IKEA FURNITURE PURCHASES BY CARDIFF MET STUDENTS BY VR

A dissertation submitted in partial fulfilment of the requirements for the degree of Bachelor of Science (Honours) in Computing

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Declaration

I hereby declare that this dissertation entitled IKEA FURNITURE PURCHASES BY CARDIFF MET STUDENTS BY VR is entirely my own work, and it has never been submitted nor is it currently being submitted for any other degree.

Candidate: Thomas Szpak

Signature:

Date:

Supervisor: Stuart McNeil

Signature:

Date:
Abstract

With the recent increased interest in Virtual Reality many have argues that it could be the “the next big thing”. Science fiction has gotten us used to the idea of that one day people will integrate their brains with computers and Virtual Reality has been a core of the concept of putting a human in to a virtual world. Recently companies have made improvements of the technology as the computing power of computers increased and motion sensors became more advanced. New opportunities emerge for companies to take advantage of as the awaiting disruption could influence how we study, shop and consume content. IKEA as one of the largest furniture companies is perfectly positioned to take advantage and be at the forefront of the coming changes. This research will look at how IKEA can take advantage of VR in the context of Cardiff Metropolitan University students. It will look in to whether this technology has any future and what it might be and whether Cardiff Met students will be interested in this technology and would be the a good target market.
Acknowledgements

I would like to thank my dissertation supervisor Stuart McNeil for being very helpful offering help and advice thorough the development of the project. I would also like to thank my friends and family for the help and support their offered. The author would also like to thank the Cardiff Met students who took their time to complete the questionnaire in the primary research process.

Commented [2]: This is your opportunity to mention individuals who have been particularly helpful. Reading the acknowledgements in other dissertations in your field will give you an idea of the ways in which different kinds of help have been appreciated and mentioned.
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Chapter 1 – Introduction

1.0 Introduction
The forthcoming chapters are a result of an extensive research performed to analyse the potential of VR within the context of IKEA e-commerce among the Cardiff Metropolitan University students. The research consists of both primary and secondary research where several articles and other analysis have been conducted. To gain understanding of the specific research area the research will include a questionnaire and several numerical data analyses that have not been done so far or the researchers did not look at the specific area that this research will cover.

1.1 Aims and Objectives
This research investigates the last couple of years of VR development and what success it had so far on changing the way that consumers shop. Specifically, it will focus on the ecommerce and potential of implementation by IKEA.

Aims:
- To analyse the overall potential for implementing VR by IKEA as an alternative to regular website based online shopping.
- Identify what level of exposure Cardiff Met students had with VR and IKEA and what was their experience so far.

Objectives:
- To analyse the health risk thru the primary research.
- Find out what attempts IKEA has made so far to utilise VR.
- Collect data from Steam.com that would help identify the VR trends.
- Collect information from Cardiff Met students using questionnaires.
- Analyse the findings and discuss what they mean for the future of VR
1.2 Background

With the recent improvements in technology we have experienced a booming market of smartphones as well as other devices that have changed the way people interact with each other but also shop and work. The booming smartphone market has fuelled a surge of investment into the technology sector where many young entrepreneurs with ideas create start-ups that offer disruptive innovations that are supposed to change the way we live even further. One of these technologies in 2017 appears to be VR/AR which stands for virtual and augmented reality. According to Mark Zuckerberg VR could be “the next big thing” as it will transform the way we interact with our friends and perform various tasks with them. He has outlined the disruptive nature of the new technology on his live demo at the Oculus Connect.

Other than new forms of interaction between people the VR opens several new possibilities for businesses to interact with their customers while theory are in their daily routines. One of the aims of this research will be to analyse possible ways to interact with a potential customer and engage with him/her in a way that is not intrusive and off-putting but engages the user to explore what products the company must offer. While VR gaming is already available there are several limitations and problems that already started occurring that show the weakness of the platform but also exciting opportunities and ideas for improvement. Even more exciting could concept of augmented reality headset that could be used as an accessory along the side with your phone as a daily device that people would always carry with them. Concept artist imagine users having their daily lives filled with virtual amendments to our everyday world that will allow us to interact with social and media apps without looking down at the phone. People will be able to use navigation tools that already today offer various features like looking thru restaurants that are around them except with the augmented reality in the future people will be able to use these features as they are roaming the city streets.

1.3 VR The Potential Enhancement Of Online Shopping

This paper will also look at different ways IKEA can improve the shopping experience for its customers as well as reduce certain running costs. One of the visions that could be worth looking into would be the application on VR and AR into interior decoration industry. The users could for example test what certain furniture in the catalogue would look like in their room as the virtual reality headsets would be able to adjust the size of the furniture so the user would be able to see whether it will fit in certain corner of the room. Also, the user could

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switch between the colour swatches to match the furniture with the rest of the room. This way the user would be able to decorate the entire house without having to visit the store to see what is available and what furniture will fit in certain parts of the house as this information will be immediately available. Fashion industry could benefit from allowing their users to try on virtual outfits so the users would be able to see what fits them and not have to visit the store to try on the clothes as their dimensions would already be calculated so the application would know which size of clothes fits them the best.

1.1 Research Strategy
The primary goal of this paper is to specifically look at the e-commerce side of the industry and how the companies could benefit from applying this technology. However, in order to be able to assess the possibilities this paper will also refer to other proposed applications of this technology as a reference to the conclusions that have perhaps been drawn by other researchers.
Chapter 2 – Literature Review

2.1 Previous Research

One of the problems noted by et al. So-Yeon were constraints of the applying Virtual Reality to furniture industry. One of the limitations was pointed out by the subjects of a survey that for example when choosing a new sofa the customer will be making the choice based largely on how comfortable it is to sit on it. While there is an appeal in being able to look into many furniture items in a quick span of time some of the limitations of the technology might prompt the designers to rethink some of the design choices. As well as the appearance the furniture has to also be functional which might prove challenging to convey to the users in the means of virtual interaction. the authors of this research draw attention at another important aspect of using integrated VR technology as a means of providing services to the customers and that is the ability to track the responses as well as many other data elements that can be collected from customers. For the designers this could prove to be a vital tool for immediate feedback from their clients as to what improvements they expect from the latter iterations of their products. This relates to the practicality of the product as well as the design from the visual aspect. By tracking the reactions of the customers the map of popular trends can be drawn that could help the designers to see what type of furniture would people be likely to want based on what they already have in their rooms. This type of research could be further improved by including the data about the interiors that the clients usually live in. Data about the interiors could be gathered from the users VR headsets as they wander around their rooms and picking new furniture.

2.2 Health Effects and Risks

While the audience sample appears to be sufficient and accurate with aiming at the student base there could have been an inclusion of the VR technology to the experiment. This could provide additional feedback about how ergonomic the use of the system is. While the VR headsets are not yet as advanced yet some problems identified by for example the gaming community appears to spread doubts about the future of the VR technology. While that research paper mostly focused on the benefits for the furniture designers that will come from that technology some health effects have been overlooked as they will affect mostly the
potential users. It is still largely unknown what penetration of VR in to the non-gaming society will be considering the cost of the hardware but another big factor will be the health effects of prolonged use of VR headsets. Some of the health concerns might be attributed to the fact that the technology is at its relatively early stages even today. For example, one of the problems is the weight of the device which make it uncomfortable to wear for long periods of time but that could be combated by minimizing the headsets overtime and decreasing their weight. However the full immersion provided by the VR headset means that all of the outside visual signals are isolated. That combined with the fact that human eye sees in a stereoscopic view (that’s 200 degrees) means that in order to become really immersive and make the user feel like they are in that location. Furthermore, to reduce the eye strain the improvements would need to be make with the GPU so that the frame rate could remain consistent with a high resolution images that would need to be provided to allow for a wide viewing angle.

