University of Reading

Designing to Assist Older Adults' Navigation in E-Commerce Websites

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Computer Science

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Dedication

I dedicate this work special to:

- My husband, Mohd Azrul Nadziadin Md Nadzar, who is always there with me throughout this long and winding journey,
- Parents for the endless love, motivational and financial support,
- Siblings for taking care of our forever love (mak, abah, ma, ayah) while we are away, and
- NAAF, this is for you, and
- Closest friends, old and new, who had always, cherish my life throughout the journey.

ROZIANAWATY OSMAN

11 JANUARY 2019

Declaration of Original Authorship

I confirm that this is my own work and the use of all material from other sources has been properly and fully acknowledged.

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11 JANUARY 2019

Abstract

The growth of the older population has drawn attention and interest in investigating approaches to help older people to live independently for longer, including the use of Web technology. For example, with online shopping, older consumers will no longer need to carry heavy shopping loads as the goods purchased can be delivered to the house. However, the usage of online shopping among older adults is still low. Furthermore, it has been reported that older adults often experience disorientation while navigating websites. This low usage of online shopping and also disorientation motivates this research.

To gain a better understanding on how older adults navigate on e-commerce website and challenges experienced, an observation on older adults' navigation with an online grocery shopping site was conducted. The study found that technological experience was helpful in easing web navigation. Inexperienced participants were found to face more difficulties while navigating the website than the experienced users, and main difficulties included identifying the 'add to cart' button, finding items in menu lists, finding the main menu, and changing the website's default shopping settings. The difficulties were manifested as complex navigation paths and long task completion times.

As difficulty in identifying the 'add to cart' button was observed frequently, 'add to cart' buttons were investigated further. An evaluation of the 'add to cart' button designs conventions on 51 websites was conducted to assess existing button designs against design guidelines for older users. This review highlighted the potential areas for improvement with regard to design for the older users, including the use of colour, focus indicators, contrast ratio and font size.

A co-design study was conducted to understand how older users would design e-commerce web pages. Several objects were selected frequently by the older adults for inclusion in the e-commerce websites, that is, product images, price, and an 'add to cart' button. Some other objects were selected for inclusion depending on what type of website it was. For example, quantity selection was selected for cheap, multiple purchase items (e.g. groceries), whereas descriptions, reviews and shipping/return

information was deemed important to the older adults for expensive, single-item purchases (e.g. assistive technology). The study also investigated older adults' designs in terms of physical placement of the 'add to cart' button, and their designs, the button was most often placed close to the quantity selection and/or the price.

The outcomes from these three studies provided design input for the prototype developed in the fourth study. In this fourth study, a 'senior friendly' and a 'senior unfriendly' design were compared. The two websites were developed and tested with two tasks, that is, a navigation task and shopping. Participants compared the two websites and answered questions pertaining to ease of performing the tasks. This study provides empirical evidence of the benefits on the users' performance from the use of 'senior-friendly' design.

The outcomes of this research have contributed to the existing knowledge of what designs could help older users' navigation. The data provide support for new recommendations that an object that is important and frequently accessed (e.g. main menu) should always be visible to users rather than disappearing when scrolling down the page or appearing only when the cursor is in a particular position, and 'buy boxes' on e-commerce websites should be included in order to make important objects such as 'add to cart' buttons stand out.

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Table of Contents

List of Tables

List of Figures

Chapter 1:

Introduction

1.1 Background and Problem Statement

As reported by the World Health Organization (WHO) [1], the older population is estimated to reach 2 billion by 2050, representing 22% of the world population. In 2017, the proportion of the world population aged 65 years and older reached 8.69%, while in the United Kingdom itself, the older population increased from 11.76% in 1960 to 18.52% in 2017 according to the World Bank [2].

Human abilities deteriorate over time, and they start to decline at the age of 30 to 40 [3]. Deterioration includes visual and auditory abilities, movement control, cognition, sensation and perception. For example, visual ability, which declines faster than other abilities, as early as the age of 30, worsens after the age of 65. The decline of human abilities will also affect performance; for instance, as movement control becomes slower, older adults may have greater challenges controlling their body position or movements, and their responses will be less precise, slower and more error-prone. Research has recorded such incidents demonstrating performance decline in relation to ageing, for example in [4]–[6].

Older adults prefer to live in their own homes for as long as possible [7], [8]. Living independently is of great importance to older adults as this could improve their quality of life [9]. In supporting the older population's access to a good independent life, technology is seen to play an important and promising role in enabling older adults to live independently for longer [10]. Technology can support them in various domains, namely home, work and health [11]–[13]. Some of the technology that could be used by older adults includes computers and the internet, microwaves, mobile phones, television, scanners, digital cameras, blood glucose monitors and blood pressure monitors. Online applications are also seen as useful technologies to help older adults for example, through maintaining food supplies in the home using online grocery shopping. Grocery shopping is an important routine activity as people perform their grocery shopping as frequently as once a week, or once or twice a month, complemented by fill-in shopping (daily/weekly) in the interval between main shopping trips [14]. Those who are unable to do their grocery shopping in a physical store can benefit from online grocery shopping since purchases are made from home (i.e. online), and groceries will be delivered to their doors. Therefore, online shopping could be seen as helpful in supporting older adults to live independently, especially when their physical abilities limit their movements.

Because of ageing-related factors, older people have been reported to have difficulties with in-store grocery shopping. These include physical and/or constraint issues, such as difficulty getting to the shop, an inability to carry a heavy load, long-waiting times in checkout queues, difficulty in accessing products due to inappropriate shelf height (too low or high), and confusion when products are relocated [15]–[18]. Thus, online grocery shopping has the potential to ease the process of buying groceries and completing purchases, in that consumers no longer need to be physically in the shop. Web technology allows them to perform their shopping at a time and from a place of their choosing.

E-commerce, or electronic commerce refers to "transacting or facilitating business on the Internet" [19] and can be classified into business to business (B2B), business to consumer (B2C) and consumer to consumer (C2C) transactions. An example of e-commerce is online shopping, which is "buying and selling goods on the Internet" [19]. Other examples of e-commerce include online auctions, internet banking and online ticketing. The term 'e-commerce site' used in this thesis will refer to general e-commerce websites. However, the term 'online shopping site' will be used to refer to websites that sell physical goods (e.g. books, clothes, shoes, and groceries) or digital goods (e.g. software, ebooks, music). 'Online *grocery* shopping', an example of online shopping, refers to the act of purchasing groceries over the Internet. Among the terms commonly used are 'online grocery shopping' (most used), 'electronic grocery shopping', 'e-grocery shopping', 'online grocery shop', and 'internet grocery shopping'. Throughout this thesis, the term 'online grocery shopping' will be used to refer to the act of purchasing groceries online.

The number of adults aged 55 years and older using the Internet is increasing. Recent statistics from the UK Office for National Statistics [20] show a significant increase in internet usage in this age group for 2018 as compared to 2011, and [21] reports that online shopping is among the top ICT activities of older adults. Online shopping can provide a good alternative for those who find in-store shopping difficult; yet, previous studies have shown that older adults experience difficulties while navigating websites, such as disorientation [22]–[24]. Disorientation, the condition where the user loses the sense of direction and orientation, can lead to frustration and the abandonment of technology [25].

The tendency for disorientation among older adults could result from i) decline of cognitive abilities [23], [26]–[28]; ii) decline of spatial abilities [4], [24]; or iii) an

unfamiliar environment [24], [29]. A low level of computer experience can also contribute to disorientation [30]. People develop familiarity through experience, which could help them use technology more easily. Thus, indirectly, experience may then help reduce the level of disorientation. For example, in a comparison between three groups of older people – no prior website experience, low website experience and high website experience – it was found that having prior website experience had a significant influence on the performance of a website information retrieval task [30].

In addition, technology is advancing. In an article by Hanson [31] that examines issues of age and experience related to web usage, it is noted that devices change over time and on getting older many users may find it too difficult to use current technology. Thus, to cope with this advancement in technology, it is worth investigating how the current older population uses technology, to minimise problems of computer usage and adoption for future older generations.

This research aims to develop a better understanding of older adults' web navigation, especially of online shopping sites, and to investigate possible approaches to support site navigation. The work explores the difficulties experienced by older adults that can contribute to disorientation, and also investigates interface designs that could help ease navigation. Older adults were involved from the beginning of this research, following Rogers and Mitzner's suggestion in [32] of "designing the technology with involvement by today's older adults who represent the needs and capabilities of tomorrow's older adults".

1.2 Research Questions

This research aims to understand older adults' navigation through online shopping technology and the challenges faced while navigating through online grocery shopping sites, and to investigate possible interface designs that could help ease older adults' navigation. It investigates the following research questions:

- How do older adults navigate online shopping websites and what difficulties do they encounter?
- Are there designs that can help older users' navigation on online shopping websites?

1.3 Novel Contributions

This research provides insights into how older adults navigate through e-commerce websites and the problems encountered while performing online shopping activities. It is important to understand what works well for this population as technology is known to be a medium that could support better quality of life among older people. Thus, empirical data from this research can contribute to existing knowledge of older adults' web navigation and create a better understanding of possible support for this group, as well as provide valuable input for strategies to increase retention and encourage older users who are technology novices to use technology.

Design that is 'senior-friendly' could help older users succeed with technology [33] and this research contributes to the knowledge on how to design online shopping sites to make them more 'senior-friendly'. An exploration of older users' navigation in an online grocery shopping site, a review of existing e-commerce website designs against guidelines on designing websites for older adults, and also a co-design process with older adults contributes to proposed designs that could aid older users' navigation.

This research also contributes to the body of empirical data relating to the benefits that 'senior-friendly' design can have on the performance of older adults. The data provides support for new recommendations suggesting that an object that is important and frequently accessed (e.g. the main menu) should always be visible to users rather than disappearing when scrolling down the page or appearing only when the cursor is in a particular position.

'Call to action' buttons are important buttons for websites that are designed with the intention of invoking responses from the users. 'Call to action' buttons include 'Click Here', 'Sign up', 'Submit', and 'Add to Cart'. Appropriate design of such buttons could assist users with their navigation. For example, for e-commerce businesses, the 'add to cart' button has the most critical function as it is essential for actual sales to happen. This research contributes to the new design of a 'buy box', which could potentially be used to aid user navigation; data supports that the 'box' design can help enhance visibility of the 'call to action' button, namely, in the case of this research, the 'add to cart' button. In short, the 'box' design can make buttons stand out.

1.4 Outline of the Thesis

This thesis is organised as a collection of papers. Chapter 2 reviews the literature related to older adults and technology, online grocery shopping among older users, and web navigation; Chapter 3 discusses older adults' navigation of an online grocery shopping site; Chapter 4 reviews the 'add to cart' button design conventions of existing e-commerce websites; Chapter 5 explores how older adults design e-commerce websites (i.e. an online grocery shopping and an assistive technology site); Chapter 6 validates the features that were designed by and for older adults; and finally Chapter 7 summaries major findings of the thesis, and explores issues inviting future research.

The work comprises four main studies, presented in Chapter 3 to Chapter 6. Fig 1.1 illustrates the research in a holistic view; it shows how the chapters are connected and also the relationships between the chapters and the studies conducted. The figure also highlights the main methods used in each study. Three studies involved older adults as participants: Studies 1, 3 and 4. In total, 40 older adults aged 52 to 80 years (both mean and median of 67 years old) participated in the three studies – Study 1 (9 participants), Study 3 (20 participants) and Study 4 (11 participants) with different participants in each study.

This research began with an exploration of older adults' navigation in an online grocery shopping site (Chapter 3). It involved user observations of participants performing shopping tasks with a predetermined shopping list, whilst recording mouse clicks and scrolling, and videos of the on-screen activity. Following the observations, an interview was conducted asking questions pertaining to ease of use, and motivation to use online grocery shopping. Mouse clicks and scrolling were analysed and converted into navigation path maps which were then further analysed for strategies used, route decisions, completeness, and completion time. Interview data was analysed, providing insight into the reasons for the users' navigation actions and also people's motivation to use online grocery shopping. The analysis identifies several difficulties, including difficulty in finding a functional button for adding an item to the cart, that is 'add to cart' button which is an essential button for e-

commerce websites, and thus ‘add to cart’ button were investigated further in the next study.

In Chapter 4, a review of 51 e-commerce websites was conducted to investigate the existing button designs practised within e-commerce websites and to assess them against design guidelines for older users. An evaluation instrument reviewing four aspects – visible, readable, understandable and navigable – was developed based on three different perspectives:

(i) relevant principles and guidelines on designing websites for older adults,
(ii) recommendations for older users by practitioners (designers/developers) on the design of ‘add to cart’ buttons, and
(iii) scientific academic literature discussing design for older adults, design of e-commerce websites, and design of web buttons.

This instrument was used to evaluate 51 e-commerce websites that were selected based on a keyword search performed on Google for ‘best e-commerce web design’. This review sheds light on the designs used by practitioners in the industry and reveals potential areas for improvement with regard to design for older users. These improvements include colour, focus indicator, contrast ratio and font size.

Further investigation of how older users would design e-commerce websites was conducted through a paper-based prototype co-design exercise, described in Chapter 5. Each designed page was photographed and analysed for its layout patterns, for web objects selected for inclusion in the design, and for the location of the ‘add to cart’ button. A new design (i.e. the ‘buy box’ design) was also introduced to understand its potential to attract attention to the ‘add to cart’ button. This study enabled us to understand how e-commerce websites should look from the perspective of older adults.

Chapter 6 describes two web prototypes – ‘senior-friendly’ and ‘senior-unfriendly’ – which were developed based on the output gathered from the earlier studies. The two websites were compared in terms of user performance and subjective evaluation and preferences. The results of this study have implications for the design of websites to better support older users’ navigation.

Finally, Chapter 7 concludes the major findings obtained from this research, and explores issues inviting future research. The content of this chapter is also

designed to briefly address the questions of what challenges older users face while navigating the web and what designs help older adults' navigation.

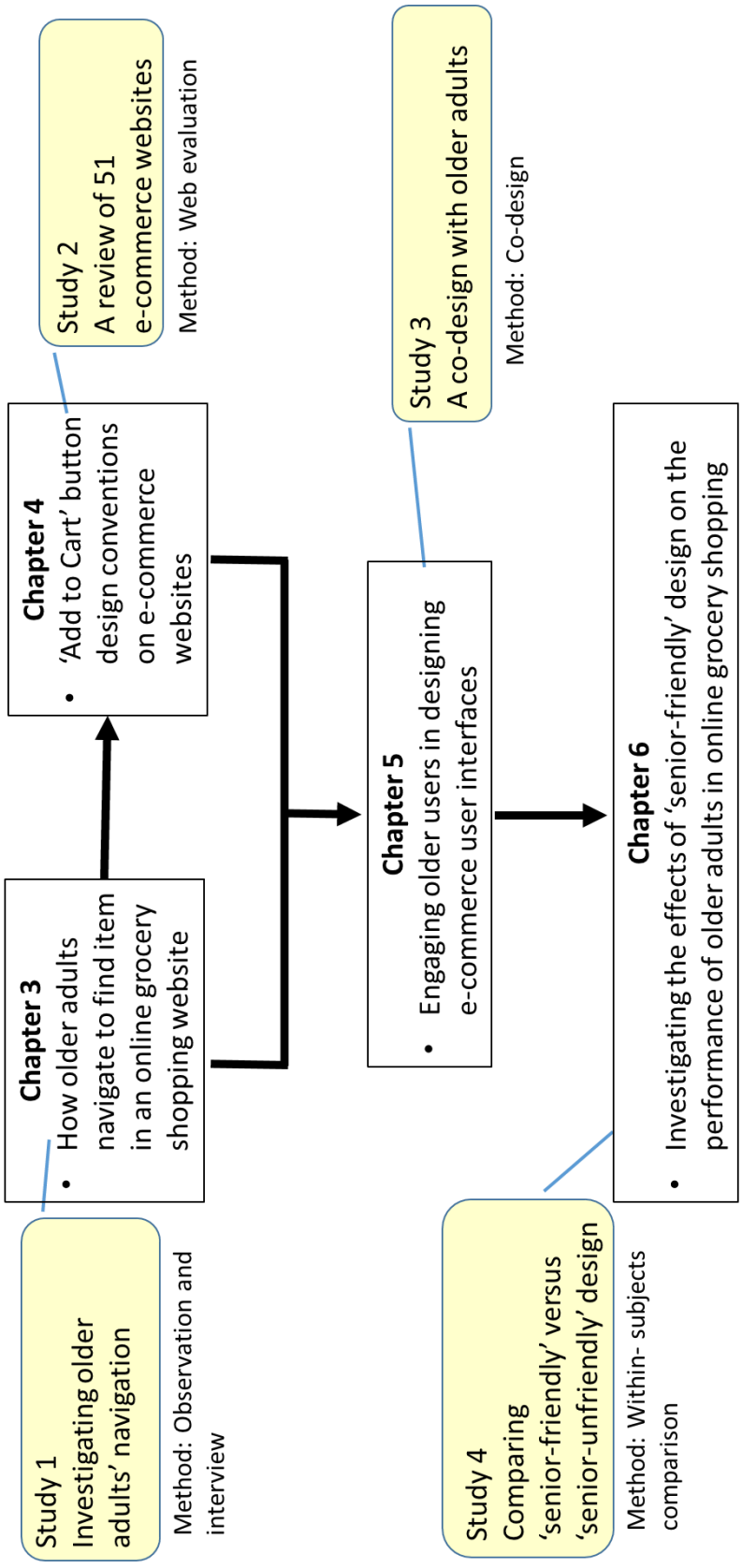

Fig 1.1 The association of studies and chapters; and main methods used in each study

1.5 References

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Chapter 2:

Literature Review

ABSTRACT

This chapter reviews the topics of older adults and technology usage and challenges due to ageing factors, and online grocery shopping – the benefits and challenges. The challenges include web navigation issue – disorientation.

2.1 Older Adults and Technology

Populations worldwide are growing older. The World Health Organization (WHO) [1] estimates that by 2050, the population of older adults will be of 2 billion people representing 22% of the total population. This group of adults is considered old when their chronological age reaches 65 years old - a number which is agreed upon by most. According to American Psychological Association [2] (American Psychological Association, 2014), "older adults" is defined as "persons 65 years of age and older and is widely used by gerontological researchers and policymakers". WHO also mentioned that 65 is the accepted age when referring to older people in most of the developed countries, however, 50 years of age was also used in the association with ageing research in Africa. Other research related to older adults that include 50 to 64 years old participants include [3]–[5].

Statistics have shown that 13% of the population of England and Wales were living alone in 2011, and most of those living alone are of older adults ageing 50 and above (76%) [6]. Being able to live independently is important to older adults as it could improve their existence in life [7]. Although older adults are keen to live by themselves in their own house, the decrease of physical and cognitive abilities have restricted their movements and abilities to perform tasks (e.g. household chores).

Therefore, older adults have to seek assistance to help them with their activities; and technologies are seen to play important and promising roles in supporting older adults to live independently for an extended period. Technology can provide support across a range of domains including home, work, and health [8] and a range of tasks such as preparing food, doing house chores (e.g. using the tumble dryer to dry clothes), staying informed and getting food (via online services) [9]–[11].

At present, the number of older adults using technology including online technology is increasing compared to the past. However, the usage is rather basic; and low-usage scores were associated to products and information search, online purchasing and online banking, and that older adults were also facing several difficulties while using the technology due to the decrease of sensory, physical and cognitive abilities [12].

The following sections discussed the deterioration of the human abilities that could have affected the technology adoption among older adults and also the drivers and barriers to the technology adoption among older adults.

2.1.1 Abilities when Aging

Vision, cognition, and motor skills are essential for users to use a website [13]. However, these abilities deteriorate with age.

The human visual ability is said to start declining at the age of 30 to 40 and worsening at 65. When visual ability decreases, a person may experience a decline in their ability to adapt to darkness, illumination sensitivity, visual acuity, and also experience hypersensitivity to glare as well as a reduction in the size of their visual field [14]. A decline in vision could affect cognitive ability as the processing speed for both types of information gathering is slower; since there is a delay in receiving the information.

Cognitive ability decreases with age [15]; and short-term memory problems are associated with ageing [5], [16]. As information is processed more slowly, it may cause a reduction in the response time of older adults [17], and this is possibly the reason why older adults' navigation time is twice slower of that younger person [18]. Problems affecting cognitive abilities were also seen when technology with complex interfaces design were presented to older adults [19]. The difficulty or inability to decipher the meaning of the interface design has led to complex interface design is one of the barriers to technology adoption. Despite the decrease in cognitive abilities, to take advantage of older adults' semantic memory may be helpful; that is the ability to recall concepts, and general or factual knowledge [20], [21]; for example, the knowledge about a clock that is used to tell the time. A picture depicting a clock is used to relate information about time, operation hours for instance.

Importantly, semantic memory "remains relatively stable across the adult lifespan or may even increase as more semantic knowledge is accumulated with age," [21]. In contrast, working memory and the ability to encode and process new knowledge declines with age. In other words, it may be easier for an older adult to know or learn how to use new technology if the use of the technology draws on things already within their knowledge, rather than requiring them to learn things anew. In supporting older users with decreased cognitive powers, it is suggested that design should allow users for ample time to read information, use recognition rather than recall aids, and provide less selection [22]. An exhaustive list may confuse older adults with the selections; thus, eight link items are the most ideal for the core navigation [23].

Ageing may also affect a person's physical ability, for example, their control of movement. Older adults will experience an inability to control body position or movement, contributing to them being less precise, having slow responses and being more error-prone [14]. These affect task performance, and consequently, older adults need more time to perform tasks compared to younger people [18], [24]. Physical disabilities also affect mobility. A study [25] which profiled the characteristics of users of online grocery shopping has found that older adults had given physical reasons as factors that hinder them from doing in-store shopping. Some of their specific reasons include difficulty in driving, lifting loads [25] and slow pace of movement [26]. These difficulties, in turn, make online shopping an attractive alternative.

Technologies do advance, and people are ageing and experiencing decrease in abilities. As this cycle continues, the existence of older adults who lags in technology adoption is potential. For example, mobile phones have evolved from only functioning for calls and text messaging to become smartphones, allowing users to access various applications that can help their activities (e.g. reminder system). However, older people may use phones only for its 'traditional' usage, such as calls and messaging. Although the possibility of lag in technology adoption among older population continues to happen, it is possible to minimise the lag by providing better design guidelines, and tools that cater for older adults' needs and capabilities [27].

2.1.2 Drivers and Barriers to Technology Acceptance among Older Population

Various factors drive the user to the technology such as perceived usefulness, ease of use, adequate instruction, familiar design and living independently. However, there are also barriers that hinder technology to be utilised, such as limited usefulness, lack of interest/no need/not fit to lifestyle, lack of awareness, complex design, unfamiliar design, navigation, age-related disabilities, and not ready to use the technology. This section reviews the literature on drivers and barriers to technology acceptance among older adults.

One of the factors that determine the intention to use a technology is perceived usefulness [28]. As suggested in [11], technology should be designed relevant to the needs of older adults. Some studies [11], [12], [14], [29] have found that most of the

older adults are enthusiastic to use the technology when benefit or value is clearly seen. However, if the benefit is apparently limited to the older adults, the technology may be rejected [14]. Also, the possibility of rejection is greater when the technology is seen as unneeded or not fit to their lifestyle, and even when there is a lack of interest in the technology itself [12], [19], [30]. If the technology is seen to be not needed or not interesting to the users, so does the willingness for the investment of effort; it will score low [10].

Lack of interest on certain functions may also be contributed by the lack of familiarity with the user interface design [31]. A study [32] on wellness self-monitoring tools also found that lack of interest to use technology results from an unfamiliar condition of the technology. Thus, the value or benefits of the technology must be visible to the users. It is an important factor to consider when designing technology for older adults as this seems critical in defining the adoption or rejection of the technology. This perceived usefulness may also be influenced by perceived ease-of-use [33].

Another enabler in technology adoption is ease of use. For users to easily understand the handling of technology, making it easy for them to use the technology is thus essential. For example, when a new technology is introduced to a user, she or he may struggle to use it when all the functions are not understandable, yet, a simple instruction may probably increase the chances of retention.

Adequate instruction can ease-the-use of the technology [14] as instructions can act as references on how to use the technology whenever needed. However, inappropriate or complex designs may cause difficulties in using technology. Small buttons and display, fiddly controls and keypads, and unnecessarily complex interfaces may have contributed to these difficulties [17], [29]. For example, small buttons and display may be found challenging to the older adults. Older adults may not only find it hard to perform a task, but also fear of breaking things [29]; since physical and cognitive disabilities associated with ageing could limit the use of technology which further contributes to the difficulties in using the technology [9]. The difficulties experienced by the users may lead them to frustration and further hindering the technology.

There is also evidence of technology rejection that linked to a lack of familiarity [9], [19], [34], [35]. The literature reports unfamiliar designs including difficulty in understanding the meanings of icons [36], task failure and alienation [37].

A survey with older adults ageing 50 to 93 years old to assess knowledge and intentions to use Internet-delivered mental health treatments had found that majority of the participants were unfamiliar with the technology, contributed by either never heard of the technology or not knowing any details of what they were involved with [38]. As in [39], it is summarised that some reasons for unfamiliar concepts related to navigation difficulties are having to deal with scrollbars, navigation confusion, understanding and identifying hypertext links, and dealing with a search engine. This unfamiliarity may potentially lead to non-use or abandonment of a product [40].

Furthermore, whenever the unfamiliar designs contribute to the non-use of technology among older adults, there are also costs associated with the increased dependence on caregivers or assistants [41]. Since some older adults are having the anxiety of doing the wrong thing, hence the presence of an assistant can provide confidence as they realised help is available [42]. Establishing familiarity with the unknown product may improve understanding of the product and minimising alienation [40]. Therefore, the incorporation of familiar content into applications can facilitate users' understanding of the technology and further leads to technology engagement. As mentioned by [38], the higher the level of familiarity that a user has, the higher is the intention to use the technology.

Another enabler to technology adoption is to live independently. In the perspective of older adults, to be able to live independently and perform a task is a matter of proving their existence in life [7], yet, the deterioration of their cognitive and physical abilities may restrain them from using the technology. Therefore, in order to help them to live independently, older adults concur and agree that household activities may at times involve technology [9]–[11]. Even though some perceived that technology does help them to live independently, still some older people are not ready to include certain technology in their lives. For example, some older people still prefer human being as representatives when dealing with certain occasions [43]. An example in the literature had described an old woman preferring a human representative to monitor her health rather than using technology to assist her in continuing living independently.

In conclusion, the availability of technologies around older adults enables an independent living as long as the technology itself is familiar; which allow older adults to perceive its value, and to use the technology easily. An example of

technology that could help the older population is the online grocery shopping sites which allow consumers to buy groceries virtually.

2.2 Older Adults and the Web

2.2.1 Supporting Older Adults Activities

In today's world of technology, various activities are conducted online, and for older adults, the Internet is used for social interaction (e.g., communicate with friends/family), informational (e.g., reading health-related information) and instrumental (e.g., shopping) [44].

Communication is essential for older adults as it may reduce loneliness. With the use of the Internet, social interaction with others increased, thus decrease loneliness [45]. As mentioned by [46], older adults were found to use computer and internet mainly for communication and social support. Through the use of email, and even the social media technologies could help connect them to others anytime. A survey on 198 respondents ageing 64 to 104, found email was an application used by most (74%) to communicate with family [47]. While social technologies such as Facebook, Twitter, and Skype, create a platform that could enable older adults to stay in contact with others and allow communication between them.

The Internet is known as a source of powerful information. Various websites are developed, and knowledge and information are shared with the audience including the older population. Moreover, second top activities performed online by older adults is looking for health & wellness information [47]. The Internet has been the primary source for the older adults when seeking health information as reported in a survey conducted on 118 respondents ageing 67 to 78 years [48]; and among the top health-related information sought for was symptoms, prognosis, and treatment options.

The online shopping, as opposed to the traditional 'physical' shopping, could have benefits for older adults. There will be no necessity to carry heavy shopping loads, and online shopping could also solve the mobility issues (e.g. unable to drive to the shop or get out of the house) because the goods purchased can be delivered to the front door of the house. Although purchased online provides the advantages, yet, the number of older shoppers is still low. In 2013, [12] reported that 69% of older adults never purchase products/services online, but, this scenario may change in the future as

in 2015 [47], online shopping had been reported as the top ten computer activities among older adults. Various items sold and bought online include groceries, and online grocery shopping will be discussed further in section 2.3.

2.2.2 Web Navigation Issues

Navigation in the context of computing as defined by the Oxford Advanced Learner's Dictionary as "…the way that you move around a website or the Internet when you are looking for information". Kalbach in his book 'Designing Web Navigation' [49], defines web navigation in three ways:

"(1) The theory and practice of how people move from page to page on the Web;

(2) The process of goal-directed seeking and locating hyperlinked information; browsing the Web; and

(3) All of the links, labels, and other elements that provide access to pages and help people orient themselves while interacting with a given web site."

While Hoffman & Novak [50] refer navigation to "the process of self-directed movement through a hypermedia computer-mediated environment". Thus, it can be concluded that navigation can is the action of moving around the website, either within the page or from one to another via links provided, particularly to seek information.

Navigation can be easy with the help of navigation features or aids which could provide access to or inform locations within a website. Good navigation features may guide users to the information needed and also throughout the process of finding the information need. On the other hand, users may encounter some difficulties including disorientation. In a study [51] that evaluated the influence of user disorientation on engagement and performance via three versions of the web navigation system (i.e. navigation feature disappears while scrolling, navigation features can (partially) disappear when scrolling and always viewable navigation features while scrolling), it was found that with a good design of navigation features, low disorientation has been reported.

Disorientation is the tendency for users to lose their sense of location and direction [52]. When disorientated, users found to (i) cannot find what wanted, (ii) cannot reach page known to exist, (iii) cannot find page already visited, (iv) not knowing where they are in the website (location), (v) not knowing where to go next,

(vi) not knowing how to get back to previous navigation routes, or (vii) knowing where to go but not knowing how to get there [51], [53]–[56]. Disorientation could also lower the intention of using technology and also lower the engagement to the technology [51]. In other words, disorientation could lead to frustration which further could result in abandonment of technology.

Disorientation was also reported among older adults when the website has usability problems. This was demonstrated in a study [57] that compared an original website with 52 usability problems (e.g. visibility problems, and unclear feedback messages) and a redesigned website to be 'senior-friendly', had found that older users experienced disorientation with the original website and not with a 'senior-friendly' website. Perhaps, when the websites were designed to adhere to the design for older users guidelines, high-performance rates could be achieved [58]. Disorientation among older adults is discussed more in Chapter 3.

2.2.3 Web Design Guidelines for Older User

The deteriorations of human abilities while ageing affect the use of the web. Older users may find it difficult to read web pages, difficult to use a mouse and click small targets, difficult to navigate and difficult to complete tasks. In order to minimise such incidents, principles and guidelines design for older users are developed. The guidelines include the Web Content Accessibility Guidelines (WCAG) which is widely accepted.

WCAG covers a wide range of recommendations for universal access which include guidance to design websites that work better for older users in general [59]. WCAG is organised in four layers that are principles, guidelines, success criteria and techniques. Four main principles (i.e. perceivable, operable, understandable, and robust) provide the foundation for the web accessibility with twelve guidelines that provide the primary goals, and several techniques for each guideline with two categories of meeting the success criteria or advisory.

In 2007, Zaphiris et al. [60] have published the SilverWeb Guidelines, which extends their previous work [22] and later was validated in 2009 [61]. Begun with a review of over 100 peer-reviewed papers of HCI, web design and ageing, an initial set of 52 guidelines was extracted. Further, it underwent a categorisation process which resulted in 38 guidelines with 11 categories. The guidelines were then compared to

other seven set of design guidelines for older and/or disabled people resulted in a revised set of 37 guidelines. Finally, the validation experiment conducted with 24 older users showed that 36 guidelines were accepted, 1 guideline was disagreed with, and 5 new issues found which were uncovered in the guidelines.

Guidelines for designing websites targeting older users have also been developed by The National Institute of Aging and National Library of Medicine (NIA/NLM) [62]. These guidelines have been cited in many articles, for example in [58] which examined the adherence of 40 websites designed for older adults to the guidelines and found that higher success rates of tasks performed were associated with the websites that were most compliant to the 'senior-friendly' guidelines.

Various other literature [5], [57], [63-64] also research on design for old. For example, a study [63] that conducted a systematic literature review on designing user interfaces for older users over a variety of domains (e.g. Mobile, Web, Desktop) presented the challenges (i.e. Physical issues, computer experience, and cognitive issues) and the solutions (i.e. interface and control design, input controls, natural language, and cognitive evaluation) addressed in the 30 articles reviewed. The evaluation of the user interfaces designed for older users were also demonstrated in such experiments conducted in [5], [57], [64].

2.3 Online Grocery Shopping Among Older Adults

The online shopping provides convenience to people including to older adults where less physical effort are involved since all goods purchased is delivered to the front door of the house. Older adults will not need to carry heavy shopping loads, and also could solve mobility issues when they are unable to drive to the shop or get out of the house.

Although online shopping provides various advantages, yet, the number of older shoppers is still low [12]. This scenario is expected to improve in the future as in 2015 [47], online shopping had been reported as one of the top ten computer activities among older adults. Thus, the online grocery shopping is also seen to gain its attention among consumers. In addition, the statistics by Bord Bia [65], [66] of the online grocery shopping frequencies of Great Britain consumers show a growth pattern in the online shopping for groceries. There was an increase of 11% between

2013 (11%) and 2015 (22%) who buy at least once a week and the percentage of who less often buy online also decreased by 20% between 2013 (56%) and 2015 (36%). Another report by Bord Bia [67] in 2014 shows that 50% of the baby boomer respondents in Great Britain also had bought groceries online. However, only 40% bought groceries online once a month or more while others bought less than that. This growing online grocery market was also seen throughout other European countries including Netherlands (55%), Germany (38%), and France (25%) as reported in [68]. The groceries shopping frequency varies among consumers from weekly, twice a month, or once a month with a fill-in shopping (daily/weekly) during the time-lag between major shopping trips [69].

2.3.1 The Advantages of Online Grocery Shopping

The online grocery shopping can provide advantages which the in-store grocery shopping is unable to offer including solving mobility issues resulting from physical or constraints issues. The Age UK report [70] which had summarised the barriers to food shopping for older adults includes difficulties in getting to food shops. For example, difficulties in getting to the shops could be contributed by mobility difficulties, especially those living in rural areas and encountering problems with transport (e.g. unable to drive to the shop, costly taxi, hard to get access to free transport facilities, or unable to stand in the bus for long periods of time). Shopping groceries in-store could also be ended with a heavy shopping load which then could be a problem to carry them, especially for older people; which is also mentioned in [71] as one of the reasons to buy groceries online. Since 2000 [25], physical reasons especially those among older people were mentioned to be one of the drivers for online shopping, and the reason remains to the fact that the groceries purchased are delivered straight to the customers' door, instead of them having to carry the heavy load, or even drive to the stores.

Instead of going through the in-store shopping hassles such as overcrowding, waiting in long queue for checkout, or even inaccessible shelves due to the height which were a problem to older shoppers [26], older adults can opt for online shopping for it convenience and may have the privilege of choosing products themselves as everything is just at a click of a finger. In addition, the location of products in-store can confuse the consumers when switching stores since the products organisation may

differ from one store to another and also products are usually relocated within stores [26], [72]. In contrast, in online grocery shopping sites, products were grouped within a similar type of products and usually remain the same over time.

2.3.2 The Challenges of Online Grocery Shopping

One aspect that differentiates groceries shopping to other online shopping products is that it involves perishable products which are fresh products such as meat, fish, bread, fruit and vegetables. These perishable products with expiry date make them a bit difficult to be sold online, apart from the need for them to be delivered in a timely manner. Also, the shoppers always demand good quality and freshness of the groceries [73]–[75]. The product quality may be the reason as to why online grocery shopping is not a preferred option for some people especially for older adults as they used to feel and see by themselves the products chosen. However, in an online grocery shopping, shoppers are not able to feel the freshness of the product, and not able to touch and smell the products before purchase; yet, since they prefer to see, touch, feel, and smell the products, it remains as one of the barriers to online grocery shopping [73], [74], [76].

When users use online grocery shopping, issues such as misunderstood when ordering was reported. Misinterpreting the site's interface functions or icons could lead to the wrong judgement. For example, in [75], a participant who experienced from a misunderstanding during purchase order had resulted in receiving five kilos of apples instead of five pieces intended to purchase. Possibly, such misunderstanding could be avoided with good interface design and sufficient product information to guide purchases [77].

Online grocery shopping navigation is sometimes perceived as time-consuming. In [78], it was mentioned that time is costly when it comes to performing a search for information. The long waiting time was the cumulative results of the time taken to move from one page to another. Also, another study showing similar evidence of disagreement with time-saving [25] said that the respondents mentioned that it "takes so long to go from screen to screen" (navigation). Older adults' navigation time was also said to be twice as more than the younger people [18]. For example, an experiment of navigation using a 3D-environment to purchase groceries also showed that older adults need more time in performing tasks [24]. In searching for products, the older participants were indecisive with the navigation – where to go,

and what to do. This could have been caused by less experience and consequently, resulted in more time spent to perform tasks as compared to the younger participants. Possibly, time can be reduced as more experience is gained. With experience, people would know, understand and be able to use technology effortlessly as they are familiar with it.

Another barrier of online grocery shopping that is related to web navigation which reported to experience by older adults is disorientation [18], [55]. A later study also shows that disorientation among older adults remains to be an issue while navigating websites [56]. Designs could also affect user performance and disorientation. For example, in [51], where three navigation systems were compared, the results showed that with improved designs, perceived disorientation score was low, and performances increased. Disorientation among older adult is also discussed further in chapter 3.

2.4 Conclusion

Online shopping has become an alternative to traditional shopping methods for many people including older adults, yet, the number of older shoppers was still low, although it shows some growth, especially the online grocery shopping. Several difficulties reported while older users navigate the websites that include disorientation. For an insight of what may contribute to disorientation in an online grocery shopping site, first, how older adults navigate through the online grocery site and what difficulties experienced should be explored, and later possible solutions could be offered.

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Chapter 3:

How Older Adults Navigate to Find Items in an Online Grocery Shopping Website

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ABSTRACT

This study aims to investigate older adults' navigation in an online grocery shopping website. Nine participants aged 67 to 78 years, either with or without experience in online grocery shopping, volunteered for the study. User observations on the shopping task with a pre-determined shopping list were conducted. The mouse clicks and scrolling actions were automatically logged during the observations and converted into a navigation path map which was then analysed for strategies used, route decisions, completeness, and completion time. Following the observation, interviews pertaining to ease of use, and motivation to use online grocery shopping were conducted. The interviews were examined for recurring themes. The results showed that novice users performed less and experienced more difficulties than those with online shopping experience; difficulties included identifying, finding and operating web objects (e.g. the 'add to cart' button). Various reasons were also mentioned regarding using or not using online grocery shopping. This study elaborates on the challenges older users experience while navigating an online grocery shopping site and provides an understanding of their motivations and barriers towards online grocery shopping usage.

3.1 Introduction

The older population is increasing worldwide and is estimated to reach 2 billion by 2050, which represents 22% of the world population [1]. Living independently and being able to perform household tasks are very important to older adults, as these acknowledges their existence in life [2]. In supporting older adults abilities to live independently, technology is seen as able to support them by offering possibilities to assist them with a range of tasks [3]–[5]. Such tasks include preparing food, doing household chores (e.g. using the tumble dryer to dry clothes), staying informed, and ordering food (via online services). Online grocery shopping can be seen as an option that offers advantages for those restricted from traditional 'physical' shopping. Due to ageing factors, older adults can experience difficulties with getting their food supplies in-stores [6], [7], including driving difficulties and the inability to lift heavy loads [8], [9]. Therefore, the fact that groceries purchased online are delivered straight to their door is advantageous for them.

Nevertheless, there are challenges associated with navigation through websites, including online shopping sites. For older people, these challenges include incidents such as getting lost or becoming disoriented during navigation [10]–[13]. In anticipation of understanding the reasons behind becoming disoriented while navigating through websites, this study was conducted within the context of an online grocery shopping site. It was chosen because online shopping has been mentioned as one of the main activities among older adults when online [14], yet online grocery shopping is still less favourable. Various reasons have been reported as to why older people do not engage in online grocery shopping, including misunderstandings when ordering, time-consuming, and web navigation issues.

Thus, this study aims to investigate older adults' navigation in an online grocery shopping website as well as their motivations to use online shopping. It is anticipated that the findings will provide insight into how older adults use the website and the difficulties they experience while navigating it. Additionally, this study intends to provide reasons for the use and rejection of online grocery shopping.

3.2 Related Work

3.2.1 Older Adults and Online Shopping

It was reported that 82% of the total population of the older community has never bought anything online [15]. Although not many older adults buy things online, online shopping was listed among the top 10 of information communication technology activities among older people [14]. Online grocery shopping is still uncommon among older adults [16].

The literature also discussed several reasons as to why consumers do not engage in online grocery shopping. The issues that contributed to the rejection of online grocery shopping concerned quality and freshness, delivery, and the complexity of product returns. Groceries can be difficult to sell online since consumers demand fresh, good-quality groceries [17]. Receiving low-quality products that are not fresh is intolerable to customers [18], and as such, customers prefer to see, touch, feel, and smell the products they want to purchase [17], [19], [20]. Since products purchased online are usually bought based on the information provided on the websites, unwanted or unsatisfactory goods should be able to be returned to the seller whenever delivered; therefore, the return goods policy is important. Internet retailing was mentioned as experiencing high product returns and is influenced by product policies and product attributes [21]. However, navigating the return procedure and having to go to the physical store is dislike by users and seen as a drawback to online grocery shopping [18]. While online shopping provides convenience to consumers through the delivery of the goods to their doors, delivery charges usually cost them. These home delivery charges worry consumers as they are not ready for such a cost being imposed on them [9], especially when their purchases involve a small quantity [18]. Older adults who are used to purchasing a small amount of groceries are at a disadvantage.

However, when online grocery shopping, users were found to misunderstand things when ordering and experience web navigation issues. Misinterpreting a site's interface functions or icons could lead to an incorrect judgement. A study in [18] highlighted unwanted purchases in which cases of misunderstanding occurred during purchase orders. For example, one participant explained that instead of ordering five pieces of apples, five kilos were delivered. Providing sufficient product information is

necessary, as it can help guide product purchases [22]. Perhaps a better interface design would have been able to avoid such a misunderstanding. Older adults can also experience navigation problems such as disorientation. For example, in another experiment, the older participants were found to be indecisive with the navigation in regard to where to go and what to do [23]. This could have resulted from lack of experience, which further contributed to more time spent performing tasks as compared to the younger participants.

