites: - “I felt confused and frustrated by the different subsections and I blamed myself for not finding it.”&lt;br&gt;- “I was confused by different menu names and the overall structure.”&lt;br&gt;- “It was easier to find the article on the phone rather than on the computer.”</td>
</tr>
<tr>
<td><strong>Findability</strong>&lt;br&gt;The ease with which information can be found on a website</td>
<td>Inconsistent websites: - “I had to go through all of the menu items, and eventually found the one.”&lt;br&gt;- “I didn’t find the same menu item on the phone, so I started scrolling.”&lt;br&gt;- “I didn’t find the article in the same spot so quick reading of the web page, I scrolled down a bit and then looked at all the headlines to find something relevant.”&lt;br&gt;- “I looked at all the other menu items as I didn’t know to which section the article could belong to.”&lt;br&gt;- “Finding the article on the phone was much easier than finding it on the laptop.”</td>
</tr>
<tr>
<td><strong>Learnability</strong>&lt;br&gt;The ease with which the information can be memorised and reused</td>
<td>Consistent websites: - “I was looking for the same menu item on the second device but couldn’t find it. I thought it would be in the same place.”&lt;br&gt;- “Straight away I looked at the same spot as I did on the phone and didn’t find anything.”&lt;br&gt;- “On the phone it was under its own headline but when I looked for it on the desktop, it wasn’t there.”</td>
</tr>
</tbody>
</table>
4.1.1 Consistent websites analysis

The consistent online newspapers used in this study were “The Economist” and “Global News”. The results found through audio recordings revealed the following data. All participants agreed on the fact that the given tasks were easy to complete. More precisely, what made it easy for them was the consistency of the menu items and labelling on both devices. On the first device, they found the article according to its category. Completing the task on the second device was even easier since participants remembered the structure of the websites and learned the way of using them. Therefore, completing the same task on the second device was by simply following the same path as they did on the first device.

4.1.2 Inconsistent websites analysis

The inconsistent online newspapers used in this study were “New York Times” and “SF Gate”. The results found through audio recordings revealed the following data. Participants found the structure and the organisation of inconsistent websites more problematic and challenging when it came to locating the given article. More specifically, 8 participants stated that they had little or no problems with finding the article on the first device, however, the difficulties occurred when resuming the task on the second device. One of the issues was the category to which the article belonged on the first device as it was renamed or put under another menu item on the second device. As a consequence, participants felt confused and frustrated by the differences. For instance, Participant 1 blamed herself for not finding the article as she thought she had missed it. Another difficulty concerned the structure of the menu items, which resulted in participants having to unnecessary click on irrelevant menu items.

4.2 Screen recordings analysis

The metrics that were used in order to evaluate the usability on the websites were task success, task time, efficiency and continuity (See Table 3). The results presented in the table were calculated as a mean number from the collected data.
Findings and analysis

Table 3: Mean from four assessment metrics

<table>
<thead>
<tr>
<th>Website</th>
<th>Task time (Overall execution time)</th>
<th>Continuity (Task resuming time)</th>
<th>Efficiency (Number of actions)</th>
<th>Task success Completion of task</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device used</td>
<td>PC</td>
<td>Smartphone</td>
<td>Both devices</td>
<td>PC</td>
</tr>
<tr>
<td>Inconsistent 1: The New York Times</td>
<td>3m 18s</td>
<td>1m 36s</td>
<td>*</td>
<td>8</td>
</tr>
<tr>
<td>Inconsistent 2: Sky Gate</td>
<td>1m 12s</td>
<td>29s</td>
<td>*</td>
<td>11</td>
</tr>
<tr>
<td>Consistent 1: Global News</td>
<td>18s</td>
<td>27s</td>
<td>*</td>
<td>2</td>
</tr>
<tr>
<td>Consistent 2: The Economist</td>
<td>53s</td>
<td>*</td>
<td>1m 18s</td>
<td>53s</td>
</tr>
</tbody>
</table>

* - the first device used

Overall execution time analysis
The overall time was measured from the first action taken by the participant until achieving the goal of the task. The table shows the independent times of the task execution on PC and on smartphone. The results indicate that the time of completing the task on inconsistent websites was doubled on the second device. On the consistent websites, however, the difference was not as noticeable.