2.3 Reshaping the Future

Target sample is smaller as only around 35 people from a specific location were selected primarily women. Though the justification was that the research focused on a specific type of consumer to examine further to whom the technology can be targeted with regards to the e-commerce business in commerce. This research also focuses on the features as well as the limitations of VR in e-commerce due to the inherent nature of virtually generated environments not being able to provide physical elements of shopping experience like touch (Oh et al. 2008). This research paper has proposed a theory that furniture companies are likely to boost their sales by adapting VR because it allows the users to interact with the virtual shop. This was based on the fact that in the past shops that adopted online technologies and developed their e-commerce business had more consumers who had more time constraints so they found it easier to shop online as supposed to physically visiting the store. Then the research concluded that this could be repeated in the context of the vr as the surveyed users have shows more inclined to explore certain products in the 3d VR form then when they viewed it in more traditional 2D format.

2.4 Personalisation Aspect

One of the explosive areas of study in recent years was application of big data management technologies in E-commerce (Chittaro and Ranon 2000). Specifically, e-stores have gained an advantage to track their user’s activity to be able to determine what products are they in

Commented [5]: find sources for "health effects of VR" is it safe? can limitations be overcome with technology

Commented [6]: 2nd research paper - How Can Virtual Reality Reshape Furniture Retailing? page 147
the market for now. Data analysis companies have been working hard on analysing trends using data sourced in various ways to predict shopping trends and certain specifications of consumers who purchase certain products. All this information has been used by various businesses not to just target their adverts in front of the right people but also to improve their product based on information that they would previously not have could gain otherwise. The concept of virtual stores opens new possibilities of enhancing this method to produce more accurate statistics. For example, current user activity technologies rely on the assumption that the user is viewing everything that has been displayed on the web page. Depending on the page design the current applications might find it challenging to determine what exactly is the consumer looking for and what level of attention is paid on different things. VR could enable better tracking of user activity and follow user behaviours. While the user is wandering around the virtual store he or she could voluntarily look at certain items over. This combined with the observation of the behaviours allows to develop better algorithm that could more accurately understand the consumer interest.

2.5 Interaction Aspect
Information gathered tracking the choice patterns could be used to create personalised experience for each customer. For example, counting the number of times the consumer entered different sections of the store or what music is the user most interested in could help to determine what would create the most desirable shopping experience by switching the music played in the background into the preferred genres. Personalising VR stores could lead to more inviting store experiences regardless of the size of the store chain that created it. This could lead to the democratization in this area where smaller retailers could become quickly available to a wide audience depending on certain trends. Currently only the largest retailers can afford to have a robust network of store in various countries and cities but soon even small retailers could enable their customers to visit their store just like they became more available thanks to web ecommerce.

2.6 Costs of VR
Prices for VR headsets vary dramatically based on the quality of image and variety of sensors that are being used for the purpose of improving the experience. Each option answers to different needs of the users and to some extent exist as a proof of concept that allows the developers to get on the platform. Varied sensors and input features available on HTC Vive
make it arguably the best VR solution in terms of the quality (Porter 2017). However some of the options are more suitable for other users such as the PlayStation VR which is made primarily for gamers. The cheapest options are the systems that utilise the user’s smartphone provided that it also includes a number of useful features and sensors. Smartphone VR systems can be considered as more of a proof of concept or an affordable point of entry for the users as it allows to use some of the functionality. However due to limited processing power and other hardware limitations these solutions are more limited in their capabilities. Another factor is the powerful PC’s that are required to run some of the headsets.
<table>
<thead>
<tr>
<th>Product</th>
<th>Image</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>HTC Vive</td>
<td><img src="image" alt="HTC Vive" /></td>
<td>£769</td>
</tr>
<tr>
<td>PlayStation VR</td>
<td><img src="image" alt="PlayStation VR" /></td>
<td>£349</td>
</tr>
<tr>
<td>Oculus Rift</td>
<td><img src="image" alt="Oculus Rift" /></td>
<td>£499</td>
</tr>
<tr>
<td>Samsung Gear VR</td>
<td><img src="image" alt="Samsung Gear VR" /></td>
<td>£169</td>
</tr>
<tr>
<td>Google Cardboard</td>
<td>£4.99</td>
<td></td>
</tr>
</tbody>
</table>
2.7 Costs of GPU

The following GPU’s recommended by (Safford 2017). The costs span between $399 and $679.

Table 2 GPU Pricing

<table>
<thead>
<tr>
<th>Product</th>
<th>Image</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nvidia GeForce GTX 1080 Ti</td>
<td><img src="image1.png" alt="Image" /></td>
<td>$679.99</td>
</tr>
<tr>
<td>Founders Edition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nvidia GeForce GTX 1080 (Founders Edition)</td>
<td><img src="image2.png" alt="Image" /></td>
<td>$630.00</td>
</tr>
<tr>
<td>Zotac GeForce GTX 1080 Amp Extreme</td>
<td><img src="image3.png" alt="Image" /></td>
<td>$574.99</td>
</tr>
<tr>
<td>MSI GeForce GTX 1080 Gaming X 8G</td>
<td><img src="image4.png" alt="Image" /></td>
<td>$549.99</td>
</tr>
<tr>
<td>Nvidia GeForce GTX 1070 (Founders Edition)</td>
<td><img src="image5.png" alt="Image" /></td>
<td>$399.99</td>
</tr>
</tbody>
</table>
2.8 IKEA Experience

In mid 2016 IKEA Communications AB released a demo VR kitchen exploration experience which allows the user to enter a virtual showroom. The users can roam the virtual space much like in the life but few enhancements are available such as the ability to toggle between different materials and colours of the furniture. Unique functionality also includes the ability to turn in to a child which allows the user to see the kitchen from the short person perspective. This allows the user to see whether the kitchen is safe for children and whether there are any elements that might seem dangerous or child unfriendly.

![Image of IKEA VR showroom](image_url)

*Figure 1 IKEA VR showroom allows to instantly change the look and feel of the kitchen by selecting a different material finish.*
Figure 2 IKEA VR showroom allows the user to interact with the facilities unlike on a regular website.
Chapter 3 – Methodology

3.1 Introduction
In this chapter, it will be explained what methods of research were utilised to complete the research including the research approach, strategy and sampling and collection method. It will also identify the key areas that the questionnaire will focus on and analyse the advantages and disadvantages of this method and estimation of who will be the target audience and what will be the sample size and why.

3.2 Ethical Approach
The questionnaires will be carried out using Google Forms, according to (“The Complete University Guide”) around 13,670 student have enrolled to this university in 2014/15. According to (Saunders, 2015) using the statistical data processing method the minimum number of respondents that should be questioned is 370. With this number of people the margin of error is reduced to 5%. As the population being studied is being clearly defined so the non-probability sampling method will be used where particular students are contacted directly to complete the questionnaire. Snowball sampling method will be used to get the desired number of respondents. This is due to the fact that the population is limited to Cardiff Met Students so selecting respondents based on referrals would ensure that data would be collected from appropriate sources. Steam has it’s own user agreement that prohibits anything that would exploit personal data of other users for your own gain. However it does not mention any thing about the specific topic of scraping data of it’s website.
3.3 Research Approach

This research will use positivistic approach as it will look at the numerical data that will be gathered from the structured closed questionnaires that will offer a choice of answers. The research will also be enhanced using statistical data gathered from datasets. The questionnaires would be anonymous and any collected data would not be traceable to specific people but confidentiality of the data collected would be ensured as the results will be stored in the cloud protected under a password.

3.4 Research Strategy

This research will use the mono research method utilising the quantitative type of research. In order to be able to analyse the potential for this technology and its application in real life scenarios the research will be based on two main elements. The first one is the questionnaire which will be trying to find out what is the percentage of students who own the VR headset. Given that this number will be relatively small even among the students the questions will also be trying to analyse whether they have ever experienced VR and if they liked the sensation. It will also ask them for feedback on whether they felt like it was affecting their eye sight or if they felt uncomfortable. The reason for these questions is the often-mentioned
side effect of prolonged use of virtual reality headsets which could affect the potential for these types of products to ever go mainstream. The target population that will be researched is the total number of Cardiff Metropolitan University students which is around 13,670 according to (“The Complete University Guide”). The students will be randomly selected as there are not specific prerequisites that they will need to have other than studying at this university. Since the population that is the target is clearly defined the non-probability sampling technique will be used to select the subjects. To provide unbiased sample the key will be to make the number of respondents as big as possible. This would ensure that the margin of error is as small as possible. According to (Saunders, 2015) the appropriate sample size for this population would be at least 370 respondents which reduces the margin of error to 5%.