3.2.2 Web Navigation

The act of manoeuvring within a website is almost similar to the act of manoeuvring in the physical world; the differences lie in the environments. Manoeuvring in the physical world, associated with brick-and-mortar structure, is referred to as wayfinding, while manoeuvring within a website or digital environment, in which users use scrolling and links, is referred to as navigation. Both are manoeuvrings with the objective of reaching a certain destination. As summarised by [24], wayfinding is "the act of individual determining where they are within a setting and what actions to take in order to reach a desired location within the setting"; and navigation according to [25], is referred to as "the process of self-directed movement through a hypermedia computer-mediated environment".

Web navigation has been reported to pose certain challenges for some users. Web usability guru Jakob Nielsen pictured navigation difficulties as the main issue of website usage [26]. The navigation difficulties documented in the literature include navigation time [27] and navigation loss or disorientation [12], [28]–[30]. A study [12] that compared navigation performance between old and young adults in hypermedia E-mall shopping found that disorientation among older adults was evident when they were not able to retain product information. Although necessary guidance of navigation paths had been provided, a disorientation problem still occurred due to their decreasing cognitive ability. It was suggested that navigating through familiar spaces could better improve their navigation [13].

Web navigation contributes to the overall user experience [31], so studying the behaviour of older adults when navigating websites could help in understanding the problems that they may encounter. Several methods were used to study web navigation, including eye tracking and observation.

The eye tracking technique measures eye positions and eye movements. It is possible to identify the exact location on which the eyes are focused within a website, and it provides information on locations that draws people's interest or attention. For example, a study by Hanson [32] employed the eye tracking technique to understand user behaviour when navigating websites. The eye tracking produced a heatmap showing the locations viewed on the website, but not the actual actions. Hanson also observed mouse clicks in the study to see whether actual actions had taken place from the users' interests. This showed that mouse clicks could determine the real behaviour of how users navigate a website.

Through the observation technique, it is possible to understand users' behaviour in real environment settings by collecting evidence of how they navigate through a website, e.g. by clicking and scrolling. In their study, Geng and Tian's [33] also mentioned that studying the actual usage can be done by capturing the accurate usage data through mouse movements. The clicks and scrolling will then help generate patterns of navigation that can further help identify issues or areas for improvement in the web navigation.

Observations alone may not be sufficient to justify users' actions since the data recorded only provides information on the actions rather than the reasons behind the actions [34]. During the analysis, assumptions may be made based on those actions. Therefore, to avoid this bias, a post-interview following the observation should be included. This combination method was demonstrated in a study [35] that combined the data collection methods of observation and interview to reveal the challenges and opportunities of movement-based games for young people with mobility impairments.

3.2.3 Disorientation among Older Adults

Disorientation is referred to as a situation in which users tend to lose their sense of location and direction [29]. In this condition, users tend to have difficulties concerning knowing their whereabouts and figuring out how to reach their desired position. When disorientated in web navigation, users may struggle to find what they want, reach pages that they know exist, find pages that have already been visited, know where they are within a website (location), know where they want to go next,

and know how to get back to previous navigation routes; additionally, they may know where they wish to go but not know how to get there [10], [12], [30], [36], [37].

Disorientation may lead to frustration. A study by [37] evaluated the influence of user disorientation on engagement and performance via web navigation system. They found that greater disorientation could lower the intention to use the technology as well as lower engagement with the technology. In other words, disorientation may lead to frustration, which in turn might result in the abandonment of technology.

Disorientation has been reported not only among young people but also among older adults. For example, older users were found to experience disorientation with one website that was reported to have 52 usability problems (e.g. visibility problems, and unclear feedback messages), while no disorientation was found with a website that had been redesigned to be senior-friendly [38]. Another study [12] that compared navigation performance between younger and older users in an E-Mall showed that older adults became disoriented more often as compared to younger users; they were found to repeatedly visit the same page when they did not know where to go next.

The tendency of disorientation among older adults could result from i) a decline of cognitive abilities [10]–[12], [28]; ii) a decline of spatial abilities [13], [31]; and iii) an unfamiliar environment [31], [39].

Prior experience is important in helping user navigation, as it creates a feeling of familiarity that can aid in avoiding disorientation. Users seek something familiarity when it comes to novelty [40]. Furthermore, being familiar with technology may lead to better performance: improved accuracy, fewer errors, and faster task execution [41]–[44]. In other words, users look for something within their knowledge or familiarity first when dealing with something new, and familiarity may build up from experience and be developed through exposure to similar or the same technology.

In an effort to avoid disorientation among older users, many design guidelines suggest grouping information into meaningful categories [45] and not using a deep hierarchy; at most, up to 4-5 levels in terms of depth-of-information should be used [30], [45].

3.2.4 Measuring Disorientation in Web Navigation

Several techniques for measuring disorientation were reported in the literature [46]–[49], including subjective opinions, performance, metrics, and optimal path.

Subjective opinions concern reporting feelings of disorientation through a series of questions using Likert scales. However, with these kinds of questions users may not be reporting their actual perceptions, resulting in the over-reporting or under-reporting of their feelings, especially in older adults. In study [10], an experimental informational healthy living website, in which a mental model accuracy (MMA) exercise was performed to understand the hierarchy of the website, it was found that perceived disorientation was reported more among younger adults than older adults. This surprising result was mentioned to have been affected by over-reported or under-reported feelings of disorientation, as the older adults tended to be polite when answering the questionnaire and always tried to show their positivity. However, it was observed in the study that the older adults experienced more disorientation during the experiment.

Time can be used to measure user performance, where a longer time taken may contribute to more steps taken to complete a task, which could be a sign of disorientation. For example, in [48], disorientation was associated with a long time spent on locating information tasks. Another study [50] also used time in an attempt to understand disorientation problems in web-based learning.

Metrics to measure disorientation can be derived from raw navigation data or a graph consisting of nodes and links drawn from users' navigation. These metrics include switching strategies and route decision (e.g. detour steps, revisit). A study [51] that aimed to understand how older adults search for health information online indicated that switching strategies could signify that users experienced confusion. In [12], older adults were identified as experiencing disorientation when they were found to revisit the same pages and fail to find the next movements. Another study [36] that compared young and old adults' menu navigation performance discovered that the older adults made significantly more detour steps and had more revisited nodes compared to the younger adults, which could have been an indication of disorientation.

Similarly, users' navigation to the optimal path when performing a task can also be used to measure disorientation. The optimal path can be referred to as "the shortest path leading to the web page containing the required target information" [52]. Gwidzka and Spence in [53] also compared the similarity to the optimal path in understanding navigation problems. The optimal path was also used in a formula introduced by Dias and Sousa [54] to measure disorientation; the formula calculates

disorientation based on the ratio of visited pages and the optimal web pages. In other words, the results demonstrate the degree of orientation experienced by users when navigating web pages.

Above mentioned methods can also be combined to measure disorientation. For instance, in [48], both performance measurements (i.e. time and accuracy) and subjective opinions were used to measure disorientation in a task of locating information.

3.3 Methods

This study was conducted from Oct 2016 to Mar 2017 to explore older adults' navigation in an online grocery shopping site through direct observation of shopping tasks and a post-shopping interview session.

3.3.1 Shopping Tasks

User navigation was investigated in a goal-oriented task in which participants had to find items from a pre-determined shopping list (see Table 3.1) and add them to the shopping cart. In order to allow for some 'natural' product selection, no restrictions were imposed regarding brand or price selections. An established online grocery shopping site (Tesco – http://www.tesco.com/groceries/) was chosen for this study, partly because Tesco was reported to be the top UK retailer in the food and grocery sector [55] and partly because their website was rated as 'easy' for finding products as reported in *Which?* magazine [56].

The shopping list comprised five items, selected from a range of product categories: drinks, bakery, food cupboard, fresh, and frozen. The items were also selected to represent a range of task difficulties. The difficulties were determined by the location of the items in the menu list, the number of choices in the menu item, and also changing the default purchase. When few choices were available in a menu item, it was assigned as easy (e.g. 'Bread', 'Cheese' and 'Tea'). When there were many choices available in a menu item, it was assigned as hard (e.g. 'Dried Pasta, Rice, Noodles & Cous Cous'; 'Cakes, Cake Bars, Slices & Pies'; and 'Continental & Cooked Meats, Olives & Pate'). When the item to purchase required some changes to the default setting, it was assigned as hard. For example, to buy 1.3 kg of carrots, a

user would need to change the default ‘quantity’ to ‘weight’ and define the weight to purchase. Table 3.2 summarises the criteria and difficulties for the items included in the shopping list.

In this study, actual online payments were excluded from the tasks since the main interest of the study was on the web navigation aspects rather than on the challenges related to making online payments. Therefore, participants were not asked to make any payments, and the task stopped at the point when all items were added to the shopping cart. Similarly, study [57] also successfully studied purchasing scenarios without involving actual payments.

Table 3.1 Shopping List

Shopping list	Category	Difficulty
Item 1: A pack of green tea	Drinks	Easy • Middle menu list • Few choices in the menu item
Item 2: 2 loaves of white bread	Bakery	Easy • Top menu list • Few choices in the menu item • Increase the default quantity
Item 3: 2 packs of 500g lasagne sheets	Food Cupboard	Hard • Middle menu list • Many choices in the menu item • Increase the default quantity
Item 4: 1.3 kg of carrots	Fresh	Hard • Middle menu list • Many choices in the menu item • Change the default quantity to weight and define the weight for purchase
Item 5: 1 vanilla ice-cream tubs with an offer	Frozen	Medium • Middle menu list • Few choices in the menu item • Selection with some restrictions (i.e. the offer)

Table 3.2 Criteria for Items to be Included in the Shopping List

Criteria	Difficulty: Easy	Difficulty: Hard
Location of an item in menu list	Top/bottom	Middle
Number of choices in the menu item	Few choices (1 choice)	Many (4 or more choices)
Change the default purchase	E.g. Default quantity No need to change the default quantity	Change the default quantity

3.3.2 Participants

A total of nine participants – six female and three male – aged 67 to 78 years old volunteered for this study. Most of the participants were recruited from the University of the Third Age (U3A), while others were recruited through word-of-mouth and posters advertised in local libraries. The participants education ranged were from secondary to postgraduate levels, and they worked, or had worked, as a social researcher, clinical scientist, medical secretary, social worker, painter and decorator, secretary, nurse manager, clerk typist and statistician.

This study has been reviewed according to the procedures specified by the University Research Ethics Committee and has been given a favourable opinion for conduct. Written consent was obtained from the participants at the beginning of the study (Appendix 1).

3.3.3 Procedure

Each participant took part in a single session, with a duration range of 45 to 100 minutes. The session was organised in three parts: user characterisation, observation of the online shopping task, and the interview.

3.3.3.1 Part I – User characterisation

Individual abilities and experiences may affect user performance. Thus, the first part of the session was designed to collect the users' characteristics through a questionnaire, cognitive assessments, and a motor skill assessment.

The questionnaire collected information related to demographics and computer and internet experience, including online shopping experience (Appendix 2).

The cognitive assessments were conducted with the aim of collecting data on cognitive abilities, including short-term memory, long-term memory, and visuospatial ability. For short-term memory, a letter span test was used in which participants were asked to recall letters that were displayed on a monitor screen for three seconds. A total of 6 trials with 2, 4, 6, 8, 10, and 12 letters occurred. For long-term memory, two recalls were made; the first recall was done immediately after a list of 10 items was shown, and the second recall took place after a 10-minute delay. The participants also performed a paper folding test [58] to measure their visuospatial ability. In this test, the participants were asked to match a folded paper to an unfolded piece of paper based on the punched hole(s). They were shown an image of a folded piece of paper with holes punched in it, along with five possible images of the same piece of paper unfolded. The participants were asked to select which of the five images matched the folded piece.

The final assessment was meant to measure motor skill; a Fitts' law task was performed using a mouse. The Fittsstudy application (available online at http://depts.washington.edu/madlab/proj/fittsstudy/index.html, developed by Jacob O Wobbrock, Susumu Harada, Edward Cutrell, and I. Scott MacKenzie) was used to measure the participants' performance in selecting targets of different sizes and distances on a monitor computer screen. In this study, this application was configured to administer 6 A-W conditions defined by 3 levels of A (distance) {256, 384, 512 pixels} crossed with 2 levels of W (size) {8, 128 pixels} yielding 6 unique IDs (indices of difficulty) ranging from 1.585 to 6.0224 bits. Additionally, a circular arrangement of targets in a randomised order was used. Each participant performed 30 trials (5 trials in each A-W condition); each trial was a single attempt to click a target, and the participants were instructed to click the target as quickly and accurately as possible.

3.3.3.2 Part II – Observation of the online shopping task

In the second part of this study, the users' web navigation was observed. A goal-oriented shopping task was assigned to the participants with a pre-determined shopping list using a popular online grocery shopping site. The participants'

interaction with the website was observed and automatically logged by the computer using the Steps Recorder application.

The Steps Recorder application records each mouse click, scrolling action, and keyboard input. The program also provides screenshots of each action with notes of the exact date and time the action took place. Although this application is usually used for computer troubleshooting purposes, it was deemed appropriate because it provided step-by-step information on the users' actions, and the information provided was just enough for the analysis. In this study, recording commenced with the participants' first click on the menu or search function and stopped when the shopping process was completed, i.e. when all the items had been added to the shopping cart.

At the end of this second part, a System Usability Scale (SUS) evaluation was conducted. This tool, which was introduced by John Brooke in 1986 [59], [60], includes 10 questions to measure the usability of various products or services, including hardware, software, mobile devices, websites, and applications.

3.3.3.3 Part III – Interview

The session ended with an interview. Questions pertaining to ease of use, and the motivation to use online grocery shopping sites were asked. The participants' verbal responses in this interview were audio recorded.

3.3.4 Methods of Analysis

3.3.4.1 Cognitive and Motor Skill Assessments

As mentioned in section 3.3.1, several assessments were used in this study including short-term memory, long-term memory, visuospatial, and motor skill assessments. The following table summarises the measures that were analysed.

The first assessment used in this study to evaluate short-term memory was a letter span test in which the number of correct letters recalled was measured. The second assessment evaluated long-term memory using two recalls: (i) immediate and (ii) after ten minutes. The number of correct items recalled was measured. The third assessment used was a paper folding test, which examined participants' visuospatial ability; it required them to mentally perform complex spatial manoeuvres. Therefore, orientation was an important aspect of this assessment. As the task in this test was to

match folded papers to unfolded papers, the number of correct matches was measured. Each correct answer was given 1 point, with the total score ranging from 0 to 20.

Table 3.3 Cognitive and Motor Skill Measures

Assessments	Measures
Cognitive assessments	
Letter span	Number of correct letters recalled
Recall	Number of correct items recalled Two recalls: 1) Immediate 2) After 10 minutes
Paper folding	Number of correct matches
Motor skill assessment	
Fitts' Law	Throughput, error rate, and average movement time

The final assessment was the Fitts' Law task, which was used to assess the participants' motor skill performances. Throughput, error rate, and average movement time were measured to understand the participants' ability to use a mouse.

3.3.4.2 User performances

Performance in the online shopping task was measured through strategies used, route decisions, completeness, and completion time. These metrics will be discussed further in sections 3.3.4.4 to 3.3.4.7. A quantitative approach was the primary method used for the data collection process. However, this approach could only provide information on user actions rather than on the reasons behind these actions. A qualitative approach was seen as appropriate to resolve this issue; therefore, interviews were used to support the results gained from the quantitative analysis.

3.3.4.3 Navigation Path Map

Diagrams were used to demonstrate user navigation in order to ease the analysis of the performances. This study adopted the method used in [53] to demonstrate user navigation by mapping the user clicks into diagrams using where they use a node-and-link model. Nodes were used to present the visited web pages, and the edges of the graph represented the traversed links. Similarly, in our study,

nodes were used to represent each click, and arrows were used to represent traversed links. The nodes recorded data on navigation including visited links, timestamp, and additional annotations. Such annotations included errors and irrelevant shopping categories. There were also some nodes that were visited more than once, and dotted lines demonstrated these revisited links. In addition to the mouse clicks, scrolling actions were also recorded in the maps.

An excerpt of a navigation path map is shown in Fig 3.1. This path map captured that the user clicked on 'Food Cupboard' at 11:40:10 a.m. and then 'Dried Pasta, Rice, Noodles & Cous Cous'. The node 'Food Cupboard' was revisited at 11:43:59 a.m. The map also captured that the user had difficulty with a click target because the mouse was pressed longer; this happened several times: 11:41:10 a.m., 11:44:24 a.m., 11:44:36 a.m. (node 30), and 11:43:20 a.m. (node 36). Additionally, the map demonstrates that the user made some errors. For example, the user clicked on the product image while trying to add an item to the cart (node 36). It also shows that the user had to scrolling up and down for 101 seconds in total to search for an appropriate item to add to the cart.

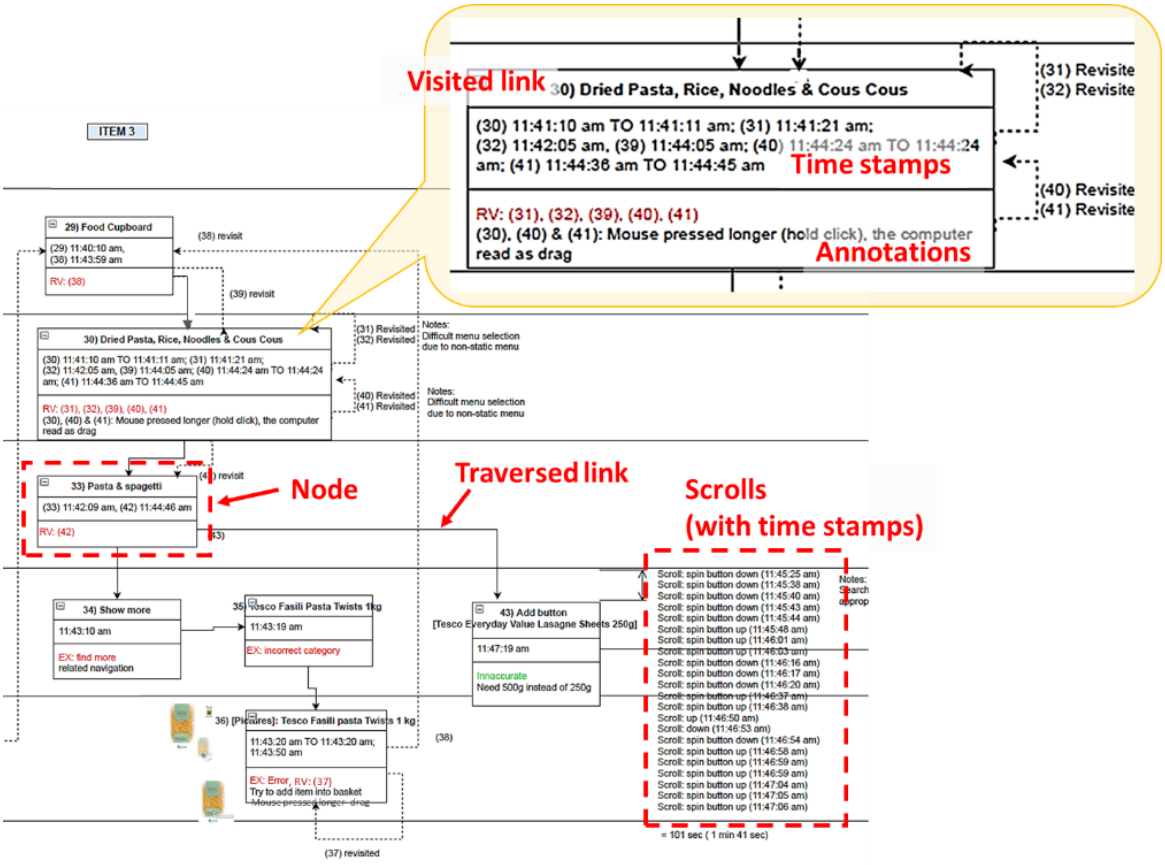


Fig 3.1 An excerpt from a navigation path map. The click activities are annotated to highlight a revisited link (RV).

3.3.4.4 Performance – Route Decisions

The participants' navigation paths were tracked to understand the route decisions they took when performing the pre-determined shopping tasks. The number of nodes followed per item was counted and measured against the optimal path, as an approach to capture disorientation.

Firstly, following Dias and Sousa's [54] method of calculating the orientation ratio, the optimal path for each item was first identified. This was done by reviewing the online grocery shopping site that was used in the shopping tasks (i.e. Tesco) and working out the optimal path for each item (see Table 3.4). Secondly, the participants' navigation path (nodes) for each item was analysed for any 'relevant nodes', that is, the nodes that lay on the optimal path. If any relevant node was revisited more than once, this was still counted as one relevant node. Finally, the following equation was used to calculate the orientation ratio (OR) for each item:

$OR = \sum RN / \sum Npi$

Where

OR is the orientation ratio, and

RN is the number of relevant nodes. Note that if any relevant node was revisited more than once, it was still counted as one relevant node.

Npi is the number of nodes followed per item. Note that if a user revisited the same node more than once, e.g., three times, it was counted as three nodes.

Other performance measurements that were used in the route decisions were the extraneous nodes and revisits. The extraneous nodes were irrelevant or unrelated navigations during the shopping task given that were not within the optimal path. For example, if a participant clicked on a different category than where an item would be, this particular click action would be counted as an extraneous click. As mentioned before, each click was translated into nodes, so extraneous nodes were named. Revisits refer to the nodes that were visited more than once.

Table 3.4 Optimal Path for Each Shopping Task

Task	Path
Item1	Drinks > Tea > Green Tea > x* > Add
Item2	Bakery > Bread & Rolls > White Bread > x* >'+' > Add OR Bakery > Bread & Rolls > White Bread > x* > Add > Add
Item3	Food Cupboard > Dried Pasta, Rice, Noodles & Cous Cous > Pasta & Spaghetti > x* > '+' > Add OR Food Cupboard > Dried Pasta, Rice, Noodles & Cous Cous > Pasta & Spaghetti > x* > Add > Add
Item4	Fresh Food > Fresh Vegetables > Carrots, Parsnips, Squash & Root Veg > x* > weight (kg) > [several]'+' > Add
Item5	Frozen Food > Ice Cream, Ice Lollies & Frozen Yoghurt > Family Ice Cream Tubs > x* > Add
If use search:	
	Search box > [keyboard input] > search button > x* > [continue with above sequence]

Notes: * x is the item chosen by the participants

3.3.4.5 Performance – Strategies Used

The frequency of preferred strategies was calculated by counting the successful strategies used to put items into the cart. For example, if a participant used the menu navigation to look for an item and then changed to a search strategy using the search box and successfully added items into the cart, a search strategy would be counted for this item. Notes were also taken to record any changes in the strategies.

3.3.4.6 Performance – Completeness

The success rate was measured based on the number of items that were successfully added to the cart. The completeness was also measured by accuracy and captured the correctness of the items in the cart as compared to the items listed on the pre-determined shopping list.

3.3.4.7 Performance – Completion Time

The completion time was recorded for the completion of each task as well as for the entire shopping task. The completion time for each task was measured from the first click, when participants started to look for an item, to the last click, when the item was put into the cart. The completion time for the entire shopping task was

recorded from the very beginning, from the first click of the first item to the last click to add the fifth item.

3.3.4.8 SUS Score

The SUS is a reliable tool used to measure perceived ease-of-use with a ten-item questionnaire using 5-point Likert scale with items from 1 (strongly disagree) to 5 (strongly agree) (see Table 3.5). Various applications and software have also been measured using the SUS assessment including Excel, Gmail, and Wii [61].

Table 3.5 SUS Questions

	Strongly Disagree				Strongly Agree
1. I think that I would like to use this system frequently.	1	2	3	4	5
2. I found the system unnecessarily complex.	1	2	3	4	5
3. I thought the system was easy to use.	1	2	3	4	5
4. I think that I would need the support of a technical person to be able to use this system.	1	2	3	4	5
5. I found the various functions in this system were well integrated.	1	2	3	4	5
6. I thought there was too much inconsistency in this system.	1	2	3	4	5
7. I would imagine that most people would learn to use this system very quickly.	1	2	3	4	5
8. I found the system very awkward to use.	1	2	3	4	5
9. I felt very confident using the system.	1	2	3	4	5
10. I needed to learn a lot of things before I could get going with this system.	1	2	3	4	5

Overall, I would rate the user-friendliness of this system as:

◯	◯	◯	◯	◯	◯	◯
Worst imaginable	Awful	Poor	OK	Good	Excellent	Best imaginable

3.3.4.9 Interview

The interviews were audio recorded, and these recordings were later transcribed. The transcriptions were then analysed for any emerging themes.

3.4 Results

3.4.1 Online Shopping and Online Grocery Shopping Experience

Table 3.6 summarises the participants' experiences with computers, the internet, and online shopping. The participants were found to use a computer, either a laptop or desktop, every day or at least once a week. Communication and reading the news were among the top usages reported regarding going online. Other Internet usages informed involved searching for health information, entertainment, shopping, work, and spiritual information.

Not all participants were enthusiastic about online shopping. Three participants (A05, A06, and A08) reported having never purchased anything online, while the others did buy online. Purchases reported among those who used online shopping included travel arrangements, holiday accommodation, books, magazines, newspapers, and event tickets. Although not everyone used online shopping, all participants reported having browsed some shopping-related websites, including Amazon, John Lewis, National Rail, and so on.

Table 3.6 Computer, Internet, and Online Shopping Experiences

Computer experience	Frequency using computer	
	Everyday	7
	Once a week	2
	Most used device to access the Internet	
	Laptop	6
	Desktop	3
Internet experience	Internet usage	
	Work	3
	News	7
	Health information	6
	Spiritual information	3
	Shopping	3
	Entertainment	5
	Communication	8
Online shopping experience	Online purchases	
	Clothes	1
	Household goods	2
	Travel arrangement	5
	Holiday accommodation	4
	Tickets for events	4
	Film, music	1
	Books, magazine, newspapers	4
	Electric equipment	1

	Computer hardware, software	2
	Shares purchases, insurance policies	2
	Medicine	2
	e-learning material	1

Individual Experiences

	Online Shopping	Online Grocery Shopping	Browsing Online Grocery Shopping Site
A01	√	X	X
A02	√	X	X
A03	√	X	X
A04	√	X	X
A05	X	X	X
A06	X	X	X
A07	√	√ (Waitrose)	√ (Tesco, Asda)
A08	X	X	X
A09	√	X	X

The participants were found to buy groceries frequently. They reported performing grocery shopping either daily, more than once a week, or weekly. These purchases were made offline (in-store) within an hour. One participant (A07) mentioned that the main reason to use online grocery shopping sites was to make price comparisons rather than buy fresh food such as vegetables. Table 3.7 demonstrates the grocery shopping activities among older adults.

Table 3.7 Grocery Shopping among Older Adults

Shopping frequency	More than once a week	5
	Weekly	3
	Daily	1
Method of shopping	Offline (in-store)	8
	Online	1
Duration of offline shopping	Less than 20 min	1
	20 – 40 min	3
	40 – 60 min	5
Online grocery shopping used	Not applicable	8
	Waitrose	1

3.4.2 Cognitive and Physical Abilities

As mentioned in Section 3.3.3.1, several assessments were conducted to test the participants' performance regarding short-term memory, long-term memory, visuospatial memory and physical abilities.

In the short-term memory assessment, all participants performed well with 2 letters and 4 letters. However, the data show that their performances started to decline with six letters and decreased with more letters to remember – 8 letters, 10 letters, and 12 letters. The worst performances occurred when the participants were asked to remember 12 letters. Interestingly, most participants performed the same or better on the long-term memory test in the second recall. Only participant A05 had a contrary result in which they were able to recall fewer words in the second recall. In the visuospatial test, it was found that most of the participants (n=7) performed poorly, with scores of 35% or below for the correct matches. Another two participants did better in this test, scoring 50% (A06) and 70% (A01) correct matches.

The last assessment tested the participants' motor skill performance with a mouse using the Fitts' law task. The participants were instructed to perform the task quickly and accurately. When participants did not accurately click on a target, it counted an error. It was found that two participants (A01, A02) scored 0% error, four participants (A03, A05, A06, A09) had 5% errors, one participant (A07) had 11% and one participant (A04) had 27% errors. Participant A04, with the highest error rate, also had the fastest average movement time and this may have contributed to their high error rate, i.e. the participant was unable to accurately click on the targets with such fast movements. Table 3.8 shows the average movement time, error rate, and throughput for each participant.

3.4.3 Route Decision

A total of 45 navigation paths (9 participants x 5 tasks) was generated from the participants' clicks. From these, the number of nodes followed per item was analysed and presented in Table 3.9.

Table 3.8 The Average Movement Time, Error Rate, and Throughput of the Fitts' Law Task

	MTavg (ms)	Error	TP (bits/s)
A01	1173.1667	0%	2.9213
A02	1095.3333	0%	3.0877
A03	1697.3333	5%	1.9215
A04	995.3333	27%	2.8972
A05	1737.0000	5%	2.0806
A06	1276.0000	5%	2.3829
A07	1223.8333	11%	2.8065
A08	2276.3333	16%	1.6522
A09	1072.0000	5%	3.1433

Table 3.9 Number of Nodes Followed Per Item

	A01	A02	A03	A04	A05	A06	A07	A08	A09
item1	5	6	7	8	5	10	4	14	4
item2	6	6	7	7	23	7	5	16	5
item3	6	6	5	6	6	8	5	20	18
item4	7	7	9	8	5	14	9	14	6
item5	6	5	5	5	5	7	4	5	14
Total	30	30	33	34	44	46	27	69	47

Using the navigation path maps, it is also easy to define at which depth-level participants started to add items to the cart. It is found that participants will start adding items to the cart when they arrived at the 4-level or 5-level depth of navigation. There were three participants (A04, A07, and A09) that never went beyond the 4-level depth of navigation for each item bought. They added the items when they first saw the items with the 'add to cart' button.

Orientation ratio was then calculated and is presented in Table 3.10. It was found that participant A08 who was the eldest, 78 years old, with neither online shopping nor online grocery shopping experience had experienced the most disorientation as compared to others throughout the entire shopping tasks. Another participant, A05, 71 years old, who was also with no experience, was found to get lost in the navigation in the beginning, but when he had fully understood how the system works, he performed well. Participant A06, 75 years old, again with no experience, also did not performed well. Participant A09, 68 years old, with online shopping experience, also experienced difficulties while looking for item 3 (lasagne) and item 5 (ice-cream) where the disorientation score was 0.28 and 0.21, respectively. While

finding lasagne, the participant was looking for the specific word 'lasagne' which was not on the menu list; instead, the lasagne belongs to 'pasta'. Therefore, the participant had found to click on other categories including 'Fresh Food', 'World Food', and 'Greek Groceries', and also had revisited 'Food Cupboard' several times to find lasagne.

Table 3.10 Orientation Ratio

	A01	**A02**	**A03**	**A04**	**A05**	**A06**	**A07**	**A08**	**A09**
item 1	1.00	0.83	0.71	0.50	1.00	0.50	1.00	0.29	1.00
item 2	1.00	1.00	0.86	0.71	0.26	0.86	1.00	0.31	1.00
item 3	1.00	1.00	1.00	0.83	1.00	0.63	1.00	0.20	0.28
item 4	1.00	1.00	0.78	0.50	1.00	0.36	0.67	0.43	1.00
item 5	0.67	1.00	0.80	0.80	1.00	0.57	0.75	0.60	0.21
Average score	0.93	0.96	0.83	0.66	0.85	0.58	0.88	0.36	0.69

Across all participants, there were 93 occurrences of unnecessary clicks (see Table 3.11) which were related to difficulty finding items in pre-defined item categories, difficulty finding the main menu, and difficulty identifying the 'add to cart' button.

Table 3.11 Number of Extraneous Nodes Followed Per Item

	A01	A02	A03	A04	A05	A06	A07	A08	A09	Total
item1		1	1	3		4		3		12
item2			1	2	17	1		9		30
item3				1		3		7	8	19
item4			3	4		5	2	8		22
item5	2		1	1		2		1	3	10
Total	2	1	6	11	17	15	2	28	11	93

Navigating in different categories was a prominent issue with item 1 (i.e. green tea) that was experienced by five participants. They were looking for the green tea under the Food Cupboard category instead of Drinks. This action reflected how the participants stored their groceries at home where tea was usually stored in the food cupboard.

"…since my food cupboard at home, I put tea and coffee…"(A06).

"…having things dry food like tea and things in your cupboard in your kitchen"(A08).

In addition, for some of the participants, tea, coffee and such did not belong to drinks. Instead, drinks to them were alcohol, lemonade, and other liquid items. Therefore, the participants suggested that drinks could be grouped into alcoholic and non-alcoholic.

"Drinks to me mean liquid that you buy off the shelves. The liquid"(A02).

"I thought drinks much meant on alcohol, and lemonade, not on tea, coffee, Horlicks, and that sort of things"(A06).

"Drinks might be subdivided into alcoholic and non-alcoholic drinks"(A07).

Bread and lasagne were also looked for under the wrong category. For example, A08 looked for bread in the Fresh category, as they assumed that bread was freshly made every day.

"…because it was fresh, and I didn't realise the food was Bakery"(A08).

A09 was found to have difficulty with finding lasagne. The participant was looking for the word 'lasagne' on the menu; however, it was not on the menu list as lasagne is a kind of pasta, so pasta was on the list instead.

"I had difficulty finding the lasagne because I was looking for the word lasagne,... I didn't realise that in the beginning, that it was under pasta"(A09).

Some participants (n=4) were discovered to have difficulty proceeding to the next task due to the menu at the top of the page no longer being visible after the user had scrolled down the page (non-sticky menu). For that, the simplest solution taken by the participants was to click on the browser's 'Back' button. The participants also tended to make some detours in which they clicked on other links such as related navigation, thinking that it was the main menu.

A total of 48 extraneous nodes (51.6%) were found related to errors in adding items to the cart. Of these 48 occurrences, 22 (45.8%) were associated with difficulties in recognising the 'add to cart' buttons, which are essential web objects in an e-commerce website. The participants mistakenly clicked on labels (13 occurrences), notification messages (4 occurrences), product images (4 occurrences), and graphical navigation (i.e. hyperlinked images) (1 occurrence) when trying to add items to the cart. Samples of the errors made are illustrated in Table 3.12. Note that the 'add to cart' button in the website had a similar blue colour and tone as other elements (e.g. shopping cart label), and no clear focus indicator was available (only a slight change of colour tone when the mouse hovered over a button).

Clicking on notification messages happened when the participants did not realise that the items were already added to the cart. When an item was added to the

cart, a notification message was displayed indicating that the item was in the cart. Not realising that the item had been added to the cart, the participants tried to add the item again by clicking on anything that appeared to be clickable, such as the notification message.

Revisits were identified to be apparent with those who were disorientated. Table 3.13 tabulates the number of revisit nodes followed per item. When the navigation path maps were analysed, loops were identified associated with revisits, indicating that the participants had moved in a circle back to the same node. The combination of many revisits and extraneous nodes made the navigation paths hard to trace.

Table 3.12 Errors Made while Trying to Add Items to the Cart

Type of errors	Samples of error made
Click on label	
Click on notification message	
Click on picture	
Click on graphical navigation	

Table 3.13 Number of Revisit Nodes Followed Per Item

	A01	A02	A03	A04	A05	A06	A07	A08	A09
item 1				1		1		1	
item 2					5			4	
item 3								9	5
item 4						5	1	4	
item 5								1	7
Total	0	0	0	1	5	6	1	19	12

3.4.4 Strategies Used

From the 45 navigation paths extracted from the nine participants (5 items each participant), there were 42 uses (93.33%) of menu navigation and only three (6.67%) uses of the search strategy. This shows that menu navigation was the main strategy used to find items on the website.

To some participants, menu navigation was considered to be quicker and simpler due to the fact that the item lists were visible to the participants.

> *"It is much quicker...because you can immediately see that you could go to fresh meat and click on that and scroll down"*(A02).

The search, however, was viewed as an alternative solution when the menu navigation failed, as mentioned by some participants:

> *"I would go to the menu to start off with. Only search if I have a problem finding something"*(A02).
>
> *"Well, I looked in obvious headings (menu) as I did and if I can't see it there, then I might do it in search"*(A03).

Another reason to use the search strategy was when the menu was not visible to the participants. It was not that the participants were unaware that the menu was hidden and the act of scrolling up the page could help them uncover the menu; it was just that the action was not instantaneous because it was not done regularly.

> *"…It is down there. I should have gone up…Well, I did expect it, and I should have scrolled up…the more one did it the more one would realise, because I don't do it very often"*(A03).

It seems that the more users are exposed to the use of technology, the more they become familiar with the technology and can easily use it, including in the case of web navigation on online grocery shopping sites.

3.4.5 Success and Accuracy

All participants were found to be able to complete the shopping tasks and added items to the cart. However, four participants (A05, A06, A08 and A09) needed to be assisted in completing the tasks. The results also showed that those who needed assistance were those with no online shopping experience and those who had scored low for orientation ratio (see Table 3.10). The assistance that was requested included

how to add items to the cart, whether items had already been added to the cart, and where items were.

Participant A08 had no online shopping experience, was the most disoriented (see Table 3.10), and needed the most assistance throughout the tasks (needed assistance 4 items, with 10 assistances in total). Participant A05, who also had no online shopping experience, was given assistance (n=4) for item 2 which was also disoriented (see Table 3.10). In addition, the items added to the cart were also found to be inaccurate. Participant A06, who also had no online shopping experience, was assisted (n=4) with items 1 and 4 and acknowledged the assistance needed: *"I couldn't have done it without anybody supervising me."* However, participant A09, who had online shopping experience, was given minimal assistance (2 assistances with 2 items).

All items added to the cart were examined for accuracy and are presented in Table 3.14. Items 4 and 5 were identified among the items that were not accurately added to the cart. As designed, these items did carry some difficult tasks to be performed. For example, item 4 needed the participants to change the default setting from quantity to 'weight (kg)', and item 5 was required to be bought with an offer.

Table 3.14 Accuracy of Items Added to Shopping Cart

	A01	A02	A03	A04	A05	A06	A07	A08	A09
item 1	Y	Y	Y	Y	Y	Y	Y	Y	Y
item 2	Y	Y	Y	Y	Y	Y	Y	N	Y
item 3	Y	Y	Y	Y	Y	Y	Y	N	Y
item 4	Y	Y	Y	Y	N	N	Y	N	Y
item 5	N	N	Y	N	N	Y	Y	N	Y

Item 4. Three participants were unable to buy item 4 accurately. They ended up buying only 1 or 2 pieces of carrots instead of 1.3kg as required. This was the result of not realising that the default setting was in 'pieces' and needed to be altered to 'weight (kg)' before the action of adding the item to the cart could be performed. For example, A08, with no online shopping or online grocery shopping experience, was unaware of the setting: *"I didn't realise that…Because I haven't used it…I haven't doing the online shopping with grocery."*

Item 5. The results showed that five out of nine participants did not qualify for the discount offered. This could have resulted from (1) being unaware of the offer

sign or (2) being unsure of actions taken. Although offer signs were provided at the top left corner of images, participants mentioned that they still missed them. For example, A08, who was unaware of the offer signs, said, *"I didn't realise that the offer did come up."* They had scrolled up and down the page to find the best option, but in the end, they clicked on whatever seemed clickable even though the product details were not visible at the time the decision was made (see Fig. 3.2).

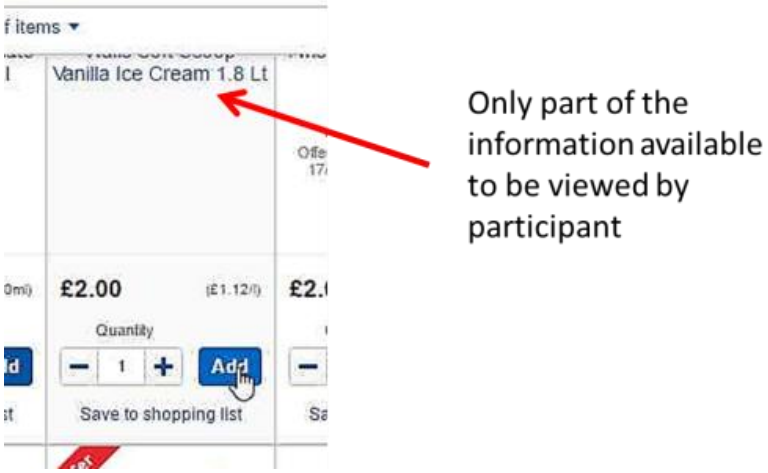


Fig 3.2 Participant added an item without the full view of the product.

Some participants, although they noticed the offer signs, were unsure of their actions and whether they qualified for the offer. For example, A01 said, *"Vanilla ice-cream, I found had an offer that was two for $3.50, but I only bought one, so I don't technically know whether I got the offer or not."*

However, those who had successfully executed Task 5 mentioned that the offer sign located at the top left corner of the product's image was visible to them. In addition, text in red informing the amount save (e.g. 'Save 30p' or 'Any 2 for £3.50') was helpful in identifying products with offers. Some participants thought that the location of the offer sign was not suitable, though, and suggested relocating it nearer to the price. They also recommended highlighting the offer with capital text and exclamation marks (see Fig 3.3).

Although not the main interest of this study, an interesting incident was observed regarding older users' motor functions while using a mouse. One participant (A08) was found to experience difficulties while using a mouse in that the mouse was clicked longer (hold click), which was then translated as a drag by the computer; this happened throughout almost the entire session of the shopping tasks.

(a) (b)

Fig 3.3 Discounted marks – (a) available on the website used in the study, and (b) suggestion by participants to remark offer.

3.4.6 Completion Time

It was found that the fastest time taken for the participants to put an item into the shopping cart was 21 seconds while the longest time taken was 490 seconds (8 min 10 sec) (see Table 3.15). The time taken to complete the shopping tasks for the five items ranged from 243 seconds (4 min 3 sec) to 1575 seconds (26 min 15 sec), regardless of the accuracy of the items added to the shopping cart. The average time taken to buy an item ranged from 48 seconds (~1 min) to 315 seconds (~5 min).

Table 3.15 Time to Add Items to the Cart

	A01	A02	A03	A04	A05	A06	A07	A08	A09
item1	21	54	78	67	71	65	36	313	22
item2	50	21	62	32	310	98	37	165	30
item3	49	46	55	73	71	76	43	490	413
item4	59	39	49	87	25	90	52	209	31
item5	160	31	31	47	88	124	58	147	255
per cart	394	243	343	332	681	534	299	1575	754

Several scroll actions were found to take as long as almost two minutes (see Table 3.16). These long scroll times were associated with the decision to determine the best item to purchase. For example, when asked during the interview, participant A06 mentioned that the action of scrolling up and down the page was to compare the best offer based on quality and price.

