Diffusion of VR/AR first aid training for the wide use of the general public

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ABBREVIATIONS

AR - Augmented Reality

BRC - British Red Cross

IFRC - International Federation of Red Cross and Red Crescent Societies

ICRC - International Committee of the Red Cross

IT - Immersive Technologies

mApps - Mobile Applications

MCI - Mass Casualty Incident

MR - Mixed Reality

PBL - Problem-Based Learning

SCA - Sudden Cardiac Arrest

TAM - Technology Acceptance Model

TRI - Technology Readiness Index

VR - Virtual Reality

VRLE - Virtual Reality Learning Environment

VRTS - Virtual Reality Training Systems

XR - Extended Reality

ABSTRACT

The following dissertation focuses on assessing the diffusion and adoption of VR and AR technologies with specific focus on their application for first aid training purposes. The study examines a number of established diffusion models, as well as important factors discovered in previous literature concerning the successful adoption of new VR/AR technologies.

The study then combines primary and secondary research to validate some of the hypotheses and theories in the literature review and reaches to some new conclusions that have not been considered in past research.

DECLARATION

This dissertation is the author's original work. No portion of the work referred to in the dissertation has been submitted in support of an application for another degree or qualification of this or any other university or other institute of learning.

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CHAPTER 1: INTRODUCTION

‘Emergencies are serious, unexpected, and sometimes highly catastrophic events that require our prompt actions’ (Kwok, P. et al, 2019, p.711-722). In case of an accident, injury, or sudden illness, first aid delivered by bystanders can save lives and limit damage until professional help has arrived significantly increasing the victim’s outcomes (Van de Velde, et al, 2009). Laypersons trained in first aid can also potentially reduce delays in seeking medical assistance.

The International Federation of the Red Cross (IFRC) now numbers 192 National Societies worldwide, operating through some 166,000 branches, and nearly 14 million volunteers; and while the Red Cross and Red Crescent movement is responsible for training over 20 million people per year in first aid skills and employs more than 40,000 first aid trainers, these numbers are still relatively low when compared to the rest of the population across the globe.

In emergencies, 90% of lives can be saved by ordinary people (ICRC, 2020) if they have the right skills in place and confidence to perform first aid. For these reasons, it has been one of the core missions of the IFRC, the International Committee of the Red Cross (ICRC), and all Red Cross societies around the world to enable everyone to have easy access to first aid skills and training.

By enabling wide access to learning and providing first aid training accessible to all, we can ensure that more lives are saved not just in areas where there is shortage of medical staff, but also in developed countries where unforeseen events can prevent an ambulance getting to an injured person on time.

Using a virtual reality (VR)/augmented reality (AR) interactive training environment can not only deliver remote training to anyone anywhere in the world, but it often provides means to get learners to experience the training goals, help support learning transfer, as well as accelerate learning (Goulding, 2020). It can help create close to real training environments and simulate real life first aid scenarios, therefore,

exposing the learner to the pressure they'll be under when having to perform first aid during an accident.

While a VR/AR first aid training programme has never been implemented before on a large scale for the wide use by the general public due to the complexity and cost associated with the technology, the IFRC and ICRC combined have the scope, resources and reach through their access to 192 societies across the world to quickly and easily diffuse a VR/AR first aid training product for the use of the masses.

Therefore, the motivation for this study is to assess learnings from past research into the factors that have played a successful role in the diffusion of VR technology, as well as examine more specifically some of the challenges and perceptions that users might have in terms of VR first aid training specifically, therefore, providing useful insight into how the diffusion of a new VR first aid product should be approached.

The author of this study is an employee of the British Red Cross and is part of the team leading on the development of a VR/AR first aid training product for the use of the general public, therefore, the learnings from this research would contribute directly to the aforementioned project and feed into the successful dissemination of the the product.

Focus and scope

Medical research points to the fact that although there is no training that can completely prepare a real life mass casualty incident (MCI), 'familiarity with the process helps to increase the efficiency in the performing of the triage tasks that can determine the survival of the critically-injured' (Ferrandini Price, et.al, 2018).

Due to the high level of positive social impact that such technology can achieve in educating people and providing essential life saving skills to regions where medical availability is scarce, this study has set to explore the feasibility and factors that would play part of the successful dissemination of VR/AR first aid training for the use of the general public.

This study will focus on examining the barriers and user criteria that plays part of the successful dissemination of new technology and VR products in general and will then draw comparison through the primary and secondary research used in the findings and discussion section with the wider literature supporting and contrading certain findings.

Aims and objectives

The main research topic of this study will be exploring the diffusion of VR/AR first aid training for the wide use of the general public. When considering the diffusion of VR/AR first aid training we need to consider the different audiences that will gain access to the technology and establish who are most likely to be the early and late adopters (Albusberger, 2020). Therefore, some supporting questions that will be assessed in the study include:

- What are the different diffusion models that are found in literature
- What are the barriers to adoption of VR and AR technologies
- What are the most important factors that play part of the acceptance of new VR/AR products
- How does adoption and acceptance vary between different audience

Overview and structure

This dissertation comprises eight chapters. The information included in each one of the chapters is as follow:

Chapter 1: Introduction - an overview of the relevance of this study, as well as background of the motivational drivers for its implementation.

Chapter 2: Literature review - a review of existing literature and research into the topics of diffusion of technology and acceptance and adoption of VR/AR technology.

Chapter 3: Research methodology - an an overview of the methodology used to complete the research including data collection and analysis

Chapter 4: Findings - a summation of the main findings of the primary and secondary data analysis

Chapter 5: Discussion - a more deep dive into the findings, drawing parallels between the literature review assessing the implications of any new discoveries

Chapter 6: Limitations - looking into the limitations the author has come across when gathering and analysing the data, as well as limitation of the research findings

Chapter 7: Recommendations - guidance and recommendations for future research into the topic of diffusion of VR/AR first aid training

Chapter 8: Conclusion - concluding remarks and findings of the research

CHAPTER 2: LITERATURE REVIEW

In recent years, there has been a significant increase in the pace with which technology evolves.(Chambers, 2004). This rapid advancement of technology has also been one of the biggest contributing factors to the changes in the use of VR/AR technology.

Over the past 10 years, the virtual reality and augmented reality user ‘has shifted from being an expert working in an office to every Joe and Jane at home or on the move’ (Arnaldi, Guitton and Moreau, 2018). While certain applications of the technology were initially intended for a few professional fields, they have now been extended to all of society, even entering our homes in the form of gaming and services with many mainstream electronics equipment vendors now holding a complete range of equipment in their stock, from headsets to sensors and more. VR has been even further commercialised by the launch of the PlayStation VR headset in 2016, which was marketed as one of the cheapest VR headsets available to consumers, hoping to take the VR technology to mass-market (Stuart, 2016).

When analysing previous research and literature on the topic of virtual and augmented reality, we can see that the design and development of VR/AR technology is ultimately driven and intertwined with user perception and adoption. As Ramirez-Correa (2020) points out, ‘theories concerning the determinants of adoption of innovations is one of the four theoretical cornerstones of the topic of innovation.’

However, to be able to truly understand why certain VR products are more successfully adopted than others, we need to build a basic understanding of what the technology actually is and what makes it especially suitable for certain applications.

What is virtual reality?

VR/AR technology dates back several decades and there is a very large international community continuously working on its development both on a scientific and an industrial level (Arnaldi, Guitton and Moreau, 2018). A large number of companies have also been successfully using VR and AR technologies for many years now.

Some examples of the already established uses of VR include design and architecture, learning specific skills (piloting), tourism, games (*Pokémon Go*), ergonomics(Arnaldi, Guitton and Moreau, 2018); computer science, robotics, mechanics, behavioural sciences, physiology and neurobiology (Fuchs, Moreau and Guitton, 2012); accident rescue, medicine, military practice, crane training (Xu, et al, 2018); collaborative VR (Vaughan, Gabrys and Dubey, 2016) and many more.