Task resuming time analysis
Task resuming time was measured on the second device. It was the time it took for the participant to complete the same task as on the first device. The goal was to measure how seamlessly participants were able to switch between devices and to continue an interrupted task, which supports task continuity principle. The values from the table clearly show that it took more time to resume the given task on inconsistent websites.

Number of actions analysis
Number of actions means number of steps taken by participants which were counted on both devices when completing the assigned tasks. The results indicate that in order to complete the tasks more actions were taken on inconsistent websites. However, the number of actions performed on consistent websites was lower compared to inconsistent ones. What is more, regarding consistent websites, the number of actions was identical on both devices.

4.3 Questionnaires analysis
Post-test questionnaire was used as a complementary method for measuring participants’ satisfaction and for addressing the usability issues when performing the tasks. The median value was calculated from all of the participants’ answers, which were ranging from “Strongly disagree” to “Strongly agree” with assigned numbers from 1 to 5. The answers gathered from the questionnaire were divided and presented in two different tables, consistent and inconsistent online newspapers.
Findings and analysis

4.3.1 Consistent and inconsistent websites

The questionnaire table including the median values for consistent and inconsistent websites is presented below (See Tables 4 and 5).

Table 4: Median values for consistent online newspapers

<table>
<thead>
<tr>
<th>Consistent websites questionnaire</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I found I needed to remember information from one device to be able to finish the task on another device</td>
<td>2.5</td>
</tr>
<tr>
<td>2. I found that I could continue seamlessly my tasks after switching from one device to another</td>
<td>5</td>
</tr>
<tr>
<td>3. I found it easy to complete the given tasks</td>
<td>5</td>
</tr>
<tr>
<td>4. I noticed inconsistencies in the structure of the website when searching for the same information on both devices</td>
<td>2</td>
</tr>
<tr>
<td>5. I found the way the information was structured and organised on a website logical</td>
<td>4</td>
</tr>
<tr>
<td>6. I felt frustrated by the differences in the structure and organization of websites between the devices</td>
<td>1</td>
</tr>
</tbody>
</table>

1 - Strongly disagree  2 - Disagree  3 - Neutral  4 - Agree  5 - Strongly agree

Table 5: Median values for inconsistent online newspapers

<table>
<thead>
<tr>
<th>Inconsistent websites questionnaire</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I found I needed to remember information from one device to be able to finish the task on another device</td>
<td>2</td>
</tr>
<tr>
<td>2. I found that I could continue seamlessly my tasks after switching from one device to another</td>
<td>2.5</td>
</tr>
<tr>
<td>3. I found it easy to complete the given tasks</td>
<td>4</td>
</tr>
<tr>
<td>4. I noticed inconsistencies in the structure of the website when searching for the same information on both devices</td>
<td>5</td>
</tr>
<tr>
<td>5. I found the way the information was structured and organised on a website logical</td>
<td>3</td>
</tr>
<tr>
<td>6. I felt frustrated by the differences in the structure and organization of websites between the devices</td>
<td>4</td>
</tr>
</tbody>
</table>

1 - Strongly disagree  2 - Disagree  3 - Neutral  4 - Agree  5 - Strongly agree
Findings and analysis

The answers from both post-test questionnaires show that participants had similar median results for the first and third questions, meaning, they were able to finish given task easily and without the need of memorising the information when switching devices. On inconsistent websites, participants inclined to disagree with the statement that they were able to seamlessly continue with the task interrupted on another device, whereas, the median on consistent websites was doubled, meaning all participants agreed with the statement. Moreover, all participants testing inconsistent websites noticed the inconsistencies that occurred in the structure of the websites. Regarding the median values for the fourth and fifth questions, participants on consistent websites leaned towards agreeing with the statement that information on given websites was well-structured and organised logically, whereas, half of the testers on inconsistent websites agreed and the other half disagreed with the statement. What is more, the results showed that participants on inconsistent websites tended to get frustrated by the differences in the structure and organisation between the devices while the participants on consistent websites disagreed with the statement.
5 Discussion and conclusions

The following chapter includes the discussion of methodology and discussion of findings with the research questions answered, in relation to the analysed empirical data. Finally, the conclusions of the study were made with further research suggestions.