Table 3.16 Durations of Long Scrolling Action

Participant	Item	Total scroll time	Comment
A01	item 5	113 seconds (1 min 53 sec)	Looking for a good offer
A06	item 5	72 seconds (1 min 12 sec)	Looking for a good offer
A08	item 3	101 seconds (1 min 41 sec)	Looking for suitable item

3.4.7 SUS Score

Table 3.17 presents the means scores for each question of the SUS, while Table 3.18 presents the total score for each participant. The participants scored between 62.5 (ok/fair) and 95 (Excellent). Moreover, four participants scored below 68 points, the average score suggested for a website to have good usability (http://www.measuringu.com/sus.php). Although some scores achieved were below the average score, the participants rated the overall score of the user-friendliness of the online grocery shopping site as ok, good, excellent or best imaginable.

Table 3.17 Mean SUS Scores for Each Question

	Questions	Mean
1.	I think that I would like to use this system frequently.	2.77
2.	I found the system unnecessarily complex.	2.11
3.	I thought the system was easy to use.	4.00
4.	I think that I would need the support of a technical person to be able to use this system.	2.77
5.	I found the various functions in this system were well integrated.	3.55
6.	I thought there was too much inconsistency in this system.	1.55
7.	I would imagine that most people would learn to use this system very quickly.	4.00
8.	I found the system very awkward to use.	1.55
9.	I felt very confident using the system.	4.44
10.	I needed to learn a lot of things before I could get going with this system.	1.77

Note: Scores range from 1 (strongly disagree) to 5 (strongly agree)

Table 3.18 SUS Scores

Participant	SUS Score	Overall user-friendliness
A01	77.5 (Good)	Ok
A02	95 (Best imaginable)	Good
A03	62.5 (Ok/fair)	Good
A04	90 (Excellent)	Ok
A05	62.5 (Ok/fair)	Excellent
A06	65 (Ok/fair)	Good
A07	62.5 (Ok/fair)	Ok
A08	77.5 (Good)	Best imaginable
A09	72.5 (Good)	Good

3.4.8 Interviews

The interviews findings were used to support the results from the quantitative analysis mentioned before as well as provide other findings such as motivations to use online grocery shopping websites. Various reasons were mentioned by the participants when they were asked: *"What are the motivation to use online grocery shopping?"*

Participant A01. Participant felt there was no necessity to buy online, as physical shops were conveniently near their home at just a 10-minute walk away . However, they would use online grocery shopping if incapacitated and also saw the potential in that online shopping may help avoid impulse buying, which usually happens with in-store shopping.

Participant A02. The participant mentioned that there was no need to buy online because their food consumption was minimal and not worth a delivery. Furthermore, they preferred to feel and see the fruits and vegetables they selected and mentioned that if purchases were made online, the size and quality of the products could not be estimated accurately. Nevertheless, the participant mentioned the possibility of using online grocery shopping if they were unable to drive to the shop, immobilised, or unable to carry heavy loads, whereas physical illness such as Parkinson's or eyesight problems could hinder the use of online shopping. Bad experiences while performing online transactions such as scams or fraud could also stop them from continuing to buy online.

Participant A03. The participant said that online grocery shopping would only be considered if they were unable to leave home, e.g. due to bad weather or health

issues. However, they had the thought that providing their account information could expose confidential information to others, which could be risky. This feeling of not trusting the system hampered their use of online shopping.

Participant A04. Aware of the technology advancement and the future trend in shopping, the participant saw the possibility in buying groceries online. Furthermore, the participant also acknowledged the price differences between online and offline shopping, in which online sites offer lower prices. Food quality was mentioned to be very important; any reduction of quality could hinder their use of online grocery shopping. The participant also mentioned encouraging their spouse to use online technology, including online grocery shopping.

Participant A05. The participant mentioned that it was unnecessary for them to buy online at the moment, but if they were unable to drive to the shop, had physical difficulty going to the shop, or lived far from the shop, these could encourage their use of online grocery shopping. They also felt that online shopping would be more suitable for appliances (e.g. a fridge) or packed items, as they mentioned preferring to feel and touch the fresh fruits and vegetables themselves rather than letting the selection of goods be made by the shop workers. The difficulty of returning unwanted or unacceptable goods delivered could also hamper their use of online grocery shopping.

Participant A06. The participant would only opt for online grocery shopping if housebound. They also had the thought of using online grocery shopping as a starting point to look for product information and prices before physically doing in-store shopping. To the participant, in-store shopping could also create an opportunity to socialise with their community. Not trusting to provide their account details online was also mentioned as the main barrier that hindered their online shopping.

Participant A07. The participant mentioned that the experience of using online shopping was very convenient, as the goods were delivered to their home. Online grocery shopping sites were also used to compare product prices.

Participant A08. The participant saw online shopping as an alternative to offline shopping. Whenever goods were not found in-store, the online shop could be the alternative to find the intended items to purchase. Food quality (i.e. freshness) was important to the participant. Goods delivered that did not match their expectations could jeopardise their use of online grocery shopping. The participant suggested that

online grocery shopping was more suitable for dry food. Another issue that hampered the participant from using online grocery shopping was the high delivery cost.

Participant A09. A definite answer of ‘never buy online’ was explicitly expressed; the participant showed no sign of intending to use online grocery shopping at any cost. They mentioned that other people’s shared bad experiences had lowered their chance of using online shopping. Furthermore, the participant preferred to feel and touch the groceries and could not tolerate goods that did not match their expectations when delivered.

In summary, the findings showed that the most mentioned barrier was ‘no need’ for the technology. The participants also said that online grocery shopping was inappropriate for fresh groceries; however, it could be suitable for dry or packed foods. In addition, the inability to estimate price and quality also hindered their use; the participants preferred to see, touch, and feel the products. Although store workers could help with product selection, the participants still did not trust the handling of the groceries by the store workers. This shows that product quality was important to the participants. Thus, products received that were not up to their expectations were intolerable. Moreover, the difficulty of returning unwanted products could hinder their use of online grocery shopping. Furthermore, their small consumption of food led to small purchase quantities, which were not worth the delivery cost. Other reasons mentioned included the risks of online shopping, such as scams or fraud, which hindered them from using the technology. This could also restrain them from providing their account details for online payments. Physical disabilities such as limited eyesight or the inability to use a mouse were also barriers to online shopping. The location of physical stores did affect their choices to buy, where in-store shopping was preferred for those with homes nearer to the stores. Furthermore, in-store shopping could provide an excellent place to meet people (e.g. friends) and socialise.

Despite the barriers to online grocery shopping, the participants also saw the possibility in using the technology, especially if they were unable leave their house due to either bad weather, being housebound, or even being unable to drive to the shop. Some advantages of online grocery shopping over in-store shopping also promoted the use of the technology, including low prices and the convenience of groceries being delivered to their doorsteps. Those who lived far from the stores and could not carry heavy loads would benefit from the delivery service. Social influence could also foster the use of technology. For example, one participant encouraged her

spouse to be up-to-date with today's online trends, such as online shopping. Online shopping was also seen as an alternative in that it was opted for when products were not found in-store; it also assisted in-store shopping by providing a starting point to look for product information before in-store shopping.

These findings showed that in-store shopping remains the main option for grocery shopping among older adults, but online grocery shopping is still seen as having potential among older adults' usage.

3.5 Discussion

3.5.1 Older Adults and Online Grocery Shopping

Heart and Kalderon [62] mentioned that the main reason given by older people for not using technology was 'no need' and that their motivation concerned its usefulness. Similarly, the present study revealed that older people feel that they do not need to buy groceries online until mobility is an issue, when they are unable to leave their home, unable to drive to the shop, or housebound. This shows that need and value remains important reasons for older people to use technology [4], [5], [63], [64]. In the meantime, online grocery shopping was also seen as serving a purpose in a different way, such as by guiding purchases before physical in-store shopping took place (e.g. price comparison).

Shoppers have mentioned being anxious about receiving low-quality grocery products purchased online [18]. Similarly, in this study, product quality was important, and, it was intolerable for participants to receive fresh groceries of unacceptable quality. This could be a reason as to why older people prefer to see, touch, and feel their fresh groceries [17], [20], which was also mentioned by the participants. Thus, it remains a barrier to online grocery shopping.

When performing the shopping task, the participants in this study had an average fastest time to buy an item of almost one minute, while the longest time was five minutes. The result of the fastest time was still longer compared to that reported in [57], in which the average time taken by younger shoppers was 19 seconds. As such, it could be summarised that older adults may take up to three times longer to select an item when buying online. However, this should be investigated further with larger samples.

The longer time taken while performing tasks could be attributed to the difficulties faced when navigating the website (which will be discussed in section 3.5.3), or even to deciding one worthy purchase. For example, while looking for an item to purchase, participants scrolled up and down the page for almost two minutes. Possibly, older adults need more time to synthesise content and thus take a longer time to initiate actions [65].

Participants who experienced difficulties while navigating the website, still rated themselves as confident in using the website. Perhaps, older adults are not afraid of trying new technologies, or maybe they tend to be more polite and are favourable to showing positive aspects of their abilities and, therefore, could have under-reported their subjective opinions [10].

3.5.2 Navigating Online Grocery Shopping Site

In this study, it was found that menu navigation was preferred as compared to searching. A similar trend has also been observed in other studies [39], [66]. Consistent with the studies of Bergman [66], who reported that the search was used as an alternative to navigation only when the location of a file was not remembered, it was also noticeable in this study that the search was only used when items were nowhere to be found. The preference of menu navigation could have possibly resulted from older adults' behaviour (which tends to use less risky navigation) [67] and the fact that the hierarchical and linear navigation is appropriate for older users' use [12], [68].

Difficulties navigating online grocery shopping site will be discussed in section 3.5.3. It was evident that novice users, who were identified as having a lower orientation score, tended to experience more navigation difficulties than experienced users.

Disorientation can be illustrated on navigation path maps through complex navigation, which is characterised by a path that is hard to trace in which there are more loops resulting from revisits, a longer path with a high number of extraneous nodes, and a longer time completion as compared to simple, straightforward navigation. In [53], two different navigations with low and high values of disorientation were illustrated. They associated a simple or linear shape of graphs with low values of disorientation, while complex navigation with more loops present

and a longer path with more visited nodes was associated with high values of disorientation.

Table 3.19 summarises the navigations characteristics of simple/straightforward and complex navigation (see Fig 3.4).

Table 3.19 Characteristics of Navigation Patterns

Simple Navigation	Complex navigation
Easy to trace navigation.	Hard to trace navigation.
Sequential navigation with no loops.	Many revisit nodes create loops.
No extraneous nodes; very few, if any.	Lots of extraneous nodes.

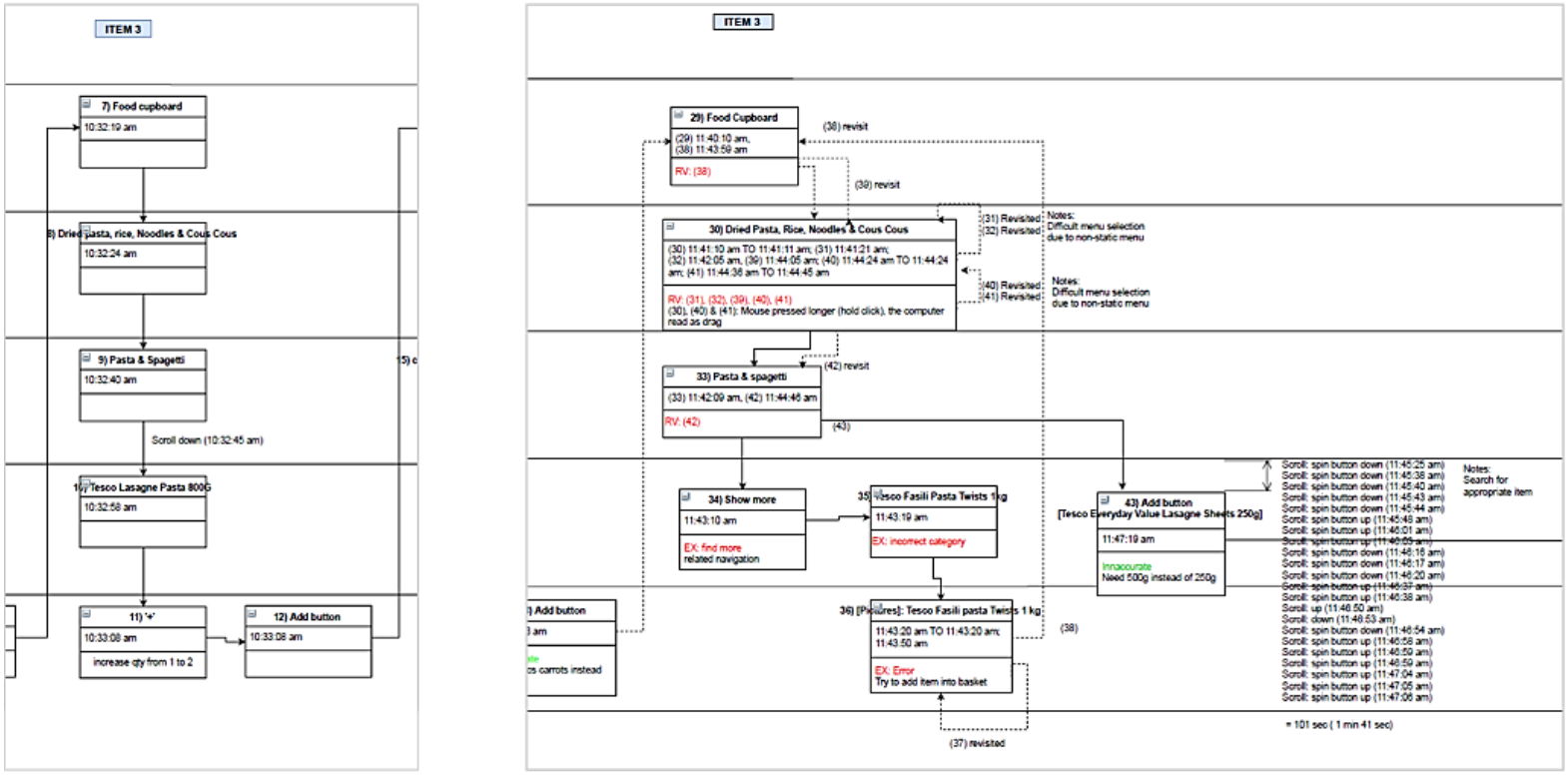
Fig 3.4 illustrates the difference between the two navigations. A simple navigation path provides navigation that is easy to trace, which reflects that the user easily navigated through the websites when completing a task. A complex path is harder to trace and exhibits more loops and more extraneous nodes (e.g. errors), indicating that the user experience difficulties in their navigation. The extended view of the navigation paths can be viewed in Appendix 3.

3.5.3 Difficulties Navigating Online Grocery Shopping Site

Several difficulties in navigating online grocery shopping site among older users were uncovered. The difficulties include the following:

3.5.3.1 Difficulty identifying the 'add to cart' button

Less experienced users may be unfamiliar with a user interface including common GUI such as buttons and menus [69]. Similarly, in this study, novice users were found to experience difficulty in identifying a valid 'add to cart' button, an important object of an e-commerce website. Misunderstanding the action button for adding items to the cart, the participants were found to click on labels, notification messages, and product pictures which could have been stemmed from the inclination to click on objects that appeared clickable to them [70]. A similar incident occurred in [71], in which older adults were found to have problems with clickable links when there was no focus indicator implied in the design (e.g. button colour did not change when a mouse hovered over the button).



(a) **(b)**

Fig 3.4 Excerpts from two different navigations for a similar item bought – (a) simple/straightforward navigation with an orientation ratio of 1.00, and (b) complex navigation with an orientation ratio of 0.20.

3.5.3.2 Difficulty finding items in the website's pre-defined item categories

The differences between a user's mental model and a system's model can make navigation challenging. Different mental models that can make navigation more challenging were demonstrated in [72], in which older and younger users' mental models of a cellular phone menu were compared. Indeed, a better understanding of the mental map of a menu can improve performance when using a device. In this study, such difficulties were observed with the task of shopping for 'a pack of green tea'. The tea was categorised under 'Drinks' on the website. However, some participants looked for the tea under the 'Food Cupboard', reflecting how they store tea at home. Another example was observed in a case in which one participant had difficulty finding lasagne. The participant took almost 7 minutes, as compared to the fastest participant, who took only 43 seconds. When asked in the interview, the participant explained that the word 'lasagne' was expected to be in the menu list, whereas it was actually categorised under 'Pasta'. The inability to recognise which category an item is grouped in could contribute to this difficulty, especially when a menu navigation strategy is used to look for the item.

3.5.3.3 Difficulty finding the main menu

Some participants were found to have difficulty proceeding to the next task due to the menu at the top of the page no longer being visible after the users had scrolled down the page (non-sticky menu). The simple act of scrolling up the page, which could have helped them find the menu, was not realised. It might be possible that older users are less inclined to think beyond what they see on-screen and only react to what is visible to them. For example, for four participants, the simplest solution was to click on the 'Back' button; this was parallel to what was mentioned in [73], in which older users used the 'Back' button to 'undo' or reverse navigation steps or to 'cancel' when they reached an unexpected location. One possible, simple solution could be to provide a 'sticky' menu so that the menu will always stay visible, no matter how far users scroll down the page.

3.5.3.4 Difficulty changing the default setting

To purchase loose carrots, the participants needed to change the default setting from 'quantity' to 'weight (kg)'. Some participants were unable to perform this task

accurately, as they did not know that the setting needed to be changed prior to making a purchase. As a result, for example, instead of buying 1.3kg of loose carrots, some participants ended up with only one carrot. Such a misunderstanding was also reported in [18], which highlighted unwanted purchases occurring during purchase orders; the participant explained that instead of ordering five apples, five kilos were delivered.

3.5.3.5 Difficulty with offer

Five out of the nine participants failed to qualify for the offer mentioned in the task (i.e. to buy '1 vanilla ice-cream with an offer'), including both those with online shopping experience and those without. Some participants reported that they were unaware of the offer sign on the top left corner of the product or were unsure whether they had qualified for the offer after adding the item to the shopping cart. A participant mentioned that text with 'OFFER!', 'GREAT OFFER!', or 'SAVE!' placed near the product prices would have been helpful for recognising the offer. This shows that the location of an object is important to help with users' navigation, as discussed in [74], in which a button appropriately placed within the website improved its usage.

3.5.3.6 Difficulty to click target

Older users often have difficulties performing tasks that require fine motor movements, including using a mouse [75]. In this study, one participant struggled with the mouse throughout the entire session. The participant often pressed the mouse button for too long, which resulted in a drag rather than a click.

3.5.4 Experience and Navigation

Technology experience has been concurred to contribute to ease of use of technology. Prior website experience was also mentioned as an important indicator for website task performances [76], and several works have shown that prior website experience influences website task performance among older adults. For example, in study [76], prior website experience was found to significantly influence user performance in a retrieving information task. Another study [51] also found that older

adults who lack technological experience undergo difficulties when performing online search tasks.

Similarly, this trend was also discovered in this study: those with online shopping experience exhibited simple navigation, while inexperienced users exhibited complex navigation (see Table 3.20). Participants A01 and A02, who were reported to purchase various items online more than the others, exhibited simple navigation and scored an average orientation ratio of 0.93 and 0.96, respectively (see Table 3.10). However, older adults who had little experience had complex navigation, at least at the beginning of the tasks, or for severe cases, could experience disorientation throughout all the tasks. A05, A06, and A08, who had no experience, demonstrated complex navigation. A09, who had less experience, only twice book purchased online , also suffered disorientation due to unfamiliarity with the website. This shows that exposure to similar or the same technology could help users become familiar with the technology, further helping their navigation. Familiarity with technology does improve performance, as described in [41], [42], [44].

Table 3.20 Participants' Navigation Patterns Against Their Technology Experience

Participant	Navigation pattern	Online Shopping	Online Grocery Shopping	Browsing Online Grocery Shopping Site
A01	Simple	√	X	X
A02	Simple	√	X	X
A03	Simple	√	X	X
A04	Simple	√	X	X
A05	Complex*	X	X	X
A06	Complex*	X	X	X
A07	Simple	√	√ (Waitrose)	√ (Tesco, Asda)
A08	Complex*	X	X	X
A09	Complex*	√	X	X

Notes: * The navigation path map indicates at least one item with complex navigation.

3.5.5 Limitation and Future Directions

Recruitment for this study was quite challenging. Although various strategies were employed for the recruitment such as the distribution of posters on public notice boards, library, social clubs, word-of-mouth, mail, and emails, still it is slow and

beyond control. Several attempts of face-to-face invitation had been turned down by the older adults just because they do not do online shopping. Although it was explained that the study requires volunteers with neither online shopping nor online grocery shopping experience a quick negative response was received with a firm statement that "*I don't do online shopping"*. This had then lead to longer duration of data collection. Thus a more creative method should be deployed for future recruitment to improve the number of interested volunteers to participate in studies.

Although this study had a small number of participants, through the combination of quantitative (user performances) and qualitative (interviews) method used, still it had generated a large amount of data to analyse that could help understand older users' actual navigation on the website and the reasoning behind their actions. For that, the root problems to navigation difficulties could be identified, thus provide insight into the aspects of web design that may need improvement. However, larger samples could help describe the older population at large.

Although designs for old were suggested to ease older users' navigation [77], [78], in this study, older users especially novice users were still found to experience difficulty with an important element of e-commerce websites, 'add to cart' button. An investigation into designs that adhere to the guidelines and principles suggested could describe the existing design scenarios which then could lead to the area for improvement.

3.6 Conclusion

The outcomes of this study provide an understanding of what difficulties are experienced by older adults while navigating in an online grocery shopping website that could associate to disorientation; and also the motivation to use the website.

This study reveals that novice older users tend to experience disorientation during online shopping, which could result from difficulties while navigating a website such as a difficulty identifying the 'add to cart' button, difficulty changing the default setting and difficulty clicking on targets. Other difficulties related to navigating e-commerce website experienced by those with or without online shopping experience are difficulty finding items in the website's pre-defined item categories, difficulty finding the main menu and difficulty with an offer. Older adults mentioned

that they do not need to use online grocery shopping and will consider its usage when mobility is an issue.

The findings of this study could be inputs to the design for better usage among older users and also help the technology accommodate purchases among this community and possibly to see other potentials of its use, for example, online grocery shopping site could provide a guide to in-store shopping.

3.7 References

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Chapter 4:

‘Add to Cart’ Button Design Conventions on e-Commerce Websites

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ABSTRACT

With the flourishing of online markets, shopping online has become an alternative to traditional shopping methods for many people including older adults. For example, for older adults who struggle with some of the constraints of traditional “physical” shopping (e.g. the need to carry heavy bags); online grocery shopping can provide a good alternative. However, it has often been reported that older adults experience disorientation in web navigation, which can further lead to the abandonment of technology. In e-commerce, ease of navigation is crucial in supporting users to make purchases. In particular, this study focuses on the design of the ‘add to cart’ buttons, since their use constitutes a crucial step in e-commerce that users must complete in order to make a purchase. In this study, a review of 51 e-commerce websites was conducted to evaluate the design conventions of their ‘add to cart’ buttons against principles and guidelines for designing for older users. Visibility, readability, understandability and navigability were the criteria covered in the evaluation. While the websites were found to adhere generally to the principles and guidelines, areas for improvement were also uncovered, relating to the use of colours, focus indicators, contrast ratios and fonts. These knowledge could provide hints to the web designers, developers and even the retailers in developing websites that could ease older adults use.

4.1 Introduction

The maturity of Internet infrastructure has supported a thriving e-commerce industry. It has changed the way people shop where online purchases have become increasingly popular among the public. Providing easy web navigation for users to buy online can avoid unfortunate experiences such as disorientation within a website, which, particularly for older adults, could lead to frustration and eventually abandonment of technology [1]. In addition, navigation elements are also being listed as one of the important components of e-commerce websites, along with the homepage, catalog, shopping cart, registration and checkout [2]–[4]. Markellou in his articles [5], [6] highlighted that the important design components for e-commerce websites are the product catalogue (list of goods and/or services) and the shopping cart (list of items the customer has chosen to purchase). Markellou's conceptual model of the shopping cart emphasises that its activities start with adding items to the cart, as it marks the starting point for an actual sale to happen.

Online shopping can provide an alternative solution for those who may have constraints in performing traditional "physical" shopping. This includes older people who, due to age-related declines, could benefit from this technology when they are unable to drive to the shops or unable to carry heavy loads, for instance. Despite some of the advantages of shopping online, older adults can experience difficulties in navigating online shopping websites such as disorientation or losing a sense of direction and orientation [7], [8]. Still, disorientation among older adults remains to be an issue while navigating websites [9]. In addition, the earlier exploratory study (Chapter 3) which investigated older adults' navigation in an online grocery shopping website, had found that older adults experienced difficulties with distinguishing the valid button for the function of adding items to cart, that is, the 'add to cart' button – a very important element of e-commerce websites.

In order to understand whether the existing websites have been designed with 'senior-friendly' button designs or otherwise, this study was undertaken. This study investigated the 'add to cart' button designs practised within the existing e-commerce websites, and evaluated them against design guidance for older users. This study also focuses explicitly on 'add to cart' button, that is, the graphical control used to trigger the 'add to cart' action. This button is an example of 'call to action' button which is an important button that solicits an action (i.e. click); where for 'add to cart' button it

requires users to click the button to put items into the shopping cart. This paper provides an overview of the current practice in 'add to cart' button designs and highlights areas that need improvement in respect of designing for older adults.

4.2 Related Studies

Web usability and ease of navigation is an essential factor for e-commerce success; therefore investigations into information structure, navigational aids, and searching/browsing behaviours have been suggested as important areas for research [10]. Buttons as navigational aids available on websites play an important role in assisting user navigation.

Literature reviews performed with peer-reviewed articles and also academic researches that discussed add to cart buttons resulted with limited resources. Within available resources [11]–[16], the discussion was not specific to 'add to cart' button but could be generalized to 'call to action' button. And it is found that labels, shapes, focus indicators, colour, location/position, and size were among the design aspects studied and explored.

Labels on buttons can be designed in the form of text only or a combination of symbol/icon and text [13] and labels can be beneficial to inform users of its function [11]. Buttons which were usually rectangle in shape [11], as well as when it is different/unique in shape [12] can be used to inform it is a button function. While capturing users attention, dynamic effects or focus indicators such as change of colour [11], [12], [16] can be an effective solution. Positions or where buttons were located within the website could also be helpful with user navigation; for example, based on data collected through a longitudinal study [15], it is found that buttons, when placed at appropriate locations could increase its usage. An informative button would be useful in persuading an action such as in [11] which explored the effects of donation button design on transactional trust found that trust ratings increased when buttons were informative, that provides information (e.g. via photographs) of the contribution (what, how much, and use for) . Studies such as in [17], [18] explored the optimal button sizes and spacing which the studies were related to touch screen user interfaces on mobile devices where interface sizes are restricted.

The literature explored the design attributes of a button in relation to attractiveness, intuition, easy to use, navigation, satisfaction, understandable, gender preferences, behaviour, trust, performance and also usage. The button design attributes that were among interests within the studies are labels, shapes, focus indicators, positions (location), button colour, and additional related information. These button attributes were evident to be important in helping users in recognising, understanding, and operating buttons. Therefore, with the use of appropriate colours, focus indicators, shapes, labels and location could help users be aware and recognise important buttons such as a 'call to action' button on websites which include an 'add to cart' button.

4.3 Preliminary Investigation: The Importance of 'Add to Cart' in E-Commerce Websites

A button is a graphical control element that is used to trigger an event, and an important button that solicits an action (i.e. click) from users when they visit websites is called 'call to action' button. An example of this type of button is 'add to cart' button which requires users to click in order to put items to purchase into the shopping cart and is an important element for e-commerce websites as it marks the point where the actual sales start.

An investigation was conducted to understand the importance of add-to-cart buttons in e-commerce websites from the industrial perspectives. This is crucial in establishing the necessity to explore whether the demand for good design for add to cart is desirable or not. This investigation should also answer the design aspects that are most desirable.

This review undertook the following steps: 1) formulate the aim and research question; 2) determine the keywords to be used in searching; 3) determine the inclusion and exclusion criteria of article selection; 4) determine the search engines to be used; 5) perform the search; 6) filter articles based on inclusion and exclusion criteria; 7) perform the analysis; and 8) present the results.

With the aim to understand the importance of 'add to cart' button for e-commerce websites, a search was performed using a Google search engine and with keywords "importance of add to cart button in e-commerce website". This had

resulted with a non-exhaustive list of blogs and websites discussing the topic. From the result, only articles from the first five pages that related to ‘add to cart’ or ‘call to action’ buttons with ‘add to cart’ included in the discussion were selected for the review. 25 articles were extracted, dated as old as 13 October 2009 to the latest 25 April 2017. Among the articles were from the following websites Shopify, Smashing Magazine, UX Booth, AddShoppers, and others. Only 20 articles were selected to be included in the results (see Table 4.1). The rejections of five articles were due to the content of the articles which did not include topics that were related to ‘add to cart’ or ‘call to action’ button designs such as discussion on testing methods to increase conversion rate.

Table 4.1 List of Web Articles

Article	Date of Article	Title of Article	URL
#1	8 Jun 2011	Ecommerce website? Bring price and add-to-cart button closer to increase sales	https://vwo.com/blog/ecommerce-increase-sales/
#2	9 Jan 2014	The importance of call to action buttons on your e-commerce site	https://www.prestashop.com/en/blog/the-importance-of-call-to-action-buttons-on-your-e-commerce-site
#3	21 Mar 2013	Where is the ‘best’ place to put your CTA?	http://www.smartinsights.com/conversion-optimisation/landing-page-optimisation/where-is-the-best-place-to-put-your-cta/?ap_id=digitaljuggler
#4	7 Dec 2013	A/B test ideas for e-commerce call to action buttons	https://blog.optimizely.com/2013/12/07/ab-test-ideas-call-to-action-buttons/
#5	25 April 2017	What is the best colour for a checkout button on an e-commerce site?	https://www.postmm.com/ecommerce-button-color/
#6	12 Feb 2015	7 inspiring ecommerce call to action examples and why they work	https://www.shopify.co.uk/blog/17156160-7-inspiring-ecommerce-call-to-action-examples-and-why-they-work
#7	6 May 2013	How to create an effective call to action for your ecommerce website	https://www.envision.io/blogs/ecommerce-pulse/28830209-how-to-create-an-effective-call-to-action-for-your-ecommerce-website
#8	22 Oct 2014	7 e-commerce design tips to increase conversion	http://blog.lemonstand.com/7-ecommerce-design-tips-to-increase-conversion/
#9	26 May 2017	Here’s how to design ecommerce CTAs that convert	https://www.invisionapp.com/blog/ecommerce-ctas-that-convert/
#10	10 Mar 2017	E-commerce call to action examples	https://www.shopwired.co.uk/blog/e-commerce-call-to-action-examples
#11	n.d.	48 bulletproof ideas to	https://securionpay.com/blog/48-

		increase ecommerce conversion	bulletproof-ideas-to-increase-ecommerce-conversion/
#12	11 Oct 2012	Buying buttons… Best practices for ecommerce	http://www.wiliam.com.au/wiliam-blog/web-design-sydney-buying-buttons-best-practices-for-ecommerce
#13	6 mar 2012	E-commerce calls to action: 10 best practice tips	https://econsultancy.com/blog/9225-e-commerce-calls-to-action-10-best-practice-tips
#14	n.d.	"Call to action" buttons: Guidelines, best practices and examples	http://www.hongkiat.com/blog/call-to-action-buttons-guidelines-best-practices-and-examples/
#15	25 Mar 2016	Best color for add to cart/buy button [industry stats]	https://blog.amasty.com/best-color-add-cart-buy-button/
#16	5 Mar 2015	Add to cart buttons: A 7 year analysis	https://www.addshoppers.com/blog/add-to-cart-buttons-a-7-year-analysis
#17	13 Oct 2009	Call to action buttons: Examples and best practices	https://www.smashingmagazine.com/2009/10/call-to-action-buttons-examples-and-best-practices/
#18	19 Mar 2009	Good call-to-action buttons	http://www.uxbooth.com/articles/good-call-to-action-buttons/
#19	21 Feb 2017	Call to action: the 10 most effective techniques	https://boagworld.com/design/call-to-action/
#20	12 Oct 2009	5 tips for creating an effective call to action button	https://www.sitepoint.com/5-tips-for-creating-an-effective-call-to-action-button/#

The selected articles were analysed for the values of 'add to cart' button or 'call to action' button. Sentences with words that reflect the importance and roles of 'add to cart' or 'call to action' were extracted from the articles. The following are some sample of quotes extracted from the articles:

Table 4.2 Themes Emerged of the Add to Cart/Call to Action Button

Themes	Samples of extraction
1) ATC/CTA* needs effective design.	• *"Call to action buttons on websites are often neglected. Designers sometimes don't understand exactly what makes a good call to action button beyond being attractive and fitting into the overall design. But call to action buttons are too important to be designed without some kind of understanding of what makes them effective. After all, the main point of a call to action button is to get visitors to do something."* (#13)
2) ATC/CTA* should help user navigation.	• *"But why aren't any visitors adding products to their cart?.... Perhaps your visitors are having a hard time navigating your store because there isn't a clear call*

	to action. They simply don't know where to click." (#6) • *"Without a call to action, a viewer is left looking at a page, unsure of what they should do next. Internet users are fast-moving, and they quickly leave your site if they are confused or don't immediately see what they want."* (#7) • *"With ecommerce websites, ... The buttons that appear with their calls-to-action (CTAs) are important signposts to help users find their way to purchase and are a key part of UX design. They arguably matter in the world of ecommerce more than anywhere, as a successful user journey has a monetary value."* (#9) • *"Having a clear call-to-action on every page allows you to steer the customer toward the most appropriate spot in your conversion funnel."* (#10)
3) ATC* remarks the actual sales start.	• *"The add to cart button, ... It is THE button that will determine whether or not a person will add an item to their cart."* (#8) • *"All e-commerce website owners know how important the add-to-cart button is .... because that's where the actual sales process start"* (#1)

*Notes: ATC = add to cart, CTA = call to action

Other interesting topics found to be discussed among the articles which were related to design aspects of 'add to cart' and 'call to action' buttons such as placement (location), wording (label on button), colour, size, space, shape, notification, animation and icon & images (see Table 4.3). The table combines the design aspects discussed in literature mentioned in section 4.2.

Although not every mentioned aspect was specifically informed on how the design should be, yet, few suggestions were able to be elicited such as use high colour contrast; use short, simple, easy wording label for easier understanding; use verb, and familiar phrase (e.g. add to cart or add to basket); to place button appropriately to improve usage effectiveness; design with big size button to imply priority and importance; and create space around button to help clear clutter and also avoid it to blend into the content which could then help user to distinguish the button.

Table 4.3 Add to Cart Design Aspects to Consider

Articles	Location	Size	Shape	Colour	Label	Space	Notification	Animation	Icon & images	Focus indicator
#1	√									
#2	√	√	√	√	√					
#3	√									
#4	√	√		√	√					
#5				√						
#6				√	√					
#7		√		√	√	√				
#8	√			√						
#9				√	√	√				
#10	√									
#11				√	√		√	√		
#12	√	√		√	√	√				
#13		√		√	√	√			√	
#14				√						
#15		√	√		√				√	
#16	√	√		√		√				
#17	√	√		√	√					
#18		√								
#19	√	√		√		√				
#20	√	√		√	√				√	
Weng & Fan, 2016 [16]			√							√
Riesenberg, 2016 [13]					√					
Seyb, 2015 [14]					√					
Burt and Gibbons, 2011 [11]	√			√	√					
Jones, 2004 [12]	√		√	√						
Wells, 2003 [15]	√									
Total	**14**	**11**	**6**	**17**	**15**	**4**	**1**	**1**	**3**	**1**

It can be concluded here that it seems that the industry has considering add-to-cart as a very important element that enables purchases to happen. Numerous articles discussed the design of ‘add to cart’ shows the importance of having appropriate designs for ‘add to cart’ to provide a better navigation further ensure purchases and that colour, label, location and size attract lots of interests.

4.4 Method

With the aim to investigate 'add to cart' button designs practised within the existing e-commerce websites, this study evaluated 51 websites against design guidance for older users. This study comprised three stages: (i) designing the evaluation instrument, (ii) selecting the websites to be evaluated, and (iii) evaluating the selected websites using the instrument.

4.4.1 Designing the Evaluation Instrument

In search of appropriate evaluation instrument to systematically access the current practices of 'add to cart' button designs had resulted in the understanding that the available web guidelines and principles provide overall or general web design recommendations. For example, WCAG 2.0 guidelines for developing websites for older people include pop-ups and new windows, page refresh and updates, and equipment/software that are not related to designing a button. Since the intention of the study was only to evaluate the button designs, rather the overall web designs, thus, an evaluation instrument which focuses on button designs were developed. Rather than develop new, this instrument was based on the existing and available recommendations found in academic researches and suggestion by the practitioners in the industry. From these sources, three important aspects were triangulated to form the evaluation instruments for this study – designs for older users, button designs, and also e-commerce website designs. The detailed development of the evaluation instrument was explained in [19].

Vision, cognition and motor skills are important aspects to be considered for an individual to use a website [20]; yet, these human capabilities deteriorate as people age. For example, a human visual ability which includes the ability to adapt to darkness, illumination sensitivity, visual acuity, hypersensitivity to glare, and size of visual field starts to decline as early as 30 to 40 years old and worsens at the age 65 years old [21]. The cognitive ability also declines with age [22]. Older adults were said to have short-term memory problems [23], [24] and older adults have slower information processing speeds and slower response times [25]. Therefore, having complex interface designs may cause difficulties for older users in deciphering the intended meaning of a website. A person's physical ability could also be affected

when ageing. For example, control of movement, resulting in being less precise, having slower responses and being more error-prone in human-computer interaction tasks [21]. Thus, web designs that accommodate to these ageing changes are essential and critical in ensuring websites are usable for older people.

Motivated by the deterioration of human abilities when aging in vision, cognitive and motor skills and the fact that these skills were important in helping older users to use a website, therefore, the development of the evaluation instrument had been based on four main areas which are visibility (making the button visually perceivable); readability (making the text of the button easy to read); understandability (making the intended meaning of the button function clear to the user); and navigability (making it easy for the user to click and activate the button). The existing guidelines, principles, recommendation, and suggestions that were extracted were then grouped within these four main areas.

Since Kurniawan and Zaphiris [26] had suggested that sources for web design guidelines could be acquired from two main streams, that is, academia and industry; this had become the basis for the sources selection. Therefore, the following sources were used in the study: (i) relevant principles and guidelines on designing websites for older adults [27], [28], (ii) academic research discussing design for older users, design of e-commerce, and design of web buttons [3], [11], [15], [29]; and (iii) recommendations by practitioners (designers/developers) on the design of 'add to cart' buttons [30]–[34]. These sources were selected for their recommendations that include or may apply to button designs. These recommendations were then extracted and grouped into the four main evaluation criteria mentioned before and form the initial draft of the instrument. Within each of the four criteria, the individual recommendations were then further grouped: visibility (colour, visibility of the focus, shape, location); readability (background, contrast, case text, font, space); understandability (consistent, feedback, label, language); and navigability (click/tap, size, space).

The instrument was then checked for any redundant guideline practices. In order to reduce redundancy, any recommendations which were very similar or which carried the same meaning were merged. For instance, there were multiple recommendations mentioned that, although worded differently, were all suggesting the use of higher contrast between the text and the background. Examples include 'use dark type/graphics against light background' [28]; 'use contrast ratio of at least

4.5:1 between text and background behind the text' [27]; 'use light pastel background rather than white background behind black text to create sufficient but not extreme contrast' [27]; and 'use high contrast colour' [30]. These recommendations were merged into one criterion – 'use the high contrast between text and background'.

With the first version of the evaluation instrument which basically return yes/no scores, it was then piloted on five e-commerce websites. In this pilot study, the instrument was revised to allow better and meaningful data to be elicited through the evaluation. For example, the visibility criterion 'use a different colour from surrounding (background)' [28] was revised such that the evaluation instrument would specifically take note of the button colour and the surrounding colour. Other revisions made to the instrument were described in [19].

When evaluating colours that involve dark or bright, colour wheels which are abundantly available online were used as a reference to make the decisions. While, in assessing location, to provide a more meaningful data, design variations were extracted. The design variations were matched to a list described in [35] (see Fig 4.1). When no suitable variations matches were found, new variations were added to the list. Analysing the elicited design variations would then inform us of the location of the buttons.

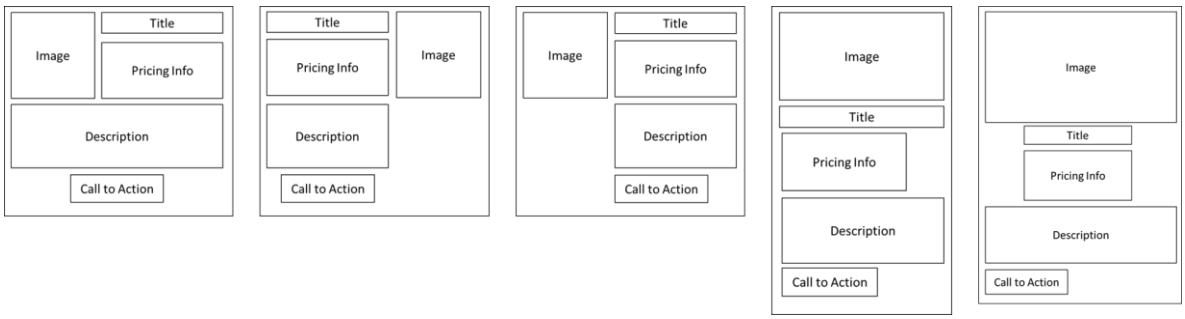


Fig 4.1 Design variations.

Table 4.4 shows the finalised evaluation instrument used for the evaluation of 'add to cart' button designs for each e-commerce website.