The term ‘virtual reality’ has now been used for more than twenty three years and it was first introduced in the United States by Jaron Lanier in the 1980s (Fuchs, Moreau and Guitton, 2012, p.28). The concept of VR is inasmuch so complex that Arnaldi, Guitton and Moreau (2018) take it back to Plato’s Allegory of the Cave; they write, ‘in Book VII of Plato’s Republic, there is a detailed description of the experiences of several men chained in a cave, who can only perceive shadows (thrown against the walls of the cave) of what happens in the outside world’, thus experiencing the world outside of the cave through the virtual reality created by the shadows.

When referring to VR we often talk about the hardware and the design of new virtual reality headsets, also called ‘visioheadset’. However, VR and AR are a lot more than a headset equipment (Arnaldi, Guitton and Moreau, 2018). According to Fuchs, Moreau and Guitton (2012, p.26), the real novelty of virtual realities today is the ability they present to the user to ‘act virtually’ in an artificial world. VR allows the user to virtually execute a task while believing that they are executing it in the real world. In order for this sensation to be generated, ‘the technology must “deceive the brain” by providing it with information identical to the information the brain would perceive in the real environment’ (Arnaldi, Guitton and Moreau, 2018). This process

of modifying perception is called ‘immersion’ and is one of the fundamental principles of VR. Immersion goes beyond creating a realistic environment and world through the use of the visioheadset. It also covers other senses which are necessary to create a realistic experience, such as sound.

Literature often mixes the purpose of VR and its functions, applications and the techniques on which it is based. Because of this, VR is wrongly defined as ‘a computer-generated simulation of a 3D environment that mimics reality using special electronic devices, such as helmets equipped with sensors and screens’ (Lee, Kim and Choi, 2019, p37-48). Fuchs, Moreau and Guitton (2012, p.28) encourage the rejection of these approaches, firstly because they’re centered around only one technology, but also because they are very restrictive in terms of the complexity involved in the interaction between the user and the virtual environment.

Success and effectiveness of VR/AR for training purposes

The interactive feedback that VR training can offer provides an invaluable aid towards understanding and learning very complex topics especially in areas where access to the information on a specific subject is impossible to access as it may no longer exist, it may be too voluminous for our brain to take in (big data), or may be imperceptible to the human sense, such as radioactivity (Arnaldi, Guitton and Moreau, 2018).

Training is also the sector where VR has had the greatest impact. According to Arnaldi, Guitton and Moreau (2018), there are four main reasons for this:

1. The simulation of work situations make it possible to put in place a new pedagogy that is aligned with training objectives
2. Complete ‘de-risking’ of the training process while at the same time still placing the learner in all kinds of dangerous situations
3. Savings on consumables and heavy equipment

4. The nature of VR training can create a lot more engaging and interactive environments that can offset the more boring aspects of traditional training

(Arnaldi, Guitton and Moreau, 2018)

Another reason why virtual reality's application for training purposes is so successful is the ability to encourage problem-solving as well as to provide highly interactive learning experiences, a critical skill for learning. By using a virtual reality learning environment (VRLE) for training purposes, designers are able to achieve individualisation of the level of difficulty with immediate feedback which provides greater realism than purely didactic instructions (Huang, Rauch, and Liaq, 2010). Furthermore, VRLEs allow learners to acquire knowledge with less of a cognitive effort than that of a traditional learning process (Chittaro and Ranon, 2007).

Why is VR/AR suitable for first aid training?

Medical research points out that while there is no training that can completely prepare a person for a scenario of a mass casualty incident (MCI), familiarity with the process can 'help to increase the efficiency in the performing of the triage tasks that can determine the survival of the critically-injured' (Ferrandini Price, et.al, 2018).

The amount of use of VR in the emergency sector is still very limited, however, such technologies have an enormous potential to bring disruptive innovation (Croatti, et al, 2018). The development of Immersive Technologies (IT), such as VR, AR and 360° video provides numerous advantages as they offers a degree of interaction and reproducibility, allowing for training anywhere and anytime that might not available through other training methods such as face to face training (Ferrandini Price, et.al, 2018).

According to Arnaldi, Guitton and Moreau (2018), the purpose of a VR system is to 'create a simulacrum of a situation that facilitates learning or the modification of a behaviour'. This so called 'simulacrum' makes a reference to the properties of a real environment and a real situation, such as a first aid scenario, but with the caveat of

being able to have an enrichment of functions depending on the learning objectives or goals, such as building confidence and willingness to act in a first aid scenario. While in person emergency first aid training is proven to lead to an improvement in safety due to an increase in perceived responsibility to take action to avoid injury by the trainees (McKenna and Hale, 1982), there are concerns about the ability of trainees to recognise certain medical conditions that would require a fast first aid response, such as a sudden cardiac arrest (SCA) due to the lack of realism of face to face educational methods. Therefore, resuscitation science organisations such as the American Heart Association (AHA) have called for innovative solutions to help increase public CPR training rates through the use of digital strategies such as virtual reality (VR) and mobile applications (mApps) (Leary, et al, 2019).

VR can not only create emergency and first aid situations that are very close to real situations, but it also allows for the content to be personalised for each learner by offering them ‘the most relevant situation depending on their progression along the learning path, remediation of errors, reflexive approach or impact that stressors and distractions might have on their readiness to act in an emergency’ (Arnaldi, Guitton and Moreau, 2018). Results from past studies have also shown that a virtual collaborative simulation-based training (VCST) method is a feasible approach for practicing crisis management training (Kwok, et al, 2019, p.711-722). The ability of VR to elicit genuine reactions from users, whether this is provoking empathy or fear and anxiety has been repeatedly documented (Richard and Lauterbach, 2011) and can lead to an increased willingness to act in a first aid scenario. This theory has been also proven by an experiment led by the British Red Cross in which a 360° video aimed to familiarise viewers with ‘the bystander effect’.

The bystander effect is a social phenomenon that suggests that the more people there are around when an emergency happens, the less likely it is that an individual will act (Ward, 2019). The results from the 360° video experiment showed an increase in willingness to act in a first aid scenario in a public environment from a 3.4 score to a 9.2 score in those participants that partook in the study.

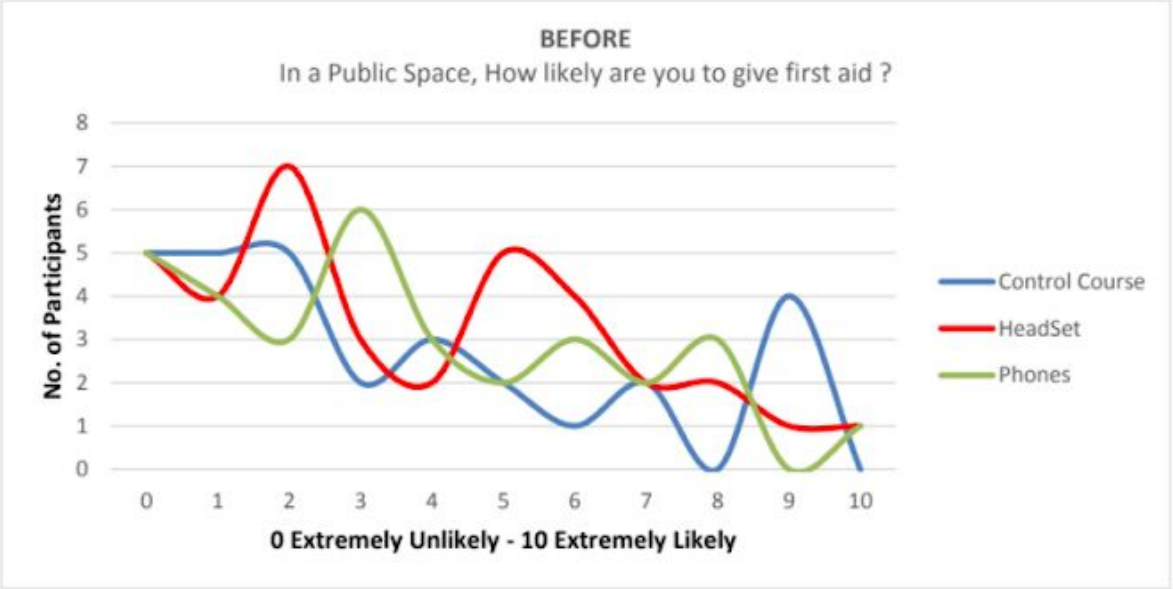

Figure 1: Likelihood to deliver first aid before experiment (Ward, 2019)