<table>
<thead>
<tr>
<th>Population</th>
<th>5%</th>
<th>3%</th>
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<td>50</td>
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<td>750</td>
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<td>440</td>
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<td>696</td>
</tr>
<tr>
<td>1,000</td>
<td>278</td>
<td>516</td>
<td>706</td>
<td>906</td>
</tr>
<tr>
<td>2,000</td>
<td>322</td>
<td>696</td>
<td>1,091</td>
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</tr>
<tr>
<td>5,000</td>
<td>357</td>
<td>879</td>
<td>1,622</td>
<td>3,288</td>
</tr>
<tr>
<td>10,000</td>
<td>370</td>
<td>964</td>
<td>1,936</td>
<td>4,899</td>
</tr>
<tr>
<td>100,000</td>
<td>383</td>
<td>1,056</td>
<td>2,345</td>
<td>8,762</td>
</tr>
<tr>
<td>1,000,000</td>
<td>384</td>
<td>1,066</td>
<td>2,395</td>
<td>9,513</td>
</tr>
<tr>
<td>10,000,000</td>
<td>384</td>
<td>1,067</td>
<td>2,400</td>
<td>9,595</td>
</tr>
</tbody>
</table>

Figure 4 Sample sizes for different sizes of population at a 95 confidence level (assuming data are collected from all cases in the sample)
3.5 Sampling Collection Method
This way if the research will find that a significant percentage of the respondents claim something then this represents the entire population give or take 5%. To obtain this result, it would be necessary that the respondents are not just students of specific course as the experiences might vary between people. This is because the interests of each person determine how much tech savvy they are and since the early application of VR into the mainstream has been relatively new there are chances that some students would be more likely to have experienced it already than others. To achieve this the respondents must nominate the next candidate that will be filling up the questionnaire. This sampling technique is called snowball as it relies on recommendations given at the end of the questionnaire as to whom could be the next person that can be asked for fill it up.

3.6 Questionnaire Design
The questionnaire will be closed ended and will provide full answers to be selected from by the respondent. The reason for that is the need to numerically classify the given responses to draw graphs and projections from it. The questionnaires will be distributed using the internet using the “Snowball” sampling method which as explained by (Saunders, Lewis and Thornhill) relies on distributing the questionnaires among the designated group of people not leaving who responds to a chance. After completing the questionnaires, the users are asked also to pass on the link to an appropriate person from the university that they might know. Given the relatively large sample of respondents needed this method fits appropriately as it allows to maximise the number of respondents as well as take advantage of being able to sample from a very specific group of people.

![Figure 5 Types of questionnaire](image-url)
3.7 Questionnaire Matrix

Below are the listed questions to appear in the questionnaire and the justifications for them being there.

<table>
<thead>
<tr>
<th>Questions</th>
<th>Theory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Have you experienced uncomfortable feeling on your eyes due to the use?</td>
<td>Due to multiple reports from the users, VR headsets remain uncomfortable mostly due to their size and weight (Bailey). Other factors include the eyes strain resulted in prolonged sessions as well as motion sickness that is experienced by only certain people who are more prone to it (Statt).</td>
</tr>
<tr>
<td>Since the beginning of your studies in Cardiff Met, did you buy any IKEA furniture?</td>
<td>Due to the presence in most major cities IKEA has become an established brand among students who move away from home for their budget shopping needs (Wahl). While IKEA does also own a store in Cardiff, this question will try to determine the exact number of already existing customers.</td>
</tr>
<tr>
<td>Are you concerned with the potential health effect of using VR?</td>
<td>While the technology has made large improvements mitigating the negative health effects, concerns persisted (Magyari) and the general view of the public will affect the approach of potential users.</td>
</tr>
<tr>
<td>What is the amount you would be willing to pay for the VR gear.</td>
<td>Determining the price the users are willing to pay for the product will help to establish the potential size of the consumer base.</td>
</tr>
<tr>
<td>If you used the VR before, how long did it take before you felt uncomfortable?</td>
<td>Determining the amount of time the users could spend in VR will help to understand the application model including the amount of time that it would require.</td>
</tr>
<tr>
<td>Did you feel that the proportions of the objects in the Virtual Environments were accurate to real world?</td>
<td>In the context of IKEA furniture sales one of the advantages outlined in the literature review was the ability to place virtual objects in to the users room using the VR/AR technology.</td>
</tr>
</tbody>
</table>
Do you feel like the virtual shops could be better option to regular online shopping?

Assessing how favourable the Cardiff Met students are to the concept of VR shopping would give an idea to IKEA and similar companies as to how likely they are to attract such customers.

3.8 Questionnaire Advantages

This questionnaire will give a unique insight into the specific group that is Cardiff Metropolitan University students. It will give an understanding on what exposure to the VR they had already and what is their approach to using it in the future for any practical applications. This will help to assess whether there is an interest to be using this product if it had practical means and whether the university students will be willing to spend enough money on it given that many of them are on tight budgets.

3.9 Questionnaire Disadvantages

It might take a long time to get the desired number of people interested in responding to the survey. This could further decrease the number of participants and therefore make the sample size too small to be considered a valid research. The questionnaire might be too long to be completed fully and therefore either they will not be finished or the respondents will try to skip thru questions by giving quick false answers.

3.10 Data Scraping and Datasets

Another area of the research will focus on the statistical data that can be obtained from various resources from the internet. This will include some publishing’s as well as the open source datasets that have been made available. One of the risks with this form of research is the ability to easily breach someone’s privacy. For this reason, the datasets will need to be anonymised and thoroughly checked for inappropriate content. The source of the datasets will have to be checked in order to ensure the credibility of data as well as that no rules or laws are being broken. Besides the anonymity the presence of any sensitive information from the questionnaires or datasets must be protected by password so that unauthorised people would not have access to it. Another issue is related to the risks of losing the data collected after the research is collected. To prevent this the datasets will have multiple backups on a computer as well as external hard drives and on the cloud where the datasets will be stored on an
external server protected under an encrypted password. This research will use positivistic approach as it will look at the numerical data that will be gathered from the structured closed questionnaires that will offer a choice of answers. The research will also be enhanced using statistical data gathered from datasets. The technologies used to collect dataset include ipython which is a dynamic python running shell build with the use of python. The python modules used to extract data were Selenium and BeautifulSoup. Selenium and BS are both data scraping tool with slightly different advantages and down sides which mean that the use of both was necessary. Microsoft Excel was used to process and clean the data from various unnecessary characters and fix the errors. Tableau was then used to crate charts from the datasets such as the histograms.

Commented [8]: list the technologies used for the collection of datasets and machine learning technologies used for the analysis
4.1 Introduction

This project will revolve around the attempt to use data scraping technologies where possible to enhance this research. The topic of VR has been hot for some time now but with the emergence of some data science technologies including machine learning there are several ways to draw information that can be used to the very specific context of this research. The numerical data drawn from the newly analysed resource could bring a completely new view on the subject.

4.2 Literature Review

Various papers have been written about the possible applications of the Virtual Reality including at least one in the context of e-commerce in the furniture business. (Oh, Yoon and Shyu 143-163) has outlined the various usage modes and advantages of using the VR and described it as the next step that will be taken eventually by the users as they switch at least partially from regular web browsing in favour of the more immersive shopping experience. Problems persist however as many claim the technology and headsets themselves are ahead of their time (Olivarez-Giles 2015) This opinion is largely justified by the fact that the price point of the headsets themselves have successfully repelled the non-daily users. The largest market for the VR now is in gaming (Carson 2015) The user base would have to be broaden massively for the VR infrastructure to become viable in the first place. [Ikea is the world’s largest furniture manufacturing company (Loeb 2012) which mass produces its product as they are distributed around the world.