Table 4.4 Evaluation Instrument and Possible Assessment Results [in brackets]

Criteria	Guidelines/Practices/Recommendations	Sources
Visible	*Make buttons stand out.*	
Colour	Use different colour from the surrounding. • [Button colour] • [Surrounding colour]	[28]
	Dark buttons/icons against a light background. [yes/no]	[28]
	Use bright colour. [yes/no]	[3]
Visual cues	Visually distinct. • Use different shape from other elements. [yes/no] • Use different colour from other elements. [yes/no]	[27], [30], [32]
	Use highly visible focus indicator/ highlight link when the mouse hovers over it, or when it receives keyboard focus. [yes/no]	[27]
Shape	Rectangle with/without rounded corner. • [Shape] • Rounded corner (if rectangle) [yes/no]	[33]
Location	Place button appropriately. • [Design layout]	[15]
Readable	*Make the text easier to read.*	
Background	Avoid patterned background. [yes/no]	[28]
Contrast	Use high contrast between text and background. • [Text colour] • [Background colour]	[27]–[30]
Case text	Uppercase Mixed case [uppercase/lowercase/ mixed]	[27], [33]
Font	Avoid using underline for text that is not link. [yes/no]	[28]
	Use large font size (e.g. 16 point). [font size]	[3], [27], [28]
	Avoid chunks of italic text. [yes/no]	[27], [28]
	Use san serif typeface. [Typeface]	[28], [30]
	Use non-condensed typeface [Letter-spacing]	[28]
	Use medium or boldface typeface. [yes/no]	[28]
Space	Allow enough white space to ensure an uncluttered look. [yes/no]	[28]

Understandable	*Able to convey the intended meaning.*	
Consistent	Use labels, names and text alternatives consistently for content that has same functionality. [yes/no]	[27]
Feedback	Provide visual feedback when an item has been added to the cart. [feedback]	[3], [29], [31], [34]
Label	Provide descriptive label. [text on button]	[27]
	Use either “Add to cart” or “Add to basket” or “Add to bag”. [yes/no]	[30], [31], [33], [34]
	Avoid ‘Buy’ unless it is used to convey immediate purchase commitments. [yes/no]	[30], [31], [33], [34]
	• Combine text with graphic/icon (e.g. shopping cart). [yes/no]	[11], [28], [31], [34]
	• [Graphic/icon used]	
Language	Use the clearest and simplest language appropriate for the content. [yes/no]	[27], [29]
	Use verbs to signal action. [yes/no]	[28]
Navigable	*Easy to activate the button.*	
Click/tap	• Use single click or screen taps to access information. [yes/no]	[28], [29]
	• Number of clicks to add item to cart from the first seen product image. [number of clicks]	
	If the button includes a link, hyperlink the entire button, not just the text. [yes/no]	[28]
Size	Use large buttons.	[28], [29]
	• [Width]	
	• [Height]	
Space	Enough space around clickable targets. [yes/no]	[28]

4.4.2 Website Selection

After the evaluation instrument was developed, websites were selected for assessment. Websites were selected based on keywords search done on Google – “best e-commerce web design”. These keywords were anticipated to provide well-designed websites as the interest of this evaluation was to know more about the available design conventions used in industry, rather than to investigate poor designs. From the Google search on 24 April 2017, three results were selected from which to select specific websites:

(i) ‘20 of the Very Best E-Commerce Web Sites’, https://www.awwwards.com/20-of-the-very-best-e-commerce-web-sites.html;
(ii) ‘24 of the Best Ecommerce Website Designs to Inspire You’, https://www.referralcandy.com/blog/24-best-ecommerce-website-designs-inspire/; and
(iii) ‘78 Best Ecommerce Website Design Examples & Award Winners’; https://www.bigcommerce.com/blog/best-ecommerce-website-design/.

These three results mentioned 131 websites. Each website was first checked to see if it was still available on the Web. Through this process, 18 websites were eliminated from the list as the websites were no longer available. Eight more websites were eliminated for the reasons that they were not using English as the medium of communication (3), they needed the user to login or join a mailing list in order to view the website (2), they only suggested where to buy products rather than enabling users to buy from the websites themselves (2), or they were not working properly (1).

Another website selection criteria used was the type of goods sold. Goods sold on e-commerce businesses can be classified into (i) physical goods (e.g., books, gadgets, furniture, appliances); (ii) digital goods (e.g., software, ebooks, music, text, images, video); and (iii) services (e.g., insurance) [36]. From the website lists, it is found that most of the websites were selling physicals goods, and very few were selling non-physical goods. Therefore for this review, only websites that sold physical goods were included in order to avoid unbalanced comparison. For that, eight websites were eliminated from the list as they were found to sell non-physical goods.

There were various goods or products sold by the selected websites, and 17 websites were found to carry mixed products in their websites, for example, a website found to sell various goods that include art, jewellery, gift, shirts and accessories. These mixed product websites were eliminated, leaving websites that sell only one product type, for example, apparel. Within the remaining websites, there were also multiple websites carrying similar products. In order to avoid any bias on certain product groups within the evaluation, only one website of those selling similar products was selected for the evaluation. For example, after the previous elimination processes, there were still 13 websites selling apparel, and for this evaluation, only one of these apparel websites was included.

Finally, 51 e-commerce websites, as listed in Appendix 4, were included in the evaluation.

These websites were further grouped into similar categories: art & design (4); baby toddler (3); bedroom (3); electronics & accessories (3); fashions (10); food & drinks (5); health (3); home furniture (6); outdoor (2); sports (5); vehicle parts & accessories (2); and others (5). Then, the selected websites were evaluated against the criteria described in Table 4.4 in section 4.3, and the evaluation process is described in the next section.

4.4.3 Website Evaluation

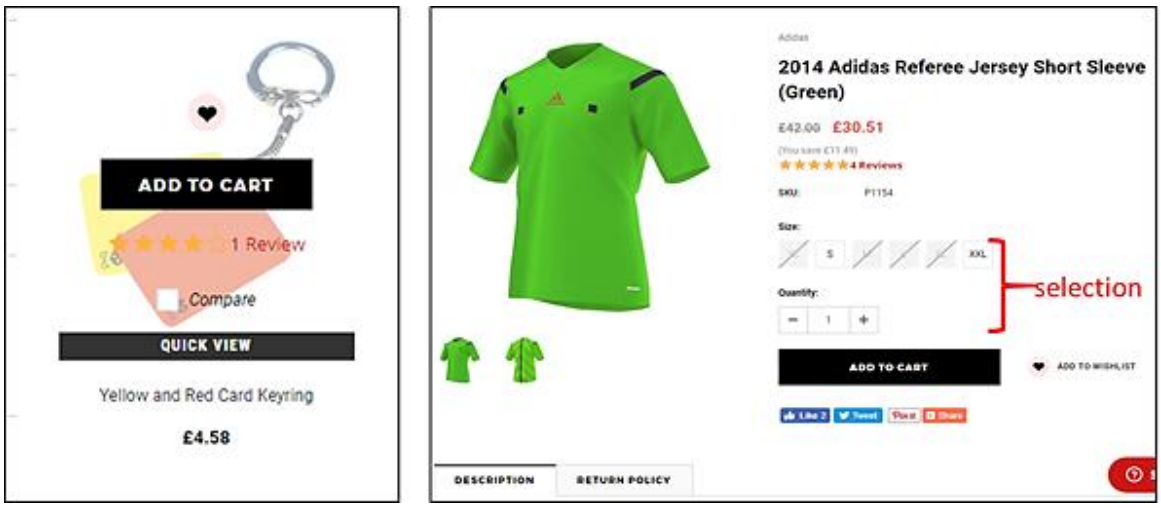
The evaluation criteria generated in Table 4.4 were used to evaluate the selected websites in Appendix 4. The evaluation was conducted in May 2017 using a 19 inch Dell 1908FP display monitor with a screen resolution of 1280 x 1204, and the Google Chrome web browser.

First, a product to purchase was selected from each website. This was randomly chosen from the available menus on the website. The evaluation performed on the first page where a product image was seen within the website and where an 'add to cart' button was available.

Google Chrome's 'Inspect Element' was used to expose the code, which is a mix of HTML, CSS and Javascript, to enable the inspection of the fonts, colour, and size being used on the 'add to cart' buttons.

4.5 Results and Discussion

51 websites were evaluated in this study. Three websites were found to have different designs between products with and without selection for parameters. An example of this condition is illustrated in Fig 4.2. In this example, website w37 offers an 'add to cart' button on the first page where the product image is presented when there is no further refinement of the selection required (e.g. a keyring where the keyring only exists in one form), whereas, for products with selections (e.g. a shirt size), the 'add to cart' button was provided on the second page. These two variants of the website were counted as two separate designs in the evaluation ended the total of 54 'add to cart' designs were assessed.



(a) (b)

Fig 4.2 Example of a website with two different designs for product – (a) without selection of any parameters, and (b) with selection of parameters (e.g. shirt size).

4.5.1 Visibility

Colours. The colours used for the 'add to cart' button were red (16.7%), blue (16.7%), grey (14.8%), orange (13.0%), white (9.3%), black (9.3%) and others (e.g. yellow, pink, green and brown). The surrounding colours which were usually the background colour of the web page were found to be dominated with white #ffffff (77.8%). The results also showed that websites tended to use buttons with dark (44.4%) or bright colour (46.3%). However, it is acknowledge that this results may contribute to some discrepancy in the evaluation of the colours since it had been performed with naked eyes. In the effort to reduce this issue, when doubt aroused in deciding the colours, colour wheels available online were referred to for assistance with the decisions.

Visible cues. Uniqueness can easily grab attention, and the use of a distinct colour can help users to distinguish an object. Yet, it was found that only 50.0% of the web pages evaluated had differentiated the button colours from its surrounding elements or objects (e.g. menus, labels, etc.). A comparison of the use of how different colours could visually draw attention is illustrated in Fig. 4.3. Black 'add to cart' buttons were used on w15 where other objects such as core navigation (e.g. menu items) also use black or grey. Although white was used as the main background of the website on w15, since the button had a similar colour to other objects, it carries

less impact on attracting users' attention compared to w11 which uses a very distinct colour for its 'add to cart' button.

(a) (b)

Fig 4.3 Examples of ‘add to cart’ button colours to its surrounding objects’ colour – (a) w15, similar colour, and (b) w11, different colour.

As many as 81.5% of the websites apply a focus indicator on ‘add to cart’ buttons. Such indicators appeared when a mouse hovers over the button. The most used indicators were a change of button colours (66.7%). The colours may change to lighter, darker, brighter or total change (e.g. from red to green). Other focus indicators used were the appearance of buttons only when a mouse hovers over the product images, and text relocation. The text relocation creates animation-like effects when, for example, the text appeared slightly lower from the original location. For that, it is understand that most buttons were found to be designed with focus indicator to help users in distinguishing buttons from other objects, still there are about 18.5% which had been designed with no focus indicator.

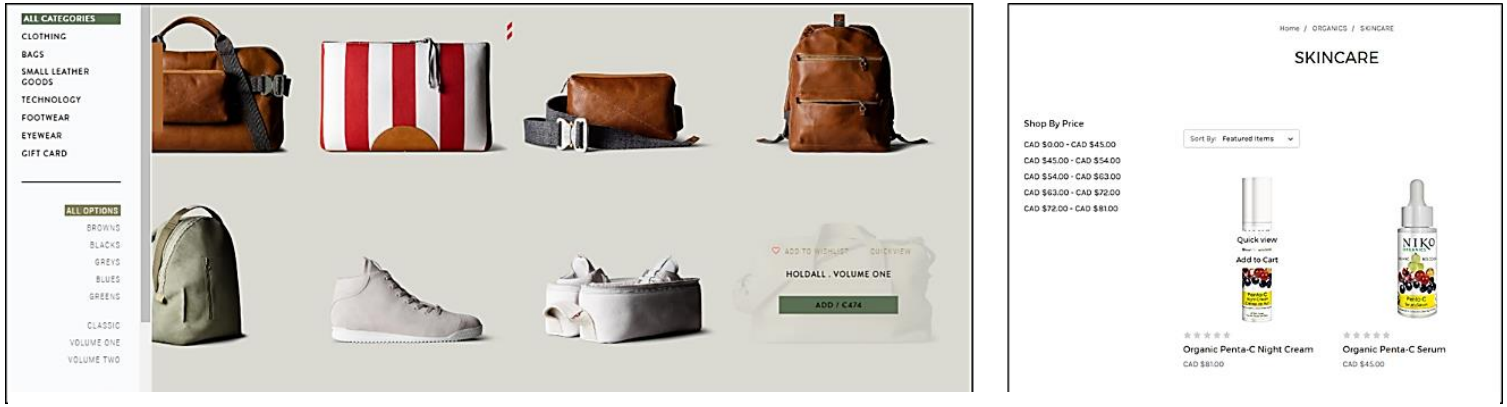
Shape. Several shapes of ‘add to cart’ buttons found to be used in the designs which include rectangle, circle, and pill shape (see Fig 4.4). A large majority of buttons, 90.7%, were designed to be a rectangle in shape with 38.8% of them with rounded corners and 61.2% with no rounded corners. The rectangular design with no rounded corner was sometimes observed to be similar to other objects, and hence may not be distinguished by novice users especially when in addition the buttons have a similar colour with other objects. As for example, in Fig 4.5 where a rectangular button has similar shape and colour to the menu on the left, could have been seen as

almost unnoticed and may also have been mistaken for a label. Far more worst when button shape is almost invisible to the users where boundaries of clickable actions to take place were unclear to the users. As shape is an attribute that could be deployed in helping the user to visibly recognise a button, thus it should not be invisible and difficult to identify.

Fig 4.4 Examples of 'add to cart' button shapes – (a) rectangle with rounded corner, (b) rectangle with no rounded corner, (c) circle, (d) pill shape, and (e) unknown.

Location. The location of a button is important as being positioned appropriately can increase its usage [15]. In understanding the button's location, the objects related to an items were studied. Various objects were found build the information of a product including image, thumbnail images, title, price, selections, 'add to cart' button, descriptions, links, product reviews, refer and reward, wish list, and product shipping and returns (see Fig 4.6). It seems that image, title, price and 'add to cart' button were a must where all websites found to include these objects. 78.3% of the designs include the parameters selection such as quantity or size, but when the designs include them, almost 95% placed the selection adjacent to 'add to cart' button.

As mentioned in 4.4.1, the organization of these objects were analysed and mapped to the design variations described in [35]. For any design variations that were unmatched to the available design in the list, a new variation added to the list. A total of 46 unique design variations were extracted through this evaluation. Further, the elicited design variations were then observed for any patterns (see Fig 4.6). Four patterns were emerged and illustrated in Fig. 4.7 with Pattern 2 was the most used (40.7%) while Pattern 4 was the least used (3.7%) and Pattern 1, and Pattern 3 made up 31.5% and 24% respectively.



(a) **(b)**

Fig 4.5 Example of inappropriately used of button designs – (a) rectangular shape similar to menus on the left, and (b) shape almost invisible to the users.

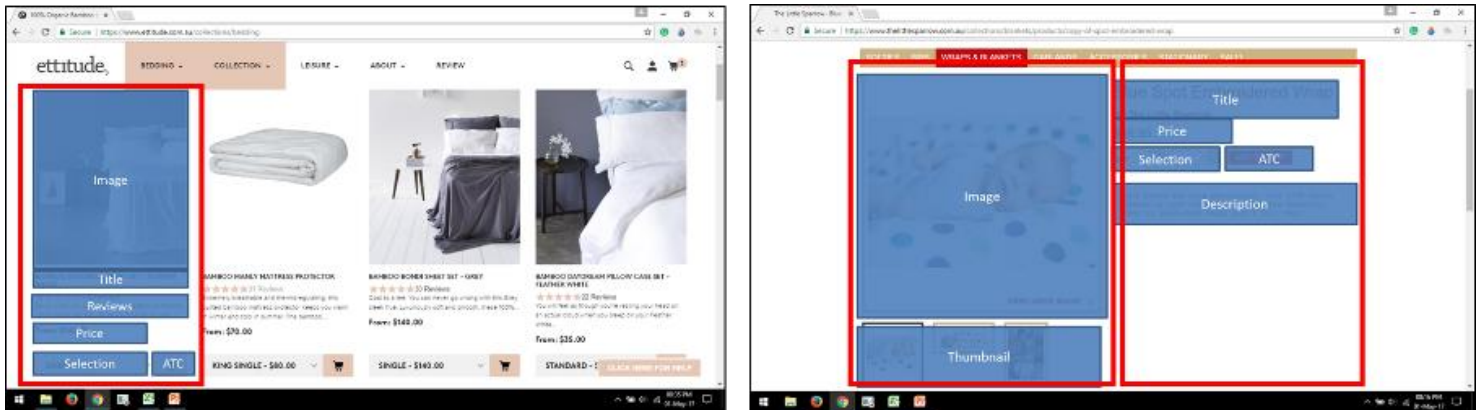


Fig 4.6 The objects (blue box) identified and pattern layouts (red line box) discovered.

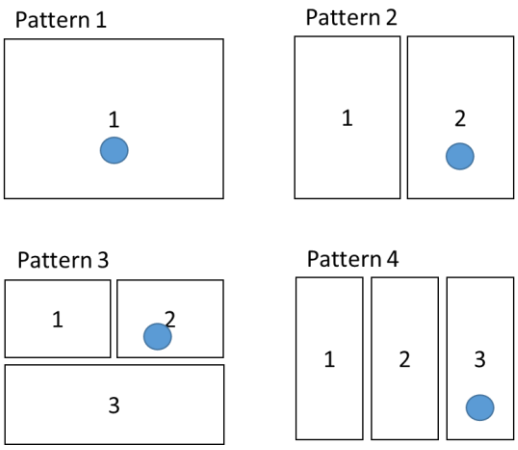


Fig 4.7 Design variation patterns. The blue dot represents the location of 'add to cart' button where commonly found.

4.5.2 Readability

Font. The large text was recommended to ease reading for older users, for example, use 12 or 14 point in size [28]. A direct evaluation of the font sizes used was unable to perform since the data were collected in pixel (px). Therefore, a conversion pixel to point was needed, and font size conversion available online at https://websemantics.uk/articles/font-size-conversion/ were used in this study. Noted that the conversion table presented on the webpage is using a 96 dpi viewpoint as compared to 86 dpi for the screen monitor used in this study. For that, the conversion calculated, and it became the basis for the analysis. The results show that almost 40% of the evaluated designs did not adhere to the suggested guidelines (see Table 4.5).

Table 4.5 The Font Size Used in 'Add to Cart' Buttons for E-commerce Websites

	Point (pt)	Percentage
Small	$x < 12$ pt	37.04%
Medium	$12 \text{ pt} \leq x < 13.5$ pt	22.22%
Large	$13.5 \text{ pt} \leq x < 18$ pt	22.22%
Extra large	$x \geq 18$ pt	12.96%
N/A	-	5.56%

Chunks of italic text are also not suitable for older users and are suggested to be avoided. Acknowledge that only short phrase was used within a button, such as 'add to cart', yet, still the button was evaluated, to understand whether the italic text

was used, and it is found that only two websites used italic text on their buttons. And only one button was found to use underline with the text on the button.

San serif fonts are more readable for older users [28], [30], and 90.7% of the websites followed this recommendation. Typefaces found to be used on buttons include Lato (13.0%), Open sans (11.1%), Montserrat (9.3%), Roboto (9.3%), Helvetica (9.3%), and others. In order to improve readability, the typefaces were suggested to be bold, yet, 61.1% of the evaluated designs were not bold.

59.3% of the evaluated add-to-cart buttons were designed to have normal letter spacing and another 20.4% use 1 px. Others extend the spacing with variations of 0.45 px, 0.55 px, 1.1 px, 1.2 px, 1.425 px and 2 px. While the recommendations do suggest using non-condensed typeface, the results show that the button designs adhere to the guidelines.

Contrast. It is very important that the text on the buttons can be read by users; therefore, colour contrast between the text and the button colour is an important attribute of the evaluation. Using a colour contrast checker available online at http://webaim.org/resources/contrastchecker/, the contrast ratio on the add-to-cart button for each website was checked. This was done by taking the font colour as the foreground and button colour as the background. Across all the websites, the most frequently used text colour was found to be white (73.6%). The analysis on the contrast ratio found that there was a large range of contrast ratios, where the smallest ratio was 1.28:1 (shade of grey (#ececec)/shade of yellow (#ffcc33)) while the biggest ratio was 21:1 (white (#ffffff)/black (#000000)).

As discussed in WCAG 2.0 for minimum contrast for older adults which normally reported with visual acuity of 20/40, the 4.5:1 ratio is required to accommodate the visual deteriorations while ageing (e.g. low visual acuity, and colour deficiencies). For those who experience with much lower visual acuity to approximately 20/80 vision, the contrast ratio of 7:1 was suggested. While when the larger text was used, the ratio reduced to 3:1 for 20/40 vision and 4.5:1 for 20/80 vision.

On the overall, the contrast ratios found in this review are 37.0% below 4.5:1; 16.7% between 4.5:1 to 7.1:1; and 40.7% have more than 7.1:1. Another 5.6% (n=3) were unable to be evaluated since images were used as the button's background. It was then analysed further the contrast ratio according to font size, and valued as fail or pass according to the WCAG 2.0 recommendation mentioned above. Text was

grouped as normal for small and medium size text, and large for large and x-large size text. The result is presented in Table 4.6.

Table 4.6 Contrast Ratio Conformance to WCAG 2.0 Standards

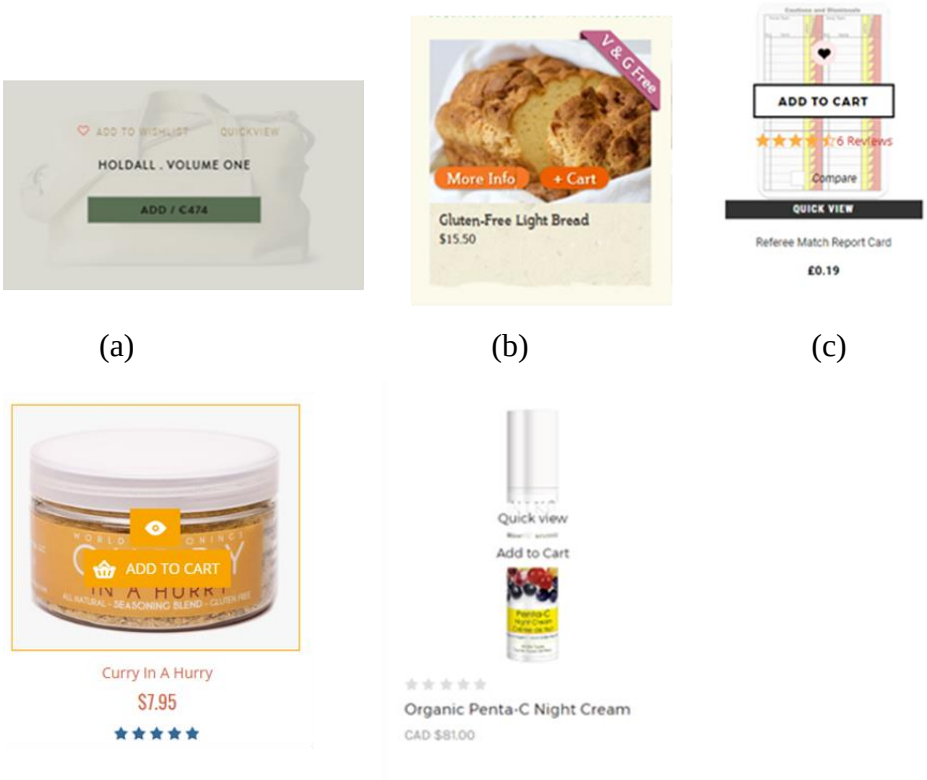
Conformance level	Text/Minimum Ratio	Fail	Pass
AA level	Normal/4.5:1	22%	40%
(20/40 vision)	Large/3:1	32%	30%
AAA level	Normal/7:1	14%	24%
(20/80 vision)	Large/4.5:1	18%	20%

The result shows that many designs fail to adhere to the contrast ratio suggested where 36% failures for normal text and 50% failures for large text, with the overall average failures is 43%. Thus, it is suggested for button designs to have a better contrast ratio to ensure its adherence to the guidelines design for old.

Background. There was a button with a pattern background which was not recommended [28] as it may cause difficulty for users to extract the text from the patterns. There were also buttons that were designed to only appear when a mouse hovers over a product, as shown in Fig 4.8. There seems to be some trade-off for this kind of designs where it can be seen from the examples when button colour matched to product colour, it is hard to distinguish a button, such as in (b), (d) and (e). In the other hand, (a) masking the background by blurring the picture to allow a better visual of the button and other elements; still, this is thought to be insufficient since, when visually evaluated, the button colour over the background may not have appropriate contrast ratio for older users use.

Case text. Most (74.1%) of the evaluated buttons were found to be designed using uppercase while the mixed case was found in 22.2% of the sites. These have reflected the suggestion in [27], [28], [33] where uppercase or mixed case can be used.

Space. Recommendations suggest the inclusion of whitespaces on a website may visually create spaces. Therefore, most websites were found to use white as the body background, thus create visual space and an uncluttered look. However, buttons were coloured, and to create the uncluttered look and to be easily read, text on buttons was usually centred and also gaps between the text and the edge of buttons were used to create spaces. The advantage of having larger buttons is that it gives extra room to create space within the button as illustrated in Fig. 4.9.



(a) (b) (c)

(d) (e)

Fig 4.8 Examples of buttons that appeared only when mouse hover over products.

Fig 4.9 Spaces generated by small and large buttons.

4.5.3 Understandability

Consistent. A consistent design could help users to easily recognise objects that carry the same functionality. For example, all ‘add to cart’ buttons within a website should be designed to have the same colour, shape, size and location. The results show that all websites were found to adhere to the design principles, guidelines and recommendations that suggest consistency for similar functions.

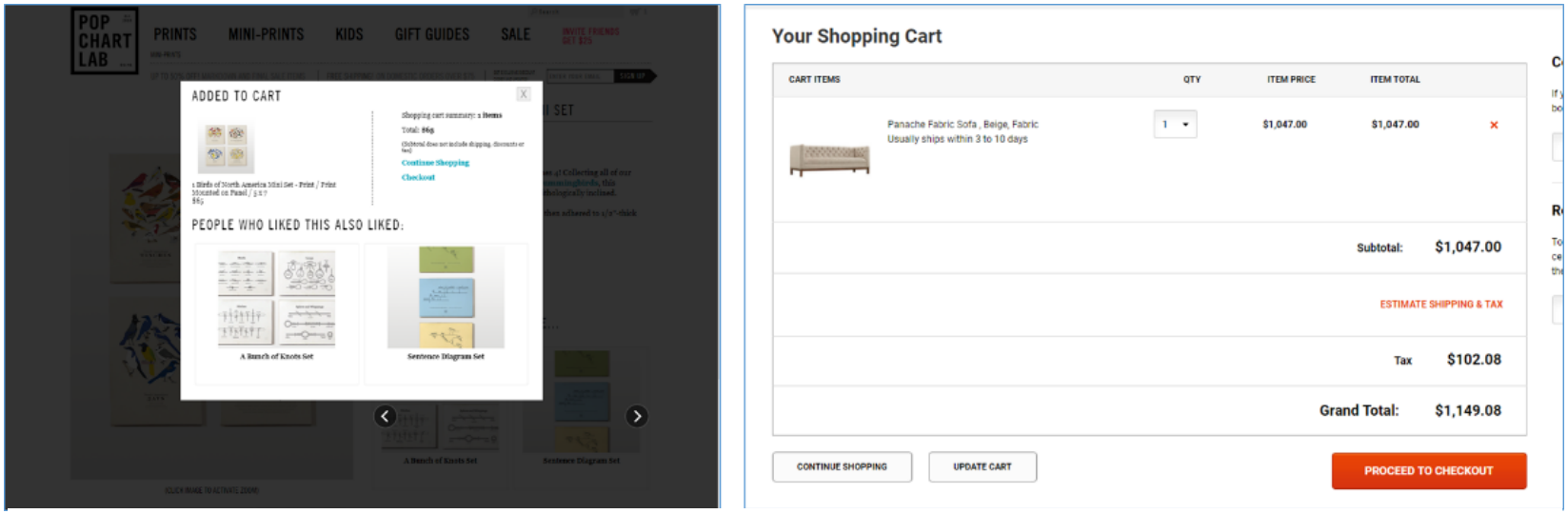
Feedback. Guidelines and principles do suggest feedback is helpful in notifying users that actions have taken place when they have clicked on clickable objects. Several forms of feedback associated with the ‘add to cart’ button were found, including (i) inform the user that an item was added to the cart (37.0%) (see

Fig 4.10 (a)), (ii) display the shopping cart (63.0%) (see Fig 4.10 (b)), and (iii) alert for non-selection, if a selection (e.g. a shirt size) is required (31.5%) (see Fig 4.11). These forms of feedback were provided either via a message box, modal box or modeless box. A message box, which usually appeared at the top of the website, would display a simple message such as 'Item added to cart', informing users that an action had been performed. A modal dialog box, for example, used to display the shopping cart, would only allow users to proceed to work with the rest of the application (e.g. continue shopping) when the user closed the dialog box. On the other hand, with a modeless box, users continue to work along with the opened dialog box.

Label and language. Words used on buttons can inform users of its function and verb is suggested to be better in explaining the action [28]. The verbs found to be used on 'add to cart' buttons were 'add' (88.89%), 'buy' (3.70%) and 'pick' (1.85%). Only one website used a noun (i.e. cart) instead of a verb.

It was also found that most websites (83.33%) used the words 'add to cart' to signify the action to be performed. In contrast, the word 'buy' is discouraged as this word may imply the necessity or compulsory purchase to the users [30], [31], [33], [34], therefore 'add to cart' is deemed to be better as it is more subtle, yet, 'buy' was found on some websites, albeit only two. There were also two other websites that used 'buy', but when clicked, instead of functioning as a button that adds an item to the cart, had leads to product detail page that contained the actual 'add to cart' button.

There is literature [37], [38] that suggests a combination of graphics and text can provide a better understanding, especially to the older generation. However, the review found that graphics were less commonly-used on buttons, only 18.5%. In [13] where buttons with text only and the combination of text and symbol '+' were tested in experiments with older adults ageing, and the results yielded that text only button was preferred by the female while symbol and text button was preferred by the male. Thus, in accommodating both genders, a combination of graphics and text could be used more in the designs. In this review, it is also found that when a graphic was used on the button, a shopping cart or '+' were among the most common. Other graphics used were a shopping bag, shopping basket, and an arrow. Examples of buttons with graphics are shown in Fig. 4.12.



(a) (b)

Fig 4.10 Examples of feedbacks when 'add to cart' button clicked – (a) inform item added to the cart, (b) display shopping cart.

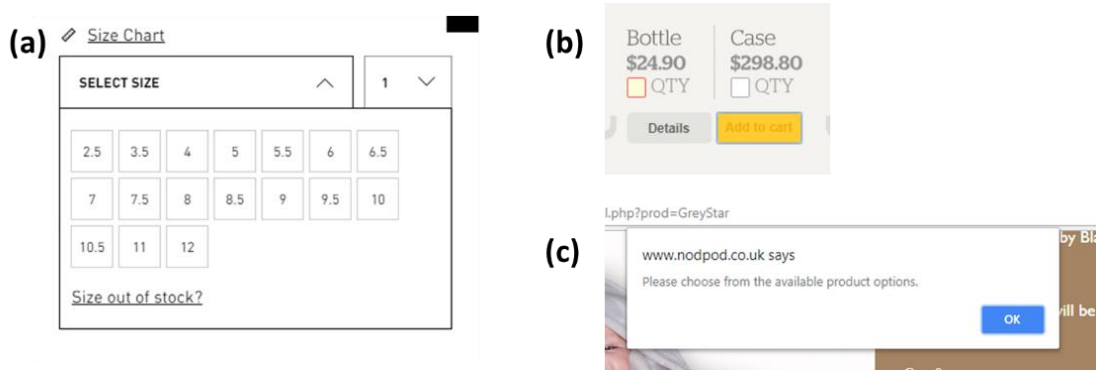


Fig 4.11 Examples of feedbacks return for non-selection – (a) specific non-selected parameter displayed to allow selection – size, (b) non-selected parameter highlighted – quantity, and (c) a message box displayed informing non-selected parameter.

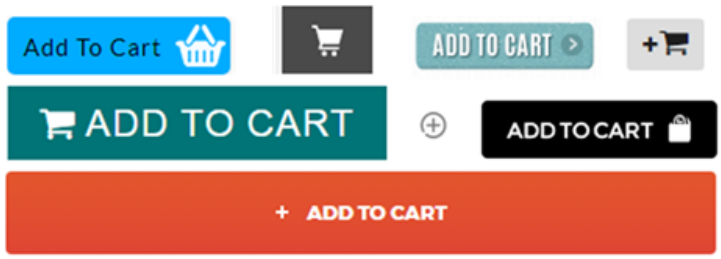


Fig 4.12 Example of buttons with graphics.

4.5.4 Navigability

Click. All websites used single click access to activate the ‘add to cart’ button function, but not all websites allowed users to directly add an item to the shopping cart by just one click from the first sight of a product (38.9%). Most of the websites used two clicks to complete ‘add to cart’ activities (61.1%).

It is also interesting to note that while two clicks dominate layout pattern 2, 3, and 4; a single click is seen to be associated with layout pattern 1 (see Fig. 4.13). Another interesting finding that can be associated with the clicks is the distribution of the clicks between product categories (see Fig. 4.14). The results show that two clicks are most common in art & design, fashions, home furniture and sports categories while one-click features most frequently in the food & drink category. However, these could not be generalised to the product categories more widely as the website sample size is relatively small. The results only indicate the events within the evaluated

websites. Future investigations could further confirm these incidents with larger samples.

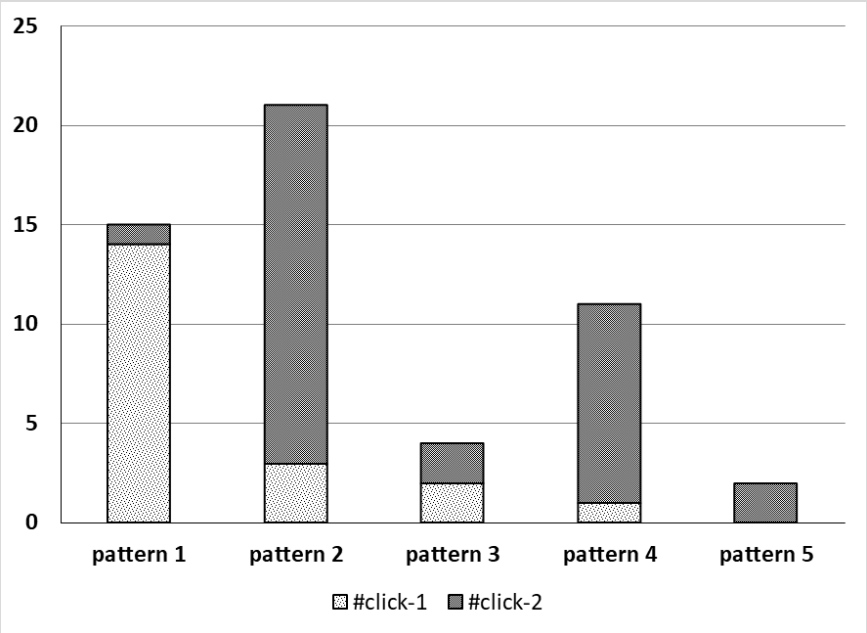


Fig 4.13 Number of clicks VS pattern layouts.

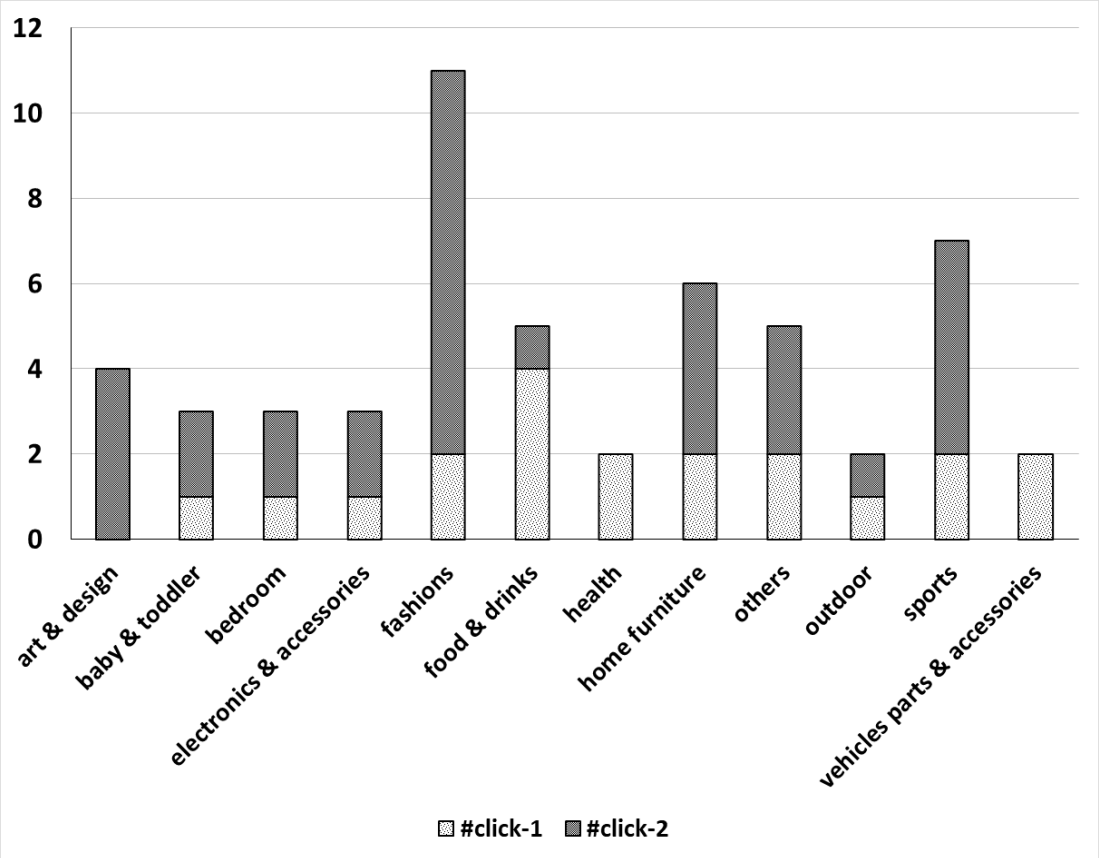


Fig 4.14 Number of clicks VS product categories.

Size. It is important for the buttons to be easily clickable targets for older users as they are less precise and more error-prone [21]. Small size buttons were found to be hard to activate for older users [25], while larger button can help improve visibility and also help user navigation where the bigger button would be easier for users to click. In addition, the larger button was proven to improve older adults' performances, and it should be at least 19.05 mm or 72 px (Jin et al., 2007). Through the evaluation, it is found that the range of button heights was to be from 21 px to 55 px; while button width had a larger range, with the smallest being 26 px and the largest is 683 px. The button sizes found to be the smallest was 26 px (width) X 21 px (height); while the largest button sizes were 671 px (width) X 53 px (height); and 683 px (width) X 50 px (height). There were also buttons that were designed to have auto width or height. The distribution of button width and height is illustrated in Fig 4.15.

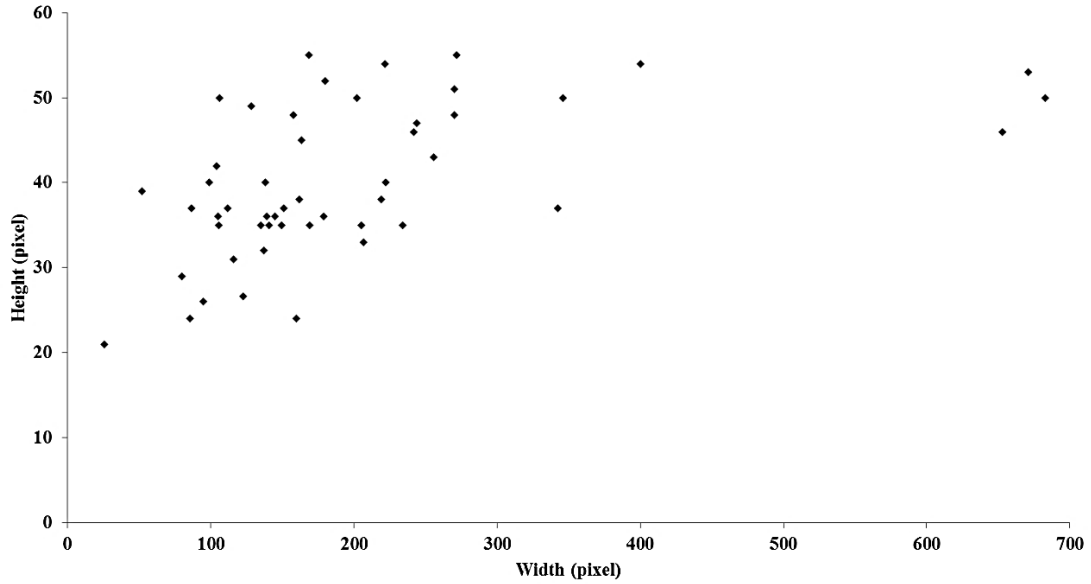


Fig 4.15 The distribution of 'add to cart' button height and width.

4.5.5 Areas for Improvement

As older people experience deterioration in cognitive, visual and physical capabilities, therefore it is important that website buttons be made visible, readable, understandable and navigable, to help users recognise that buttons are clickable items and easy to use. Yet, this review found that there are still design improvements to be made, in terms of colour, focus indicator, contrast ratio, and font. Table 4.7 tabulates the occurring designs, found in existing e-commerce websites that could pose challenges for older adults.

Although this review did not reveal any inappropriate designs for the location criterion, understanding the preferred or expected location of important objects such as the 'add to cart' buttons could be helpful in providing easier navigation for older adults, and is a topic that warrants further investigation.

Table 4.7 'Older Adult Unfriendly' Designs Practices on Existing 'Add to Cart' Buttons on E-commerce Websites

Criteria		Older adult unfriendly designs	Percentage
Visible	Colour	Similar colour to surrounding objects	50.0%
	Focus visible	No indicator used	18.5%
Readable	Contrast	Small contrast ratio (less than 4.5:1)	37.0%
	Font	Serif font	9.3%
		Small font sizes (less than 12 pt)	37.04%
		Non-bold font	61.1%
Understandable	Label	'buy', 'buy now'	5.5%
Navigable	Size	Small (width < 72 px)	3.7%

4.6 Conclusion

This review has summarised the design practices being used in the industry and reveals potential areas for improvement with regard to design for older users. The areas for improvement include choosing more visible colours and higher contrasts between the button and the website background, making the focus of the add-to-cart button more visible, using button shapes that are more visible, choosing non-patterned backgrounds for buttons, using higher contrast between the button text and the button background, using larger fonts on the buttons, and using meaningful text on the buttons.

The findings of this evaluation create opportunities to further investigate within the designs related to the activity of adding items to cart that is easier for older adults. For example, given the wide range of button sizes found in the existing websites, the impact of button size on older adults' use of e-commerce websites could be investigated more thoroughly and systematically. Given that there is little guidance about the most "appropriate" location of the 'add to cart' button in relation to the other elements on the page, this is another attribute that could be investigated further.

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Chapter 5:

Engaging Older Users in Designing E-commerce User Interfaces

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ABSTRACT

This paper provides insight into the designs of e-commerce websites by older adults. Designs yielded from co-design activities performed with 20 older adults who were presented with depicted browsers, paper-cutout web objects (e.g. product image, and 'add to cart' button), and office stationary during the activities. It was found that price, an 'add to cart' button and product images were important for all products. While quantity selection was prominent for products with cheap, multiple purchases; and reviews, description and shipping/return were associated with an expensive, single purchase.

5.1 Introduction

The previous study conducted to evaluate e-commerce websites (Chapter 4) showed that various web objects were available to provide information to help users make shopping decisions. The web objects include a product's images, title, descriptions, and 'add to cart' buttons. Another study (Chapter 3), was conducted prior to this one, which found that novice older users experienced difficulty in recognising an essential element of e-commerce websites that remarks the actual sales to start: the 'add to cart' button.