5.1 Discussion of methodology

As stated by Blomkvist and Hallin (2015), in order for the method to be valid and reliable it needs to be conducted according to criteria that is supported with scientific references. According to Rubin and Chisnell (2008), the fundamental goal of usability testing is to gather data that would help to analyse and identify all the defects in a service in order to improve it and implement adjustments. The advantages of using this method are eliminating problems and minimizing the users’ frustration by addressing the flaws in the design. One of the disadvantages is that the test is an artificial situation which may influence the user’s behaviour and interpretation. What is more, even though the usability test went smooth and trouble free, it does not particularly declare that a service is usable. The same applies to a difficulty of choosing the right candidates to participate in the test, who representing a large target population, might still neglect a crucial sample (Rubin & Chisnell, 2008). In conclusion, all of the mentioned aspects were taken into consideration when designing and conducting the methodology.

The usability study was conducted using two methods: Think Aloud Protocol and post-test questionnaire. Concerning Think Aloud Protocol, it was a suitable method for gathering participants opinions and thoughts while performing the task. Additionally, the moderators were able to ask probing questions, and therefore, get even more insights into the participants experience. Since there are many ways of conducting Think Aloud Protocol, this study’s approach was conducted after completing the tasks, which gave the study a natural flow and let the participants execute the tasks in their own pace without any interruptions, reflecting the realistic conditions. It allowed them to ultimately focus on the tasks and for the study to gain as reliable data as possible. Nevertheless, with this approach, the participants might have forgotten some of the nuances that they failed to remember and pass along to the moderators. Another aspect that could have affected the outcome was the language, in which the test was conducted. Due to the fact that none of the participants was a native English speaker, the language barrier might have influenced their expression and phrasing. Regarding the questionnaire, the questions might have been formulated in a more understandable and clearer way as additional explanations were needed for completing the questionnaire. The number of participants was adequate to the usability study, and therefore, eligible for providing meaningful insights into the user experience on consistent and inconsistent websites. In conclusion, the data gathered in this study was sufficient enough for addressing the problem and the purpose of this research.
In order to overcome threads in reliability and validity of the chosen methods, pilot test was conducted prior to the study. Two participants that met the given criteria were asked to take part in the test which revealed the faults and weaknesses of the study and provided essential feedback for finalising the test. Furthermore, comments on the representativeness and suitability of the post-test questions were received from them. This allowed to make suggestions on the structure of questionnaire as well as establish content validity.

5.2 Discussion of findings

The purpose of this research was to attempt to evaluate the usability of cross-platform services from consistency perspective, more precisely from the way the information is structured and organised. The analysed findings were evaluated with regards to the purpose and research questions.

5.2.1 Research question 1: How does consistent and inconsistent design on cross-platform services affect its usability?

With respect to questions 1.1 and 1.2 consistency on cross-platform services is an important factor that strongly influences the user experience and enhances usability. Cross-platform services that maintained consistency in information structure and organisation on both devices resulted in better usability and were perceived more adaptable by the participants.

5.2.1.1 Research question

1.1 How does inconsistent information structure and organisation affect users’ experience on a service?

The analysis of findings demonstrates that inconsistencies in information structure and organisation significantly affected users’ experience on the tested platforms in a negative way. To begin with, inconsistencies disturbed users’ cognitive behaviour. This made the process of learning and memorising the information difficult, resulting in longer execution times as they were doubled on the second device used. Similarly, the time it took for the users to resume the task and continue with it on the second device was long, therefore, the continuity was disturbed making the users feel discouraged. Due to the illogical way of labelling and grouping of the menu items, inconsistencies in information structure and organisation affected the number of actions performed on both devices. In general, all users noticed inconsistencies in the structure of the website when trying to reach the assigned goal, which made them feel frustrated and confused.