4.3 The Objectives of the project and the methods used to achieve them

The objective of this project will be to deliver additional information to support the research and analyse the potential for VR technology in the specific context of this study as well as the more broader information that gives the overall feel of how the industry is currently doing. The aim at the begging is to look for relevant datasets that could be used for plot certain graphs and analyse the trends. The risks associated with this method is the unavailability of certain datasets especially in the open source space. Another risk is related to the copy right
infringements and data protection. For this research the datasets that will be used not contain any personal information. One of the useful datasets will be obtained from steam.com which is a gaming platform. Steam contains a vast library of commercial “triple A” titles as well as indie and some smaller games and other products from smaller unknown developers. The data will be scraped using page scraping Python modules such as Selenium and BeautifulSoup modules.

4.4 Conceptual Framework
A key theme throughout this research will be the combining the global trends and breaking them down to understand them better to understand the influence on the local environment. By combining the results of the questionnaire with the board global trends it should be easier to understand whether the potential for this technology can live up to the large expectations created in recent years. One of the ways to measure the level of activity will be to measure the level of investment of technologies as well as the numbers of releases of VR software and compare it with historical figures. This can be achieved by scraping the release dates from every VR game on Steam and plot them in to the histogram.

4.5 Findings
While other researchers have been assessing the potential for VR before few seem to have looked at the most recent upward trend and assess how it was received in the early stages. To get better understanding of the current adaptation of the technology the research required uniquely written data scraping software to be written for the purpose of gathering data from other sources. One of the interesting targets was the www.steam.com which is an online game distribution platform with thousands of titles and 14.21 million users. Steam has become a popular platform for small Indy developers who create crazier projects and more extravagant games that would not have been funded by larger studios due to the risks associated with the investment. This made Steam a popular destination also for VR game developers to publish their products sometimes for free. The aim was to gather information about all the VR enabled titles available on the platform. There is a total of 1471 VR enabled titles available on steam (Steam, 2017). Scraping was done with the use of Python and a few libraries such as the Beautiful Soup and urllib to allow for data extraction. The first step was to gather all of the links for every page that included the information about the games. There were as many links gathered as the games themselves which allowed for each one of these
links to be opened and particular information could have been extracted on a massive scale creating a dataset with the following columns.

- link
- game_title
- release_date
- price
- cpu
- gpu
- ram

```python
alllinks = []
with open('steam.csv', encoding='utf-8') as pages:
    for page in pages:
        alllinks.append(page[:-1])

print(alllinks)
with open('steam/volume.csv', 'r', encoding='utf-8-sig') as pages:
    for link in alllinks:
        opener = urllib.request.urlopen(link)
        soup = BeautifulSoup(opener.read(), 'xml.parser')
        print(soup)
        for game in soup.findall('div', {'class': 'game_area_summary_full'}):
            for ii in game.findall('li')['title']:
                gpu11.text
                for li in game.findall('li')['title']:
                    setll.text
                    for ii in game.findall('li')['title']:
                        ram11.text
                        print((gpu, gpu, net, ram))

writer.writerow((gpu, gpu, net, xml))
```

*Figure 6 Code snipped utilising BeautifulSoup to extract data from Steam.com*

Code to scraping the game specifications was using the Beautiful soup to look thru all the links and extract the information from it using the CSS class that is assigned to it.
4.6 Data Extraction

This code was run using IPython and running it resulted in a csv file being generated that had the information listed from over 1400 links. After each dataset was created the cleaning process was necessary to get rid of unnecessary or repeating information. Getting the dates of the title was enough of an information to plot a histogram of dates which displays the level of intensity within the market. The Following figures 4 and 5 were plotted using Tableau where the graphs represent the intensity of certain graphics card being recommended to run the application and the number of products being released historically. The links have been collected using selenium module for python that allowed me to build a program capable of browsing thru multiple pages to automatically collect data from them.

As seen on Figure 7 there is an entire section on Steam.com dedicated for Virtual Reality applications, mostly games and demos but also other test apps made by companies for promotional purposes. All the titles have not been listed on the page at once as only 25 titles are showing per page. The program could collect all the url links but then it would have to click on the next page to be able to read the rest of them. Beautiful Soup turned out to have a limitation in that regard it did not allow to interact with the website in real time. Selenium is another python module that allows to page scrape data but it also has functions that allow for interactions that could be preprogramed such as skipping thru pages. Once the scraping process was finished a total of 1418 links have been saved as a csv file.

![Figure 7 Steam VR subsection page.](image-url)
4.9 Copy Right Protection

The biggest concern is whether Steam will allow for their datasets to be used for this research. Many companies are not keen on sharing their intellectual property even if it is made publicly available. In many cases the users who sign in to the website sign an agreement that discloses the policies of the organisation with regards to the restrictions that they throw on the data that they own. Publishing datasets and making it openly available to the public might make the restrictions voidable (“Open Data And Datasets”) however not in all cases and the best practice is to follow the policies of the particular organisation. In this case the company in questions is Steam.com which provides gaming platform services.

4.10 Data Scraping Ethics

As an example of data scraping being performed for the research purposes (Yu 2010) has presented a case where various datasets were collected about the students demographic, residency and retention rate to combine it in to a single dataset that allowed various predictions to be made using a machine learning classifier. According to (Pierzansowski, 2017) the copy right infringement claim can be valid if the author used personal information in the dataset or used it to make money out of it. Both do not apply in this example as the dataset collected does not include any personal information of any user neither usernames or otherwise. As (Bourke, et al. 2012) explains, Freedom of Information Act provides the researcher to request for information to be obtained from an authority and under the law they would be obligated to supply it. Otherwise they would need to provide justification if they rejected the request. The law allows researchers to use datasets within the outlined conduct for making a point about something. As (Hirschey n.d.) outlined some of the data is copyrightable and there is a pragmatic acceptance of the occurrence of web crawlers if they do not undercut the revenues of the company that hosted the data.

4.11 Analysis

The discussion for about the potential related with the future adoption of VR in to the mainstream mainly revolves around the price and availability and quality of the content as well as the hardware. Due to the price of the computer components as well as the quality VR gear the mass adoption of the technology will not be easy any time soon. In the context of this research this matters a lot since IKEA would ideally be aiming at the masses with their newly developed VR experience due to the large running costs (Rochefort and McElroy...
Due to this fact it would be uneconomical to develop the VR world just for the narrow group of people who own the hardware for the sake of playing games.

The slowing level of investment combined with the drop in releases of VR products presents a worrying trend that the technology might not be able to take off whatsoever at least in the current form. There are many examples of failed technologies that either did not deliver to the expectations or were too expensive to implement such as the Microsoft Spot or Virtual Boy (Morris 2017). In this case the problem might also lie in between these two. Another point of view presents an opportunity in expansion for the VR among the smart phone users. Much cheaper solution has been developed as many smartphones already include VR experience enabling sensors (Taylor 2017). Various advertising firms have already taken advantage and developed content using the technology (Crabtree 2016). However, the worry is that this could also be another then and novelty that does not really provide the full immersion of the VR.

Google cardboard has been one of the first attempts at making the VR affordable as the user would be using an already existing device such as a smartphone in order to be able to use the product. Unlike the top VR hardware thought the Google Cardboard has been criticized for being much more limited and not much more than a gimmick rather than an actual product that could be used for something productive (Ram 2016).