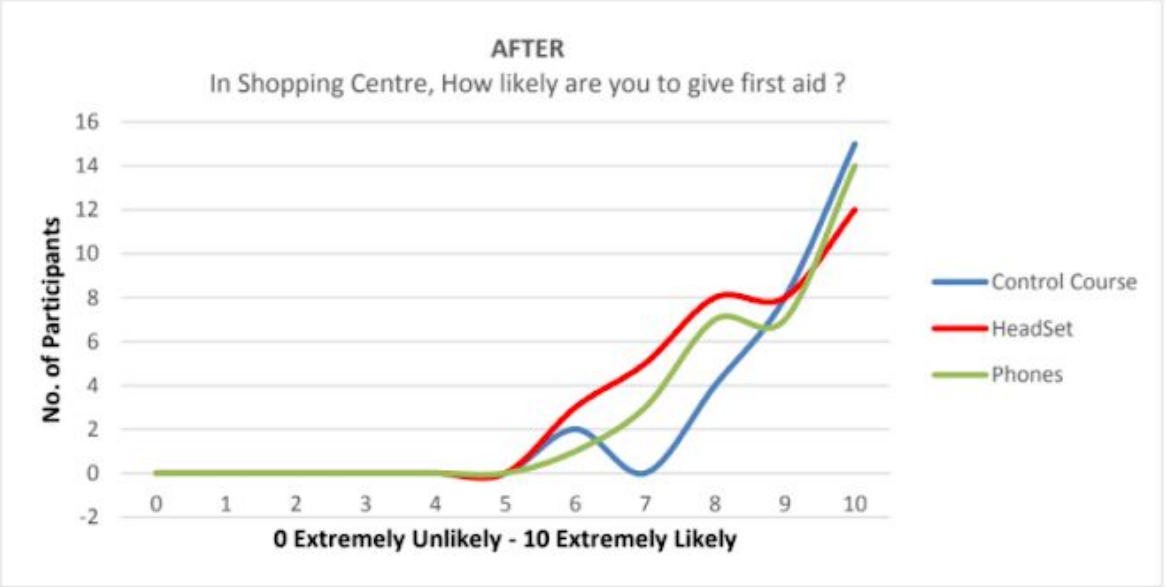

Figure 2: Likelihood to deliver first aid after experiment (Ward, 2019)

Studies comparing VR versus traditional training have found the addition of VR to significantly improve training outcomes (Leary, et al, 2019). In a recent report on SCA, the National Academy of Medicine acknowledged that, ‘innovation in smartphone and mobile applications… could significantly reduce the time interval between collapse and treatment and substantially improve patient survival rates’ (Leary, et al, 2019) which is why it’s important for us to study the dissemination and adoption of VR first aid training technologies.

Diffusion of VR/AR training technology

When we talk about diffusion of new technologies, we refer to ‘the mechanism or process that spreads the new or improved technologies across socio-economic structures such as individuals, firms, or societies’ (Diebolt, Mishra and Parhi, 2016). Diffusion is a type of communication in which the message content exchanged is related to a new idea which an individual would communicate to one or several others (Rogers, 1983). Traditionally, diffusion is one of the three pillars on which the successful introduction of new products, processes and practices into society rests, along with invention and innovation (Hall, 2004).

When studying innovation, the word ‘diffusion’ is commonly used to describe the process by which individuals and firms in a society/economy adopt a new technology, or replace an older technology with a newer one (Hall, 2004). Diffusion of technology is a crucial part of the innovation process. Without wide distribution and adoption the new technology would have little socio-economic significance. As learning and user feedback play a large part in the development of technologies, understanding the factors that influence the diffusion of innovations is ‘not only significant in itself due to its impacts but is also instrumental in triggering further improvements in technology that leads to higher innovation at large’ (Diebolt, Mishra and Parhi, 2016). In fact, Diebolt, Mishra and Parhi (2016) argue that ‘the process of new technology diffusion can be intrinsically linked to innovation so much so that it can be viewed as innovation itself’. Therefore, diffusion is not only the process and means by which an innovation is spread and becomes useful, but is, infact, a crucial part of the innovation process as learning, imitation, and feedback effects which arise during the spread of a new technology enhance the original innovation (Hall, 2004).

Therefore, understanding the diffusion process is the key to understanding how conscious innovative activities produce the improvements in economic and social welfare.

Models used in previous literature

When it comes to diffusion of technology, previous research has largely focused on incorporating theories from management information systems and computer science, such as the technology acceptance model (TAM) (Herz and Rauschnabel, 2019). TAM has been applied in previous research to mainly explain the acceptance of new information technologies and the theoretic model was designed to predict an individual's acceptance of technology incorporating two main criteria - user acceptance (perceived usefulness) and behavioral intentions (perceived ease of use) (Huang, et al, 2013). TAM is based on the Theory of Reasoned Action (TRA) and is a successful tool in empirically analysing the factors that have an impact on user attitudes and intent to use new information technologies (Davis, 1989). Recently, TAM has been widely used to analyse consumer adoption behavior of not only information services, but also information devices such as smartphones and smart watches (Lee, Kim, and Choi, 2019).

However, while models based on TAM have substantially contributed towards enhancing our understanding of why people use computers and other information technology, recent developments suggest that novel frameworks are required (Kalantari, 2017).

New technological developments allow users to satisfy a variety of needs that traditional media and technology acceptance theories do not incorporate (Herz and Rauschnabel, 2019). Past studies utilising the TAM model were found to include perceived enjoyment only as a basic factor, mainly focusing on practicality as a driver for adoption (Lee, Kim and Choi, 2019), and thus undermining the important impact that enjoyment has on intention to use and acceptance of technology.

Factors affecting the diffusion of technological innovation

The diffusion of a new technology is a gradual process. It is considered to be 'an accumulated phenomenon resulting from the series of individual decisions to switch to the new technology which generally occurs over a time period' (Diebolt, Mishra and Parhi, 2016). What tends to happen during the adoption process is that it would

begin with a few early adopters, followed by a period of accelerated adoption, with the rate of adoption saturating once most users have adopted the technology. The resulting path of diffusion is therefore characterised by an S-shaped curve (Diebolt, Mishra and Parhi, 2016). There are a number of different innovation adopters that have been outlined in literature, all falling in different parts of the S-shaped curve: innovators, early adopters, early majority, late majority, and laggards (Rogers, 1983).

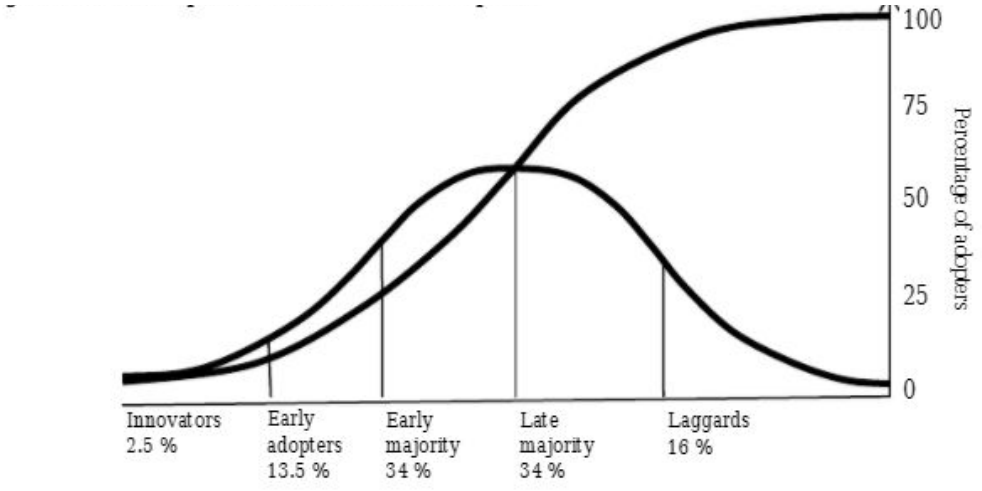

Figure 3: The S-shaped curve of innovation adoption (Kijek, 2015)

Most innovations have an S-shaped rate of adoption, but the slope of the ‘S’ would vary from innovation to innovation. Some new technology might diffuse very rapidly, creating a very steep S-curve, and others would have a slower rate of adoption with a slope that is relatively lazy. One issue addressed by diffusion research is why some innovations have a rapid rate of adoption while others are adopted more slowly (Rogers, 1983).