The literature demonstrates an interest in research that is related to web objects, including the locations of objects within the websites [1]–[7]. These studies incorporate various website domains, including organisational and financial domains, as well as tourism, online shops and news. However, most research revolves around common web objects, such as the main area, menu navigation, logo, login, search, shopping cart, about us, help, contact, and footer. Unlike this study, previous research has been more focused on the web objects that build up the main content of the product listing pages of e-commerce websites. These web objects include the 'add to cart' button that was problematic to some in the previous study (Chapter 3). Knowing where users anticipate an object to be located within a website could be helpful in terms of improving its visibility. For example, a study [7] exploring the location of the chat button found that when placing buttons appropriately within the website greatly increased the use of system services. Thus, it is possible that placing the 'add to cart' button in the most expected location can similarly facilitate user navigation.

Paper-based prototypes were chosen for this study and seen as appropriate for co-design activities with older participants. Using paper-based prototypes could help participants actively engage and help them be able to provide great suggestions without hesitation about the mistakes that could be made with digital prototypes [8]. Furthermore, participants also reportedly enjoyed the sessions. A more recent study [9] compared paper-based and tool-based prototypes to provide feedback on e-learning prototypes, revealing that the paper-based approach generated more feedback. Another study [10] used low-tech objects, such as a blank canvas and graphical cut-outs of various components (e.g. menu, labels, and icons), to investigate the use of digital television among older adults. It also discussed techniques that help promote active discussion, give reason to ideas and suggestions, and provide opinions

about the ways in which other people in their age group would use the technology. As such, this current study invites older participants to co-design e-commerce websites using paper-based prototypes of the user interfaces. Participants were asked to place the physical (paper-cutout) web objects (e.g. menu, product image, and 'add to cart' button) where they would expect to see them on the presented user interfaces.

With the aim of understanding the most anticipated location of web objects on e-commerce websites, a study was thus conducted to observe the ways in which older users organise web objects (e.g. image, title, price, button, description) on websites (i.e. online grocery shopping site and assistive technology shopping site). The study not only observed where the participants located the web objects but also took note of the designs features that were chosen. It was anticipated that the results and findings of this study would enlighten an understanding of the features and designs that should be included in e-commerce web pages, from the perspective of older people.

This paper describes the co-design activities that were conducted with older adults in order to design e-commerce websites.

5.2 Methods

The study of the co-design primarily adapts the method introduced by Muller [11], [12]; namely, PICTIVE, a method of participatory design that uses low-tech objects to encourage participants to express thoughts and ideas. This method is deemed an appropriate method when working with older people, as it is engaging, enjoyable, and productive.

In the PICTIVE method, participants are presented with a workspace to perform the design; in this study, a browser window was depicted as the design workspace. The PICTIVE method also provides design materials, such as office stationary (e.g. markers, post-it notes, stickers, and labels) and prepared materials (e.g. plastic icons). Similarly, in this study, office stationary and prepared paper-cutout web objects were provided. The paper-cutout web objects were prepared so as to be approximately match the actual size of the real objects that would be seen on the web pages displayed on the monitor screen. The materials were also designed to meet the recommendations for designs for older users (e.g. using a large font size).

Although a low-tech, paper-based method seems easy to use, issues encountered while using this technique were also documented [13], as older participants had difficulty engaging design activities because they were unable to understand the task that needed to be performed, and because they lacked confidence. Taking these issues into account, pilot experiments were conducted prior to the main study to uncover any instructions that may not be understood by the participants and thus make any necessary modifications. Such modifications included making the instructions simpler and providing a detailed explanation of what the participants needed to perform just before the co-design tasks began, rather than explaining everything during the introduction to all the activities and tasks. Participants were easily confused, due to an overload of information at the start. Therefore, instructions and explanations were given at appropriate times and with sufficient amounts of information.

To improve confidence, conversely, participants were given encouragement by not restricting their design activities and through social interactions that acted as ice breakers before embarking on the design activities. This warm-up session allowed participants to feel comfortable during all the sessions of the study.

In this study, two types of websites were used: online grocery shopping and assistive technology. One scenario was designed for each type of website, which consisted of buying carrots for online grocery shopping and buying a wheelchair from an assistive technology website. These products were chosen to represent the difference between purchasing a grocery item that is cheap and bought with multiple purchases, and an assistive technology item that is more expensive and constitutes a very small number of purchases.

An additional session was conducted at the end of the co-design sessions, which incorporated a ‘buy box’ design that is further discussed in section 5.2.5, to explore the potential of a ‘buy box’ design for e-commerce websites.

All the sessions were recorded using a video camera, to capture the co-design sessions. The setting for this study is described in 5.2.4.

5.2.1 Participants

Twenty older adults ranging from 52 to 75 (mean = 64) years old volunteered for the study, consisting of 14 men and 6 women. Most of the participants were

recruited from the university's database, the Nutrition Unit Volunteer Database of the Hugh Sinclair Human Nutrition Group. Others volunteered after seeing a poster displayed in the university or found out about the study through word of mouth.

Participants were recruited that had some experience of online shopping, in order to avoid a learning-curve process during the co-design activities. Participants were expected to have some knowledge of online shopping websites, so that they did not require explanations about what online shopping is and what the websites should look like. The study thus aimed to elicit input from the participants that was based on their experience and opinions, rather than by providing participants with hints about the designs.

Participants' experiences with computers, the internet, and online shopping is tabulated in Table 5.1. The demographics data illustrates that, in addition to shopping, participants mostly used the internet for communication (90%) and entertainment (85%). Among the top items bought online were tickets for events (85%), holiday accommodation (75%), and travel arrangements (75%). While all participants had at least a few experiences of online shopping, only eight participants (40%) had experience with online grocery shopping.

Table 5.1 Computer, Internet, and Online Shopping Experiences

Experience		Number of participants
Computer experience	Frequency using computer	
	Everyday	17
	Every 2-3 days	3
	Most used device to access the Internet	
	Laptop	6
	Desktop	9
	Tablet	3
	Smart phone	2
Internet experience	Internet usage	
	Work	10
	News	13
	Health information	9
	Spiritual information	4
	Shopping	20
	Entertainment	18
	Communication	18
	Other (e.g. betting, education, research)	2
Online shopping	Online purchases	

experience	Clothes	11
	Sporting goods	7
	Household goods	13
	Travel arrangements	15
	Holiday accommodation	15
	Tickets for events	17
	Film, music	8
	Books, magazines, newspapers	13
	Food or groceries	9
	Electric equipment	13
	Computer hardware, software	14
	Shares purchases, insurance policies	8
	Telecommunication services	8
	Medicine	4
	e-learning materials	8
	Other (e.g. vouchers, training/education)	2
Online grocery shopping		
	Yes	8
	No	12

This study has been reviewed according to procedures specified by the University Research Ethics Committee and has been given a favourable opinion for conduct. Written consent was obtained from the participants at the beginning of the study (Appendix 5).

5.2.2 The Workspace

Participants were presented with a workspace to create their designs, which consisted of a template in the form of a depicted browser. An example of the depicted browser used in the study is illustrated in Fig 5.1. It was designed to approximate the actual size of the monitor screen of a 19-inch Dell 1908FP. This depiction of browser windows was also designed to adapt the technique used in [1], [3]–[6], where grid squares were presented to facilitate the users' task of placing objects onto the interface prototypes (refer to section 5.2.3). Pre-designed, common web objects on the pages, such as the logo, search, menu navigation, shopping cart, and help were located on the websites as reported in [5], [6], [14].

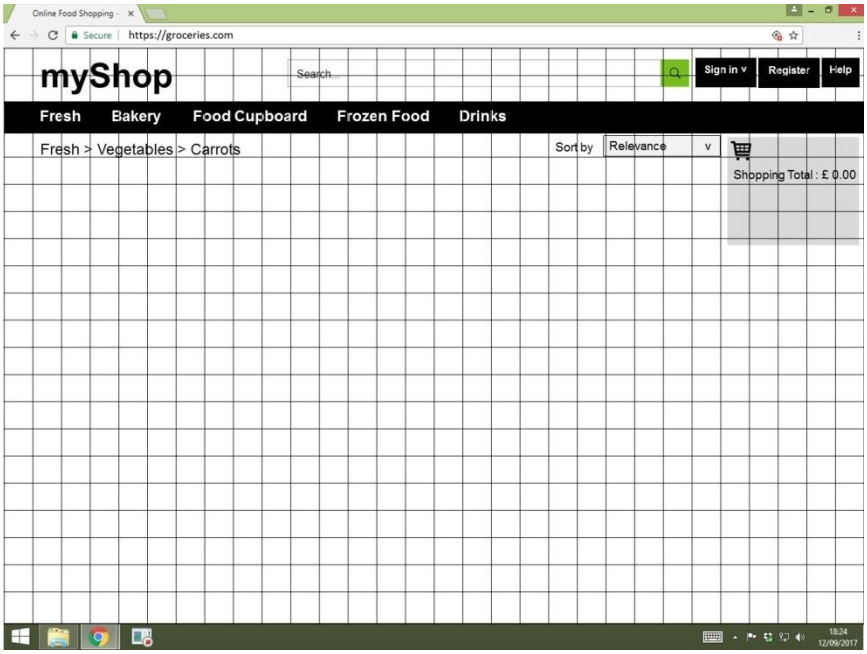


Fig 5.1 An example of the workspace used for the co-design activity.

5.2.3 The Web Objects

In the co-design sessions, participants were asked to choose and place web objects on the 'blank' workspaces provided. The web objects were crafted from paper-cutouts that were prepared to be approximately the sizes seen on a 19-inch Dell 1908FP display monitor with a screen resolution of 1280 X 1204.

The constructed web objects included product images, titles, descriptions, prices, 'add to cart' buttons, quantity selections, shipping/returns, wishlists, links, and reviews. These were the objects found on the display pages in the previous study (Chapter 4), which evaluated the 'add to cart' design conventions of e-commerce websites. The web objects were also designed to meet the guidelines and principles for older web users. For example, to facilitate older users' reading, sans-serif typefaces were suggested [15]. Thus, in this study, Arial was used for all text.

In order to ease the participants' handling of the paper-cutouts during the co-design activities, the materials used were carefully selected. The paper-cutouts were easy to pick up and hold, and did not glide across the workspace. Thus, when placed on the workspace, the web object paper-cutouts stayed in the same spot but could be easily moved within the workspace. For these reasons, foam sheets were chosen for the workspace and a thick paper (180 gsm) was used for the web objects.

In some cases, different versions of web objects were made available to the participants; for example, product images were prepared in both a small size (height 5.37 cm, width 5.87 cm) and a bigger size (height 8.86 cm, width 10.68 cm). Titles were also prepared in two different font sizes: 18 points and 24 points. The ‘add to cart’ button was prepared in four different colours: blue, orange, red, and black. These colours were selected based on the results of the previous study (Chapter 4), which indicated that these were the most commonly used colours for ‘add to cart’ buttons. This button was also prepared in two different case texts (capital and mixed) and two different sizes (small and big). Again, input from the previous study was the basis for designing the sizes of the buttons in this study. The sizes of the buttons (width and height) that were used are illustrated in Fig 5.2. Including these web objects variations aimed to understand which object designs older users would prefer and select. The prepared web objects are presented in Fig 5.3.

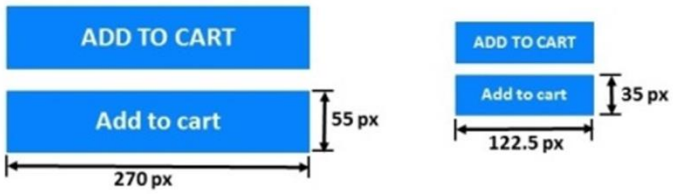


Fig 5.2 Samples of button variations: two versions of case text and two different button sizes.

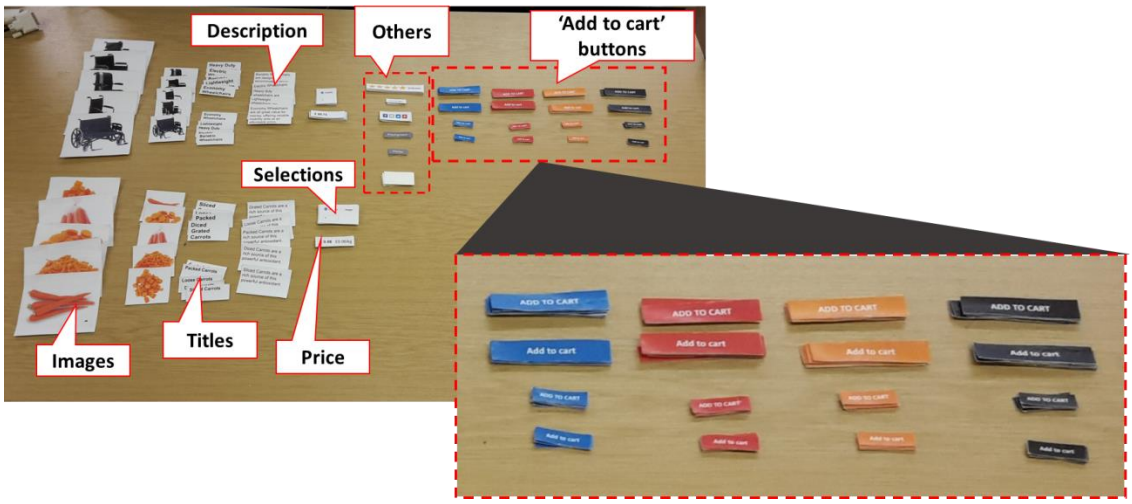


Fig 5.3 The paper-cutout web objects for co-design activity.

5.2.4 The Setting

The study was carried out in a quiet room, equipped with good lighting and enough space for the materials to be laid out (i.e. office stationery and prepared web object paper-cutouts) (see Fig 5.4).

The participant was seated at a desk with the web object paper-cutouts, the web browser, and office stationery laid out in front of them. The researcher sat across from them and there was a video camera positioned to capture the co-design activities.

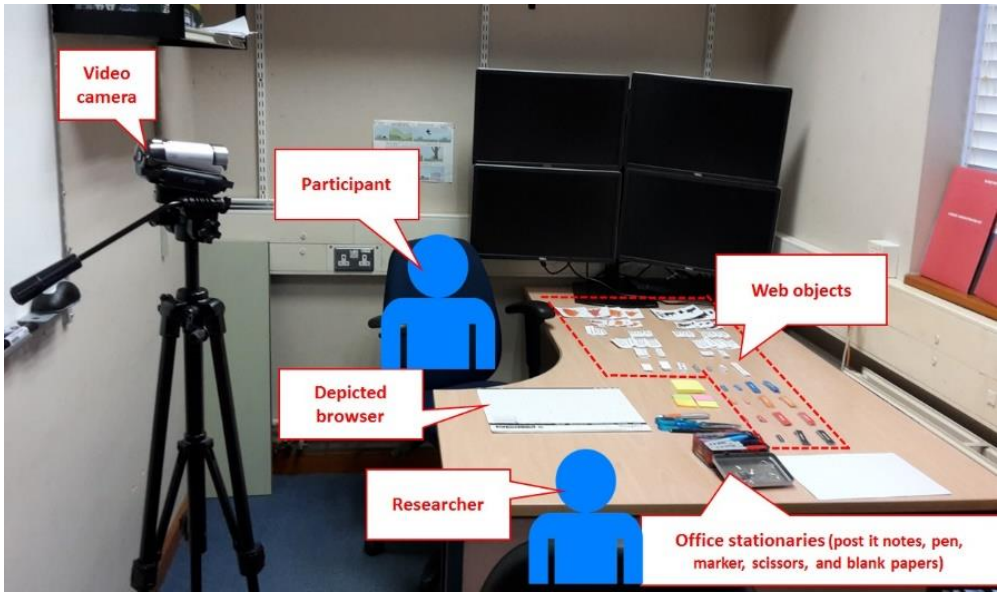


Fig 5.4 The room setting for the co-design activity.

5.2.5 Tasks and Procedures

The study began by giving the participant a questionnaire, which collected information on demographics, as well as online shopping and online grocery shopping experience. The warm-up session was the next activity.

The warm-up session was opened by asking the participant a question: *"Do you experience any problem or difficulty while doing online shopping?"* The answer to this question was excluded from the analysis, as the function of this warm-up session was to create a comfortable environment between the participant and the researcher.

The main activity, the co-design, started after the warm-up session. The participant was asked to design e-commerce interfaces for two types of websites, an online grocery shopping website and a website for purchasing assistive technology,

using the scenarios of purchasing carrots from the former and a wheelchair from the latter. These two types of website and shopping tasks were devised to investigate the potential differences between a relatively inexpensive purchase of multiple items and a relatively expensive purchase of a single item.

The activity started with the first scenario, which was buying carrots. The scenario was described to the participants: *"Assume that you are going to buy carrots. You go to an online grocery shopping site, and you click on menus and select carrot. So now you are in the carrots selection area."* Then, the participant was asked what they thought the screen should looked like and were asked to design the page in which the 'add to cart' button was usually first displayed, in order to initiate a purchase. Then, a depicted browser was presented as a design workspace. Using the paper-cutout web objects and office stationery, the participant designed the pages on the workspace by following the Bernard procedure [1]. Web objects could be placed on the provided workspace either horizontally, vertically, overlapping, or centred between the grid lines. Participants were also reminded that it was not mandatory to select all objects presented; instead, any objects that they deemed important could be included in the design. If the participant wanted to include an object that was not included in the paper-cutouts, they could use the blank cards, post-it notes, or new paper-cutouts to present it.

When the participant stopped designing, they were asked the following question: *"Would you like to add your carrots now?"* If they answered *"yes"*, this marked the end of their design activities. If the answer was *"no"*, an additional page usually needed to be designed, after which the procedure was repeated until the answer was *"yes."* Blank paper was used to design additional pages, where necessary. Photographs were taken of the designed pages.

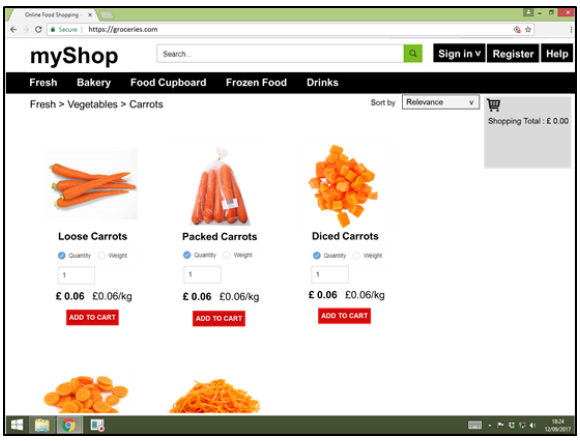
The entire co-design activity procedure was then repeated for the second scenario of buying a wheelchair.

Following the co-design activities, participants were asked simple questions about designs preferences for the 'add to cart' button. These concerned choices for the label (text only, icon only, or both text and icon), the image to represent the icon (trolley, plus sign, bag, or basket), and designs related to the 'buy box'.

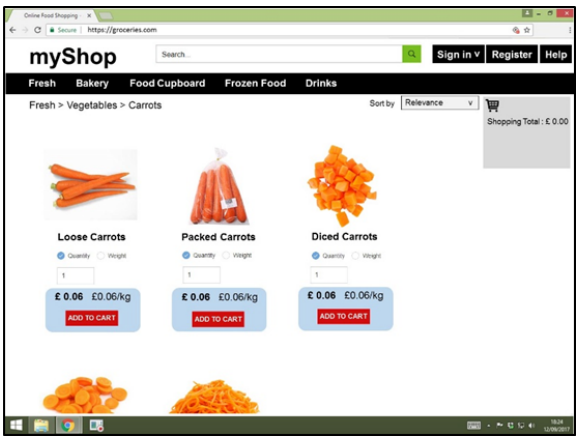
The 'buy box' design was inspired by the design implemented on the Amazon website, where a box is used to indicate the starting point of a buying process and where items are added to the shopping cart [16]. The box contains the "price of the

product, shipping information, the name of the seller, and a button to purchase the product" [17]. It is useful to understand whether placement of the box beneath certain objects (e.g. price and 'add to cart' button) better attracts older users' attention to the 'add to cart' button, compared to designs that lack a 'buy box.' As such, participants were presented with two website designs, with and without a 'buy box' design (see Fig 5.5), and were asked which design they preferred. Participants were also asked what elements should be included in the buy box.

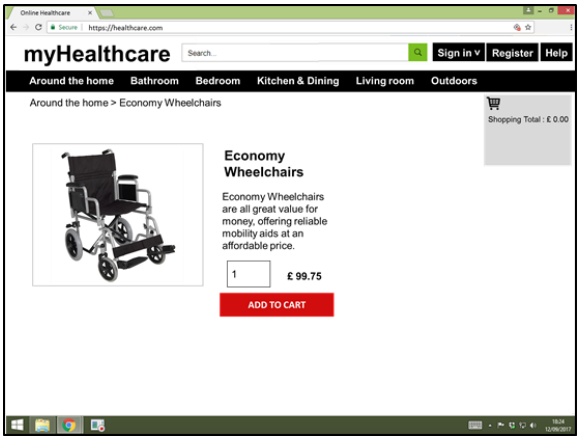
Finally, each participant was thanked for their efforts and contribution to the study.



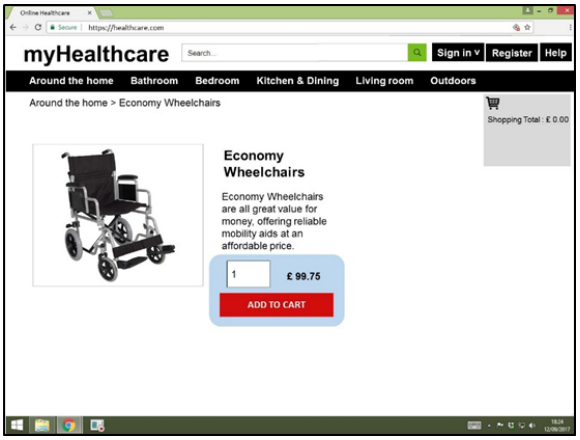
(a) carrots page without 'buy box' design



(b) carrots page with 'buy box' design



(c) wheelchair page without 'buy box' design



(d) wheelchair page with 'buy box' design

Fig 5.5 Pages with and without 'buy box' designs.

5.2.6 Analysis

This study investigates e-commerce web pages designed by older adults, focusing on the last stage of shopping and the starting point of sales, which allows users to add an item to their cart. Therefore, only pages designed with ‘add to cart’ buttons were considered in the analysis.

The pages designed by the older adults were photographed and the design processes were recorded. Photographs were analysed, specifically where participants placed the web objects on the depicted browsers. The analysis led to the identification of several layouts, including the horizontal list, vertical list, grid, and single item. Fig 5.6 provides samples of the analysed pages. The layouts were determined by identifying a cluster of web objects for an item, which were easily determined because the pattern of the layouts was obvious.

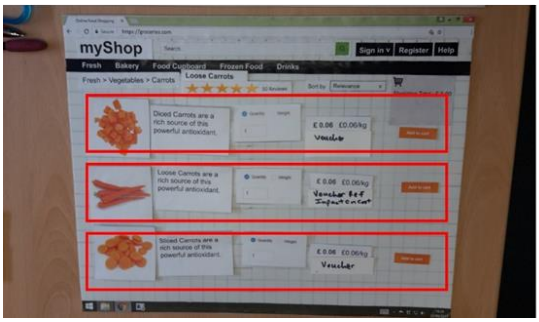
The horizontal list layout presents one product per row, typically with an image on the left followed by other objects and usually with an ‘add to cart’ button on the right, with objects arranged from left to right. In comparison, the vertical list layout presents one product per column, usually with the images placed on the top, followed by other objects in a vertical arrangement and the ‘add to cart’ button usually placed towards the bottom of the assembly. Conversely, a grid or matrix layout presents more than one item in a row and column. A single item layout was assigned when a page was designed exclusively for one item only. Any pages with layouts that do not fit any of the above were then grouped into others.

The photographs reveal the web objects that were selected. Any objects selected was noted and included in the analysis. The selected colour and size of the ‘add to cart’ button were also noted.

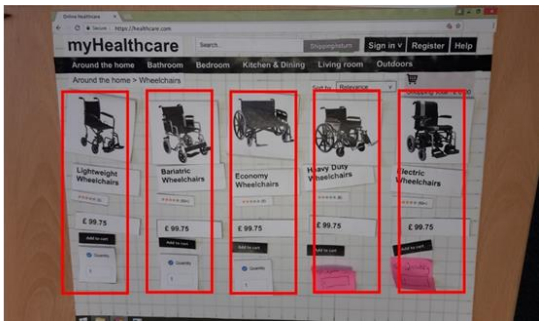
An object can facilitate user navigation when it is placed in the most expected location [7]. Where older adults expect the ‘add to cart’ button to be located on the page is also noteworthy, so the locations of ‘add to cart’ buttons were also analysed. The study initially planned to analyse locations using a percentage of concentration of grid techniques, which is used in [1], [6]. However, the variation of design layouts made it almost impossible to come to a consensus. Instead, this current study employed a more objective way of analysing the location of the ‘add to cart’ button: any objects that were ‘close to’ a button (i.e. within two grid squares of a button) were noted, and the frequency of the occurrences was analysed.

The frequency of ‘buy box’ design preferences were also noted, as were objects suggested for inclusion in the ‘buy box’ design.

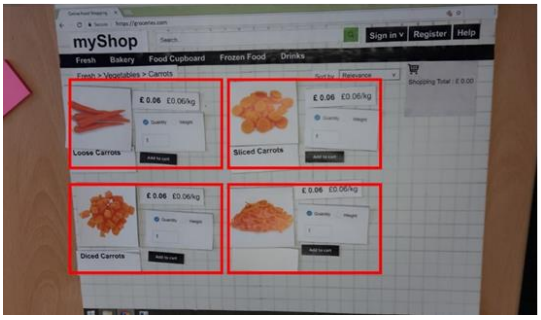
The videos recorded were used to analyse the reasoning behind the selected web objects. The videos were then transcribed and coded. Emerging themes thus provided the reasons behind the selection of web objects.



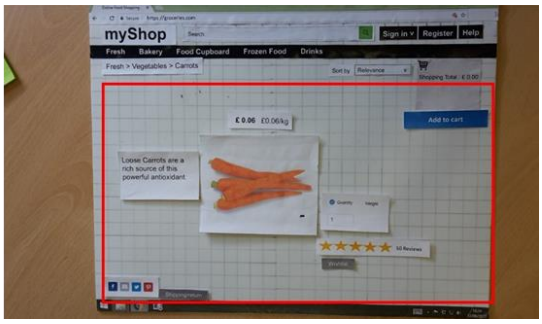
(a) horizontal



(b) vertical



(c) grid



(d) single item

Fig 5.6 Samples of the layout of pages designed by participants.

5.3 Results

Only pages designed with an ‘add to cart’ button were included in the analysis of this study, which resulted in 48 designed pages (20 participants x 2 websites [carrots, wheelchair] plus eight additional pages). The additional pages were typically designed to be linked by either clicking on a ‘more info’ button or link, or by clicking on the image of an item. For example, a page with various wheelchair products was designed because more information was needed on a particular item; therefore, an additional page was created. Appendix 6 presents a participant’s design sessions and the pages they subsequently designed.

5.3.1 Layout Patterns

The horizontal, vertical, grid, single item, and other layout patterns were all designed. The distribution of the type of layout designed by the participants is tabulated in Table 5.2, and the additional pages designed are presented separately in Table 5.3.

Table 5.2 demonstrates that the horizontal list layout dominated the designs, with 45%, followed by the single item layout, with 32.5%. Participants that designed pages with a single item layout wanted items for selection to be displayed either on the page before or on a menu list.

When additional pages were designed (n=8), the single item layout was the most popular (see Table 5.3), which reflects the needs of the additional page. Typically, these pages were designed when there was a need for more detailed information about a particular item. Only one additional page was designed with a vertical layout, as the participant wanted to use that page to compare items intended for purchase.

Table 5.2 Page Design Layouts

Type	Horizontal		Vertical		Grid		Single item		Others	
	n	%	n	%	n	%	n	%	n	%
Carrot	10	25.0	1	2.5	2	5.0	6	15.0	1	2.5
Wheelchair	8	20.0	3	7.5	0	0.0	7	17.5	2	5.0
TOTAL	18	45.0	4	10.0	2	5.0	13	32.5	3	7.5

Table 5.3 Additional Pages Design Layouts

Type	Horizontal	Vertical	Grid	Single item	Others
Ext-carrot	0	1	0	3	0
Ext-wheelchair	0	0	0	4	0
TOTAL	0	1	0	7	0

5.3.2 Web Objects

The participants were given the freedom to select an object. The results in Fig 5.7 and Fig 5.8 indicate the percentage of participants that included web objects in the designed pages.

The graph presented in Fig 5.7 highlights several objects that were commonly selected by the participants, including price (100%), an ‘add to cart’ button (97.5%),

and an image (95%). There were clear differences between the objects selected for the carrot and wheelchair pages, including description, quantity selection, shipping/return, and reviews (see Fig 5.8).

A paired t-test was conducted on the web objects selected, which found significant differences ($p < 0.05$) (see Table 5.4) that suggest the type of item (e.g. carrots, wheelchair) affects the selection of these objects. In turn, the description, reviews, and shipping/return objects were selected more for the wheelchair page, which represents an expensive and single purchase; while quantity was selected more for carrots, which represent a cheap and multiple purchase.

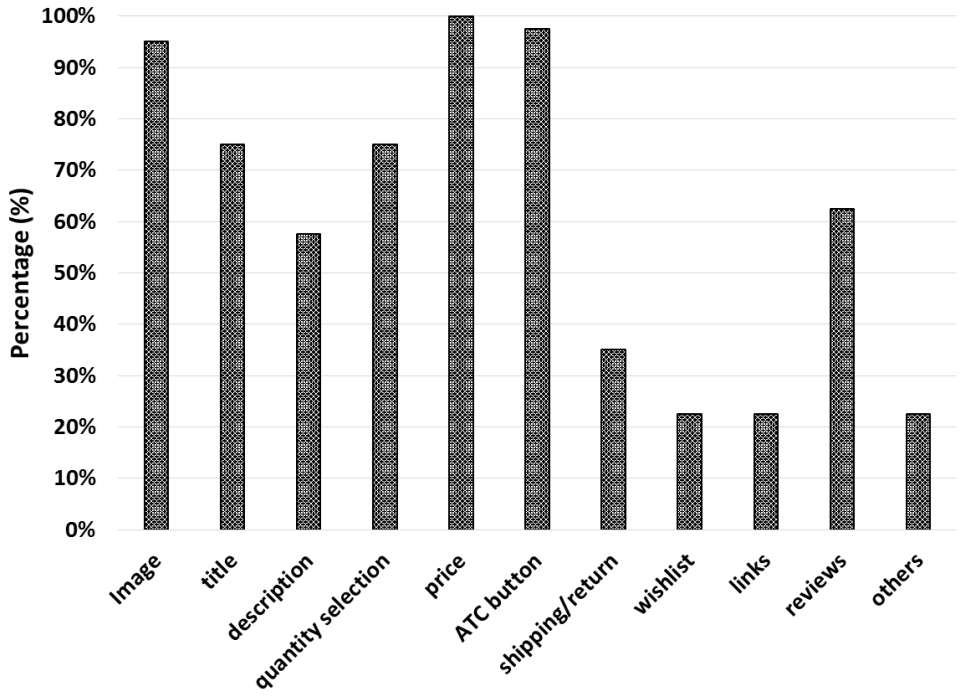


Fig 5.7 The percentage of participants who included the web objects in their designed pages.

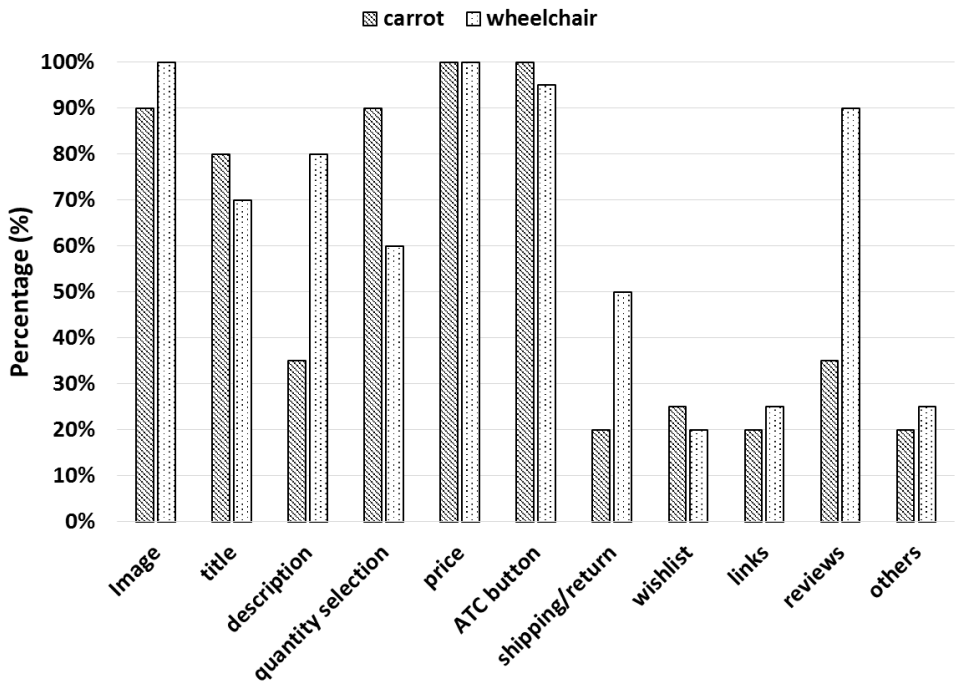


Fig 5.8 The percentage of participants who included the web objects in their designed pages, in a comparison between the carrots and wheelchair pages.

Table 5.4 The Results of Paired T-Test Runs on the Web Objects

	Carrots		Wheelchair		p-value	df	t
Objects	Mean	SD	Mean	SD			
Image	0.90	0.308	1.00	0.000	0.163	19	-1.453
Title	0.80	0.410	0.70	0.470	0.309	19	1.000
Description	0.35	0.489	0.80	0.410	0.001*	19	-3.943
Quantity selection	0.90	0.308	0.60	0.503	0.010*	19	2.854
Price	1.00	0.000	1.00	0.00	-	-	-
ATC button	1.00	0.000	0.95	0.224	0.330	19	1.000
Shipping/return	0.20	0.410	0.50	0.513	0.030*	19	-2.349
Wishlist	0.25	0.444	0.20	0.410	0.577	19	0.567
Links	0.20	0.10	0.25	0.444	0.577	19	-0.567
Reviews	0.35	0.489	0.90	0.308	0.000*	19	-4.819

*Notes: p-value < 0.05

Participants commented that more information was needed when buying a more expensive item, compared to a cheaper purchase. Reviews from others, such as *"experience in using the products"*, were also said to be helpful when making purchase decisions. Shipping/return, meanwhile, was important for returning unwanted goods, especially with expensive purchases.

It is also interesting that some participants wanted reviews and shipping/return information to be included on the grocery page. When asked what information was expected from these objects, participants suggested that reviews should provide other buyers' opinions about their purchases, particularly in terms of quality, packaging, delivery, and cooking suggestions; while shipping/return information should offer an easier process for returning unacceptable groceries. Table 5.5 presents suggestions for reviews and shipping/return objects for the grocery website.

Table 5.5 Samples of Suggestions for Reviews and Shipping/Return for Grocery Page

Objects	Attributes (frequency)	Samples of Transcription
Reviews	Quality (7)	*"I thought the quality of the carrots"* (B04) *"It could be nice, fresh, and crunchy"* (B12)
	Packaging (1)	*"How they pack them. The package, how would you see them. That's how I would review them."* (B15)
	Delivery (1)	*"The delivery speed and accuracy. They come when they say it."* (B10)
	Suggestion for cooking (1)	*"You might say in the reviews, this is good for using in a fish pie. This is good for using in a stew."* (B16)
Shipping/return	Return unacceptable goods (3)	*"I was thinking it is important ... but to find out what happens when you didn't like it. You want to know how to send it back for whatever reason."* (B10)

As previously discussed in section 5.2.3, the paper-cutout objects presented in this study were prepared to approximate the actual size they would appear on the screen. Some objects were offered in different sizes; for example, image objects were offered in both a small size (height 5.37 cm, width 5.87 cm) and a big size (height 8.86 cm, width 10.63 cm). Of the total designed pages that were analysed, 58.3% used small size images, 33.3% used big size images, and 8.33% used no image. The title object was also offered in two sizes, and the designed pages favoured Arial 18 pt (47.9%) over Arial 24 pt (25.0%).

Participants also suggested including objects that were not originally offered; their suggestions are presented in Table 5.6.

Table 5.6 Additional Objects Suggested by Participants

Objects	Number of participants
Compare	2
Contact us	2
Delivery option (e.g. 3 days, 1 week)	1
Delivery cost	2
Payment	1
More info	3
Origin	1
Update cart	1
Voucher	2
Unit sold	1

5.3.3 'Add to Cart' Button

Almost all the designed pages included 'add to cart' buttons, with the exception of two pages that they were designed with a 'payment' button to direct the user to the payment section (i.e. not via a shopping cart). Pages (n=4) were also designed to have only one 'add to cart' button, with more than one item displayed on the same page (see Fig 5.9).

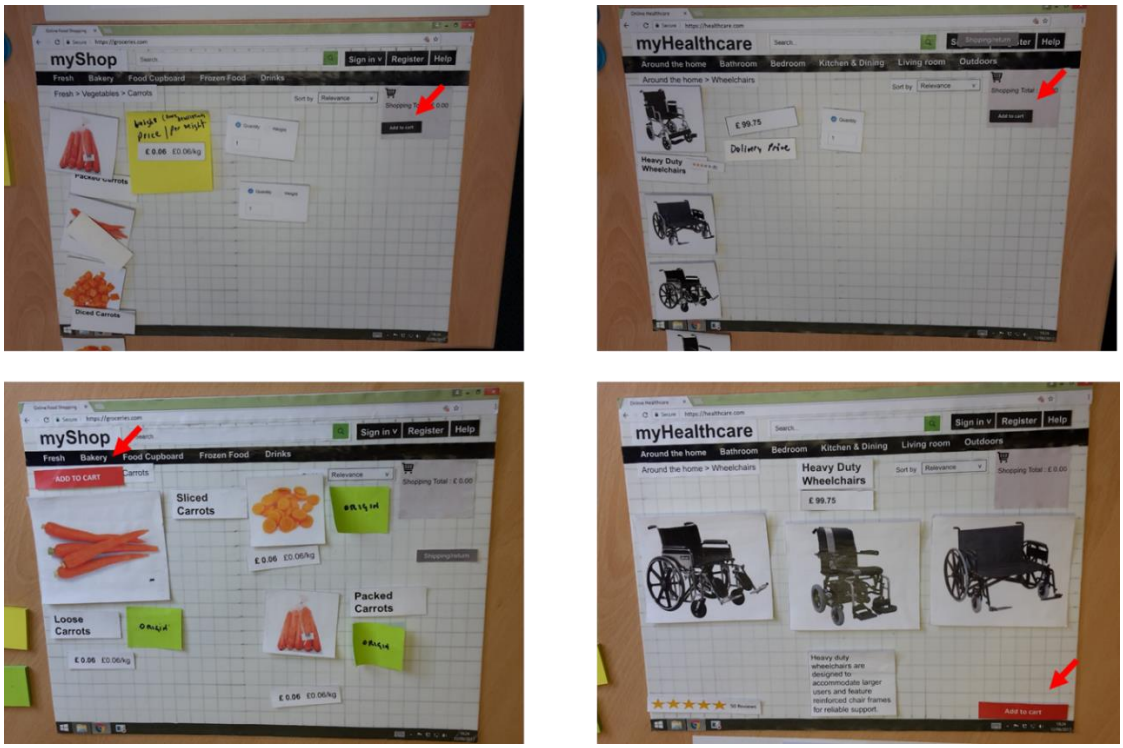


Fig 5.9 Samples of multiple items page designed with only one 'add to cart' button.

When asked about the selection mechanism, participants reported that the image should first be clicked to select an item, followed by clicking the 'add to cart' button to put the item into their cart. However, it is noteworthy that this selection mechanism could have some issues, as it may be unclear which items would be added to the cart. This is compared to existing designs that have a dedicated 'add' button for each individual item.

By analysing the total 48 designed pages, the preferred colour, size, and text case for the 'add to cart' button designs were discerned (see Table 5.7). Participants mostly preferred options with a dark (blue or black) button colour, medium size button, and a label with mixed text case (i.e. 'Add to cart'). In addition, participants were also found to prefer a button incorporating both an icon and text as a label, with a trolley as the icon graphic (see Table 5.8).

Table 5.7 Characteristics of 'Add to Cart' Button Selected by Participants

Components	Characteristics	Number of designed pages	Percentage (%)
Colour	Black	14	30.4
	Blue	15	32.6
	Orange	10	21.7
	Red	7	15.2
	n/a	2	4.2
Size	Big (270 px X 55 px)	18	39.1
	Medium (122.5 px X 35 px)	28	60.9
Text case	Capital	20	43.5
	Mixed	26	56.5

Table 5.8 Characteristics of Label of 'Add to Cart' Button Preferred by Participants

Components	Characteristics	Number of participants	Percentage (%)
Label	Text only	5	25.0
	Icon only	0	0.0
	Both icon and text	15	75.0
Icon graphic	Basket	4	20.0
	Trolley	16	80.0

Various reasons were cited for the colour choice of the 'add to cart' button. Participants (n=9) seemed to have 'no particular reason' for selecting a colour, or it was simply personal preference (for example, *"I like blue"*). Colour choice was also influenced by the meaning associated with the colour; for example, some participants (n=4) selected blue because they thought *"blue is an action colour"* or that *"blue is a conservative colour."* Previous experience may also have influenced colour choice. For example, one participant associated blue with hyperlinks, which are usually used in the introduction to a website: *"I remember [an] earlier website; it always hyperlinked. Anything you clicked on was always in blue. The text was in blue. So it is just a memory from 20 years ago. So, I relate to that."* (B11).

Again, with black, the participants mentioned that they simply like black. Other reasons included the colour's *"high contrast"*, which made it *"easy to read"* and *"stand out."* One participant chose black because it has a similar colour to another object within the website: the main menu.

Interestingly, some participants (n=3) chose the colour according to the product's colour. In this study, participants were buying carrots that were orange in colour, which influenced their selection of the button's colour. One participant (B18) suggested colour coding the button according to the product's colour: *"Well, carrots pretty obvious[ly] would be this colour (orange), isn't it? Orange, carrot. Good visual thing. Orange, orange [carrot's colour vs button's colour]. I mean if I am going to buy frozen fish, I go for the blue. Red, only if I was shopping for the hot chilli. I will colour code my purchase to what I expect to see."* Other reasons reported for selecting the colour orange were its *"distinctive colour"* and a personal preference for the colour.