4.12 Conclusion
The research presents an interesting case that confirms the overall trend that has been noticed by many tech blogs and other media outlets that the VR hype might be taming. Slowing interest among the investors as well as the developers might stand as a confirmation of this problem. Meanwhile the opinions that the VR enabled content requires expensive hardware have also been confirmed as the most popular recommended GPU costs more than £300. While there might still be some hope for the full scale VR headsets among the gamers and specialist professionals it appears that it might simply take too a very long time for the technology to be adopted by the masses.
Chapter 5 – Research Findings

5.1 Introduction
In this sections the primary and secondary research findings are presented in a way that helps to understand them in the context. It will consist of the questionnaire results as well as the results of the research conducted in the project report. The aims are to find out what is the current approach to the technology overall and what exposure do the Cardiff Met students already have to the VR. Finding this will help to understand the future trends related to this technology as well as the overall direction to which the technology is heading. This will help to understand the potential in the context of IKEA ecommerce sales and Cardiff Met Students. Other elements of the research will also include the more in-depth findings conducted in the primary research. Some of the research that has already been conducted by other analysts will be presented to enhance the understanding in the context.
5.2 Primary Research

5.3 Investment Patterns

Data shows that the total capital that was attracted to the Virtual Reality start-ups has had its surge during the first quarter of 2016 (Crunchbase 2017). This correlates with the collected data from Steam which shows that the most popular time for game releases and the first peak was marked by the 4th of April 2016 with 70 VR titles released on that one day on Steam. This was the first and last increase of this type up until today which begs the question as to whether the concept of Virtual Reality has not been over estimated and the investment flow was based on false assumptions. This worrying trend could be explained by the fact that people who have been looking to invest in these start-ups have realised that the technology is not quite there based on what has been made available in recent years or that the used case applications could be more limited at least in the short term. A theory by Anthony Batt 2017 suggests that the first wave of investment could be caused by the typical “hype circle” where people and companies will be excited by the new possibilities enabled by the new technology and for the emotions to tame and establish more sustainable growth speed.

This theory could be confirmed when looking at the level of investment into the tech start-ups Figure 8 and the total numbers of deals made globally which included the VR start-ups Figure 9. However, the same is not being reflected by the Release Dates for VR software products on the Steam platform Figure 17 where the drop is even greater. The releases of demos, games and other VR enabled applications have had their surge and in the recent months the number of games released or announced to be released is at its lowest since the initial investment hype started. This could mean several things as either the VR as a concept has been proven to be ahead of its time or simply not applicable given the technology or the gaming community has for some reason decided to avoid developing for the platform due to the small number of available users. Initial programs released have been Demos that people who had their first VR headsets could play to be able to experience the immersive sensation of being in a VR environment. Large entry cost associated with the hardware is currently limiting the number of potential receivers of the content which disincarnates developers. Large publishers might not be as interested in developing for the platform due to...
small number of users and the lack of content further discourages people from purchasing the hardware. Another possibility could be the fact that the VR has been proven more useful at least for the near future with other applications than video games. Whichever use case application would prove to be more popular the hardware requirements remain a significant barrier for spreading of this technology to the wider public.

5.4 Secondary Research
As mentioned in the introduction the secondary research consists of the data collected using data scraping technologies as well as the questionnaire that was conducted among Cardiff Met students. The datasets that were harvested have been used to draw graphs in Tableau. The findings will be explained and briefly concluded to provide some understanding. The final data analysis of all findings will then be put together in the Discussion chapter of this paper.
5.5 Questionnaire

The following are the questions presented to the Cardiff Met students who were surveyed.

1. Have you experienced uncomfortable feeling on your eyes due to the use?

![Bar chart showing the response to question 1](image)

Out of those who responded 53.8% declared that they did not experience negative side effects. 46.2% deflected that they did. This could be since many students have used the cheaper versions of VR such as the Google Cardboard.

2. Since the beginning of your studies in Cardiff Met, did you buy any IKEA furniture?

The overwhelming majority 73.3% of the respondents declared that they have made a purchase at IKEA at some point throughout their time as a student. This suggests that IKEA is very popular among them. Over one quarter 26.7% of respondents declared that they have not made a purchase at IKEA. This could be due to the fact that not all student live outside of their parents homes during their study at the university but also it could mean that there is still potential to attract some buyers.
3. Are you concerned with the potential health effect of using VR?

The audience is largely split here with as much as 13.3% declaring they strongly worry about the potential health effects of using VR. The largest proportion of respondents 40% claims that they are only a little worried about the potential health effects. Up to 26.7% of respondents claim that they are not really worried about any health risks. This could in part be because of the lack of negative effects experienced by those who had the VR headset on their head. As much as 20% of the respondents claim however that do not know about any potential health effects.
4. What is the amount you would be willing to pay for the VR gear.

Over a quarter of the respondents 26.7% claim that they would not be willing to pay any thing for the gear dedicated for using the VR. Also 6.7% of the respondents claim they would be willing to pay less than £50 and the same number claims that they would be willing to pay anything between £50 and £100. Up to 13.3% of respondents claim they would be willing to pay between £100 and £200 and 33.3% claim they would be ok with paying between £200 and £300. The number of people willing to pay more than £300 is around 13.3% among Cardiff Met students.

5. If you used the VR before, how long did it take before you felt uncomfortable?

There are several differences of comfort offered by the differing ranges of technologies that provide VR of commercial use. However, they all utilise two convex lenses as external viewing devices to be worn on the head. Differing in weight and adjustability to the user.
Given all these variables there are still some generalisms that can be evaluated in relation to comfort. The data drawn indicates that only 6.7% of respondents claimed that they felt immediately uncomfortable after putting on the VR headset. Up to 20% claimed that they felt the uncomfortable feeling up to 2 mins after putting it on. Again 6.7% of respondents claimed they felt uncomfortable between 6 to 10 mins after putting it on and 20% of respondents felt uncomfortable at some point after 10 mins of wearing it. Only 46.7% of respondents claim they did not experience any uncomforted due to wearing the gear. This casts shadow of doubt over the concept of having users carry longer sessions in a long term.

6. Did you feel that the proportions of the objects in the Virtual Environments were accurate to real world?

![Pie chart showing responses to the question about the accuracy of object proportions.](image)

Figure 15 Did you feel that the proportions of the objects in the Virtual Environments were accurate to real world?

Up to 47.8% of respondents claimed that the objects sizes were accurate to the real world. However, the other half claimed that they either are not sure or think that the object sizes are not accurate with 30.4% claiming that the objects were not accurate and 21.7% claiming that they were not sure. This is an important factor in the context of IKEA and overall retail business as the accurate perceptions of products thru the VR is one of the main elements that would attract customers over using regular online shopping websites.
7. Do you feel like the virtual shops could be better option to regular online shopping?

Up to 43.5% of respondents claim that they see potential in VR enhanced shopping and ecommerce activities and would like to participate. However up to 17.4% of respondents claim that there cannot be any future or at least they do not see this being attractive. This could be justified either by their poor VR experience that they had so far or perhaps they simply do not see VR shopping as an interesting solution currently. Up to 39.1% of respondents claim that there is a chance they could be convinced however they would like to see improvement in the technology.

The information’s saved in the CSV files will be transported to Tableau which will help to view the data in the more helpful visual way that allows to draw certain conclusions from it.
5.6 Recommended GPU and cost analysis

On Steam website, various Graphics Processing Units (GPU’s) are listed as the ideal to run their content. But the higher end models are preferred options to allow for smooth frame rates. Most popular Nvidia GeForce GTX 970 retails at around £360.00 (Amazon, 2017) which must be included on top of the cost related to the VR headset itself. Given the price tag and the additional cost for the Virtual Headsets the lack of available content a part from the vast numbers of demos has made the VR headset unattractive for the average user.

Commented [ts21]: https://www.amazon.com/Gigabyte-GeForce-Gaming-GDDR5/dp/B00NHST1MS
5.7 Machine Learning Predictions

Due to the lack of long continuing trend of growth it is hard to predict the future spending on this technology. This is especially to do with the fact that people who will buy the hardware will want the software products to be already available for it in relatively large quantities to justify the purchase. Like it was pointed out by (Christopher Mims, 2016) just like with the advent of the TV the users wanted the platform to already have content available, likewise the content producers wanted the users to be able to receive it. When first TV’s were sold the companies that sold them also funded the creation of the content and the same is being done by Oculus which has spent $10 million to produce video games by independent developers.

With that in mind much of the investment could have been due to the initial stimulus that VR headset producing companies who wanted the clients to feel like there is a library of products already available. The technology has been pointed out to be ahead of itself as while it delivers the immersive experience the lack of software has been the cause of tamed investment and VR sales.

Chapter 6 – Discussion

6.1 Introduction
This chapter will analyse the results of the questionnaire as well as other elements of the research. It will give an explanation to certain patterns and similarities between different findings. The aim is to put some of the research in to the context of VR potential in IKEA online retail business. The questionnaire provides some insight in to what the Cardiff Met students have on the concept of VR shopping.