An innovation usually has at least some degree of benefit for its adopters even if that is not initially clear to its potential users. Rogers (1983) has established five analytic categories that help classify the attributes that influence the potential adopters of an innovation:

1. The relative advantage of the innovation

2. Its compatibility, with the potential adopter's current way of doing things and with social norms
3. The complexity of the innovation
4. Trialability, the ease with which the innovation can be tested by a potential adopter
5. Observability, the ease with which the innovation can be evaluated after trial

(Hall, 2004)

According to Hall (2004), there are a number of external or social conditions that may accelerate or slow the process of diffusion such as: whether the decision is made collectively, by individuals, or by a central authority; the communication channels used to acquire information about an innovation; the nature of the social system in which the potential adopters are embedded, its norms, and the degree of interconnectedness; the extent of change agents' promotion efforts.

Past diffusion research generally has investigated each innovation as if it were independent from other innovations. Rogers (1983) considers this an oversimplification in that an adopter's experience with one innovation would obviously influence that individual's perception of the next innovation to diffuse through the individual's system.

When examining past diffusion literature we can see very different research approaches being utilised. Economists and management scientists mainly focus on the behaviors and decision making processes of users; sociologists consider diffusion to be a purely social phenomenon; geographers depict it as a spatial process. Due to the significant differences between approaches modelling the diffusion process incorporating all the dimensions has been a challenging task and explains partly the dissociation of disciplines from each other (Diebolt, Mishra and Parhi, 2016).

Epidemic models

Most of the modern work on diffusion owes its origin to the epidemic approach pioneered by Griliches and Mansfield (Diebolt, Mishra and Parhi, 2016). This approach regards diffusion as resulting from the spread of information. In the epidemic model 'consumers can have identical tastes and the cost of the new technology can be constant over time, but not all consumers are informed about the new technology at the same time' (Hall, 2004). The information spread takes place through personal contacts like the spread of an epidemic, thus generating the name 'epidemic models' (Diebolt, Mishra and Parhi, 2016). The epidemic process begins with an innovator who is the first adopter, followed by a potential adopter who will adopt the technology upon learning of its existence, with 'most people depend mainly upon a subjective evaluation of an innovation that is conveyed to them from other individuals like themselves who have already adopted the innovation' (Rogers, 1983). Information will then spread between the existing user and potential users with the maximum number of the adopting population being fixed. The epidemic model is particularly popular in sociological and marketing literature, but has also been used by economists (Hall, 2004).

Diffusion is a very social process and in some cases, innovations become more compelling to potential adopters as the level of previous adoption increases; in the language of economists, there are 'network effects' or 'dynamic increasing returns' (Rogers, 1983; Nelson, 2004). People, by nature, will resist change unless they can be convinced that they can directly benefit from it. Designing an effective approach for increasing end-user acceptance and subsequent use of innovation continues to be a fundamental challenge that has not always provided straight-forward solutions (Talukder, 2012).

Geographical models

Another way of looking at and examining the diffusion process is by assessing the difference in adoption rate based on geographical location. Ha¨gerstrand's view of

geographical diffusion (Diebolt, Mishra and Parhi, 2016) conceived diffusion as a three-stage process:

1. The innovation is introduced in some major centre
2. The innovation is spread in the neighbourhood of the first centres and transmitted to minor centres
3. Then it is spread in the neighbourhood of the minor centres, thus saturating the diffusion process

(Diebolt, Mishra and Parhi, 2016)

Equilibrium models

Another type of adoption models discussed in literature are the equilibrium models, also known as ‘decision theoretic’ or ‘rational choice’ models. These types of models explain the rate of technological adoption entirely by objective changes in the profitability of using a new technology (Diebolt, Mishra and Parhi, 2016). Therefore, in contrast to the epidemic models where information drives the process of diffusion, the equilibrium models are based on the assumption that at any point in time those who find the adoption profitable to them acquire the technology. The main features of these models are that the adoption occurs when the actual costs of adoption are identical to the perceived benefits of adoption (Diebolt, Mishra and Parhi, 2016).

This cost includes not only the price of acquisition, but also the cost of the additional investment and learning required to make use of the technology. The need for development of complementary investment is incredibly important especially for complex modern technology (Hall, 2004). In many cases some form of promotional or marketing activities and advertising would take place to bring information about the technology to its potential adopter, which would also directly influence the cost of the new technology directly (Hall, 2004).

The resulting logic from the examples above is that ‘it is not always enough that a new technology has a great stand-alone value; in order to diffuse in a population, the new technology's value needs to exceed the combined value of technological utility, the installed base and the availability of complementary goods of the old technology’

(Laurell, et al, 2019). Therefore, the total value of the technology is the sum of the value attributed to the stand-alone product and the value attributed to the network externalities. This example is confirmed with the high popularity of the PlayStation VR headset compared to other competitors on the market, that comes with an existing integration with the PlayStation console, as well as a number of VR games that the user can purchase or play for free (Wingfield, 2017). As Laurell, et al. (2019) highlights, ‘a large installed base increases the likelihood of products and services being developed for a particular platform’. A larger install base would also increase the access to complementary products, as shown in the PlayStation example, meaning heightened value of the product in terms of its so-called network externalities’ value.

Diffusion within social systems

Katz (1961) remarked, ‘it is as unthinkable to study diffusion without some knowledge of the social structure in which potential adopters are located as it is to study blood circulation without adequate knowledge of the veins and the arteries.’

The structure of a social system can affect the diffusion of an innovation and the social system itself can constitute a boundary for diffusion of innovations. Norms and the roles of opinion leaders and change agents can all have an impact on the types of innovation-decisions made (Katz, 1961). In addition to formal structures that can be found within a social system, there are also informal structures that exist in the interpersonal networks linking a system’s members. The structures within a social system, formal or informal, can facilitate or impede the diffusion of innovations (Katz, 1961). Often these information structures could have a negative impact on diffusion if their actors are opposed to the new technology. Sometimes, the most innovative member of a system tends to be perceived as a deviant from the social system and is accorded a status of low credibility. Therefore, the individual’s role in diffusion can be very limited (Rogers, 1983).

Compared to other diffusion studies, however, there have been relatively few studies focusing on how the social structure affects the diffusion and adoption of innovations,

as it is a rather complicated matter to untangle the effects of the characteristics of individuals that make up the system (Rogers, 1983).

Acceptance and adoption of VR/AR technology

‘A large and well-established literature has concerned itself with how and why certain technologies are accepted,’ writes Laurell, et al. (2019). The technology acceptance model (TAM) mentioned in the previous section has demonstrated that there are various factors that could play part in influencing the intention to adopt a new technology (Luse, Mennecke and Triplett, 2013).

Therefore, to be able to effectively assess the barriers to adoption of a new technology and its associated ecosystem we need to examine a number of dimensions. First, we need to evaluate the system on its own merit and its standalone value, based on the benefits the innovations bring to the user, such as how much fun will the user have using the technology, how simple it is to use and so on. Second, the technology can be assessed on its network externalities’ value or the value of an innovation that is based on its installed base and access to complementary goods as described in the section about equilibrium models (Laurell, et al, 2019).