5.2.1.2 Research question

1.2 How does consistent information structure and organisation affect users’ experience on a service?
The analysis of findings presents that users were positively affected when using services that were consistent with regards to information structure and organisation. All participants agreed on the fact that the assigned goal was easy to complete. The well-structured and organised websites helped users to find the correct information effortlessly by simply following the same steps on both devices. What is more, the number of actions was exactly the same on both platforms, which definitely helped to maintain a good user experience. Naturally, the overall time of completing the task on the second device was even shorter since participants remembered the structure of the website on the first device and used the acquired knowledge on the next one. In consequence, participants were able to seamlessly switch between devices and continue with their task.

5.3 Conclusions

The aim of this bachelor thesis was to evaluate cross-platform usability from consistency perspective. To accomplish this, one research question consisting of two sub-questions was formulated. The questions strived to address how consistency of information structure and organisation affect usability. In order to gather relevant knowledge within the field, the research was conducted, followed by a literature review. To answer the research questions, two methods were conducted: usability test and post-test questionnaire. The usability test consisted of Think Aloud Protocol which was analysed thematically and screen recordings which were analysed by estimating the mean of the overall time on each device. Furthermore, the post-test questionnaire was analysed with univariate analysis, that looked at one variation at a time and estimated the median of all responses. The findings from both methods revealed that the information structure consistency on cross-platform services is an important factor that enhances usability and provides positive user experience, whereas inconsistencies in the information structure cause inconveniences in overall user experience and usability.

5.4 Further research

Since this study focused on evaluating cross-platform usability only from one of the components of consistency, further research could be conducted from more aspects, which would be beneficial for the overall assessment of usability. Moreover, additional usability assessment methods such as observations or the use of eye-tracking tool would deliver results on usability from different perspectives. Performing the study with more participants would definitely provide richer data and reveal more insights into the users’ experience on websites. What is more, future research could also expand on the number of devices used for testing. Since cross-platform comprises of more than only a smartphone and PC, the inclusion of other devices for testing would give a broader understanding of usability across services. Additionally, the research could be improved by testing more consistent and inconsistent websites.
6 References


Rosenzweig, E., Green, T., & Pearson, V. (2015). Successful user experience: Strategies and roadmaps (First ed.). MA, USA: Morgan Kaufmann


# Appendices

Appendix 1  Post-test questionnaire

## Post-test Questionnaire

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1</strong></td>
<td>I found I needed to remember information from one device to be able to finish the task on another device</td>
<td>Strongly disagree</td>
<td>Disagree</td>
<td>Neutral</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
</tr>
</tbody>
</table>

| **2** | I found that I could continue seamlessly my tasks after switching from one device to another | Strongly disagree | Disagree | Neutral | Agree | Strongly agree |
|   |   | 1 | 2 | 3 | 4 | 5 |
|   |   | 〇 | 〇 | 〇 | 〇 | 〇 |

| **3** | I found it easy to complete the given tasks | Strongly disagree | Disagree | Neutral | Agree | Strongly agree |
|   |   | 1 | 2 | 3 | 4 | 5 |
|   |   | 〇 | 〇 | 〇 | 〇 | 〇 |

| **4** | I noticed inconsistencies in the structure of the website when searching for the same information on both devices | Strongly disagree | Disagree | Neutral | Agree | Strongly agree |
|   |   | 1 | 2 | 3 | 4 | 5 |
|   |   | 〇 | 〇 | 〇 | 〇 | 〇 |

| **5** | I found the way the information was structured and organized on a website logical | Strongly disagree | Disagree | Neutral | Agree | Strongly agree |
|   |   | 1 | 2 | 3 | 4 | 5 |
|   |   | 〇 | 〇 | 〇 | 〇 | 〇 |

| **6** | I felt frustrated by the differences in the structure and organization of websites between the devices | Strongly disagree | Disagree | Neutral | Agree | Strongly agree |
|   |   | 1 | 2 | 3 | 4 | 5 |
|   |   | 〇 | 〇 | 〇 | 〇 | 〇 |

*Appendix 1*