Red was less popular because, to some, this colour had a connotation of 'no' or 'do not.' Words that were mentioned in this regard included 'danger' (2), 'don't do' (1), 'don't push me' (1), 'emergency' (1), and 'mistake made' (1). Conversely, some participants chose red for its attractiveness (2) and also because of the association of 'red for medical' (1), which the participant chose for the wheelchair because they associated it with hospitals.

In summary, reasons that were cited for colour choice of the 'add to cart' buttons were the meaning associated with the colour (11), preferences (9), contrasting colour (3), associating the colour with the product's colour (3), influencing of others (2), attractive colours (2), easy to read (1), and similar colour to other objects (1).

Location of the ‘add to cart’ button was also analysed. The frequency with which web objects were placed close to the ‘add to cart’ button is tabulated in Table 5.9. It is noteworthy that, in this study, ‘close to’ is defined as being within two grid squares. The results clearly demonstrate that participants frequently placed the quantity selection and price close to the ‘add to cart’ button. Fig 5.10 presents examples of the location of ‘add to cart’ buttons, relative to the quantity selection and price objects. Appendix 7 provides a compilation of the location of the button.

Table 5.9 Frequency of the Web Objects Placed Within Two Grid Squares of the ‘Add to Cart’ Button

Web objects	Frequency
compare	1
delivery cost	1
delivery option	1
description	4
links	1
picture	1
price	10
review	1
quantity selection	22
shipping/return	2
shopping cart	5
voucher	2
wishlist	1

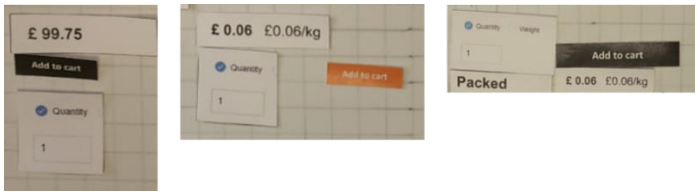
5.3.4 ‘Buy Box’ Design

In the ‘buy box’ design sessions, participants were asked about their preferences of the two designs: with and without the ‘buy box.’ 80% of participants chose to have a ‘buy box’ design for groceries and 85% for assistive technology. 75% of the participants mentioned that the ‘buy box’ designs stood out and drew their attention to objects within the box. They also noted that the designs attract or catch the eye, as highlighted by a participant (B08): *“I think the ‘add to cart’ button is quite pronounced, quite different. You can’t miss it…. you will be able to quickly see where the ‘add to cart’ is.”*

Participants were subsequently asked a further question to identify objects that should be included in the ‘buy box.’ The objects most commonly mentioned were price, the ‘add to cart’ button, and quantity selection (see Table 5.10).

(a) Close to quantity selection

(b) Close to price



(c) Close to both price and quantity selection

Fig 5.10 Examples of the location of ‘add to cart’ buttons, relative to the quantity selection and price objects: (a) close to quantity selection, (b) close to price, and (c) close to both price and quantity selection. Note that ‘close to’ is defined as being within two grid squares.

Table 5.10 Web Objects for Inclusion in ‘Buy Box’ Designs

Web objects	Number of participants	Percentage
Price	20	100.0
‘Add to cart’ button	19	95.0
Quantity selection	16	80.0
Reviews	1	5.0
Made of/material	1	5.0
Voucher	1	5.0
Shipping cost	1	5.0

5.4 Discussion and Conclusion

This study focuses on how older adults design product list pages for two types of e-commerce websites. The scenario of buying carrots from a groceries website represents multiple purchases, while the scenario of buying a wheelchair from an assistive technology website represents a more expensive single item purchase. In the co-design process, various paper-cutout web objects were offered for incorporation into designs.

Results reveal that quantity selection was prominent for the carrots page, which reflects how groceries purchases may be made in multiple quantities. Meanwhile, description, reviews, and shipping/return were more important when purchasing an expensive item such as a wheelchair, which will usually be a single item purchase. Users may possibly want to ensure that they have made a worthy purchase, as a description provides details or more information about the products; and reviews could be helpful when deciding to purchase an expensive item. As in study [18], which investigates reviews about purchase decisions, reviews can influence the purchase of higher-priced products. Reviews should also provide information about the product's quality, as suggested by the participants. Shipping/return information should ensure customers can return purchased items to the seller when the item is no longer required, which provides insurance when purchasing a higher-price product.

The findings also suggest that web objects such as price, the 'add to cart' button, and image are important for both cheap, multiple purchase items and expensive, single purchase pages: price (100%), 'add to cart' button (97.5%), and image (95%). In addition, 'add to cart' buttons on e-commerce websites were also notably placed close to the quantity selection and/or price.

Table 5.11 summarises the important objects that should be included in e-commerce websites. These objects are sufficient enough for users to make their purchase decisions. Overloaded of information, particularly to older adults, may contribute to the burden of processing unnecessary or less important information; yet, this should be further investigated.

Table 5.11 Important Objects for E-Commerce Websites

Cheap, multiple purchases (e.g. grocery – carrots)	Expensive, single purchase (e.g. assistive technology – wheelchair)
• Price • 'Add to cart' button • Product's image • Quantity selection	• Price • 'Add to cart' button • Product's image • Reviews • Description • Shipping/return

Another notable design feature is the 'buy box' design. Participants mentioned commented that the 'buy box' should include the price, an 'add to cart' button, and a

quantity selection object. The design was also said to *"stand out"* and *"draw attention"* when layered under important objects, such as the 'add to cart' button for e-commerce websites. The 'buy box' could potentially improve the design because it is visually attractive. Further investigation should be undertaken to understand the effectiveness of this 'buy box' design in terms of the actual shopping task.

The horizontal list layout was most preferred by participants (n=18), which may result from the fact that this format offers a low cognitive load [19] and to that this it also starts from left to right, which is similar to the normal reading of English text.

Participants reported that the co-design exercises were enjoyable, in response to a question that was not systematically recorded but was informally asked at the end of the sessions.

This study focuses on only two items (i.e. carrots and a wheelchair), which may limit the generalisation of its conclusion to other types of purchases. However, the information generated provides us with significant input about objects that can be included in e-commerce website designs, from the perspective of older adults. Also, it is noteworthy that item descriptions were unintentionally designed to start with the title of a product (see Fig 5.11). The study showed a low number of selection on title object, which may have been influenced by this unintended duplication of the title.

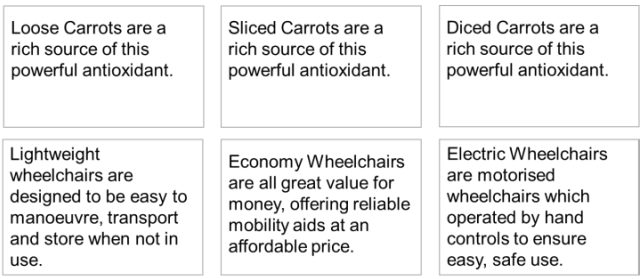


Fig 5.11 Samples of descriptions used in the study.

This study has enabled us to understand how e-commerce websites should look, from the perspective of older adults. Their thoughts are very important, not only to the developer but also to industrial players, in order to grasp the full potential of usable online shopping applications. Considering what older adults consider important may indicate where and what these populations are looking for in e-commerce websites. Nevertheless, whether the objects selected are sufficient enough for older

adults to make a purchase should be further examined, particularly within a real online shopping environment.

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Chapter 6:

Investigating the Effects of 'Senior-friendly' Design on the Performance of Older Adults in Online Grocery Shopping

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ABSTRACT

This paper presents the results of a comparative analysis between two websites – (1) a 'senior-friendly' website co-designed with older adults, and (2) a website exhibiting 'senior-unfriendly' features that are common in existing websites, in the aims to evaluate the usability of an online shopping website between the two websites. The two websites were developed and tested with two tasks, that is, a navigation task which to navigate through the 'sticky' and 'non-sticky' menu, and shopping tasks, which involved buying any five items from each website. Eleven participants aged 57 to 80 years of age compared the two websites, and answered questions pertaining to the ease of performing the tasks. Design features such as a 'sticky' menu and the use of 'buy boxes' were found to aid user navigation. The results also suggest that essential elements on a website should always be visible and distinct enough to attract user attention.

6.1 Introduction

The global expansion of an older population is inevitable [1], and the cost of carers required for this population will therefore likely increase. Thus, the ability to live independently can provide significant benefits to older adults, as well the country. Technology such as e-commerce provides alternative shopping methods to traditional 'physical' in-store shopping. Goods can be purchased online and are delivered directly to the home, avoiding the difficulty of carrying heavy loads and long waiting times in queues, all of which can be of benefit to older people.

This study was designed following the output of previous studies (Chapter 3 to 5). In the study (Chapter 3) that observed older adults' navigation, some difficulties were identified; these included issues with the 'add to cart' buttons and menus. Another study (Chapter 4) that investigated e-commerce web design identified several design practices that were 'senior-unfriendly'. While the co-design study (Chapter 5) provides insight into how older people would design the e-commerce websites.

Based on above mentioned studies, two versions of an online shopping website were created with the aim to evaluate the usability of an online shopping website that has been co-designed with, and for older adults, compared to one that incorporates many of the 'senior-unfriendly' features that are common in existing websites.

6.2 The Designs for the Websites

In this study, rather than imposing a completely new design for websites, designs that had the potential to promote ease of navigation for older users were sourced from existing e-commerce websites. It was thought that the use of existing designs would promote familiarity among users. As noted in [2], unfamiliarity may potentially lead to non-use or abandonment of a product; furthermore, experience with the use of other websites may eliminate feelings of alienation. Additionatilly, existing results (see Chapter 3) show that although older people do not necessarily buy online, they still browse online shopping sites. Therefore, in this study, familiarity was established with websites by recycling existing designs found on other e-commerce websites (e.g. 'buy box', and layout), as doing so was expected to improve an understanding of design and also assist in navigation.

The output from the existing studies (see Chapter 3, 4 and 5) shaped the selection of the features to be investigated in this study. Specifically, this study investigates website aspects such as menu, font size, ‘add to cart’ button designs, ‘buy box’ designs, and general webpage layout.

6.2.1 Menu

Menu navigation strategy has been reported as a first choice for finding products [3], compared to alternatives such as using a search box. Similarly, the study described in Chapter 3 found menu navigation to be preferred option (93.3%), compared to using a search box (6.7%), among older users who participated in said study. Thus, a menu is an essential element for assisting older users’ website navigation. However, older adults were also found to experience difficulty finding the main menu when it disappeared as they scrolled down web pages. There were also incidents in which participants mistook other lists (e.g. related navigation) for the main menu when the main menu was not visible. To address this, a simple solution such as making the main menu always visible throughout the entire session of navigation can be helpful for user navigation. This technique, referred to as a ‘sticky’ menu, was also applied by [4] to allow for quick navigation within long display pages in a Personalized News (PEN) recommender systems. In the current study, ‘sticky’ menu refers to a menu that will always be visible to users, even when scrolling down pages, while a ‘non-sticky’ menu is one that scrolls off the page.

6.2.2 Font Size

Larger font sizes have been suggested as more appropriate for older users, as it provides ease of reading, with text that is 12 or 14 points in size recommended in the literature [5]. A previous survey of existing websites (Chapter 4) found that 37.0% of reviewed websites used small font sizes, which may contribute to difficulty in reading among older adults.

6.2.3 ‘Add to Cart’ Button

6.2.3.1 Colour

As mentioned in [6], colour and uniqueness can help to attract user attention. Thus, objects with a different colour to their environment may be easier to recognise, due to their distinctive nature. Unfortunately, ‘call to action’ buttons such as ‘add to cart’ are still not being designed in a manner than differentiates them from other objects on website pages (see Chapter 4).

6.2.3.2 Contrast Ratio

WCAG 2.0 [7] suggests a minimum contrast ratio for older users with a visual acuity of 20/40 to be 4.5:1, and a much higher ratio of 7:1 is suggested for those with 20/80 vision. When larger text is used, the ratio is reduced to 3:1 for 20/40 vision and 4.5:1 for 20/80 vision. Despite this suggestion, the result in previous study (see Chapter 4) shows that lower contrast ratio was still in use with the existing e-commerce websites.

6.2.3.3 Focus Indicator

It is suggested that a link or control be highlighted when the mouse pointer hovers over it, or when it receives keyboard focus input [7]. However, according to the existing results (Chapter 4), 18.5% of buttons evaluated still provide no indicator to signify that a button is clickable.

6.2.3.4 Feedback

Older users may have a limited understanding of online processes [8], therefore, whenever unclear or no feedback is provided to users, such as no notifications when an item is added to their cart, it can create anxiety, as users may find it difficult to understand the process. Additionally, [9]–[11] also suggest providing visual feedback for an item that has been added to the cart.

6.2.3.5 Label

Misinterpreting a site’s interface functions or icons can lead to making incorrect judgement; however, sufficient information can help guide purchases [12]

and evade receiving unwanted products. Regarding buttons, it is important to clearly label the function they represent in order to guide user navigation and actions. A combination of text and symbols can provide significant value to the meaning of a button and make its function less confusing. Additionally [13], [14] also suggest that a combination of symbols and text, can, particularly in the case of older adults, improve understanding. In order to add more value to the designed button, such as making it more intuitive, familiar symbols and words should be employed [15]. In addition, a verb functions better when explaining the action of a button [5]. Previous results show that the phrase ‘add to cart’ was primarily used (83.33%) (see Chapter 4), and in the case of older adults, regarding the ‘add’ button, they preferred the 'trolley' symbol (see Chapter 5).

6.2.4 ‘Buy Box’ Design

While delivering a keynote address title, ‘Web UX 2016 vs 2004’ at Nielsen Norman Group UX Conference in 2016, Jakob Nielsen proposed that the success rate of user tasks has increased over the years; however, only 30% of tasks were being completed successfully and easily. Findability (60%) was mentioned as a primary contributor to failures, with Nielsen highlighting that getting where a user needs to be on a website remains a significant issue.

Landmarks have long been supporting people’s wayfinding in the real world, where they can serve as indicators of whether a correct path has been taken. Similarly, this concept can be applied in the digital world, as in a study by [16], which explored the effects of using landmarks in user navigation. The study found that users were able to easily identify items with the help of provided landmark. Using this motivation, the present research introduced the concept of a ‘buy box’ design in a previous co-designed study (see Chapter 5). It is anticipated that the ‘buy box’ will be able to act as a landmark on a website in a manner that attracts user attention. As noted previously, instead of introducing new web designs, available designs on existing websites were used. Therefore, the Amazon website was used as a reference for the ‘buy box’ designs, which represents “the box on a product detail page where customers can begin the purchasing process by adding items to their shopping carts” [17], and includes the “price of the product, shipping information, the name of the seller, and a button to purchase the product” [18]. In the previous study (see Chapter

5), older adults were found to prefer the design with a ‘buy box’, compared to one without this design. An example comparison between the two options is illustrated in Fig 6.1 and Fig 6.2.

6.2.5 Listing Pages Presentation Format

The presentation format of items on web pages has been an interest for some time, particularly for e-commerce websites. The effects of presentation format have been examined for efficiency, perceived aesthetics, cognitive load, decision making, performance, and satisfaction [19]–[22].

In this study, two presentation formats were compared: a grid design and list design. A grid or matrix design displays more than one item in a row, while a list design displays only one item per row. Grid design scored higher than list design in terms of perceived aesthetics [19]. Furthermore, a quick review of existing online grocery shopping sites (i.e. Tesco, ASDA, Morrisons, Waitrose and Ocado) found that all these sites use grid designs. However, previous co-design activities (see Chapter 5) showed that older adults prefer a horizontal list format, compared to other formats (e.g. grid). List presentation can support older users’ navigation as it offers a lower cognitive load compared to grid presentation [20].

6.2.6 Offer

The previous study (see Chapter 3) found that participants experienced difficulty with an offer, where they were found to be unaware with the offer signs. As mentioned in [23], appropriately locating an object can improve its use; thus, as suggested by the participants, placing the offer sign near the product’s price can improve its visibility.

6.2.7 Other Features

The location of other objects such as a menu, logo, search bar, login, help, register, and shopping cart was designed for the current study following results reported in [24]–[26].

The menu depth-level was designed as suggested, that is, in order to avoid disorientation, the depth-of-information level should be four to five levels deep at a

maximum [27]. Additionally, [28] also recommends not using a too-deep hierarchy, and to group information into meaningful categories. Five product categories (i.e. fresh, bakery, food cupboard, frozen, and drinks) were used, based on the results of a review conducted on existing online grocery shopping sites (i.e. Tesco, ASDA, and Morrisons), to indicate available food and drink-related products.

The information about products in both prototype websites was extracted from existing online grocery shopping sites to ensure that the information presented was logically sound. The number of grocery items used in the prototype was also reduced to a total number of only 480 items, compared to the higher number of items available on existing online grocery shopping sites. Although the number of items had been reduced, there were nonetheless enough items for selection. Similarly, a study by [29] also reduced the overall content for the developed website used in their study, with a sufficient choice range remaining.

6.2.8 Summary Designs Used for Both Websites

The number of products was reduced, and specific brands were avoided, resulting in five item categories (i.e. fresh, bakery, food cupboard, frozen, and drinks), with 480 items in total.

Table 6.1 summarises the designs applied for both websites. The design comparison is shown in Fig 6.1 and Fig 6.2. Although the websites were designed in such a manner that Website B may not ease participants' navigation, these designs are still applied within existing e-commerce websites (see Chapter 4). The present study anticipated investigating the extent to which better website design might improve performance.

Table 6.1 Designs Comparison between Website A and Website B

Features	Design Aspects	Website A (senior-friendly)	Website B (senior-unfriendly)
Menu ❶	Navigation	Sticky menu	Non-sticky menu
Font ❷	Size	14 pt	10 pt
Add to cart button ❸	Colour	Different colour to surrounding objects Button:	A similar colour to surrounding objects Button:

		Blue (#0000FF) Text: White (#FFFFFF)	Grey (#807E59) Text: Grey (#BFBFBF)
4	Focus indicator	Change colour when hovering mouse pointer over the button Button: Lime (#00FF00) Text: Black (#000000)	No indicator
5	Contrast ratio	High contrast ratio between text & background of button Blue (#3333CC) vs White (#FFFFFF) with a contrast ratio of 8.45:1 When hover over: Lime (#00FF00) vs Black (#000000) with a contrast ratio of 15.30:1	Low contrast ratio between text & background of button Grey (#807E59) vs Grey (#BFBFBF) with a contrast ratio of 2.26:1
6	Label	Symbol + text (trolley + 'add to cart')	Text only ('add to cart')
7	Feedback	Clear notification inform item added to cart	Only provide 'tick' to notify item added to cart
Buy box design 8	Buy box	Buy box colour: Amber (#FFC000)	None
	Objects within buy box	• Add to cart button • Price • Quantity selection	None
Offer 9	Location	Near to price and add to cart button	Top corner image
Product page 10	Presentation format	Horizontal	Grid

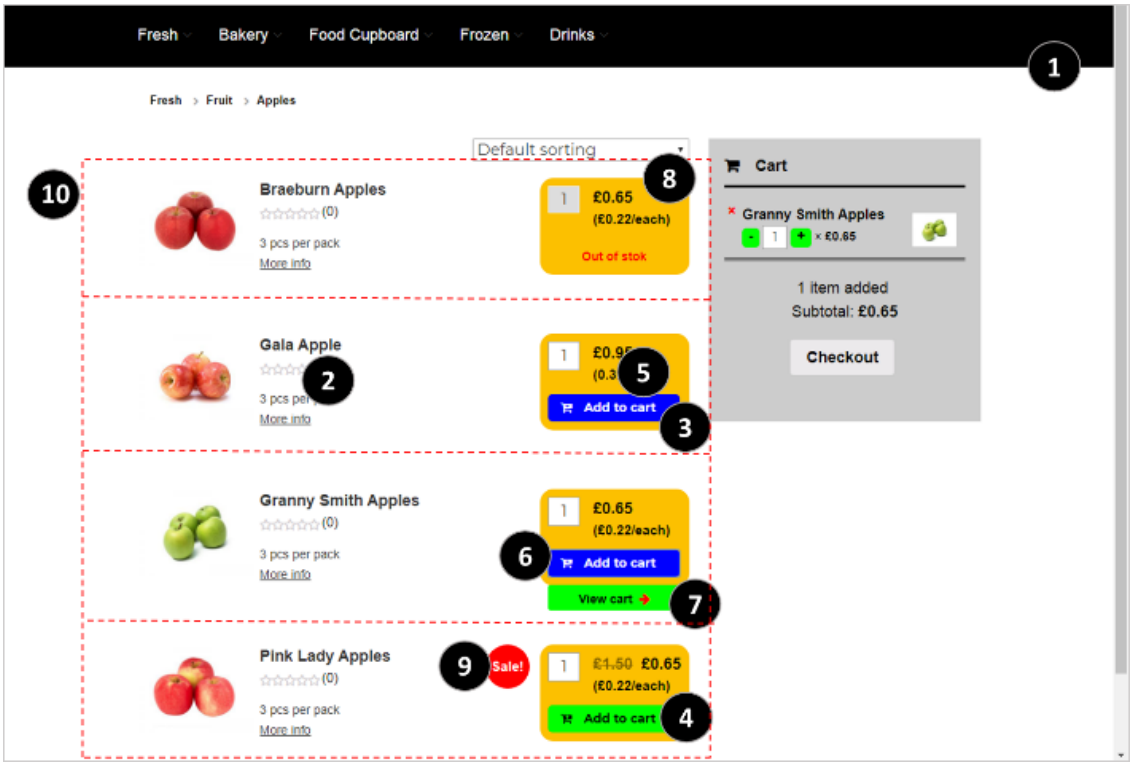


Fig 6.1 The designs for Website A, which incorporated 'senior-friendly' features that were designed with and for older adults.

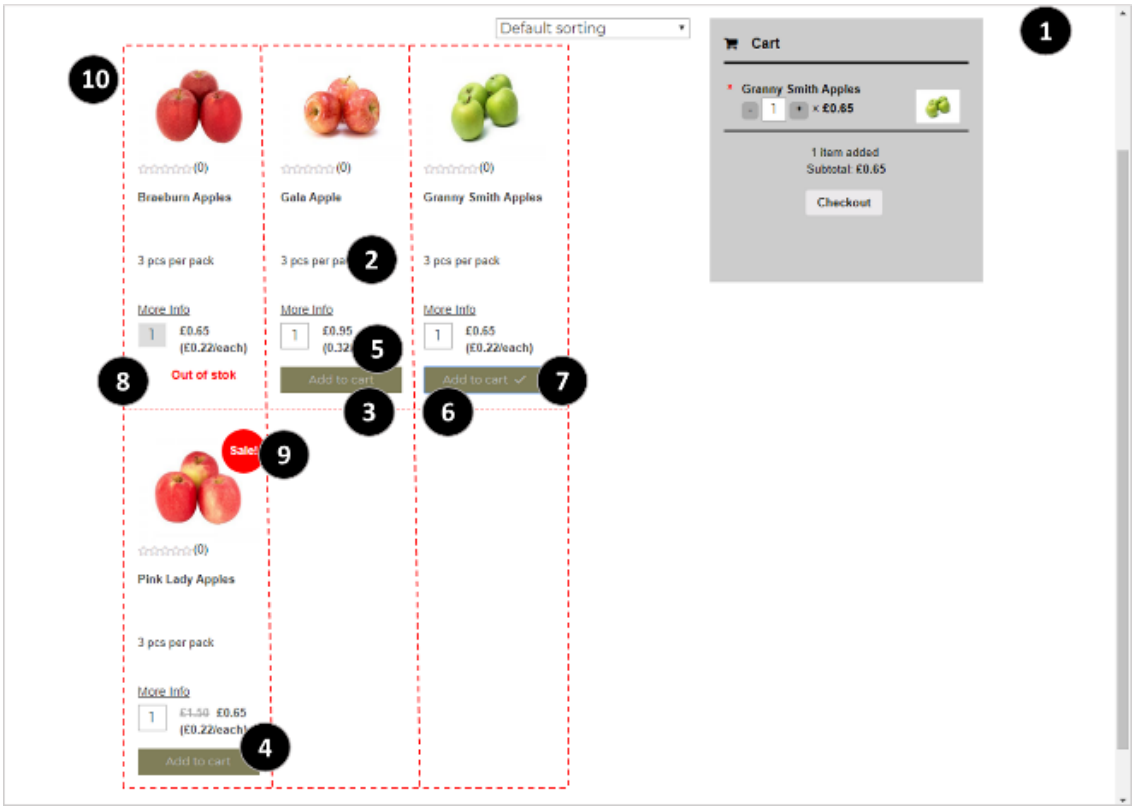


Fig 6.2 The designs for Website B, which incorporated 'senior-unfriendly' features that are commonly found on existing websites.

6.3 Methods and Procedures

6.3.1 Participants

Eleven older adults (four male, seven female), aged 57 to 80 (mean = 69 years) volunteered to participate in the study. Participants' computer, internet and online shopping experience are summarised in Table 6.2.

This study has been reviewed according to procedures specified by the University Research Ethics Committee and has been given a favourable opinion for conduct. Written consent was obtained from participants at the beginning of the study (see Appendix 8).

Table 6.2 Computer, Internet, and Online Shopping Experience

Experience		Number of participants
Computer experience	Frequency using computer	
	Everyday	8
	Every 2-3 days	2
	Once a month	1
	Most used device to access the Internet	
	Laptop	1
	Desktop	8
	Tablet	2
Internet experience	Internet usage	
	Work	3
	News	10
	Health information	6
	Spiritual information	3
	Shopping	7
	Entertainment	3
	Communication	9
Online shopping experience	Experience	7
	Non-experience	4
	Online purchases	
	Clothes	1
	Sport goods	1
	Household goods	2
	Travel arrangements	7
	Holiday accommodation	6
	Tickets for events	4
	Film, music	2
	Books, magazines, newspapers	6
	Food or groceries	1
	Electric equipment	3
	Computer hardware, software	4

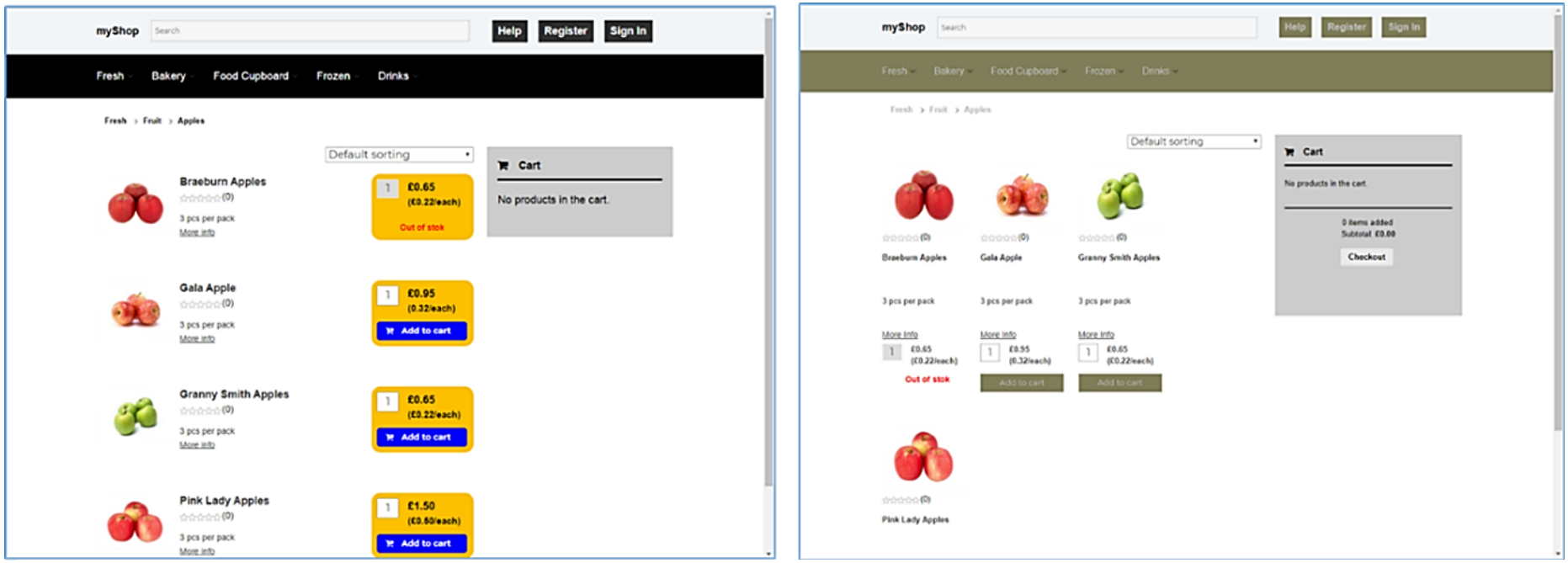
	Shares purchases, insurance policies	4
	Telecommunication services	2
	Medicine	1
	e-learning material	3
Online grocery shopping		
	Yes	1
	No	10

6.3.2 Procedure

In this study, a within-subjects design was used with two conditions: (1) Website A incorporated features designed with and for older adults; (2) Website B incorporated 'senior-unfriendly' features that are commonly found on existing websites (see Fig 6.3). Each participant was asked to complete navigation and shopping tasks using the two websites, and the order of presentation of the two websites was counterbalanced across participants. In this experiment, both websites were accessed online.

6.3.2.1 Part 1: Introduction

The first part began with an explanation of the study and gaining informed consent from participants. Then, participants were asked to complete a questionnaire that collected demographical information (age, gender, education, occupation) and information about experience (computer, Internet, online shopping, grocery shopping).



(a) (b)

Fig 6.3 The two websites used in the study: (a) Website A – incorporated features designed with and for older adults (b) Website B – incorporated 'senior-unfriendly' features that are commonly found on existing websites.

6.3.2.2 Part 2: Menu Navigation Task

The objective of the navigation task was to determine the effect of menu type on performance, using either a 'sticky' or 'non-sticky' menu. A 'sticky' menu will always be visible to users, despite scrolling down a web page, while a 'non-sticky' menu scrolls off the page.

A list of navigation tasks (see Appendix 9) was given to participants, and they were asked to navigate through the menu of the websites to find the final item in a specific page mentioned in the list. It was emphasised that tasks were to be completed in a specific manner, where participants needed to take a systematic approach. This approach was implemented to ensure that participants moved to the bottom of pages, which made it possible to observe the actions they took to arrive at the next main menu category.

At the end of the tasks, participants were asked to answer a 'Single Ease Question' (SEQ) (see Appendix 10) [30], a 7-point rating scale to assess how difficult users find a task.

Throughout the tasks, participants' actions while performing these tasks were video recorded and automatically logged by a computer via an application called 'Step Recorder'.

Upon completion of this task, interesting incidents (if any) were further investigated with the participant, in an attempt to understand the reasons for these actions. For example, a participant was observed looking for something on the keyboard while performing a menu navigation task for Website B; this action was discussed with the participant to understand the reasons for the action.

6.3.2.3 Part 3: Shopping Task

The objective of the shopping task was to observe the ability to recognise the 'add to cart' button and to evaluate the overall usability of the two websites.

In this task, participants were asked to buy any five grocery items of their choice from the website. Participants were reminded that the website was a prototype, and that no brands were associated with any of the items.

The participants' interactions with the website were again video recorded, and their clicks and scrolls were automatically logged. The recording started with the first

click and ended with the final click of the last item being added to the cart. At the end of the shopping task, participants were queried about their reasoning related to actions arising from interesting incidents (if any).

Participants were also asked to evaluate the website using the 'System Usability Scale' (SUS), introduced by John Brooke in 1986 to measure the usability of a product or service [31], [32].

The participants completed the same tasks (i.e. menu navigation and shopping task) twice, once on Website A and once on Website B. The order of presentation of the two websites was counterbalanced across participants.

6.3.2.4 Part 4: Cues and Preference

Following on, participants were asked to rate and rank the cues that were helpful for recognising the 'add to cart' button: (1) a button with a different colour to other objects; (2) a colour change when the mouse pointer hovered over the button; (3) 'add to cart' label; (4) 'buy box' (see Appendix 11).

Finally, participants were presented with printed versions of both websites and were asked to express their likes and dislikes by making notes obout each website. Participants were also explicitly asked which website they would prefer to use.

6.3.2.5 Part 5: Closing

The sessions ended by thanking the participants for their contribution to the study.

6.4 Results and Analysis

6.4.1 Menu Navigation Task

The strategy employed each time participants navigated back to the main menu was observed and recorded. It should be noted that no assistance was provided to participants during the task. Interesting comments and incidents that occurred while the navigation tasks were being performed were also noted.

It was found that all participants scrolled up pages until they found the main menu in cases where the menu was 'non-sticky', except for one participant, who had no online shopping experience (C07), and used the browser's 'back' button to access the main menu. An experienced participant (C02) also tried to find a 'back' button

key on the keyboard when the main menu was not visible, and mentioned the reason for doing so as *"to move quickly"* to the main menu. This participant was again observed to use the browser's 'back' button several times when the menu was not visible. Participant C11 was also observed using the browser's 'back' button several times during the shopping task when the menu disappeared. Another experienced participant (C08), asked, *"How do I get back to the main menu?"* However, no assistance was provided, and the participant was able to realise that scrolling up the page would slowly reveal the main menu. Participant C09, on the other hand, acknowledged that a menu that stayed visible, the 'sticky' menu, made navigation easier and faster, as there was no need to scroll back up the entire page.

Performances for completing the navigation task were also measured and the total time navigated on both websites was analysed. The time was logged automatically by the computer using the Steps Recorder application. The recording commenced from the first click of the menu until the final act of scrolling down the page of the task. Although the time was observed and measured, the participants were not informed that this would be done, or whether they needed to perform the task in a fast or accurate manner. Participants were found to be committed to completing the task. No participant asked to take a break during the activity.

The navigation time for Website A and B ranged between 99 and 329 seconds, and 111 and 443 seconds, respectively. A Wilcoxon signed-rank test was performed and found that navigation time was significantly faster ($p = 0.003$, $z = -2.937$) for Website A (median = 130 seconds) compared to Website B (median = 169 seconds). Individual navigation times are presented in Fig 6.4, and on average, participants took 44 seconds longer to complete the task on Website B than on Website A.

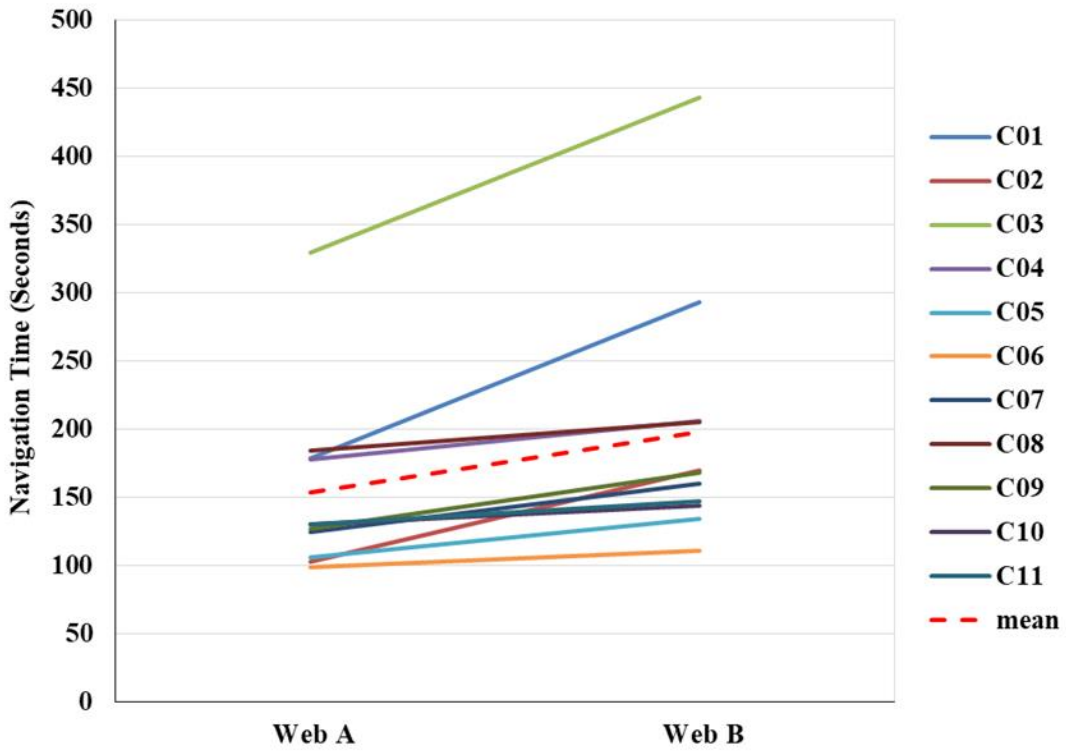


Fig 6.4 The total time taken to perform the menu navigation task across individual participants for both Website A and B.

'Single Ease Question' (SEQ), a 7-point rating scale, was used to assess how difficult users found a task. Despite Website A's faster navigation time compared to Website B, overall, participants rated the navigation tasks for both websites as easy, either when navigating with a 'sticky' or a non-sticky' menu. The SEQ scores for both websites are shown in Fig 6.5 with the median scores for Website A and B being 7 and 6, respectively. Moreover, the spread of scores between the two websites was quite similar at 4 to 7 points. The box plot graph also shows that participants who scored 6 to 7 for Website A and Website B was 70% and 50%, respectively.

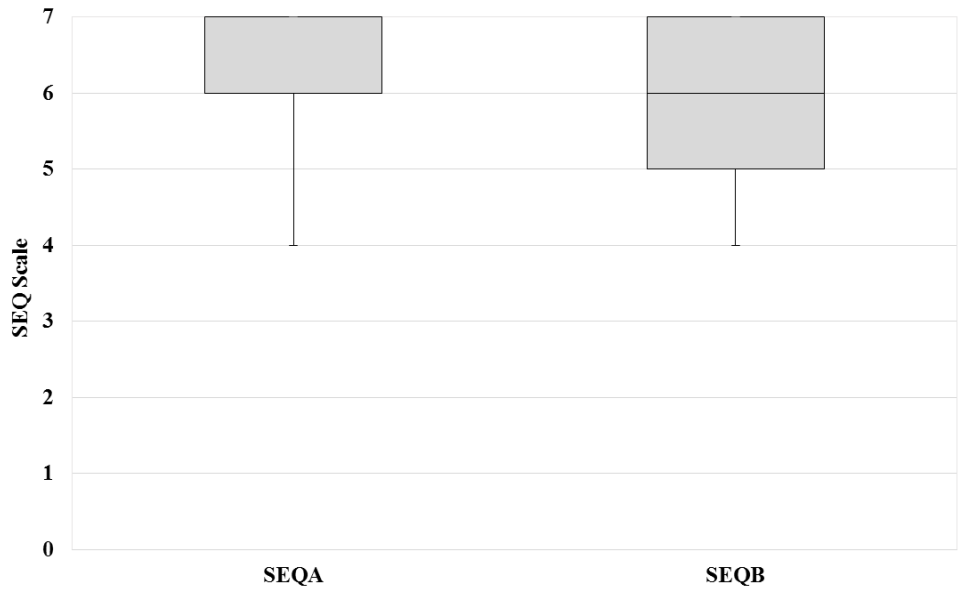


Fig 6.5 The SEQ rates for the menu navigation task for both Website A and B.

6.4.2 Shopping Task

Similar to the menu navigation task, time was also used to measure the shopping task performance. Here, recording commenced from the first click on the menu to the fifth item added to the shopping cart. The average time used to buy each item was calculated. The average shopping time for Website A and B ranged from 14 to 81 seconds, and 17 to 131 seconds, respectively. Additionally, a Wilcoxon signed-rank test was performed, and found that the average shopping time was significantly faster ($p = 0.023$, $z = -2.268$) using Website A (median = 31 seconds), compared to Website B (median = 41 seconds). The individual mean time is presented in Fig 6.6 and on average, participants took 13 seconds longer to complete the task on Website B than on Website A

The participants rated the usability of the websites using the 'System Usability Scale' (SUS), a 5-point Likert scale of 1 (Strongly disagree) to 5 (Strongly agree). The scores are presented in Fig 6.7. Both scores almost surpassed the minimum score for good usability (68 points); however, Website A showed a slightly better score, with a median of 87.5 points, compared to Website B with 82.5 points.

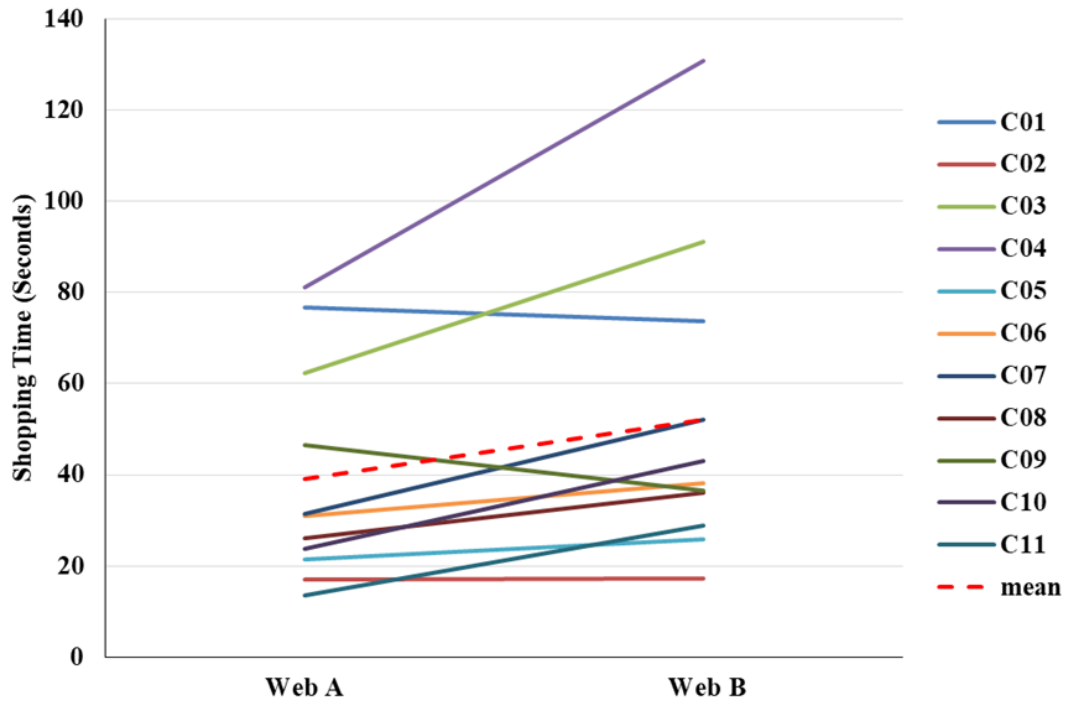


Fig 6.6 The average shopping time for an item across individual participants for both Website A and B.