The popularisation of VR headsets for the use of the general public is now slowly becoming a mainstream commodity through the video game and entertainment industries. What new entrants on the market, such as Oculus, HTC/Valve Vive, Samsung Gear VR, PlayStation, have now realised is what the professional VR world had known for a long time, ‘that immersion is first and foremost a user experience and the human factors must be prioritized over any technological consideration’ (Arnaldi, Guitton and Moreau, 2018). And indeed, most of the literature on technology adoption is from the perspective of the psychology-based acceptance of new technologies by individual users or organisations (Chen and Ma, 2014). This is how the largest video game studios started to turn commercial VR into a reality, by putting in place user-centered design approaches and carefully

considering adaptations of the application design to meet the restrictions posed by the headsets.

However, the hypothesis of widespread general use still remains doubtful for several reasons. First and foremost, VR technology is still quite far from being ‘low-cost’ equipment accessible to everyone. The second reason is to do with the technological limitations such as field of vision, resolution or display rate which can reduce the comfort and the pleasure the user derives from the experience over a long duration. The third reason is related to the richness and diversity of the range of applications available. Besides video games, which only interest a part of the general population, suppliers must design applications where the user derives true benefits from VR (Arnaldi, Guitton and Moreau, 2018). Last but not least, there are also necessary improvements that need to be made to the wearable equipment in order to make devices much more discreet and comfortable.

While waiting for these changes to take place, we can still utilise the vast amount of learnings that previous industries have found when researching and developing VR technologies, and assess the crucial user drivers that will encourage faster adoption of VR/AR products, as well as the risk and challenges posed to acceptance.

Challenges for adoption and risks

When it comes to the acceptance of VR technology, there are a wide range of factors that can play part in the decision maker's mind in a negative way.

Table 1: Challenges and risks for the adoption of VR/AR

Challenge	**Reason**
Cost	A lot of people feel nervous about using VR due to the high cost of acquiring and using the equipment which can be expensive, fragile, and not suitable for a long period of use (Arnaldi, Guitton and Moreau, 2018; Huang, Rauch and Liaq, 2010). Some technologies are still in their early stage and people may feel unsure about

	the benefits of investing (Bavaresco, et al, 2019)
Loss of interest	This is predominantly seen in the use of AR where there has been a recognised loss of interest over time once the novelty fades away (Arnaldi, Guitton and Moreau, 2018).
Technological limitations	Such as field of vision, resolution or display rate, motion sickness (Arnaldi, Guitton and Moreau, 2018).
User experience	Participants do not feel ‘relaxed, cosy and pleasant’ compared to the way they feel in a real-world experiment (Bavaresco, et al, 2019).
Personalisation and ability to create an adaptive system	A current problem is that VR trainees all experience the same training routines, which are not customised to individual learning patterns. Yet every trainee learns in a different way and will require their training to focus on specific aspects of the tasks (Vaughan, Gabrysand Dubey, 2016)
Privacy issues	Privacy concerns may lead to low acceptance levels reported by people (Bavaresco, et al, 2019)
Limitation to domains covered	Currently, VR/AR applications only cover a relatively small number of domains. The lack of applications may thus lead to potential clients moving away from these technologies (Arnaldi, Guitton and Moreau, 2018).
Harmful impact on users	We must not underestimate or ignore the possible harmful consequences of prolonged

	use of an HMD, especially by young users (Arnaldi, Guitton and Moreau, 2018).

Users and their perception of the technology

To be able to successfully diffuse a new VR technology we need to understand the factors that would influence the user's decision on whether to use the technology.

Presence

Considering VR technologies, the sense of presence can refer to the users' feelings of immersion and the experience in virtual environments fostered by VR technologies (Jang and Park, 2019). According to Witmer and Singer (1998) there are four main factors related to the feeling of presence that can impact the experience of the user. These include the control factors related to the interaction with the technology; the sensory factors related to the richness of experience; the distraction factors that have to do mainly with the psychology of the user and concern the feeling of isolation from the outside environment; and last but not least, the realism factor that is to do with the realism of the actual virtual environment (Fuchs, Moreau and Guitton, 2012, p.120).

Social aspect of technology and benefits to society

One very important aspect that is not often considered when research is completed in terms of the adoption of new technologies is the social aspect of technology and its potential benefit to society. There are times when society needs to consider the adoption of new technologies for the sustainable development of the system and 'there are occasions when technology adoption needs to be studied from the perspective of social planning instead of from the perspective of individual users or organisational psychology' (Chen and Ma, 2014).

Improvement, perceived benefit and usefulness

Clearly, the most important determinant of the benefit derived from adopting a new technology is the amount of improvement which the new technology offers to the

user (Hall, 2004). A consumer's perceptions of usefulness, enjoyment, and ease of use have been found to be positive predictors of attitude toward using and purchasing VR hardware (Manis and Choi, 2019). However, research has found that there is a variance between the perceived usefulness for potential and existing users. For potential users, perceived usefulness was shown to have a slightly stronger effect on perceived value than perceived enjoyment while, for actual users, perceived enjoyment was most influential in affecting perceived value (Yang, et al, 2016).

Another factor that has been found to impact the level of perceived usefulness of users is age. Manis and Choi's (2019) research found that the relationship between age and perceived ease of use and usefulness support the findings in previous literature showing a negative relationship between age and perceived ease of use. This negative relationship indicates that the older the consumer the less likely they will perceive VR hardware easy to use (Manis and Choi, 2019). However, Manis and Choi (2019) highlight that this could be associated with the need to have a larger sample of adults over 36 years of age. Obtaining a sample with a more equal proportion between age groups would be useful for achieving a better generalisation.

Perceived usefulness is typically found to be the primary determinant of one's use of a technology, therefore, practitioners must make VR hardware more useful for consumers if a strong ROI is to be accomplished (Manis and Choi, 2019).

Age

Research indicates that 'younger generations value technology usefulness more than older generations when deciding on use intentions' (Manis and Choi, 2019). Older generations perceive their skills in using technology as lower than younger generations due to experiencing lower self-efficacy and more technology anxiety than younger generations. Furthermore, older generations emphasize ease of use more when assessing the usefulness of a given system (Manis and Choi, 2019). This so-called digital divide between generations has developed as younger generations become exposed to digital technologies earlier and earlier (Manis and Choi, 2019).

Past use of the technology

The match between technology attributes and user's past experience is an important task compatibility dimension (Rogers, 1995). Research has found that individuals' attitudes about whether they would adopt a technology are likely to change over time as they develop experiences with a technology or as their skills grow (Luse, Mennecke and Triplett, 2013). Therefore, experience with a specific technology is associated with greater use of that technology. Kim and Malhotra (Manis and Choi, 2019) examine the effect of past use on user beliefs and behaviors and found that past use positively influences perceived usefulness and perceived ease of use, as well as behavioral intention and actual usage. For example, as users learn more about the benefits and costs associated with using a technology, they will weigh the net balance of these factors in their evaluation of whether they will use the technology (Luse, Mennecke and Triplett, 2013).

Storytelling and immersion

The wide diffusion of VR technologies has created a trend for the delivering of stories through VR. VR can be a very effective tool for sharing experiences as it has the potential to support incredibly complex narratives, tailored to promote complex viewer interactions.

Immersion is a term used to describe an experience in which the line between reality and imagination is blurred. Reactions to stories resulting from VR immersion tend to be much more emotional, and people can even get sick during fast motion videos or horror stories filmed in 360° (Shin, 2018).

The concept of immersion not only takes into account the technological aspects of VR but also the emotional, motivational, and cognitive processes involved in focusing engagement. Rather than being a static entity separate from users, immersion is a dynamic fluid that flexibly exists between technology and user cognition (Shin, 2018). To increase the immersive experience of VR stories, engaging content should be developed that provides both quality content and relevant, socially meaningful stories to users. In this case VR users are more likely to

experience emotions in response to relevant and engaging news stories (Shin, 2018). Shin builds on the concept of the physical experience of VR and poses interesting points to consider about the actual value of the content that is delivered through VR. One can go even further to argue that by quality we don't necessarily mean a high quality, realistic environment, but an emotive environment that enables the user to relate to the story being told.