6.2 Data Analysis
Many assumptions made in the thesis of this paper are being confirmed to at least to certain degree by the outcome of the questionnaire. However more worrying trends have been identified because of the research based on analysing datasets. It is still a relatively new concept even though there were other attempts at creating VR devices in the past. The current VR is still at a stage where it must prove that it is a worthwhile long term investment but as (Rolph 2016) pointed out the investors have already shown that they have become enthusiastic with this technology. Findings show however that the initial increased interest in this technology has plummeted heavily for various reasons. This has been shown in the level of investment that has decreased dramatically and with the decreased number of games released on the Steam platform. Major VR companies such as Facebook has lowered the price of theirs Oculus headset and shut down the VR film studio as of early 2017 (Shead, 2017). Findings also show that the developers who released their products on the Steam platform have overwhelmingly recommended the top of the line GPU’s. This generates additional cost

6.3 Questionnaire Results
Cardiff Metropolitan University students have shown surprising amount of enthusiasm for the technology and its possibilities. As of today more than expected have been exposed to this technology at some point. Moreover, most of the students from this university have also declared that they made a purchase from IKEA at some point during their studies at Cardiff
This can be justified with the fact that IKEA owns a branch in Cardiff ("IKEA Cardiff | Kitchen, Bedroom & Living Room Furniture"). The question about how much users would be willing to pay for the VR currently had about a quarter of the respondents to say that they would not pay anything while a relatively large proportion claimed that they would be willing to pay upwards of £300. The reason as to why a lot of respondents stated that they would pay a lot could be due to the fact that many students would purchase the set primarily for gaming. As mentioned before the population sample while being randomly selected among the eligible Students could have been largely Computing students who are more likely to be interested in the technology in the first place. This poses a challenge for the entire VR industry as while the gaming market is very large the quality VR headset is currently too expensive so it remains as a gimmick. Many people may not attach any value to the system as they might not feel like it is necessary in their live just like a smartphone or a laptop. While smartphones were not common items 20 years ago currently they are rendered as an economic necessity (Dreyfuss 2017).

6.4 Cost of development and operation
The cost of developing and running the infrastructure behind the VR stores could prove to be another barrier for the adaptation of this technology to the mainstream. IKEA stands primarily as a budget option that must compete on the price level more than anything else. Products displayed on the store would have to be presented in the 3D form that would increase the cost of development of a new line of products. IKEA has around 9500 products in its catalogue at any given time ("Key Figures - IKEA" 2017) many of which are small and low cost. Scanning or recreating them in to the virtual world could prove to be too expensive to be worth while. An example of a failed attempt to recreate products in the 3D world is boo.com which CNET labelled as one of the greatest default disasters in the dotcom era (Lanxon, 2009). The company has spent up to $135 million in venture capital on a concept to recreate a 3D model of every object that was displayed on the inventory. The costs of running the business were far too large and the business strategy not viable. Currently the ikea inventory consists of many low costs products which could be the argument against the implementation of this technology, however it has to be noted that the techniques used for moving the objects in to the virtual world have decreased dramatically with devices such as 3D scanners that could be used for smaller objects.
6.5 Cost Savings Via 3D Modelling

It has to be noted that the concept of generating 3D equivalents of the inventory is not alien to IKEA even today. The company is using modern design tools that would not have been utilised during the dotcom era such as 3D modelling of the items by the designers before it is released to production. The reason for the 3D design is the lower cost of creating a 3D model over the physical prototype of the furniture. This is due to many iterations that must occur during the design process and testing of different materials. The designers pass parameters to each elements of the design indicating what it is made of and how durable and resistant it is to shocks, cracks and bends. Another reason to make the render of every item in the inventory is that it is cheaper to create a realistic 3D model than to produce a prototype to make the picture for the catalogue (Plunkett, 2014). As of 2012 IKEA has been taking steps to replace real pictures in their catalogues with renders mainly due to the cost savings (Suppouris, 2012). Another factor in favour of developing the VR system is the fact that IKEA has already created applications such as the “Kitchen Planner” which also includes 3D renders of IKEA products that can be placed in the virtual world rendered in the browser. IKEA is currently the most ideally positioned furniture company at the moment as the largest furniture company in the world (“How IKEA Creator Ingvar Kamprad Built The World’s Largest Furniture Retailer — And A $39 Billion Fortune”). Due to the IKEA’s ethical policy they try to make their products cradle-to-grave and the key to making a cheap product is to make it in the masses (Streeter, 2009).
Figure 19. IKEA Kitchen Planner
Chapter 7 – Conclusion

7.1 Introduction

This chapter will look at the aims and objectives that were set at the beginning of this paper to conclude whether and how they were met.

7.2 Aims and Objectives

The aim of this study was to investigate the potential of VR use within IKEA and establish whether the Cardiff Met students would be willing to use it as supposed to the regular online shopping.

Objective One: The first objective was to analyse the overall potential health risks related to the VR use especially long term. This was mainly talked about in the primary research as many researchers so far have expressed their concerns related to the VR use. It was concluded that while there appear not to be any major health risks the users often experience anxieties related to prolonged use. This is largely dependent on how well the VR can replicate the true image without causing the motion sickness or eye strain.

Objective Two: The second objective was to find out what attempts has IKEA made so far in the area of developing the VR. It was concluded that IKEA could be one of the first companies that would utilise this technology due to their position on the market as one of the largest furniture manufacturers. It was found that IKEA has already made attempts and tested the grounds when releasing IKEA Experience which is available on the Steam platform. The new concept seems appealing as it opens new opportunities when it comes to integrating with the virtual products.

Objective Three: The next objective was to build data scraping tool to collect data from the Steam website in order to use this data for the statistics. This was part of the project document where the program was build that was able to extract various key textual data using Python. The data was then used to create charts and draw conclusions from it.
Objective Four: The next objective was to collect data from Cardiff Met students in order to bring the context of the research to Cardiff students. It was found that a relatively high number of students have already been exposed to VR and have relatively favourable experience with it. Also many students claimed that they have shopped at IKEA at least once during their studies which indicates that they are a good target market.

Objective Five: The last objective was about analysing all of the collected information related to the global trends as well as what people think at Cardiff Met in order to bring conclusions as to whether there is any potential for this technology to become popular. It was found that while a lot of people are keen on trying VR the global trends show that this technology may never come to the market in the masses that were initially expected and might become a niche tool for certain professionals as supposed to a necessity such as a smartphone.

7.3. Main Findings
While full VR headsets might appear to have reached the level of advancement that makes it user friendly the inherent problem of penetration of this technology hinders the hopes for rapid ecommerce development. Current attempts to make VR more affordable might throw people away as they would know that without cuffing up the full sum of money they will not be able to have the full experience with range of sensors detecting movements of the users on the high-end models. The problem with lower cost VR solutions is not just the inherently lower quality of the experience but also the health and anxiety problems that the users must endure while being exposed to VR especially of lower quality. The problems start when the frame rates drop to Lowe levels than what the human eye is used to or if the resolution is so low that the images look very poor ad blurry. One of the aims of the primary research will be to analyse the effects that the students of Cardiff Met had when exposed to the VR experience regardless of the type of headsets they used. While the health effects should not be different in case of Cardiff Met students to anyone else but it will provide additional evidence about the experience of users. A study by (Essilorusa, 2017) outlines the additional effects on the users eyes especially those of young age. Immersive environments pose threats to people who are still growing up as the prolonged has been proven to cause nausea, disorientation called virtual reality sickness. There are also problems with the 3D steering scoping effect causing disruption of the users vergence.
Price of goods in IKEA heavily rely on the costs of production and development. If the products sold online were to be scanned using some streamlined technique that cost would still have to be factored in and compared with the potential advantages of running the system. Ideally due to the position on the market that IKEA holds it is the main contender to adopt the VR to their products. This is mainly to do with the fact that they mass produce their products and distribute them across the entire globe. The cost of scanning would then be distributed across a much greater number of sold units than what any other company can currently afford.