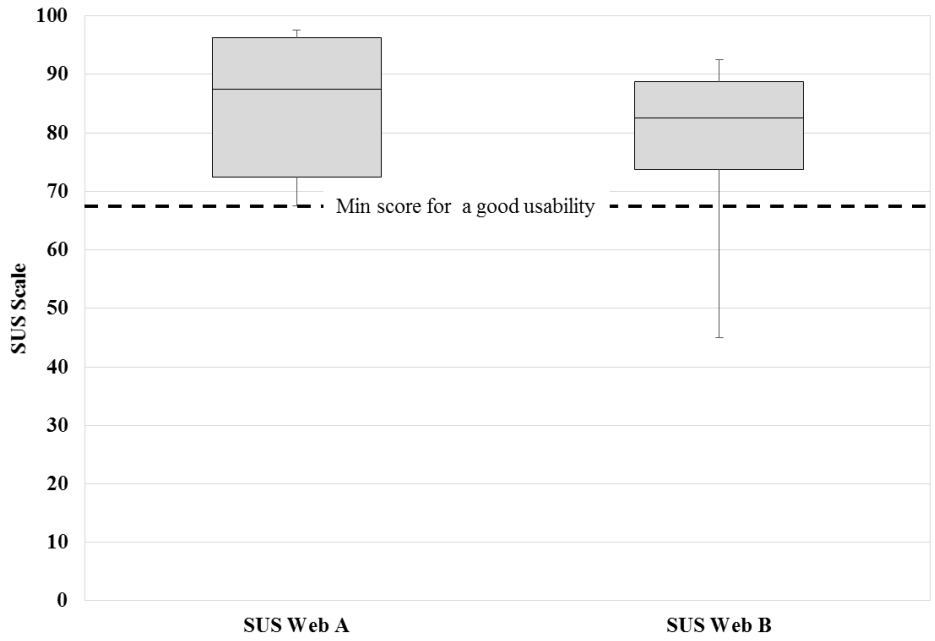


Fig 6.7 The SUS scores for Website A and B.

6.4.3 Rate and Rank

As mentioned in section 6.3.2.4, participants were asked to rate and rank the visual cues that were helpful for recognising the ‘add to cart’ button. The visual cues were: (1) a button of a different colour to other objects; (2) the button changed colour when the mouse pointer hovered over it; (3) an ‘add to cart’ label; (4) a ‘buy box’.

Cues were rated according to a five-point Likert scale, ranging from 1 (Strongly disagree) to 5 (Strongly Agree). The median rating for cues were calculated and are presented in Table 6.3.

Table 6.3 Rating Cues Scores

	Diff_colour	Hover_over	Label	Buy_box
C01	4	2	4	4
C02	5	3	5	4
C03	4	4	4	4
C04	5	1	5	5
C05	4	4	4	4
C06	5	5	5	5
C07	5	5	5	5
C08	5	5	5	5
C09	5	4	5	4
C10	5	5	5	5
C11	5	5	5	5
median	5.00	4.00	5.00	5.00

The results show that the scores skewed towards agree which indicate that all cues were helpful for recognising the ‘add to cart’ button. The ranking of the cues were further analysed to understand the most helpful among all the cues. The rank ranged from most helpful (1) to least helpful (4). In determining the overall rank position, each rank was first assigned a certain weight (see Table 6.4), and then the mean value of rank was compared across cues. The distribution of ranks and the overall rank for each design of cues are presented in Table 6.5.

Table 6.4 Weight Assigned for the Choice of Rank

Choice of rank	Weight
1	4
2	3
3	2
4	1

Table 6.5 Distribution of Ranks for Each Cue

	Rank 1	Rank 2	Rank 3	Rank 4	Mean	Overall rank
Diff_colour	1	5	3	2	2.45	3
Hover_over	1	1	3	6	1.72	4
Label	5	3	2	1	3.09	1
Buy box	4	2	3	2	2.72	2

6.4.4 Preferences

At the end of the session, as noted in section 6.3.2.4, printed versions of both websites were presented concurrently. Comments pertaining to likes and dislikes, which were explicitly noted on the printed version of the websites were analysed and grouped into categories (e.g. button, buy box, and colour). Samples of participants' comments are presented in Appendix 12. The participants were also asked to explicitly tick the website they would prefer to use, and the frequency of this preference was calculated.

Overall, the participants preferred Website A over Website B except for one participant (C03, female, aged 80), who preferred Website B, due to the fact that she liked better the grid design layout better, as she was used to seeing it rather than the horizontal list design. *"I think this [Website B, grid design] is more straightforward because …, according to my browsing [experience] at the library [it is similar] to what I [am] used to. This [Website A, list design] is [somewhat] new to me…it is … different [from what I am used to]"* (C03). Another participant (C11, female, aged 57) who preferred buying from Website A, also preferred items to be displayed in a grid layout, *"I would prefer to list the different items in [a] matrix [grid]"*.

Reasons for liking or disliking the design of both websites indicate various positive and negative comments, tabulated in Table 6.6. In total, 50 comments were extracted, with 34 positive comments and 16 negative comments; 31 out of the 34 positive comments (91%) were found to be associated with Website A, while 15 out of the 16 negative comments (94%) were linked to Website B. It can clearly be seen that positive comments dominated in annotations about Website A, which led to the overall preference for Website A over B. The participant who preferred Website B also provided positive comments about Website A. Among the most mentioned positive comments were 'prefer the menu to stay visible' (n = 5), and 'prefer list

design' (n = 4); negative comments were 'grid layout is confusing' (n = 3) and 'do not like the menu dissappearing' (n=3).

Table 6.6 Participants' Comments about their Likes and Dislikes of Website A and B

Websites	Objects	Comments
Website A	Button	+ symbol of the shopping cart is helpful
		+ label is very clear
	Buy box	+ bright colours of buy box make it easy to understand
		+ box design (bright colour – yellow) makes the price very clear
	Cart	+ shopping cart panel is helpful
		+ like the green colour (graphical navigation +/-)
	Colour	+ colour stands out (renders the 'add to cart' button clearly)
		+ prefer bright colours
		+ colourful web page as the colours help to observe the price clearly and to make a decision of buying quickly
		+ like the colour scheme
	Feedback	+ good view
		+ like the option to seeing the cart (view cart notification)
		– label need to indicates item is added to cart as well as the navigational functions
	Layout	+ logical flow from left to right
		+ single item layout made the product information clearer
		+ prefer list design*
	Menu	+ like the menu that standout
		+ prefer the menu to stay visible*
	Offer sign	+ stands out well
		+ highlights items, representative of the physical world, like a sticker for in-store offers
	Price	+ price information is clear
	Text	+ bigger font is useful
		+ text is clear and easy to read
	Other	+ website is easy to follow
		+ images of different varieties (products) are very useful
		+ there is (clear) visibility in general
		+ clear print and background
Website B	Button	– do not like the grey background and white font, not easy tofind at first
	Cart	– should provide colour on '+/-' buttons on the cart (for contrast)
	Colour	– not good contrast, not clear
		– plain and boring
	Layout	+ grid layout is good
		– the grid layout is confusing*
	Menu	**– do not like the menu disappearing***

Offer sign	– not very obvious + prefer offer to be placed near the image (image is the first aspect that is observed)
Other	– the website did not clearly differentiate places to pinpoint – less visibility (not clear) in general

Notes: '+' indicates positive comment, '–' indicates negative comment
'*' similar comments across participants, n > = 3

6.4.5 Additional Observations

Interesting incidents were observed that were similar to findings in previous study (see Chapter 3). All non-experienced users (C01, C03, C04, and C07) were observed to clicking on images, reviews, or titles while trying to add an item to their cart. This action was also observed to have occurred with two experienced users (C08, and C11). During the shopping task sessions, no direct assistance was provided to show how to complete the task; however, when participants appeared to seek assistance, for example, *"What [do] I need to click on?"*, encouragement such as *"You could try"* was provided. Interaction was kept to a minimum, as the task was timed. All participants were able to find the 'add to cart' button.

Another incident was finding an item in a different pre-defined item category. Two participants (non-experienced (C07) and experienced (C06)) were observed searching for tea in the 'food cupboard' category, because tea was kept in a cupboard in their home.

6.5 Discussion

It was hypothesised that user performance and preferences would be better in the case of Website A, which had a 'senior-friendly' design, compared to Website B, which had a 'senior-unfriendly' design. The results supported this hypothesis. Furthermore, the exercise participants explicitly expressing their opinions about the designs provided insight as to the specific designs that would be helpful for older users.

It is evident that in a website environment that was not 'senior-friendly', the task and website were still perceived as easy and good by older users, based on their subjective opinions (i.e. SEQ and SUS scores). However, data on performance (i.e.

time taken) indicated a somewhat better result for a website that was designed with ‘senior-friendly’ features. It should be noted that in the digital world, a 44-second or 13-second of time difference, is significant, particularly in the business industry as businesses are generate money every second. Companies such as Apple, JPMorgan Chase and Berkshire Hathaway were reported made profits per second as high as $1,444.76, $782.14 and $761.30, respectively [33]. In addition, when printed copies of both websites were presented at the same time, the high number of positive comments for the ‘senior-friendly’ website indicated that the design as favourable. Thus, website designs should take into consideration the advantages indicated by the ‘senior-friendly’ design, as older users may perform better using it, and because it was preferred more than the ‘senior-unfriendly’ design.

In addition, by employing a ‘sticky’ menu, users can perform faster; they also mentioned that this makes navigation seem easier, because the menu was always visible to them. Accordingly, it is suggested that, in the case of an important object that is frequently accessed by users, the design of this object should always be visible to users, regardless how far they scrolled down a web page. This finding corresponds to a study [34] that compared navigation conditions (i.e. navigation disappears when scrolling, navigation can (partially) disappear when scrolling, and navigation is always visible when scrolling), and found that navigation that is always visible demonstrated the highest performance.

In the current study, older adults were found to perform better when using a ‘senior-friendly’ website; however, their performance was still slower than that of younger people, as reported in the literature. The average time older users took to buy an item was 39 seconds using a ‘senior-friendly’ design and 52 seconds using a ‘senior-unfriendly’ design; these times were double or triple the time taken by younger shoppers (19 seconds) [35]. This difference may simply be the result of the deterioration of human abilities with age, and causing older adults to perform slower than younger people [36], [37].

On the other hand, a very experienced participant, who bought almost everything online and also stated informally that they had been using online grocery shopping sites for 16 years, recorded an average shopping time of 17 seconds for both websites. This result indicates that older adults can compete with younger users if they are experienced with technology.

The results also showed the potential of a ‘buy box’ design for use as a means to attract user attention to an important element on a website. The present study found that the use of appropriate colours can enhance the colour contrasts of objects within the box, and make these objects to stand out. Appropriate colour use was mentioned as being able to attract user attention, and to create uniqueness [6]. Although not explicitly mentioned by participants, the analysis found that some comments about Website A may indirectly have resulted from the use of a ‘buy box’ design, particularly comments that related to colours, such as *“prefer bright colours”*, *“colours made it a lot clearer”* and *“stands out”* which resulted in better contrast, particularly for the ‘add to cart’ button. It should be noted that the ‘buy box’ had been designed using a bright yellow colour, which may have improved the ‘highlighting’ of objects within the ‘buy box’. It can be concluded here that, although the ‘buy box’ design may not directly improve attention per se, the right use of colour combinations within the box can potentially create opportunities for the objects within the box to *“stand out”* , making them more obvious to users.

In addition, important and related objects being grouped together may have eased decision-making. For example, in this study, quantity selection, price, and the ‘add’ button were grouped together within the ‘buy box’. A participant mentioned that this helped him to *“[quickly] make a [purchasing] decision”*.

6.6 Conclusion

The results of this study indicate that older adults are still able to use a website with a ‘senior-unfriendly’ design; however, with a ‘senior-friendly’ design, their performance improved. Thus, this study provides empirical evidence for the benefits that a ‘senior-friendly’ website design can have on the performance of older adults, particularly for e-commerce websites, because time is considered value for money in the fast-paced electronic world. Such a ‘senior-friendly’ design includes the notion that objects that are important and frequently accessed (e.g. the ‘main menu’) always remain visible to users. An additional design element that was shown to have the potential to assist older users is the use of a ‘buy box’ for enhancing contrast on the web page, which can help to attract user attention to an important object such as an ‘add to cart’ button.

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Chapter 7:

Conclusion

7.1 General Discussion and Conclusion

This research aimed to understand older adults' navigation of online shopping technology, in particular the challenges faced in online grocery shopping sites, and investigated possible interface designs that could help ease older adults' navigation. With a view towards achieving the research objectives, four studies were conducted, three of which involved a total of 40 older adults, aged from 52 to 80 years (with both a mean and median of 67 years).

Keyboard and mouse use can be problematic when fine motor skills deteriorate with age [1]; however, whether or not this was experienced by the online shoppers in this research, the majority of older adults who volunteered used desktops (50%) and laptops (33%), both of which usually come with a keyboard and mouse as their main input devices, as opposed to mobile devices and touchscreens, meaning they were representative of the target population.

The adoption of online grocery shopping was low among the older adults who volunteered and it was found that only 30% of the 33 participants with any online shopping experience used it for groceries. Although the number of current users was low, a general interest in online grocery shopping usage was expressed by the participants.

7.1.1 Older Adults' Navigation and Difficulties

This section discusses the first research question: How do older adults navigate in an online grocery shopping site and what difficulties do they encounter?

Prior experience seems to influence user performance with technology and, as summarised in [1], computer experience can specifically influence the use of user interfaces. In this research, it was found that inexperienced users encountered more difficulties; for example, in the first study, all inexperienced participants demonstrated complex navigation patterns with longer navigation paths, loop presence, and many extraneous nodes (e.g. errors). This corresponded to the observation made in [2], where inexperienced users displayed a trial-and-error approach, which was slow, repetitive and error-prone. By contrast, experienced users exhibited simple and straightforward navigation with little or no difficulties using the website, perhaps because they had developed a familiarity with the use of the same or similar

technology. This possible familiarity has also been suggested to improve performance [3], [4].

Numerous difficulties among older adults were discussed in Section 3.5.3, including difficulty identifying the ‘add to cart’ button, and were found to be more pronounced with inexperienced than experienced users, with the former group misunderstanding buttons and clicking on images, titles, reviews, notification messages, or labels. Other difficulties included finding items within a website’s predefined item categories, finding the main menu, changing default settings, and difficulties with identifying offers. These difficulties reflected the characteristics of disorientation, where the participants seemed to be unable to find what they wanted or had trouble knowing where to go next. This disorientation may have been caused by the users’ low level of computer experience, which may in turn, have influenced their effectiveness and performance [5]. This research also demonstrated that inexperienced users took a longer time to perform tasks than experienced users.

An exceptional incident was observed in the last study (Chapter 6) where a user with 16 years of online grocery shopping experience took an average of only 17 seconds to navigate both ‘senior-friendly’ and ‘senior-unfriendly’ websites, compared to an average time of 39 seconds (‘senior-friendly’) and 52 seconds (‘senior-unfriendly’) across all participants. This supports the notion that experience is important, as with relevant experience, despite age, users’ performance can be fast. This finding seems to be consistent with other studies, which found that performance reduces with age, but is better when users possess experience and prior knowledge of a website [6].

In summary, this research contributes to the knowledge of older adults’ navigation of e-commerce websites, especially of online grocery shopping sites. The empirical data shows that inexperienced users may take longer to perform tasks and encountered more of navigational difficulties than experienced users. The navigation difficulties observed in older adults included:

- Identifying the ‘add to cart’ button.
- Finding items in the website’s predefined item categories.
- Finding the main menu.
- Changing the default settings.
- Identifying offers.
- Clicking on targets.

7.1.2 Designs that Help Older Users' Navigation

This section discusses the second research question: Are there designs that can help older users' navigation on online shopping websites?

In this research, designs were implemented in accordance with the available guidelines and principles for designing 'senior-friendly' website; for example, the use of text of at least 12 points in size to ease reading, different colours for important objects to make them stand out, high colour contrast, appropriate labels for buttons (e.g. the use of a 'verb' to signal action and a combination of symbol/icon). This research has provided data on the extent to which 'senior-friendly' designs are effective in making websites more usable for older adults. It should be noted that whilst, in this research, these 'senior-friendly' designs were adopted only for e-commerce websites, they should be applicable more generally to other domains of websites.

On the other hand, although it is advised that website designs be 'senior-friendly' to enable older users to access them more easily, the adults involved in these studies were still found to be able to use websites that were not considered 'senior-friendly', albeit at a lower performance level. In this research, it was found that the time taken to complete tasks was faster with the 'senior-friendly' website than the 'senior-unfriendly' website, and these findings were consistent with the study in [7] that found 'senior-friendly' websites had high success rates of tasks performed.

In addition, through this research, a large number of positive comments (31 out of 34 – i.e. 91%) were received for the 'senior-friendly' website, while negative comments dominated the 'senior-unfriendly' website (15 out of 16 – i.e. 94%). This shows that the 'senior-friendly' design was perceived to be superior among older adults compared to the 'senior-unfriendly' design. The 'senior-friendly' design was perceived as "clear" and "helpful", and thus attracted the high number of positive comments received.

Objects that are important and frequently accessed (e.g. the main menu) should always be kept visible to users. This eases navigation and also leads to faster user performance. It was demonstrated through this research that users performed faster with websites implemented with a 'sticky' menu than a 'non-sticky' menu. Moreover, when the main menu was no longer visible after the users had scrolled down the page, especially with inexperienced users it was found that they would

mistake other links for the main menu or opt for the simplest solution and click the 'Back' button on the browser, which could entail more steps and time to complete each task compared to one-click access. The use of the 'Back' button was also reported in [8] where older users selected it to 'undo' (i.e. reverse) navigation steps or to cancel an operation when they had reached an unexpected location. It is possible that these older adults only act within the confines of what they directly see and perceive, and that this may have been the case with the hover-over cue that scored lowly and ranked last when users were asked whether it was helpful in identifying the 'add to cart' button. The hover-over function is only activated when the user moves or hovers the pointer over the trigger area, whereas other cues not requiring user interaction are visible simply by looking at the screen. Therefore, this hover-over feature may, therefore, not be noticeable to older adults in the beginning and may explain its being lowest-ranked in the study.

Designs of e-commerce websites can benefit from the contribution of the older adults in this research. Several objects were found to be important, and this information may be beneficial for designs requiring minimal information to be displayed on a screen (i.e. a limited display) such as mobile applications. In general, product images, prices, and 'add to cart' buttons were found to be important for all e-commerce websites, while a quantity selection was more prominent for a website with cheap and multiple-purchase items; but descriptions, reviews and shipping/return information were selected most frequently on websites with expensive and single purchase items. The 'add to cart' button, an important object on e-commerce websites, was also found to be placed by older adults in close proximity to the quantity selection, and/or price details.

Additionally, older adults were found to prefer a horizontal list design layout for displayed items which, for some, made the flow more logical to follow. It should be noted that the website developed was in the English language and that the participants were also fluent in English; thus, the format was set out from left to right, in accordance with the English reading system, and this familiarity may have made it easier for the older adults to use. Furthermore, this format has been reported to exert a low cognitive load [9] and, as such, a horizontal list should be applied more often, or otherwise included as an alternative layout option for older adults.

In this research, a 'buy box' design was tested by placing it underneath an important object, such as a 'call to action' button (i.e. 'add to cart') to draw the user's

attention towards an object. An appropriate colour contrast for objects within these boxes may also attract users' attention to objects such as an 'add to cart' button where older adults have mentioned terms such as 'attract', 'stands out', 'focus attention', and 'clearer'. This high colour contrast highlights objects within a 'buy box', thereby causing them to stand out.

Not only could the box design help highlight the objects within the box, but it might also be beneficial for grouping the essential elements for decision making. For instance, in this research, it was found that older adults always paired an 'add to cart' button with the quantity selection and/or the price of a product; thus, the box design could help group these three objects together.

In conclusion, this research contributes to the existing web design recommendations and may assist older users with website navigation. As discussed above, 'senior-friendly' designs can aid older users in this regard, and the research provides further evidence of how much more effectively and efficiently older users may perform with 'senior-friendly' versus 'senior-unfriendly' designs. From the designs that were found to be helpful in assisting older adults' navigation, the following elements were deemed essential:

1) Important and frequently accessed objects should always remain visible to the users.
2) A list design layout should be used but otherwise may be included as an alternative product display option.
3) The 'box' design may help enhance the visibility of buttons.
4) Appropriate 'add to cart' button designs are required for older adults (see Table 7.1).

Table 7.1 Appropriate 'Add to Cart' Button Designs for Older Adults

Criteria	Recommendations
Colour	Blue or black. Avoid red, if possible.
Location	Close to the quantity selection, and/or price and ideally grouped in a box.
Contrast ratio	Minimum of 4.5:1 contrast ratio between the text label and button colour – e.g. shade of blue (#3333cc) vs white (#FFFFFF) with contrast ratio of 8.45:1
Label	Include both icon (e.g. trolley) and text (e.g. 'Add to cart').
Font size	Large – e.g. 14 points
Button size	Large enough to click on.
Feedback	Provide clear notification/visual feedback when an item has been added to the cart.

7.2 Limitations and Future Work

Due to the challenging recruitment of older participants in this research, the number of volunteers participating could have been larger. With a larger population, the study's findings – such as the particular difficulties experienced among the older adult volunteers – could have been generalised to a more diverse population of older adults.

Although various strategies were employed for the recruitment, such as the distribution of posters on public notice boards, in libraries, and in older adults' clubs face-to-face recruitment, postal and email advertisements, the process was still slow and outside of the researcher's control. There were several occasions when invitations to participate were rejected with negative responses such as *"No, I don't do online shopping"* and it may be that older adults are sceptical about online shopping due to its perceived risks [10], [11]. Furthermore, it seems to be harder to recruit inexperienced online shoppers than experienced ones amongst the older population. With statistics revealing a significant increase recently in online shopping activities (16% in 2008 and as much as 48% in 2018) among older adults in Great Britain [12], this increase may explain the low number of inexperienced users amongst the volunteers in this research.

Acknowledging that the samples were small and may not be representative of the broader population of older adults may mean that, rather than leading to a comprehensive conclusion about older adults' navigation difficulties or recommendations for appropriate website designs for older users, the research findings may instead act as a starting point for further studies to be conducted with a greater number of samples to contribute to the existing body of knowledge. Although the number of volunteers was relatively small, knowledge gained still proved very valuable; this included knowledge of designs, navigation, performances, and preferences with regard to older adults in the context of e-commerce websites.

Some of the better designs identified in this research (e.g. the 'buy box' and 'add to cart' buttons) should also be tested on younger users. This investigation may provide an understanding as to whether such designs that are appropriate for older people may also work well with younger users. This information could then contribute to universal designs for both the young and old.

Although this research was mainly conducted on desktops and laptops, it is recommended that subsequent studies be expanded to other devices such as tablets and smartphones, as these were also reported to be used by the older adults in this research. This might therefore determine whether or not the difficulties found in this research are also common to other devices.

This research found that the online items purchased most frequently by older adults included tickets for events, holiday accommodation and travel arrangements. Thus, similar research could be extended to related websites and explore how these are used and what difficulties are encountered during navigation, which could then inform necessary improvements.

In this research, the 'buy box' design demonstrated the potential to improve user navigation, being favoured by older users due to the superior visibility of its objects, providing that the colour contrast ratios are appropriate for older adults. A thorough investigation of this design could explore its effectiveness and efficiency and also provide an understanding as to the possible extent of its use and under what conditions it might be most appropriate.

Technologies evolve over time. A gap in older adults' abilities to use the latest technologies is inevitable with constant advancements. This gap could be minimised with improved designs and tools to cater to the needs and abilities of these older adults [13]. Consequently, evaluations of existing technology against guidelines for older adults as well as an understanding of how they use this technology need to be carried out at the present time and also in the future.

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Appendices

Appendix 1:

Study 1 – Participant Information Sheet, Consent Form

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INFORMATION SHEET

Project Title:

Investigating Older Adults' Navigation Behaviours and Challenges in Online Grocery Shopping

What is the purpose of the study?

The purpose of this study is to investigate how older adults navigate through a grocery shopping website and what are the enablers and barriers to online grocery shopping.

Can I participate?

We are looking for volunteers who

- are 65+ years old,
- have at least basic computer skills,
- may or may not have online shopping or online grocery shopping experience,
- have normal or corrected-to-normal vision (e.g. with eyeglasses, contact lenses or laser eye treatment),
- do not have any diagnosed cognitive impairments (e.g. dementia),
- do not have any physical impairments that give rise to difficulties with using a computer, and
- are available for approximately 1 hour to 1.5 hours.

Participants will need to be able to understand verbal explanations and written information in English.

What will I be asked to do?

You will be asked to find a number of items from a given shopping list via an online grocery shopping site. You do not need any experience with online shopping, but you will need to have basic computer skills (able to use mouse and keyboard). Your interaction with the website will be video recorded and logged by the computer.

As this study focuses on the navigation aspects of online shopping rather than potential barriers related to making online payments, you will not be asked to pay for any shopping. The task will finish when all items on the list have been added to the shopping cart.

After you have finished the shopping, we will ask you some questions about how you found the task, for example, what you liked or did not like. The session will end with a short survey on how you feel about the website that you have just used to do the shopping.

The entire session should take approximately 1 hour to 1.5 hours of your time.

What data will be collected, and how will it be used?

The computer will logged your interaction with the website. With your permission, we will also video and audio record the shopping and interview session.

The data collected in this study will be used for scientific purposes and may be published. The results may also contribute to the attainment of a qualification at the University of Reading.

Where will the studies take place?

The study will take place at the University of Reading Whiteknights campus. The researchers will contact you to provide further details of where you will need to go, and to arrange a time slot for you.

What if I do not wish to complete the study?

Participation is entirely voluntary, and you can withdraw at any time without giving a reason.

Will my data be kept anonymous?

You will be asked to provide your name and contact details, and to sign a consent form so that the University can keep a record of your participation in the study. However, data from the study will be stored, processed, and reported using an anonymous user ID.

The audio and video recordings will also be saved using an anonymous user ID. It is possible that you could be identified from the contents of the recordings, however, these recordings will be used only for data analysis by the research team, and will not be shared without your explicit consent.

Are there any benefits/risks to taking part [e.g. health]?

We do not expect that this project will directly benefit you. However, it may benefit you in the future, as the tools developed from this study could lead to websites that are easier to use. You may also gain some experience or knowledge of online grocery shopping.

There are no risks beyond the risks of normal day-to-day living associated with your participation in this project.

Can I learn the results of the study?

If you would like to learn the results at the end of the study, please contact the researchers.

Who are the researchers responsible for this study?

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Please feel free to contact us if you have questions about this study.

This project has been subject to ethical review, according to the procedures specified by the University Research Ethics Committee, and has been given a favourable ethical opinion for conduct.

University of Reading

Consent Form

1. I have read and had explained to me by ……..…

   the accompanying Information Sheet relating to the project on:

   "Investigating Older Adults' Navigation Behaviours and Challenges in Online Grocery Shopping"

2. I have had explained to me the purposes of the project and what will be required of me, and any questions I have had have been answered to my satisfaction. I agree to the arrangements described in the Information Sheet in so far as they relate to my participation.

3. I understand that participation is entirely voluntary and that I have the right to withdraw from the project any time, and that this will be without detriment.

4. I agree to the interview/session being **video and audio** recorded.

5. I agree for the video and/or audio to be used in presentations and publications.

   ☐ WITHOUT anonymisation.

   ☐ if my face is anonymized (e.g. blurred out).

   OR

   ☐ I DO NOT agree for the video and/or audio to be used in presentations nor publications.

6. This application has been reviewed by the University Research Ethics Committee and has been given a favourable ethical opinion for conduct.

7. I have received a copy of this Consent Form and of the accompanying Information Sheet.

Name: …… Date of birth: ……/……/……

Signed: …….. Today's date: ……/……/……

Appendix 2:

User Characteristics Questionnaire

User ID : _____ **Age: _____**

Gender

Male ( )

Female ( )

Prefer not to say ( )

Level of Education

Less than Secondary School ( )

Secondary School Graduate ( )

Vocational Training/College ( )

Bachelor Degree ( )

Postgraduate ( )

Occupation / Previous Occupation : _____

How often do you use the following devices?
(Please tick accordingly)

	Every day	Every 2-3 days	Once a week	Once a month	Rarely	Never
a. Desktop computer						
b. Laptop						
c. Tablet (e.g. iPad)						
d. Smartphone (e.g. iPhone)						
e. Other. Please specify						

Which device(s) do you own and how long have you had them?

(Please tick accordingly)

	Less 1 year	1 year	2 years	3 years	4 year +	Never
a. Desktop computer						
b. Laptop						
c. Tablet (e.g. iPad						
d. Smartphone (e.g. iPhone)						
e. Other. Please specify						

How often do you access the Internet?

Every day ( )

Every 2 - 3 days ( )

Once a week ( )

Once a month ( )

Rarely ( )

Never ( )

What main device do you use to access the Internet?

Desktop computer ( )

Laptop ( )

Tablet (e.g. ipad) ( )

Smart Phone (e.g. iphone) ( )

Other. Please specify _____

What do you use the Internet for?

(Tick all that apply)

Work	( )
News	( )
Health information	( )
Spiritual information	( )
Shopping	( )
Entertainment	( )
Communication (email/skype/social network sites (e.g. Facebook, Twitter))	( )
I don't use the Internet	( )
Other. Please specify	_____

What do you buy over the Internet?

(Tick all that apply)

Clothes	( )
Sport goods	( )
Household goods (e.g. furniture, toys)	( )
Travel arrangement (e.g. transport tickets, car hire)	( )
Holiday accommodation	( )
Tickets for events	( )
Film, music (including download)	( )
Books, magazines, newspapers (including e-book and downloads)	( )
Food or groceries	( )
Electronic equipment (e.g. camera)	( )
Computer hardware, software (including downloads)	( )
Shares purchases, insurance policies	( )
Telecommunication services (e.g. pay as you go)	( )
Medicine	( )
E-learning material	( )
Other. Please specify	_____

Which website(s) do you use for browsing the intended item(s) to purchase?

(Tick all that apply)

Amazon	( )
Argos	( )
Apple	( )
Tesco	( )
Netflix	( )
Asda	( )
Currys	( )
Next	( )
John Lewis	( )
trainline.com	( )
Expedia	( )
Easy Jet	( )
B&Q	( )
Boots	( )
Debenhams	( )
Thomson	( )
National Rail	( )
E-bay	( )
Other. Please specify	_____

How often do you do you shop for groceries (online or in-store)?

Daily ( )

More than once a week ( )

Weekly ( )

Monthly ( )

Never ( )

How do you get your groceries?

(Tick all that apply)

In-store groceries shopping ( )

Online groceries shopping ( )

Not Applicable ( )

Other. Please specify _____

If you shop in-store, how much time do you typically spend each time you shop?

Less than 20 minutes ( )

20 - 40 minutes ( )

40 – 60 minutes ( )

More than 60 minutes ( )

Not applicable ( )

If you shop online, which online grocery shopping site do you mainly use to do your grocery shopping?

Tesco ( )

Sainsbury's ( )

Asda ( )

Morrisons ( )

Co-operative ( )

Others ( )

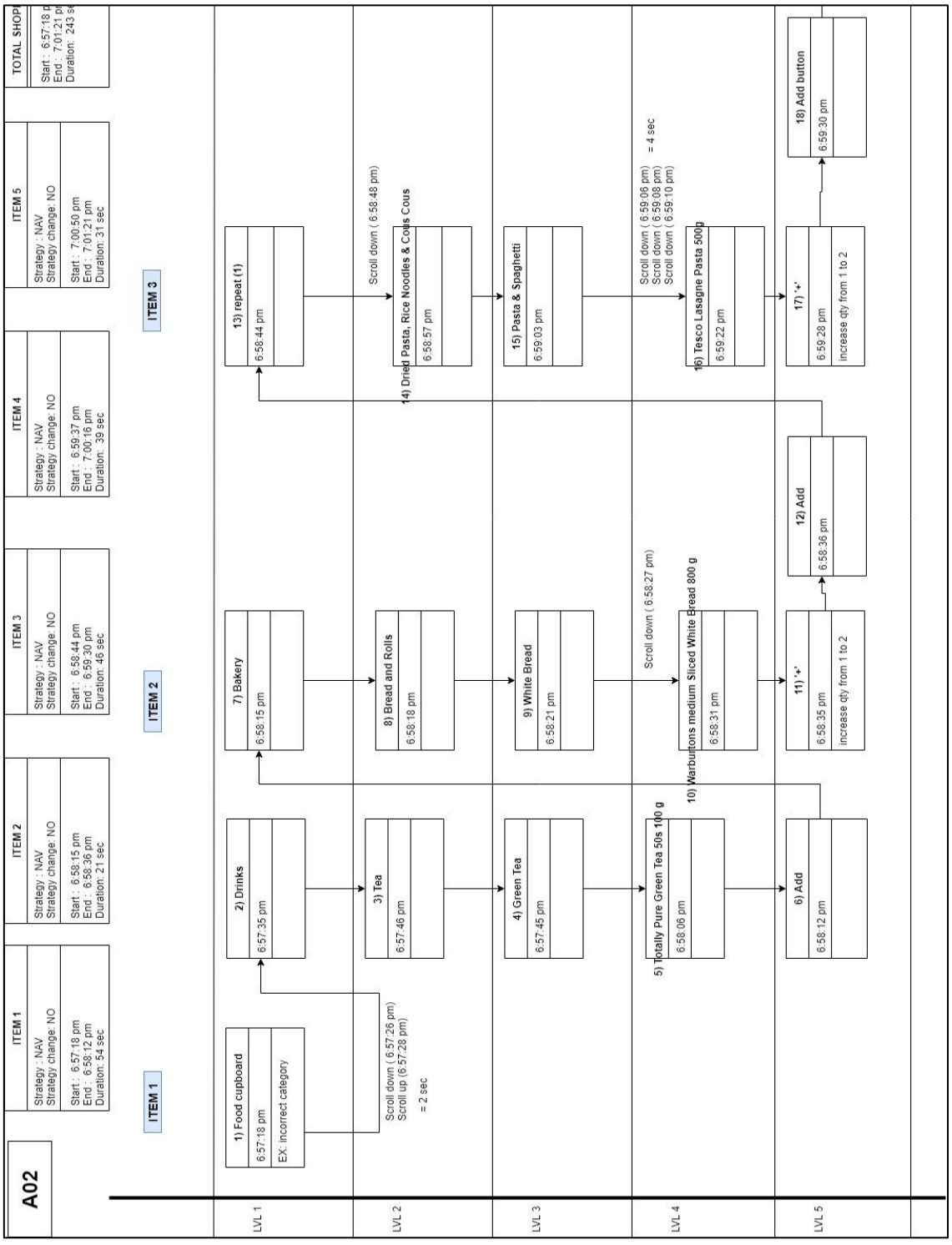
Not applicable ( )

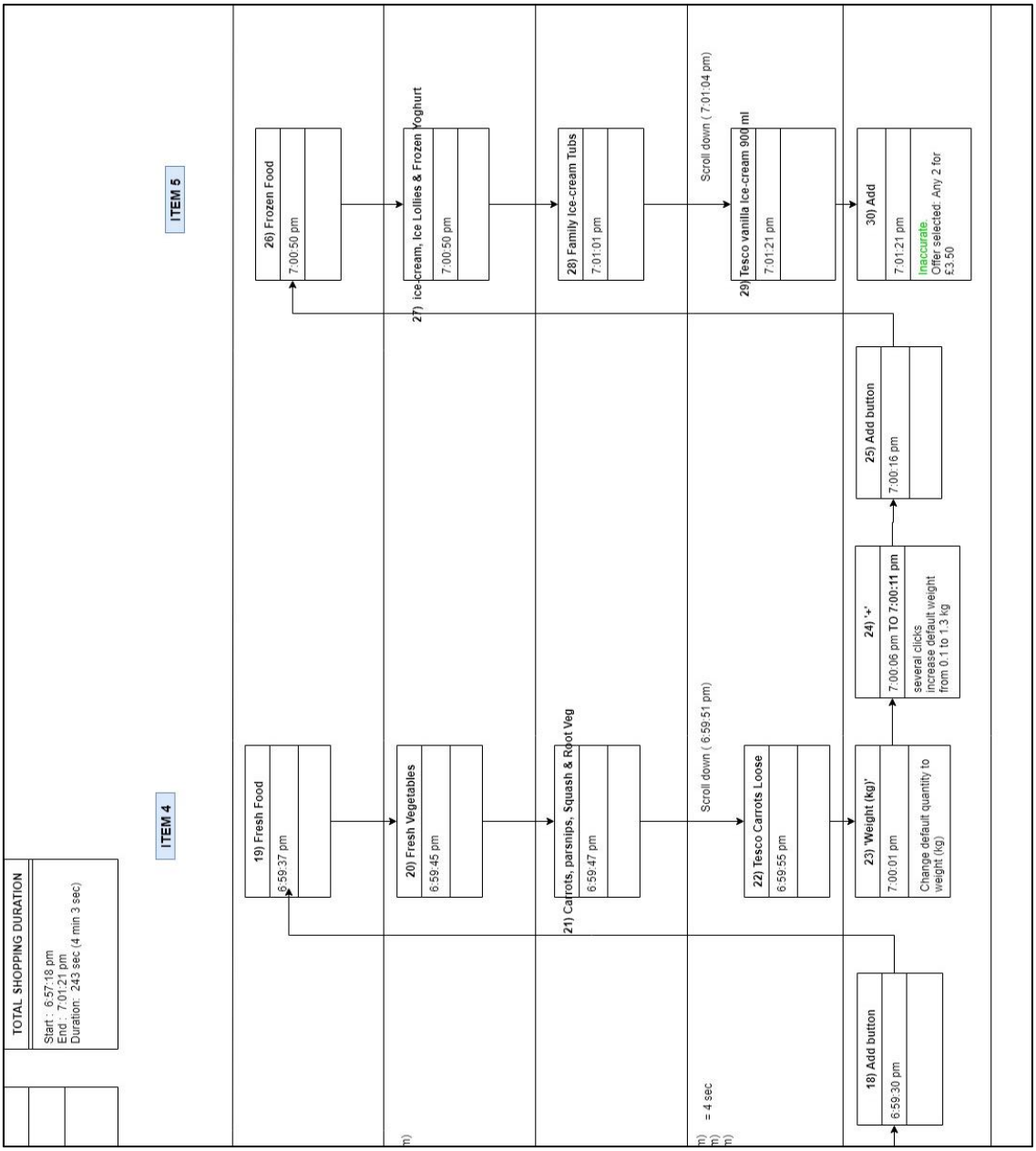
Thank you for taking the time to complete this form.