In a recent research project led by Dr Paul Cairns, a senior lecturer in Human Computer Interaction at York University, found that players do a lot of the work toward immersion themselves. More absorptive personalities who are more prone to fantasising and daydreaming are able to become more immersed in game worlds. 'One of the components we look for in immersion is emotional involvement,' says Cairns. 'Becoming immersed is partly that you really care about the outcome, for whatever reason, so you need some sort of emotional sensitivity to be able to connect to the game and want to have that connection' (Stuart, 2010).

Empathy

Empathy appears to be one of the most important factors in VR and proves that VR can effectively convey another person's feelings or experience to a viewer and can be used to make people care about groups such as refugees, the homeless, and those with physical and mental impairments, as well as to raise awareness and willingness to act in first aid emergencies (Shin, 2018; Ward, 2019). In the British Red Cross 360° degree video experiment (Ward, 2019), the bystander training intervention was proven to increase confidence across all delivery methods. This was the case for first aid emergencies in a public space, and when experiencing a first aid emergency alone. VLE users are able to embody experiences by viewing, playing, and feeling perceptual cues linked to those experiences (Shin, 2017), thus reaching a level of empathy for another person they may not be able to feel otherwise. Stimulated empathy in VLE can make users perceive a virtual environment to be a more realistic and overall empathic experience (Shin, 2017).

What are the potential barriers to adoption of VR training?

According to Laurell, et al. (2019), there is still a lot to be done to achieve widespread adoption in key consumer markets of VR/AR technology. A survey conducted by ContextWorld in 2016 concluded that one-quarter of the population has still never heard of VR, and only about 10% of consumers say they have heard 'lots about it' (Herz and Rauschnabel, 2019). Herz and Rauschnabel's (2019) study also reached the conclusion that about 1% of the surveyed respondents own a VR device, with only 10% of the respondents having an actual usage experience.

However, when one starts examining the market at a larger scale, the picture changes to a more positive present. According to a report by IDC (2016), sales of VR hardware will grow by 183% annually from 350,000 units in 2015 to about 64.8 million units by 2020. Moreover, worldwide sales of products and services related to VR, including AR, are expected to increase from $5.2 billion in 2016 to more than $162 billion in 2020 (Lee, Kim and Choi, 2019, p37-48).

While XR has brought to life exciting realities for consumers and gamers, the real action is now taking off across all parts of the economy. In fact, industry spending on AR and VR is already outstripping the consumer market and will be triple its size within four years (Accenture, 2020).

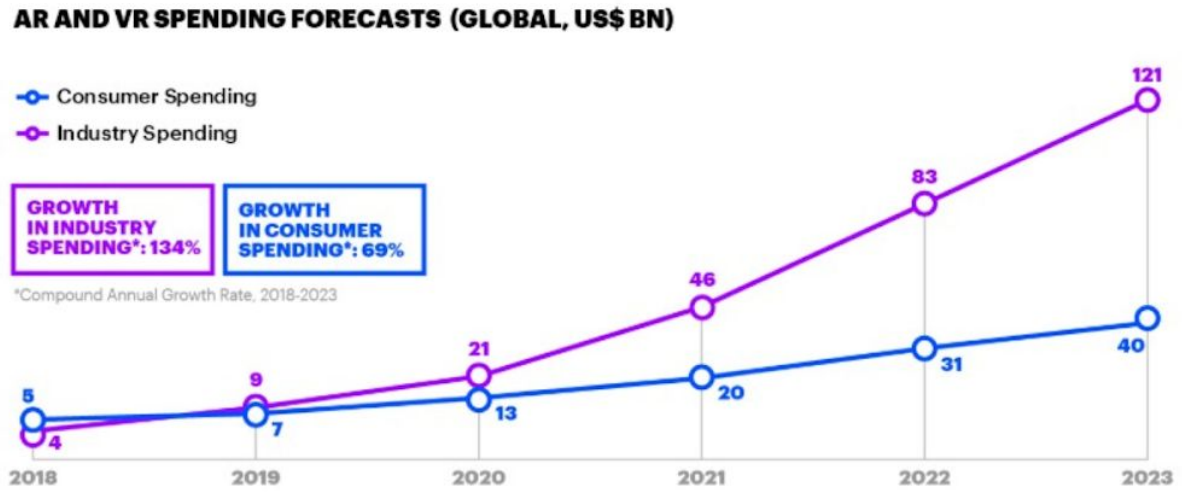

Figure 4: Industry spending vs consumer spending on AR/VR (Accenture, 2020)

Accenture (2020), rightly so highlight a number of social risks associated with VR/AR technology that anyone looking to develop such technologies needs to consider not

just for the ethical aspect of their product, but also as potential barriers to adoption of the technology due to concerns and fear of what its impact might be on the user. Some of the risks highlighted by Accenture include misuse of personal data, fake experiences, which could be used to manipulate the user and influence behaviours, opinions and decisions, cybersecurity, tech addiction, antisocial behaviour, digitally divided worlds, for example unequal access to educational or working experiences can amplify social divisions (Accenture, 2020).

Especially with newer advancements, consumers become more skeptical whether the benefits of a technology outweigh its potential threats, such as to their privacy, health, or psychological well-being (Herz and Rauschnabel, 2019).

Summary

One of the main impressions that the wider literature on the topic of diffusion of technology and the acceptance and adoption of VR/AR technology leaves is the predominant focus on the practical side of the technology, such as ease of use and its relationship with perceived usefulness, therefore, putting these two adoption criterias at the forefront of VR/AR technological acceptance.

Another predominant theme that was found in the majority of the literature assessed for this study was immersiveness and storytelling, as well as the realness of the virtual environment and the ability for the participant to feel present.

The majority of past research papers on the topic of technological diffusion and VR/AR adoption have been based on the Technology Acceptance Model which was initially constructed for the use in studies focusing on information technologies and computers. While this model has led to some significant findings in past research, it predominantly tends to focus on the hardware side of the VR/AR technology, therefore, its suitability has been questioned with certain limitations being suggested.

A very strong standing has also been found and felt throughout the literature in terms of the role that age plays in the adoption of new technologies. Some of the research

papers have expressed strong findings in terms of age impacting adoption in a negative way and implying that younger generations are much more perceptive and open to VR/AR technologies.

CHAPTER 3: RESEARCH METHODOLOGY

This dissertation has utilised a combination of primary and secondary research with specific focus on VR, AR and other digital first aid training methods, looking to trial and test some of the theories discussed in the wider literature available on the topics of diffusion of technology and the adoption and acceptance of VR and AR technology.

The main theories that this research aimed to focus on include:

- The criterias for successful adoption and diffusion from TAM theories and assessing which are the most important factors for the acceptance of VR/AR first aid training
- Understanding what role age plays in the acceptance of VR/AR technologies
- Discovering other factors that might play part of acceptance of VR/AR technologies such as gender

Primary data

As the topic of VR and AR for the delivery of first aid training is a relatively new field of study that hasn't been extensively examined in terms of the general public and it hasn't been the focus of previous research, the author of this paper chose to approach a very limited but focused selection of interviewees for the primary research. While there have been only two interviewees included in this paper, they have both come from a background with extensive experience and knowledge in VR/AR or first aid training.

The author of dissertation also approached two organisations, Attensi and Immerse, that specifically focus on the development and delivery of VR first aid and immersive training, however, both organisations declined to be interviewed due to resource challenges and implications resulting from the coronavirus pandemic. Both organisations were found through a Google search for the keyword term of 'VR first

aid training' and were contacted through a form or email address provided on their websites.

There have been two more interviews that were completed with trainers who were involved in the 360° bystander experiment that the BRC led that weren't included as part of this study. Due to the very specific nature of the topic of this dissertation, the author felt that including interviews with participants that didn't have an in-depth understanding of VR/AR technology would only contribute unsubstantiated assumptions to the study that will compromise the accuracy and validity of the data gathered.