**7.4 Recommendations**

The future improvements of the questionnaire could include more detailed insight in to what types of VR headsets people have given various options and the fact that some phone currently on the market are VR enabled and only require a relatively inexpensive attachment such as googles in order to use them. While these appear to be still relatively uncommon it is expected that like any think with technology the price of these phone and VR enabled GPU’s will go down and most GPU’s on the market will likely be VR enabled even if people will not pay much attention to that.
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7.6 Appendices

Ethics Form

When undertaking a research or enterprise project, Cardiff Met staff and students are obliged to complete this form in order that the ethics implications of that project may be considered. **If the project requires ethics approval from an external agency (e.g., NHS), you will not need to seek additional ethics approval from Cardiff Met. You should however complete Part One of this form and attach a copy of your ethics letter(s) of approval in order that your School has a record of the project.**

The document *Ethics application guidance notes* will help you complete this form. It is available from the Cardiff Met website. The School or Unit in which you are based may also have produced some guidance documents, please consult your supervisor or School Ethics Coordinator.

Once you have completed the form, sign the declaration and forward to the appropriate person(s) in your School or Unit.

**PLEASE NOTE:**

Participant recruitment or data collection MUST NOT commence until ethics approval has been obtained.

**PART ONE**

<table>
<thead>
<tr>
<th>Name of applicant:</th>
<th>Thomas Szpak</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supervisor (if student project):</td>
<td>Stuart McNeil</td>
</tr>
<tr>
<td>School / Unit:</td>
<td>Cardiff School of Management</td>
</tr>
<tr>
<td>Student number (if applicable):</td>
<td>St20071168</td>
</tr>
<tr>
<td>Programme enrolled on (if applicable):</td>
<td>BS c (Hons) Computing</td>
</tr>
<tr>
<td>Project Title:</td>
<td>What is the potential for VR use for Cardiff Metropolitan University student purchase of furniture at Ikea.</td>
</tr>
<tr>
<td>Expected start date of data collection:</td>
<td>13/04/17</td>
</tr>
<tr>
<td>Approximate duration of data collection:</td>
<td>3 weeks</td>
</tr>
<tr>
<td>Funding Body (if applicable):</td>
<td>N/A</td>
</tr>
<tr>
<td>Other researcher(s) working on the project:</td>
<td>none</td>
</tr>
<tr>
<td>Will the study involve NHS patients or staff?</td>
<td>No</td>
</tr>
<tr>
<td>Will the study involve taking samples of human origin from participants?</td>
<td>No</td>
</tr>
</tbody>
</table>

**Does your project fall entirely within one of the following categories:**

<table>
<thead>
<tr>
<th>Category</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper based, involving only documents in the public domain</td>
<td></td>
<td>No</td>
</tr>
<tr>
<td>Laboratory based, not involving human participants or human tissue samples</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Practice based not involving human</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>participants (eg curatorial, practice audit)</td>
<td></td>
<td></td>
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<td>---</td>
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<td></td>
</tr>
<tr>
<td>Compulsory projects in professional practice (eg Initial Teacher Education)</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>A project for which external approval has been obtained (e.g., NHS)</td>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>

If you have answered YES to any of these questions, expand on your answer in the non-technical summary. No further information regarding your project is required.

If you have answered NO to all of these questions, you must complete Part 2 of this form.

In no more than 150 words, give a non-technical summary of the project:

With the advancement of the Virtual and Augmented Reality technologies this paper will look at the potential of virtual and augmented reality technologies in the context of e-commerce application for furniture companies. The advent of these technologies on the market is currently fuelled by video gaming industry as the users seek for new experiences. The real potential of this technology and what could put it up as the new mainstream tool could lie in the commercial/retail usage where the user would be able to move around the virtual shopping centre and browse for the virtual furniture before buying it. This research will look into possible applications of this technology in pursuit of enhanced shopping experience that allows for the companies that sell products and services to gain technological edge in how they advertise their products. It will also look at the education leap that the current developers would have to make in order to be able to jump from coding 2d to 3d interactive environments and what techniques are used for further research.

DECLARATION:

I confirm that this project conforms with the Cardiff Met Research Governance Framework

I confirm that I will abide by the Cardiff Met requirements regarding confidentiality and anonymity when conducting this project.

STUDENTS: I confirm that I will not disseminate any material produced as a result of this project without the prior approval of my supervisor.

<table>
<thead>
<tr>
<th>Signature of the applicant:</th>
<th>Date:</th>
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</thead>
</table>

FOR STUDENT PROJECTS ONLY

<table>
<thead>
<tr>
<th>Name of supervisor:</th>
<th>Date:</th>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Signature of supervisor:</th>
<th></th>
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</table>

Research Ethics Committee use only

<table>
<thead>
<tr>
<th>Decision reached:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Project approved</td>
<td></td>
</tr>
<tr>
<td>Project approved in principle</td>
<td></td>
</tr>
<tr>
<td>Decision deferred</td>
<td></td>
</tr>
<tr>
<td>Project not approved</td>
<td></td>
</tr>
<tr>
<td>Project rejected</td>
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</table>

Project reference number: Click here to enter text.
## PART TWO
### A RESEARCH DESIGN

<table>
<thead>
<tr>
<th>A1 Will you be using an approved protocol in your project?</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>A2 If yes, please state the name and code of the approved protocol to be used¹</td>
<td>N/A</td>
</tr>
</tbody>
</table>

**A3 Describe the research design to be used in your project**

This dissertation will use mono method (Saunders, 2015) quantitative research. The research will look at the advantages and disadvantages of the implementation of this technology. Potentially VR could bring shopping online to a new level when it comes to interacting with the products and customer services. New types of products could become suitable for online shopping which could bring down the costs of product distribution. The potential for this technology will be compared with the amount of money that would have to be spent on development of the necessary software. This research will look at the technologies such as the Software Development Kits (SDK) that would have to be used to develop these interactive 3D words.

The questionnaires will be carried out using Google Forms, according to (“The Complete University Guide”) around 13,670 student have enrolled to this university in 2014/15. According to (Saunders, 2015) using the statistical data processing method the minimum number of respondents that should be questioned is 370. With this number of people the margin of error is reduced to 5%. As the population being studied is being clearly defined so the non-probability sampling method will be used where particular students are contacted directly to complete the questionnaire. Snowball sampling method will be used to get the desired number of respondents. This is due to the fact that the population is limited to Cardiff Met Students so selecting respondents based on referrals would ensure that data would be collected from appropriate sources.

This research will use positivistic approach as it will look at the numerical data that will be gathered from the structured closed questionnaires that will offer a choice of answers. The research will also be enhanced using statistical data gathered from datasets.

The questionnaires would be anonymous and any collected data would not be traceable to specific people but confidentiality of the data collected would be ensured as the results will be stored in the cloud protected under a password.

<table>
<thead>
<tr>
<th>A4 Will the project involve deceptive or covert research?</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>A5 If yes, give a rationale for the use of deceptive or covert research</td>
<td>N/A</td>
</tr>
<tr>
<td>A6 Will the project have security sensitive implications?</td>
<td>No</td>
</tr>
<tr>
<td>A7 If yes, please explain what they are and the measures that are proposed to address them</td>
<td></td>
</tr>
</tbody>
</table>

### B PREVIOUS EXPERIENCE

**B1 What previous experience of research involving human participants relevant to this project do you have?**

---

¹ An Approved Protocol is one which has been approved by Cardiff Met to be used under supervision of designated members of staff; a list of approved protocols can be found on the Cardiff Met website here
B2 Student project only
What previous experience of research involving human participants relevant to this project does your supervisor have?
16+ years of experience.

C POTENTIAL RISKS

C1 What potential risks do you foresee?

1. It might take a long time to get a desired number of people interested in responding to the survey. This could further decrease the number of participants and therefore make the sample size too small to be considered a valid research.
2. Getting student to answer the survey might prove to be difficult as may of them could be unwilling to answer a questionnaire voluntarily. The questionnaire might be too long and they might also try to finish it quickly disregarding what information they are putting in. This could distort the data from a relatively small sample.
3. Some of the research will be based on searching for findings that were discovered by other authors but some of the data necessary might not have been researched before. Since the topic of my research is accurate and focuses on specific demographic that are students of Cardiff Metropolitan University it might be hard to find data that could be related to my research since most of the publishings focus on a lot more general groups of people. This could make it harder to link some of the findings with the context of my study.
4. Another risk with using open source datasets is the fact that some of the information in it could contain personal data that has been collected along the way.
5. Security is a concern as the data that is collected from the questionnaires should be kept in a secure way in order to prevent it from being accidentally deleted due to a mistake or hardware failure.