Appendix 3:

Samples of Navigation Path Map

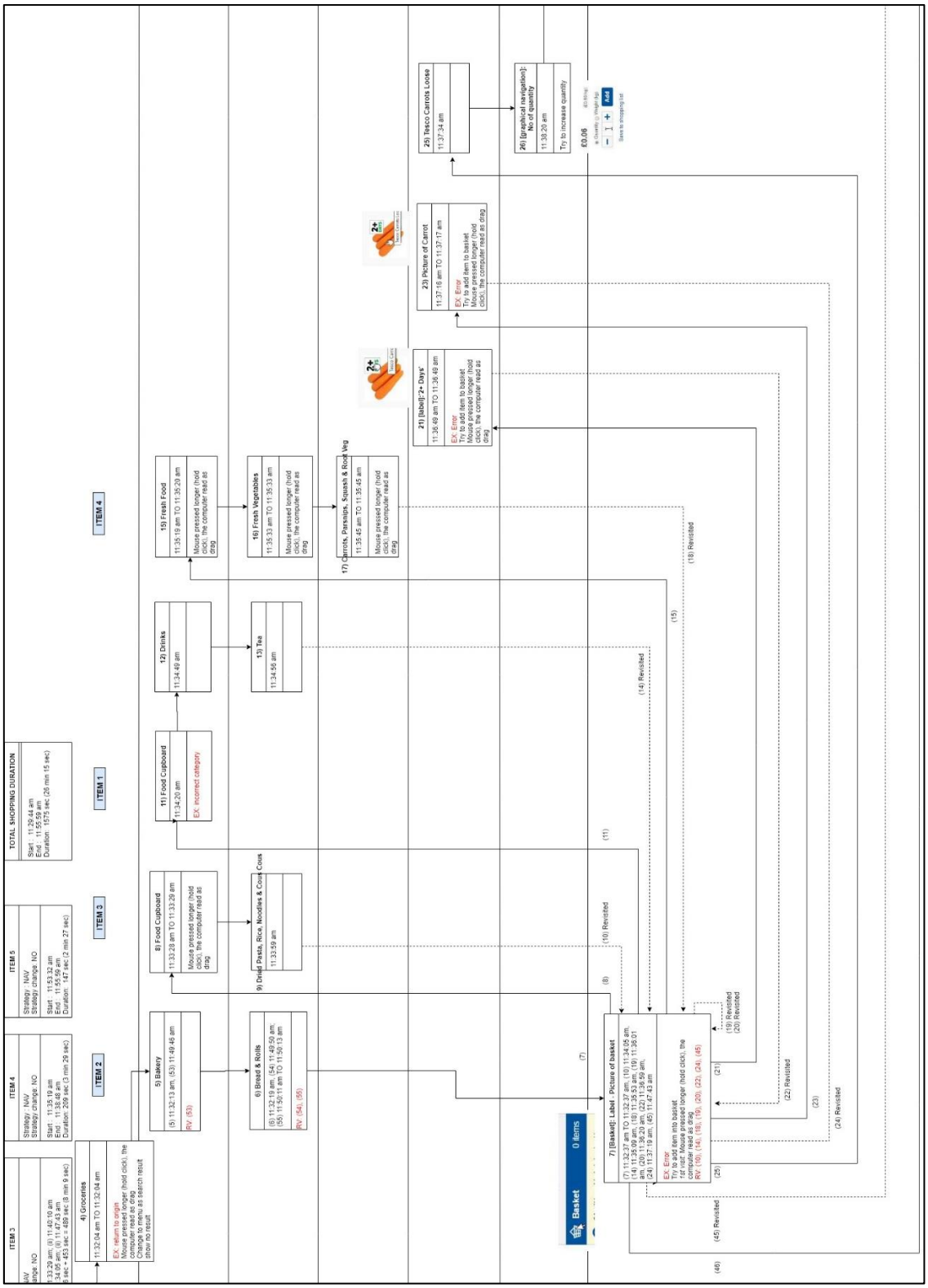
A Sample of Participant's Navigation Path Map with Simple Navigation



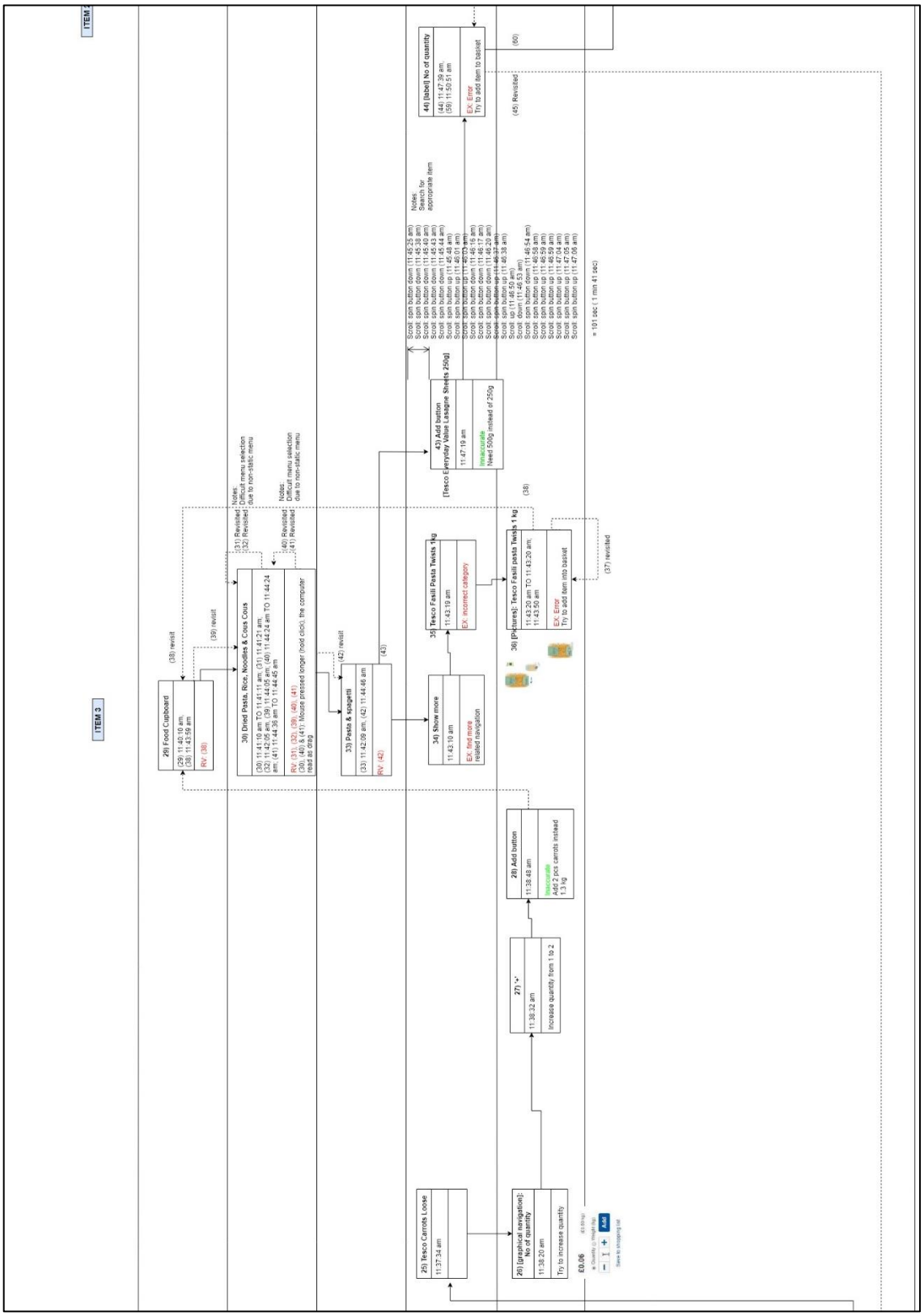

TOTAL SHOPPING DURATION
Start : 6:57:18 pm
End : 7:01:21 pm
Duration: 243 sec (4 min 3 sec)
ITEM 4
ITEM 5
18) Add button
6:59:30 pm
19) Fresh Food
6:59:37 pm
20) Fresh Vegetables
6:59:45 pm
21) Carrots, parsnips, Squash & Root Veg
6:59:47 pm
Scroll down (6:59:51 pm)
22) Tesco Carrots Loose
6:59:55 pm
23) 'Weight (kg)'
7:00:01 pm
Change default quantity to weight (kg)
24) '+'
7:00:06 pm TO 7:00:11 pm
several clicks
increase default weight
from 0.1 to 1.3 kg
25) Add button
7:00:16 pm
26) Frozen Food
7:00:50 pm
27) ice-cream, Ice Lollies & Frozen Yoghurt
7:00:50 pm
28) Family Ice-cream Tubs
7:01:01 pm
Scroll down (7:01:04 pm)
29) Tesco vanilla Ice-cream 900 ml
7:01:21 pm
30) Add
7:01:21 pm
Inaccurate:
Offer selected: Any 2 for £3.50
= 4 sec

Samples of Exerts from a Participant's Navigation Path Map with Complex Navigation

Exert 1:



Exert 2:


ITEM 3
29) Food Cupboard
(29) 11:40:10 am;
(38) 11:43:59 am
RV: (38)
(38) revisit
(39) revisit
30) Dried Pasta, Rice, Noodles & Cous Cous
(30) 11:41:10 am TO 11:41:11 am; (31) 11:41:21 am;
(32) 11:42:36 am; (39) 11:44:45 am; (40) 11:44:24 am TO 11:44:24 am;
(41) 11:44:36 am TO 11:44:45 am
RV: (31), (32), (39), (40), (41)
(30), (40) & (41): Mouse pressed longer (hold click), the computer reads as drag
Notes:
Difficult menu selection due to non-static menu
(31) Revisited;
(32) Revisited;
Notes:
Difficult menu selection due to non-static menu
(40) Revisited;
(41) Revisited;
33) Pasta & spagetti
(33) 11:42:09 am, (42) 11:44:46 am
RV: (42)
(42) revisit
(43)
34) Show more
11:43:10 am
EX: tied more
reailed navigation
35) Tesco Fasili Pasta Twists 1kg
11:43:19 am
EX: incorrect category
36) [Paranel]: Tesco Fasili pasta Twists 1 kg
11:43:20 am TO 11:43:20 am;
11:43:36 am
EX: Error
Try to add item into basket
(38)
(37) revisited
43) Add button
[Tesco Everyday Value Lasagne Sheets 250g]
11:47:19 am
Inaccurate
Need 500g instead of 350g
Notes:
Search for apporopriate item
Scroll spin button down (11:45:25 am)
Scroll spin button down (11:45:38 am)
Scroll spin button down (11:45:43 am)
Scroll spin button down (11:45:43 am)
Scroll spin button down (11:45:44 am)
Scroll spin button up (11:45:48 am)
Scroll spin button up (11:45:49 am)
Scroll spin button up (11:46:03 am)
Scroll spin button down (11:46:15 am)
Scroll spin button down (11:46:17 am)
Scroll spin button down (11:46:29 am)
Scroll spin button up (11:46:33 am)
Scroll spin button up (11:46:37 am)
Scroll up (11:46:59 am)
Scroll down (11:46:53 am)
Scroll spin button down (11:46:54 am)
Scroll spin button up (11:46:58 am)
Scroll spin button up (11:46:59 am)
Scroll spin button up (11:47:03 am)
Scroll spin button up (11:47:04 am)
Scroll spin button up (11:47:05 am)
Scroll spin button up (11:47:06 am)
= 101 sec (1 min 41 sec)
(45) Revisited
(60)
44) [label] No of quantity
(44) 11:47:39 am;
(59) 11:50:51 am
EX: Error
Try to add item to basket
28) Add button
11:38:48 am
Inaccurate
Add 2 pcs carrots instead 1.3 kg
27) +
11:38:32 am
increase quantity from 1 to 2
26) [graphical navigation]: No of quantity
11:38:20 am
Try to increase quantity
25) Tesco Carrots Loose
11:37:34 am
£0.06
Add

Appendix 4:

List of Selected E-Commerce Websites for Evaluation

Web ID	URL
w1	wineshop.hunters.co.nz
w2	http://makersmarket.us/
w3	www.spyder.com
w4	https://www.thelittlesparrow.com.au/
w5	https://www.hardgraft.com/
w6	http://www.hoopsking.com/
w7	https://www.ettitude.com.au/
w8	https://www.koreessentials.com/
w9	http://www.mxserviceparts.com.au/
w10	https://www.nostalgicbulbs.com/
w11	http://ccrsport.com/
w12	http://sweetstampshop.com/
w13	https://www.armanifinewoodworking.com/
w14	http://www.gitligoods.com/
w15	http://www.meeaudio.com/
w16	http://www.blanki.com.au/
w17	http://www.ensafeco.com/
w18	http://www.nodpod.com/
w19	https://www.thenextbesthing.com/
w20	http://www.mariecatribs.com/
w21	oakstreetbootmakers.com
w22	https://jmandsons.com/
w23	http://www.kwikboymodz.com/
w24	https://faucetface.com/
w25	https://www.abelandcole.co.uk/
w26	https://www.laurelcrown.com/
w27	http://www.goodwoodhardware.com/
w28	https://www.housebound.us/
w29	https://www.popchartlab.com/
w30	http://www.karambit.com/
w31	http://www.braveleather.com/
w32	https://sierradesigns.com/

w33	https://www.longboardliving.com/
w34	https://www.sisuguard.com/
w35	http://shop.thedairyfairy.com/
w36	x-doria.com
w37	https://www.proreferee.com/
w38	http://worldseasonings.com/
w39	http://storeca.niko.com/
w40	http://socktips.com/
w41	www.reebok.com
w42	https://www.solostove.com/
w43	http://www.premiumteas.ca/
w44	https://skinnyties.com/
w45	http://www.toyfiesta.com.au/
w46	http://www.ventandcover.com/
w47	https://bellroy.com/
w48	https://www.boldandnoble.com/
w49	www.nitewatches.co.uk
w50	http://www.kap7.com/
w51	https://www.berkeywater.com/

Appendix 5:

Study 3 – Participant Information Sheet and Consent Form

Researcher (principal): Dr. Faustina Hwang
Email: f.hwang@reading.ac.uk
Phone: +44(0) 118 378 7668

Researcher (PhD Student): Rozianawaty Osman
Email: r.osman@pgr.reading.ac.uk

Biomedical Engineering Section,
School of Biological Sciences

Contact address:
University of Reading,
Whiteknights,
Reading, RG6 6AY

INFORMATION SHEET

Project Title:

Engaging Older Users in Designing E-commerce User Interfaces

What is the purpose of the study?

The purpose of this study is to co-design with older adults the user interfaces for two e-commerce websites – an online grocery shopping site and assistive technology shopping site. We would like to find out what elements should be included on the website and where they should be placed. We are interested in making e-commerce websites easier to use generally. This work is not being sponsored by any commercial company.

Can I participate?

We are looking for volunteers who

- are 50+ years old,
- have experience of going online,
- do not have any diagnosed cognitive impairments (e.g. dementia), and
- are available for approximately 1 to 1.5 hours.

Participants will need to be able to understand verbal explanations and written information in English.

What will I be asked to do?

In this study, we will provide you with paper print-outs of two web pages – an online grocery shopping site and an assistive technology shopping site. We will also provide you with print out of a range of web components such as product images, buttons, price tags, and others. The web pages will be blank initially and you will be asked to choose and place the components where you expect to see them.

You will also be asked to complete a brief questionnaire asking for information such as age, computer and web experience, and online shopping experience.

The entire session should take approximately 1 to 1.5 hours of your time.

What data will be collected, and how will it be used?

Data will be collected through the questionnaire and the design you created. With your permission, we will also video and audio record the session.

The data collected in this study will be used for academic purposes and may be published. The results may also contribute to the attainment of a qualification at the University of Reading.

Where will the studies take place?

You will be invited to come to the University of Reading (Whiteknights campus), or alternatively to meet at a public location that is more convenient for you (e.g. public library, community centre). A researcher will contact you to provide further details of where you will need to go, and to arrange a time slot for you.

What if I do not wish to complete the study?

Participation is entirely voluntary, and you can withdraw at any time without giving a reason and this will be without detriment.

Will my data be kept anonymous?

You will be asked to provide your name and contact details, and to sign a consent form so that the University can keep a record of your participation in the study. However, data from the study will be stored, processed, and reported using an anonymous user ID.

If you give your prior permission, the audio and video recordings will also be saved using an anonymous user ID. It is possible that you could be identified from the contents of the recordings, however, these recordings will be used only for data analysis by the research team, and will not be shared without your explicit consent.

Are there any benefits/risks to taking part [e.g. health]?

We do not expect that this project will benefit you directly. However, it may benefit you in the future, as the design input from this study could lead to websites that are easier to use. You may also gain some experience or knowledge of online shopping.

Can I learn the results of the study?

If you would like to learn the results at the end of the study, please contact the researchers.

Who are the researchers responsible for this study?

Rozianawaty Osman
PhD Student
+44(0) 7941 558036
r.osman@pgr.reading.ac.uk

Dr. Faustina Hwang
Associate Professor
+44(0) 118 378 7668
f.hwang@reading.ac.uk

Please feel free to contact us if you have questions about this study.

This project has been subject to ethical review, according to the procedures specified by the University Research Ethics Committee, and has been given a favourable ethical opinion for conduct.

University of Reading

Consent Form

1. I have read and had explained to me by ……..…

   the accompanying Information Sheet relating to the project on:

   "Engaging Older Users in Designing E-commerce User Interfaces"

8. I have had explained to me the purposes of the project and what will be required of me, and any questions I have had have been answered to my satisfaction. I agree to the arrangements described in the Information Sheet in so far as they relate to my participation.

9. I understand that participation is entirely voluntary and that I have the right to withdraw from the project anytime, and that this will be without detriment.

10. ☐ I agree to the session being **photograph, video and audio** recorded.

11. I agree for the video and/or audio to be used in presentations and publications.

    ☐ WITHOUT anonymisation.

    ☐ if my face is anonymized (e.g. blurred out).

    OR

    ☐ I DO NOT agree for the photos, video and/or audio to be used in presentations nor publications.

12. This application has been reviewed by the University Research Ethics Committee and has been given a favourable ethical opinion for conduct.

13. I have received a copy of this Consent Form and of the accompanying Information Sheet.

Name: …… Date of birth: ……/……/……

Signed: …….. Today's date: ……/……/……

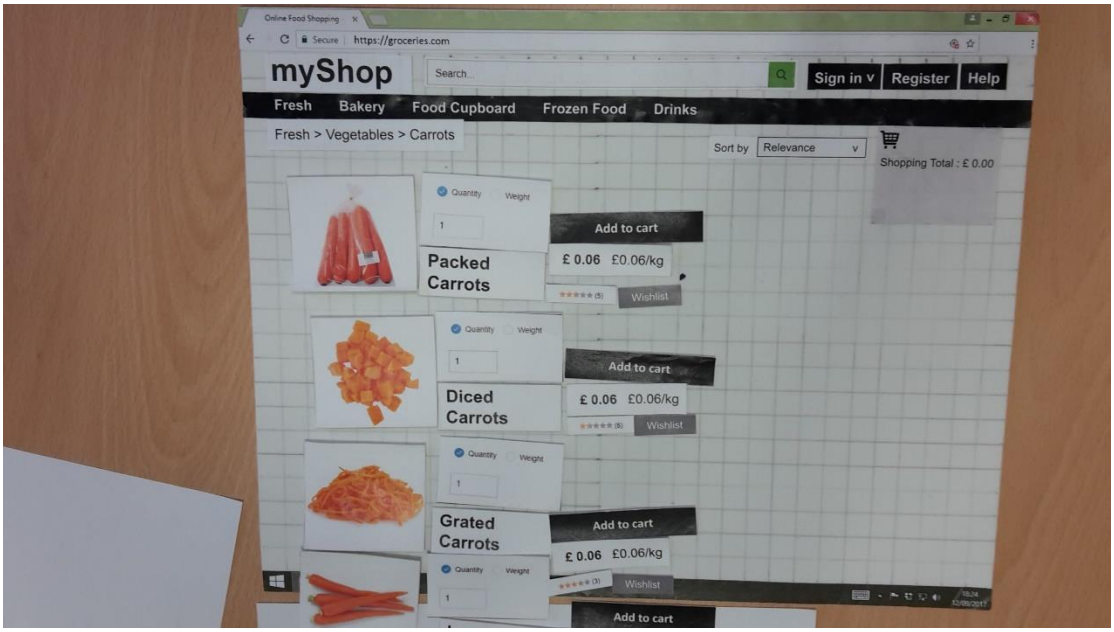
Appendix 6:

A Design Session of a Participant and His Designed Pages

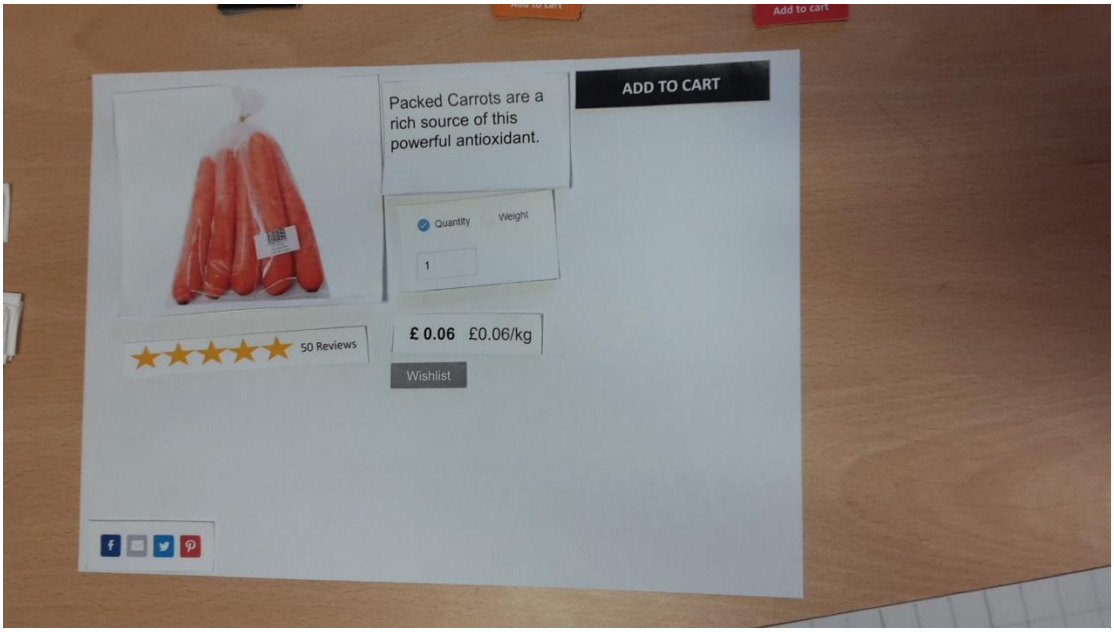
A Design Session with a Participant

Note: Photo published with explicit permission from the participant

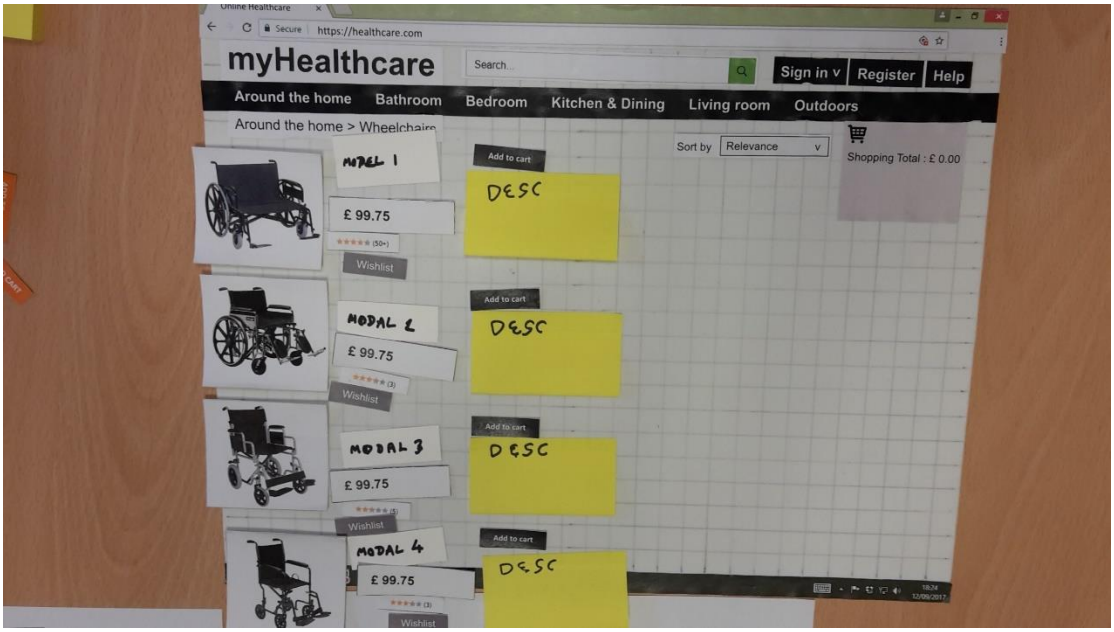
Designed Page for Carrots Item



Designed Additional Page for Carrots Item



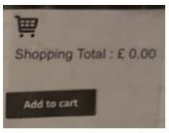
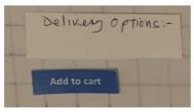
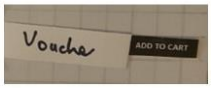
Designed Page for Wheelchair Item

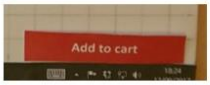
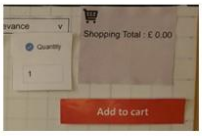


Designed Additional Page for Wheelchair Item

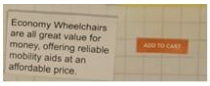
Appendix 7:

The Compilation of the Buttons' Location

				
B01_carrots ATC only one; within shopping cart area	B01_w/chair ATC only one; within shopping cart area	B02_carrots ATC close to selection	B02_w/chair ATC close to selection and price	B03_carrots ATC bottom page; no other object close
				
B03_w/chair ATC close to delivery option	B03_w/chairExt ATC close to shipping/return	B04_carrots ATC is at end of horizontal layout	B04_w/chair ATC close to voucher	B05_carrots ATC close to selection
				
B05_carrotsExt ATC close to selection	B05_w/chair ATC close to price	B06_carrots ATC close to selection	B06_w/chair ATC close to selection and wishlist	B07_carrots ATC only one; top left page

				
B07_w/chair ATC only one; bottom right	B08_carrots ATC close to selection and price	B08_w/chair ATC close to price	B09_carrots ATC close to selection	B09_carrotsExt ATC close to selection
				
B09_w/chair ATC close to delivery cost and compare	B010_carrots ATC close to review and shipping/return	B010_w/chair ATC close to selection and shopping cart	B011_carrots ATC close to selection	B011_carrotsExt ATC close to selection
				
B011_w/chair ATC close to selection	B011_w/chairExt ATC close to selection	B012_carrots ATC close to shopping cart	B012_w/chair ATC close to shopping cart	B013_carrots ATC close to selection

				
B013_w/chair No ATC; click to payment	B013_w/chairExt No ATC; payment button; bottom right	B014_carrots ATC close to selection and price	B014_carrotsExt ATC close to description	B014_w/chair ATC close to description
				
B014_w/chairExt ATC close to description	B015_carrots ATC close to selection	B015_w/chair ATC close to selection	B016_carrots ATC close to selection and links	B016_w/chair ATC close to price
				
B017_carrots ATC close to price	B017_w/chair ATC close to selection	B018_carrots ATC close to price	B018_w/chair ATC close to price	B019_carrots ATC close to selection

				
B019_w/chair ATC close to selection	B020_carrots ATC close to picture	B020_w/chair ATC close to description		

Appendix 8:

Study 4 – Participant Information Sheet and Consent Form

Researcher (principal): Dr. Faustina Hwang
Email: f.hwang@reading.ac.uk
Phone: +44(0) 118 378 7668

Researcher (PhD Student): Rozianawaty Osman
Email: r.osman@pgr.reading.ac.uk

Biomedical Engineering Section,
School of Biological Sciences

Contact address:
University of Reading,
Whiteknights,
Reading, RG6 6AY

INFORMATION SHEET

Project Title:

Evaluating a 'Senior-Friendly' Design of an Online Shopping Website

What is the purpose of the study?

The purpose of this study is to evaluate the usability of an online shopping website that has been co-designed with older adults, compared to one that incorporates features that are common in existing websites. We would like to find out which designs works to ease user navigation on websites as we are interested in making e-commerce websites easier to use generally. This work is not being sponsored by any commercial company.

Can I participate?

We are looking for volunteers who

- are 50+ years old,
- have no or very little experience of online puchasing,
- do not have any diagnosed cognitive impairments (e.g. dementia), and
- are available for approximately 1 to 1.5 hours.

Participants will need to be able to understand verbal explanations and written information in English.

What will I be asked to do?

First, you will also be asked to complete a brief questionnaire asking for information such as age, computer and web experience, and online shopping experience. Second, you will be asked to perform navigation tasks according to given instructions using the two websites mentioned above. Following the tasks, you will be asked to rate the tasks – how difficult you find the tasks. Third, again, using both websites, you will be asked to perform shopping tasks. You need to shop any five groceries items which are available within the website. Upon completion, you will be asked to complete short surveys on how you feel about the websites that you have just used to do the shopping. The entire session should take approximately 1 to 1.5 hours of your time.

What data will be collected, and how will it be used?

Data will be collected through the questionnaire and the design you created. With your permission, we will also video and audio record the session.

The data collected in this study will be used for academic purposes and may be published. The results may also contribute to the attainment of a qualification at the University of Reading.

Where will the studies take place?

You will be invited to come to the University of Reading (Whiteknights campus), or alternatively to meet at a public location that is more convenient for you (e.g. public library, community centre). A researcher will contact you to provide further details of where you will need to go, and to arrange a time slot for you.

What if I do not wish to complete the study?

Participation is entirely voluntary, and you can withdraw at any time without giving a reason and this will be without detriment.

Will my data be kept anonymous?

You will be asked to provide your name and contact details, and to sign a consent form so that the University can keep a record of your participation in the study. However, data from the study will be stored, processed, and reported using an anonymous user ID.

If you give your prior permission, the audio and video recordings will also be saved using an anonymous user ID. It is possible that you could be identified from the contents of the recordings, however, these recordings will be used only for data analysis by the research team, and will not be shared without your explicit consent.

Are there any benefits/risks to taking part [e.g. health]?

We do not expect that this project will benefit you directly. However, it may benefit you in the future, as the design input from this study could lead to websites that are easier to use. You may also gain some experience or knowledge of online shopping.

Can I learn the results of the study?

If you would like to learn the results at the end of the study, please contact the researchers.

Who are the researchers responsible for this study?

Rozianawaty Osman
PhD Student
+44(0) 7941 558036
r.osman@pgr.reading.ac.uk

Dr. Faustina Hwang
Associate Professor
+44(0) 118 378 7668
f.hwang@reading.ac.uk

Please feel free to contact us if you have questions about this study.

This project has been subject to ethical review, according to the procedures specified by the University Research Ethics Committee, and has been given a favourable ethical opinion for conduct.

University of Reading

Consent Form

1. I have read and had explained to me by ……..…

the accompanying Information Sheet relating to the project on:

"Evaluating a 'Senior-Friendly' Design of an Online Shopping Website"

14. I have had explained to me the purposes of the project and what will be required of me, and any questions I have had have been answered to my satisfaction. I agree to the arrangements described in the Information Sheet in so far as they relate to my participation.

15. I understand that participation is entirely voluntary and that I have the right to withdraw from the project anytime, and that this will be without detriment.

16. ☐ I agree to the session being **photographed, video and audio** recorded.

17. I agree for the video and/or audio to be used in presentations and publications.

☐ WITHOUT anonymisation.

OR

☐ if my face is anonymized (e.g. blurred out).

OR

☐ I DO NOT agree for the photos, video and/or audio to be used in presentations nor publications.

18. This application has been reviewed by the University Research Ethics Committee and has been given a favourable ethical opinion for conduct.

19. I have received a copy of this Consent Form and of the accompanying Information Sheet.

Name: …… Date of birth: ……/……/……

Signed: …….. Today's date: ……/……/……

Appendix 9:

Instructions for the Navigation Task

Navigation Task

You need to perform the following tasks, step-by-step.

The tasks:

1. Select ‘Fresh’ category from the main menu.
2. From the list, choose ‘Vegetables’.
3. Then choose ‘Garlic, Ginger, Onion, & Leek’.
4. Scroll to the end of the page.
5. Name the last item on the page.

   Answer: _____

6. Now, go to the main menu and select ‘Bakery’.
7. Select ‘Bread & Rolls’.
8. Then select ‘White Bread & Wholemeal Bread’.
9. Scroll to the end of the page.
10. Name the last item on the page.

    Answer: _____

11. Now, go to the main menu and select ‘Food Cupboard’.
12. Select ‘Dessert’
13. Then select ‘Cones, Flakes & Sauces’.
14. Scroll to the end of the page.
15. Name the last item on the page.

    Answer: _____

16. Now, go to the main menu and select ‘Drinks’.
17. Select ‘Adult Drinks’,
18. Then select ‘Tonic water & Mixers’.
19. Scroll to the end of the page.
20. Name the last item on the page.

    Answer: _____

Navigation Task

You need to perform the following tasks, step-by-step.

The tasks:

1. Select ‘Fresh’ category from the main menu.
2. From the list, choose ‘Meat & Poultry’.
3. Then choose ‘Chicken & Turkey’.
4. Scroll to the end of the page.
5. Name the last item on the page.

   Answer: _____

6. Now, go to the main menu and select ‘Bakery’.
7. Select ‘Cakes, Pies & Tarts’.
8. Then select ‘Pies & Tarts’.
9. Scroll to the end of the page.
10. Name the last item on the page.

    Answer: _____

11. Now, go to the main menu and select ‘Food Cupboard’.
12. Select ‘Cooking Sauces & Meal Kits’
13. Then select ‘Oriental & Stir Fry Sauces & Kits’.
14. Scroll to the end of the page.
15. Name the last item on the page.

    Answer: _____

16. Now, go to the main menu and select ‘Frozen’.
17. Select ‘Frozen Pizza, Bread, Fruit & Pastry’,
18. Then select ‘Frozen Fruit & Pastry’.
19. Scroll to the end of the page.
20. Name the last item on the page.

    Answer: _____

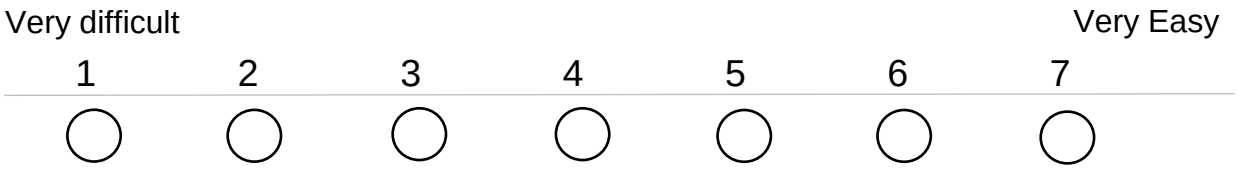
Appendix 10:

Single Ease Question

Single Ease Question (SEQ)

Instruction:
Please tick appropriately.

Overall, how difficult or easy did you find this task?

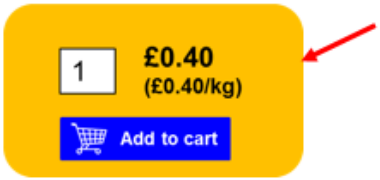


Appendix 11:

Rate and Rank Cues

Rate the cues of 'add to cart' button

Instruction:
Rate the following appropriately.

The following helped me to identify the 'add to cart' button:	Strongly Disagree 1	2	3	4	Strongly Agree 5	
1. Different colour from other elements.	○	○	○	○	○	
2. When the mouse hovered over the button, it changed colour.	○	○	○	○	○	
3. The label on button – says 'add to cart'.	○	○	○	○	○	
4. Highlighted box (coloured box placed beneath the price and the 'add to cart' button). e.g.: 	○	○	○	○	○	

Appendix 12:

Samples of Participants' Comments of Like and Dislikes about the Websites

C02

Website A

good that main menu stays visible

Fresh Bakery Food Cupboard Frozen Drinks

Fresh › Fruit › Apples

Default sorting

Braeburn Apples (0) — 3 pcs per pack — More info — 1 £0.65 (£0.22/each) — Out of stok

Gala Apple (0) — 3 pcs per pack — More info — 1 £0.95 (0.32/each) — Add to cart

Granny Smith Apples (0) — 3 pcs per pack — More info — 1 £0.65 (£0.22/each) — Add to cart — View cart

Pink Lady Apples (0) — 3 pcs per pack — More info — Sale! 1 ~~£1.50~~ £0.65 (£0.22/each) — Add to cart

Cart
Granny Smith Apples 1 × £0.65
1 item added
Subtotal: £0.65
Checkout

easy to understand how many pieces per pack

Good to have bigger font

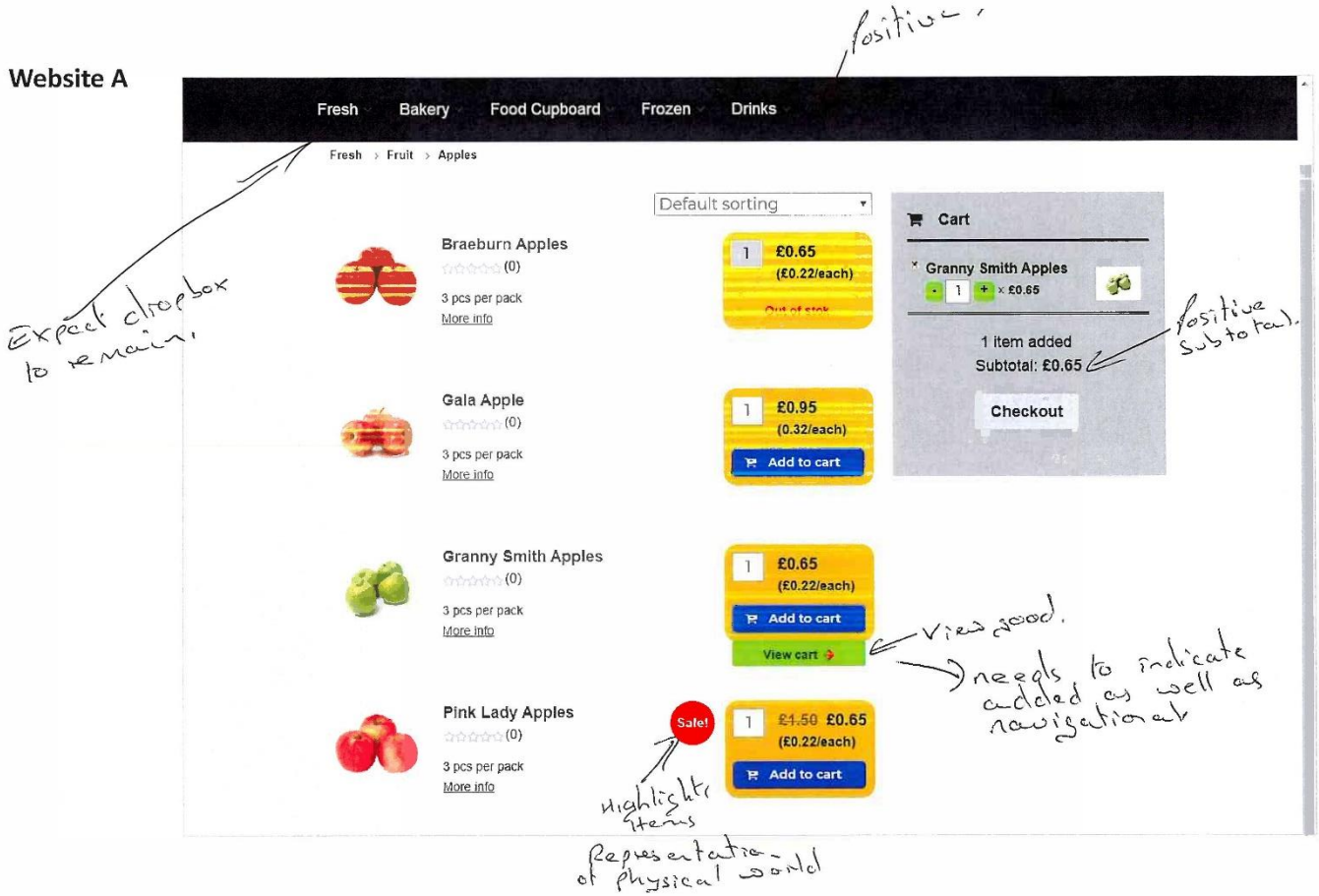
(whole box) like bright colours, easy to understand

stands out well

picture of shopping cart is helpful

don't mind which layout ie. boxes to the side of items or underneath

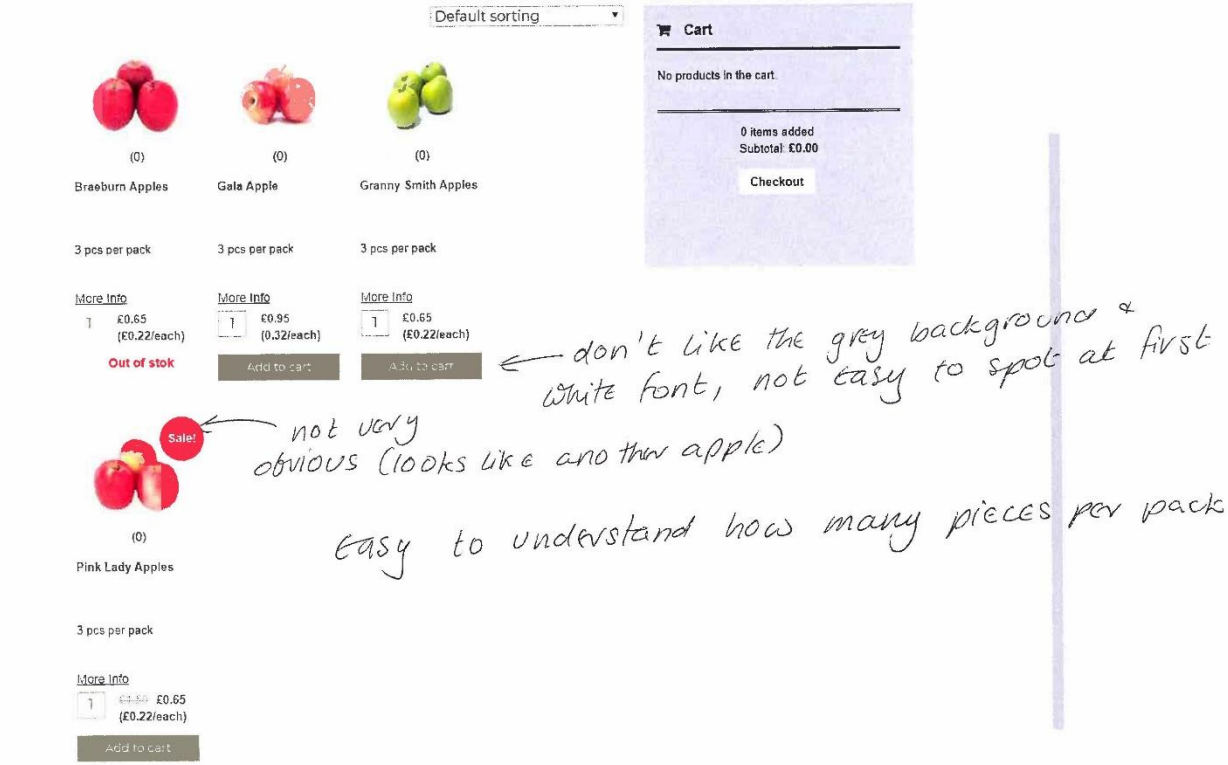
Website A


positive.
Fresh
Bakery
Food Cupboard
Frozen
Drinks
Fresh › Fruit › Apples
Default sorting
Braeburn Apples
(0)
3 pcs per pack
More info
1 £0.65 (£0.22/each)
Out of stock
Gala Apple
(0)
3 pcs per pack
More info
1 £0.95 (0.32/each)
Add to cart
Granny Smith Apples
(0)
3 pcs per pack
More info
1 £0.65 (£0.22/each)
Add to cart
View cart
Pink Lady Apples
(0)
3 pcs per pack
More info
Sale!
1 £1.50 £0.65 (£0.22/each)
Add to cart
Cart
Granny Smith Apples
- 1 + x £0.65
1 item added
Subtotal: £0.65
Checkout
Expect checkbox to remain.
positive subtotal.
View good.
needs to indicate added as well as navigation at
Highlight items
Representation of physical world

Website B

C02

don't like that main menu isn't visible when further down the page

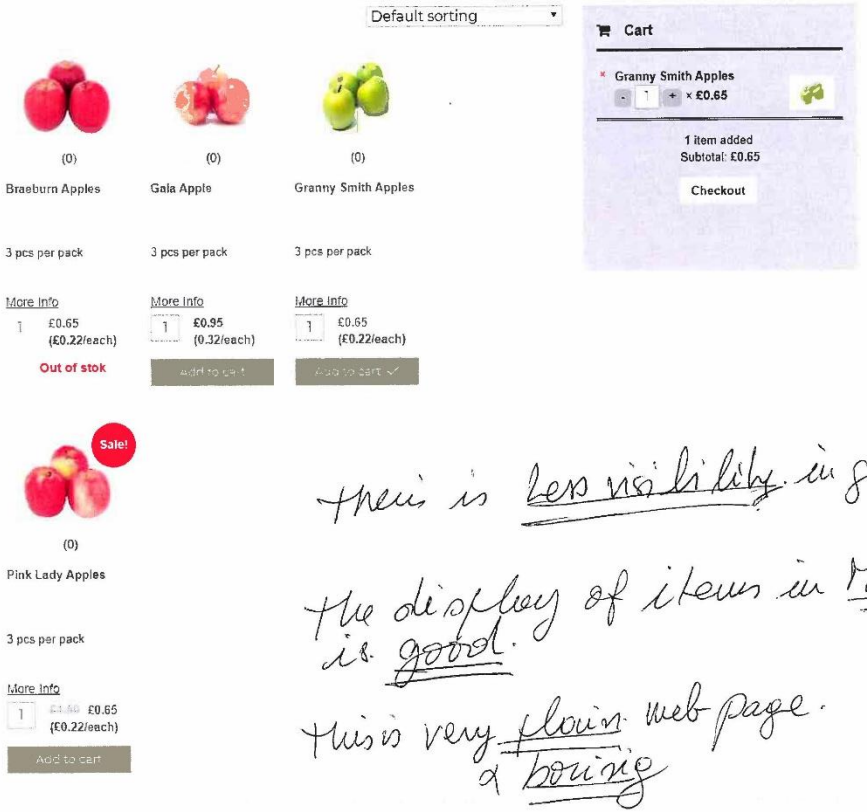


don't like the grey background & white font, not easy to spot at first

not very obvious (looks like another apple)

easy to understand how many pieces per pack

Website B



there is less visibility in general view

the display of items in Matrix is good.

this is very plain web page. & boring

Appendix 13:

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