Secondary data

The secondary data which was also utilised as part of the discussion section uncovers some new pieces of information that contradict some of the theories and findings of previous literature. The data consists of a survey filled in by 499 participants and sent out to the British Red Cross contact database. The author of this dissertation was involved in the design of the survey within their capacity as an employee of the British Red Cross and while the survey poses and answers some of the main questions of the dissertation, was not done exclusively for it. As the survey has been reviewed and approved by other BRC stakeholders and the information in it is also going to benefit the British Red Cross organisation, the author of the dissertation felt that the survey results need to be presented as secondary data for ethical reasons. The BRC has signed a consent form for the survey, as well as any other research on the topic of VR and AR first aid training completed by the organisation to be utilised as part of the dissertation. As the analysis of the survey has been completed solely by the author of the dissertation and has taken an extensive amount of work to do so, this process will still be featured in the data analysis section to shine a light and help the reader understand the importance of the findings.

Methodological approach

Interviews

Interviews are a qualitative research technique which involves ‘conducting intensive individual interviews with a small number of respondents to explore their perspectives on a particular idea, program or situation’ (Boyce and Neale, 2006). For the two interviews completed the author has used a semi-structured interview method. A ‘semi-structured interview method enables the interviewer to explore emerging responses and themes further, but also keeps a unified structure for comparable and transparent analysis’ (Keegan, et al, 2009). The interview tactics explored by the author follow a case study approach, so rather than trying to test individual hypotheses or prove relationships with previous literature, the aim is to identify themes and trends that have been raised by the experts interviewed resulting from their direct experience in the diffusion of VR and AR training technologies. A semi-structured approach to interviews has both advantages and disadvantages. In semi-structured interviews, the interviewees are more likely to express their ideas and thoughts about a topic than in a standardised situation such as questionnaires (Flick, 2002). Some of the advantages of conducting an interview in this way include the possibility of collecting detailed information about the research questions and having direct control over the flow of the discussion as well as a chance to clarify certain points and ask follow up questions (Keegan, et al, 2009). Some of disadvantages include longer time requirements, as well as the possibility of the interviewee going off on a tangent that is not relevant to the piece of research.

Before conducting the interviews, the process was discussed with this study's supervisor to outline any potential ethical issues due to the relationship of the author with the British Red Cross and how to address those. Based on the guidelines provided by the Alliance MBS and the Guidelines for postgraduate students ‘ethical approval for research involving human participants’, it was decided that there weren’t any ethical issues and that the consent forms gathered for this dissertation to

approve the use of BRC, IFRC and ICRC research data and interviews would be sufficient.

Two documents have been sent to the participants of this study - the Alliance MBS consent form which has been modified slightly to be suitable to the purpose of this dissertation, as well as a transcript of the interview to ensure that participants are clear on the content that is going to be used within the dissertation and are given a last chance to withdraw any statements that they might not want featured. Due to the professional relationship of the author of this research and the interviewees, the author felt the obligation when approaching the participants to make them aware that they have the right to decline participation. This was not the case.

Survey

The Digital First Aid Training survey was completed through the use of a Google form and has been split into two sections. The first section utilises the Technology Readiness Index 2.0 (TRI 0.2), which is a multi-item survey research scale that has been ‘extensively evaluated for reliability and validity in measuring and classifying individuals by their propensity to adopt and embrace technology at home and work’ (Rockbridge, 2020). The questions that have comprised the first half of the survey are part of the Technology Readiness Index 2.0 which is copyrighted by A. Parasuraman and Rockbridge Associates, Inc., 2014. This scale may be duplicated only with written permission from the authors, which has been provided to the author of this dissertation.

The TRI 2.0 has been used in the past to evaluate the technology readiness of individuals in current technologies. Some examples of how TRI 2.0 has been used in the past include for the adoption of mobile applications that can potentially influence vaccination behavior in Canada; to segment users of sports wearable devices; to comprehend the adoption of brand-new technologies among adolescents (Ramirez-Correa, et al, 2020).

Technology readiness measured by TRI 2.0 ‘can be used as a potentially valuable psychographic variable in applied, decision-oriented research in contexts where

technology based innovation plays an important role' (Parasuraman and Colby, 2014). The construct of the TRI 2.0 is multifaceted, comprising of four dimensions:

- Optimism - a positive view of technology and a belief that it offers people increased control, flexibility, and efficiency in their lives.
- Innovativeness - a tendency to be a technology pioneer and thought leader.
- Discomfort - a perceived lack of control over technology and a feeling of being overwhelmed by it.
- Insecurity - distrust of technology, stemming from skepticism about its ability to work properly and concerns about its potential harmful consequences.

(Parasuraman and Colby, 2014)

The answers to each one of the questions of the TRI 0.2 utilise the five point Likert scale, which 'uses psychometric testing to measure beliefs, attitudes, and opinions of subjects' (Formplus, 2020). The five point Likert scale comprises two extreme poles and a neutral one. The scale utilised in the TRI 0.2 survey questions uses the following answers: strongly agree; somewhat agree; neutral; somewhat disagree; strongly disagree. The advantages of the five point Likert scale include that it's relatively easy for respondents to understand and it tends to produce better distribution of data. However, it can sometimes be inaccurate and the results may not always be objective (Formplus, 2020).

The second part of the survey has taken a traditional survey approach where the subjective opinions of the participants were collected from a sample of subjects and analysed for some aspects of the study population that they represent. Descriptive Survey was chosen as the best approach to structure this part of the survey as it tends to be used to describe the perception of respondents and the association of their characteristics (Lau, 2017). The design is mostly quantitative and involves the use of descriptive statistics such as frequency distributions of Likert scale responses from participants.

Methods of analysis

Interviews

To anonymise the responses from the data collected through the interviews the author has chosen the following coding approach of the two participants.

Table 2: Final sample of interviewees

Participant code	Institution	Role
DT1CR	ICRC	Head of the Virtual Reality Unit
DT2PC	IFRC	Head of Global First Aid Reference Centre

The approach taken for analysing the interviews is thematic content analysis. Thematic content analysis 'begins with weeding out biases and establishing your overarching impressions of the data' (Canary, 2020). Rather than approaching data with a predetermined framework in thematic content analysis the researcher aims to identify common themes as they search the materials organically. While thematic analysis is flexible, this flexibility can lead to inconsistency and a lack of coherence when developing themes derived from the research data (Nowell, et al, 2017). This is certainly a pitfall that the author felt during the analysis of the interview responses which required multiple reviews to ensure that the reported data is relevant to the focus of the research.

Another approach utilised in the data analysis is a narrative analysis which involves making sense of the interview respondents' individual stories. This type of qualitative data analysis highlights important aspects of the interviewee's stories that will best resonate with aims of the research and the reader. It will also help to highlight critical points that have been found in other areas of the research (Canary, 2020). Thus, the experience of the interviewees and the learnings that they have achieved in their

years of implementing VR and first aid training solution have been considered a sufficient piece of information to contradict or validate points made in past literature.

TRI 2.0 data results analysis

When it comes to calculating the Technology Readiness Index 2.0 score, the creators of the model provide a detailed guidance on how the results need to be calculated. Therefore, following steps have been taken from the guidance sent by the Rockbridge team:

1. Determine the number of missing values across all statements (TR items). Compute new variables for all items and make missing data (don't' know or refused) equal to "3" or a neutral response. We recommend excluding respondents who do not answer more than 3 items.

2. Compute the average of the five positive items (from the Optimism and Innovativeness scales) and the five negative items (from the Discomfort and Insecurity scales).

3. To calculate a total TR Score, first reverse the mean of the negative items by subtracting from 6. Next, compute the average for the two dimensions.

   TRI 2.0 (10 item version) = (Positive + (6-Negative))/2

   The lowest possible score is 1.0 and the highest is 5.0. A higher score indicates higher techno-readiness.

4. There is also a technology segmentation, which classifies respondents into one of 5 categories based on their pattern of beliefs about technology. This classification is created using a proprietary algorithm. If Rockbridge is provided a SPSS dataset, the cases can be classified and the dataset returned to you with the information. We can also provide normative

> comparisons from the most recent National Technology Readiness Survey in the U.S.
>
> (Rockbridge, 2020)

There has been only one question utilised from the second part of survey, therefore, the author won't go into the detail of how the results have been analysed. For the analysis of the one answer in question a frequency distribution approach has been taken as mentioned in the previous section.