C2 How will you deal with the potential risks?

1. In order to get persuade people to answer questionnaires it could be useful to offer some type of incentive in exchange for completing the questionnaire. This could also be a good way to increase the sample size and therefore make the research more valid.
2. The incentive will encourage people to answer the questionnaire and in order to get people to finish it, the form will have to be short and relatively simple. The questions should only be one sentence long with clear bullet points. This way answering the survey should be relatively simple and the user will be able to finish it quickly. This will make sure that the number of people who actually read the questions before answering will be as high as possible.
3. In order to conduct quantitative research it might be necessary for me to create data scraping tools in order to be able to collect unique data that people perhaps have not paid attention to before. Another way to gather statistical information could be to search thru some databases that contain useful datasets about the subject such as https://www.kaggle.com/.
4. Data will have to be thoroughly checked and cleaned from anything that should not be used in the research. The data can be anonymised by removing personal information from the datasets.
5. In order to secure the data there will be multiple backups that include a personal computer a laptop and a cloud service. The cloud services are convenient solution to making sure that the data is backed up on multiple hard drives and protected under a password.
FORM

CARDIFF METROPOLITAN UNIVERSITY

STUDENT NUMBER:

TITLE OF PROJECT
IF USING A WORKING TITLE, IT SHOULD CONVEY WHAT THE PROJECT IS ABOUT

NAME OF RESEARCHER:

__________________________________________

PARTICIPANT MUST COMPLETE THIS SECTION: PLEASE
TICK EACH BOX.

1. I CAN APPROVE THAT I HAVE READ AND AGREED TO THE INFORMATION ON THE STUDY AND TO ANSWER QUESTIONS REGARDING THE TOPIC TO SUPPORT THE PROJECT.

2. AS A VOLUNTEER TO THE STUDY, I HAVE FULL CONTROL TO REFUSE TO ANSWER QUESTIONS AT ANY TIME IF I FEEL UNCOMFORTABLE.

3. I AM 18+.

4. I CAN CONFIRM THAT ANY RECORDINGS AND QUOTES ARE AVAILABLE TO BE USED TO HELP THE STUDY, AS LONG AS IT IS CONFIDENTIAL AND IDENTITIES ARE NOT REVEALED.

5. I WOULD LIKE TO TAKE PART IN THIS STUDY.

__________________________________________

PARTICIPANT SIGNATURE DATE

__________________________________________

NAME OF PARTICIPANT DATE

__________________________________________

SIGNATURE OF RESEARCHER
IKEA VIRTUAL REALITY ASSESSMENT

THIS QUESTIONNAIRE IS DESIGNED TO HELP UNDERSTAND THE POTENTIAL FOR APPLICATION OF VR TECHNOLOGIES BY IKEA IN RELATION TO THE CARDIFF METROPOLITAN STUDENTS.

PLEASE READ AND TICK THE BOX BELOW IF YOU AGREE TO THE TERMS AND CONDITIONS.

☐ I CAN APPROVE THAT I HAVE READ AND AGREED TO THE INFORMATION ON THE STUDY AND TO ANSWER QUESTIONS REGARDING THE TOPIC TO SUPPORT THE PROJECT.

☐ AS A VOLUNTEER TO THE STUDY, I HAVE FULL CONTROL TO REFUSE TO ANSWER QUESTIONS AT ANY TIME IF I FEEL UNCOMFORTABLE.

☐ I AM 18+

☐ I CAN CONFIRM THAT ANY RECORDINGS AND QUOTES ARE AVAILABLE TO BE USED TO HELP THE STUDY, AS LONG AS IT IS CONFIDENTIAL AND IDENTITIES ARE NOT REVEALED.

☐ I WOULD LIKE TO TAKE PART IN THIS STUDY.

1. PLEASE PROVIDE YOUR EMAIL ADDRESS.

2. DO YOU OWN A VIRTUAL REALITY (VR) HEADSET?
   ☐ YES
   ☐ NO

3. IF YES HAVE YOU EXPERIENCED UNCOMFORTABLE FEELING ON YOUR EYES DUE TO THE USE?
   ☐ YES
   ☐ NO

4. SINCE THE BEGINNING OF YOUR STUDIES IN CARDIFF MET, DID YOU BUY ANY IKEA FURNITURE?
   ☐ YES
   ☐ NO

5. ARE YOU CONCERNED WITH THE POTENTIAL HEALTH EFFECTS OF USING VR?
   ☐ YES STRONGLY
   ☐ A LITTLE BIT
   ☐ NOT REALLY
   ☐ I DON'T KNOW ABOUT ANY HEALTH EFFECTS

6. WHAT IS THE AMOUNT YOU WOULD BE WILLING TO PAY FOR THE VR GEAR?
   ☐ NOTHING
   ☐ LESS THAN £50
   ☐ BETWEEN £50 AND £100
   ☐ BETWEEN £100 AND £200
7. IF YOU USED THE VR BEFORE, WHAT IS THE MAXIMUM AMOUNT OF TIME YOU CAN USE IT BEFORE YOU EXPERIENCED THAT IT WAS GETTING UNCOMFORTABLE.
   ☐ IMMEDIATELY IT WAS UNCOMFORTABLE
   ☐ 0 TO 2 MIN
   ☐ 3 TO 5 MIN
   ☐ 6 TO 10 MIN
   ☐ 10 MIN ONWARDS
   ☐ I'VE NEVER EXPERIENCED UNCOMFORTABLE FEELING

8. DID YOU FEEL THAT THE PROPORTIONS OF THE OBJECT IN THE VIRTUAL ENVIRONMENT WERE ACCURATE TO REAL WORLD?
   ☐ YES
   ☐ NO
   ☐ NOT SURE

9. DO YOU FEEL LIKE THE VIRTUAL SHOPS COULD BE BETTER OPTION TO REGULAR ONLINE SHOPPING?
   ☐ YES
   ☐ NO
   ☐ DEPENDS ON HOW THE TECHNOLOGY WILL IMPROVE
**DEVOLVED ETHICS APPROVAL APPLICATION SUMMARY**

Student Name: Thomas Szpak  
Student Number: st20071168

Module Name: Dissertation  
Module Number: BCO6022

Programme Name: BSc Computing  
Supervisor Name: Stuart McNeil

<table>
<thead>
<tr>
<th>To be completed by student and supervisor before submission to Ethics Approval Panel</th>
<th>Student Signature</th>
<th>Supervisor Signature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application for ethics approval</td>
<td>Yes</td>
<td>N/A</td>
</tr>
<tr>
<td>Participant information sheet</td>
<td>]</td>
<td>-</td>
</tr>
<tr>
<td>Participant consent form</td>
<td>]</td>
<td>[ ]</td>
</tr>
<tr>
<td>Pilot interview/s</td>
<td>]</td>
<td>[ ]</td>
</tr>
<tr>
<td>Pilot questionnaire/s</td>
<td>]</td>
<td>[ ]</td>
</tr>
<tr>
<td>Letter/s to participating organisation/s</td>
<td>]</td>
<td>[ ]</td>
</tr>
<tr>
<td>Confirmation of interviewee participation</td>
<td>]</td>
<td>[ ]</td>
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</tbody>
</table>

First Submission [ ]  
Resubmission [ ]

Date: 10/04/17

For use by the devolved ethics approval panel:

<table>
<thead>
<tr>
<th>Panel Members</th>
<th>Name</th>
<th>Signature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module Leader, Chair</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supervisor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CSM Ethics Committee Representative</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Date:  
Date of Reassessment:  

Outcome:

Project Approved [ ]  
Reference number issued:  
Chair’s Action [ ]

Application Not Approved [ ]

Comments for projects not fully approved:

The original to be retained by the module leader and a copy given to the student