CHAPTER 4: FINDINGS

There are a number of important findings that the primary and secondary research established which either contradicted findings in past literature reviews or were not included in them altogether.

While past literature mainly focuses on the practical aspect of VR/AR technology, such as ease of use or the emotional aspect, such as enjoyment, as being the core drivers for adoption. However, the primary research (interviews) completed for this study mainly focus on referring to VR first aid training in terms of its effectiveness and ability to prepare the user to act in an emergency as well as to recognise specific medical conditions that would require immediate intervention. The survey results from the secondary data also confirm this with 61.1% of respondents classifying the effectiveness of the training as the most important factor when considering utilising new technologies.

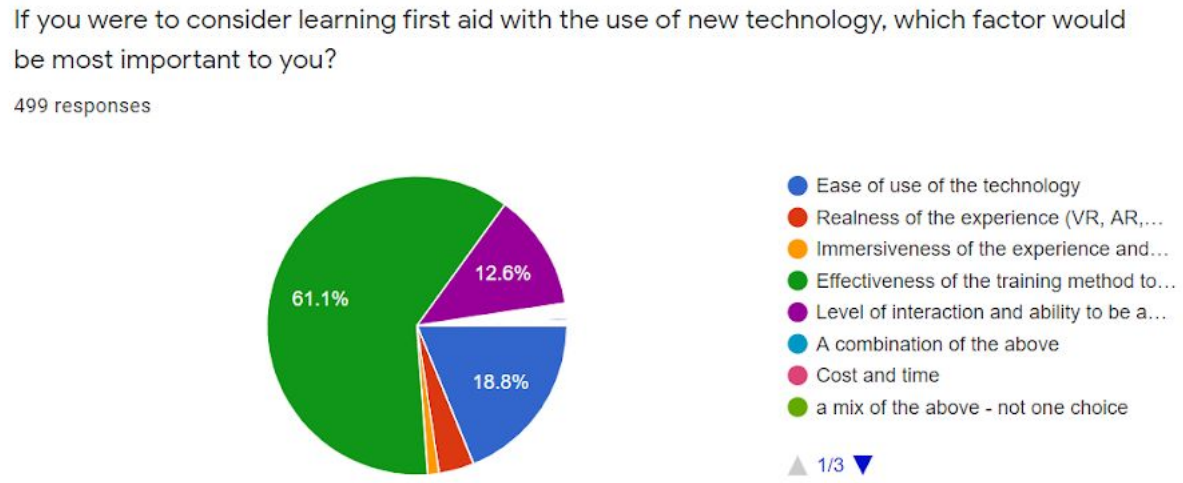

Figure 5: Importance of factors in adopting new technology for first aid training

The ranking of results in the diagram above are as follow:

- Effectiveness of the training method - 61.1%
- Ease of use of the technology - 18.8%
- Level of interaction and ability to be an active participant - 12.6%
- Realness of the experience - 3.8%

- Immersiveness of the experience and the story - 1.2%

Another important finding of the results which contradicts statements in the literature review is the role that age plays in the adoption of new technologies. 80.2% of the surveys' participants were older than 45 years. The study results, both primary and secondary, established that older audiences are in fact open and willing to adopt new technologies for first aid learning, with 68.3% of participants either strongly agreeing or somewhat agreeing that there is a need for alternative to classroom based first aid training.

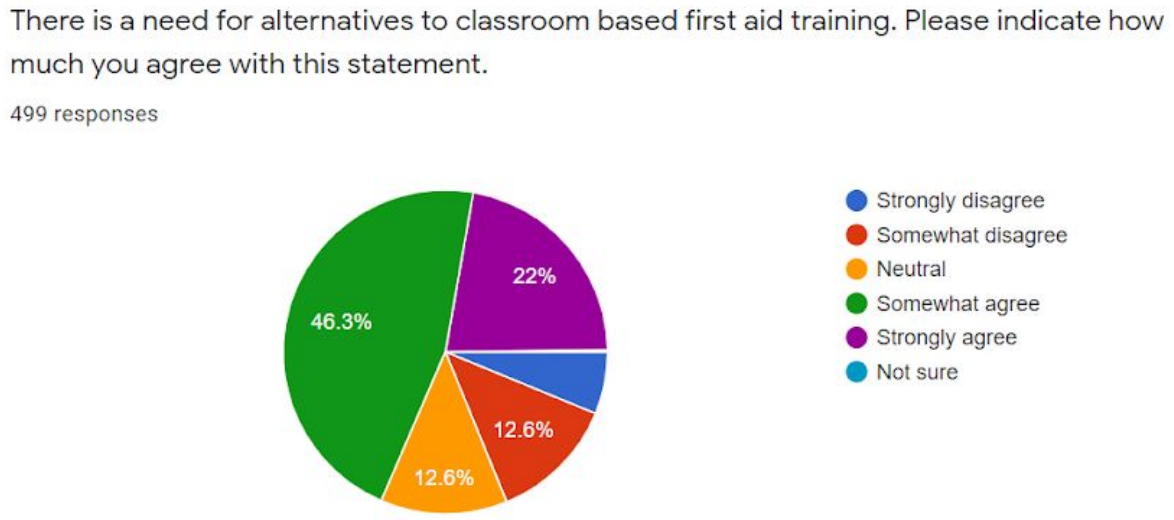

Figure 6: Need for alternatives to classroom first aid training

59.3% agreed that they would be comfortable learning first aid through digital methods if those proved to be as effective as face to face first aid training. And 48.5% of participants stated that they would be willing to trial all VR, AR and 360° technologies to learn first aid. 49.3% of participants were also aware and educated on the fact that VR technology is used or can be used for the delivery first aid training as well. All of these results are demonstrated in the graphs below.

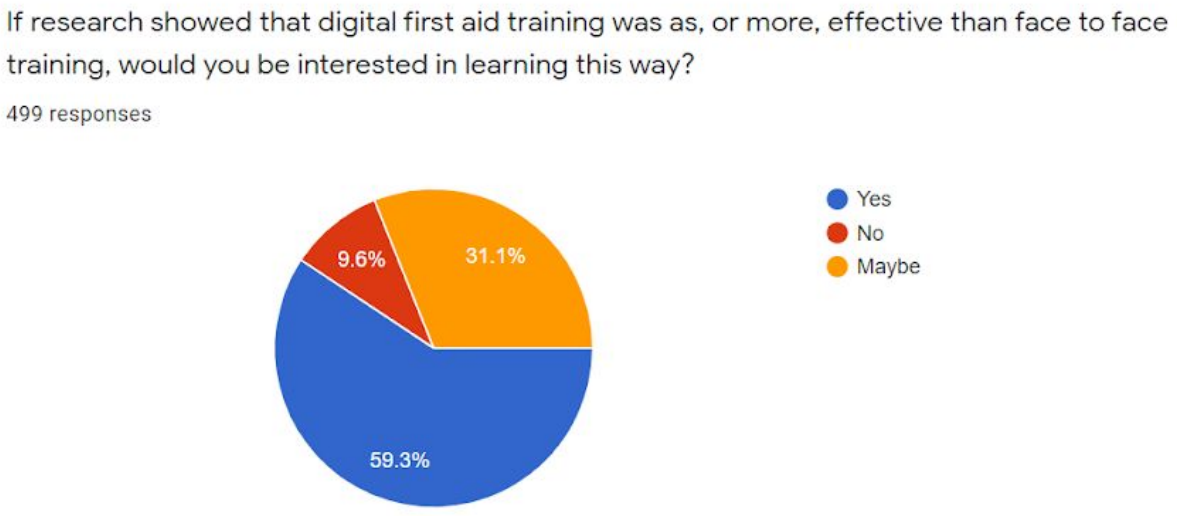

Figure 7: Willingness to learn through digital first aid methods

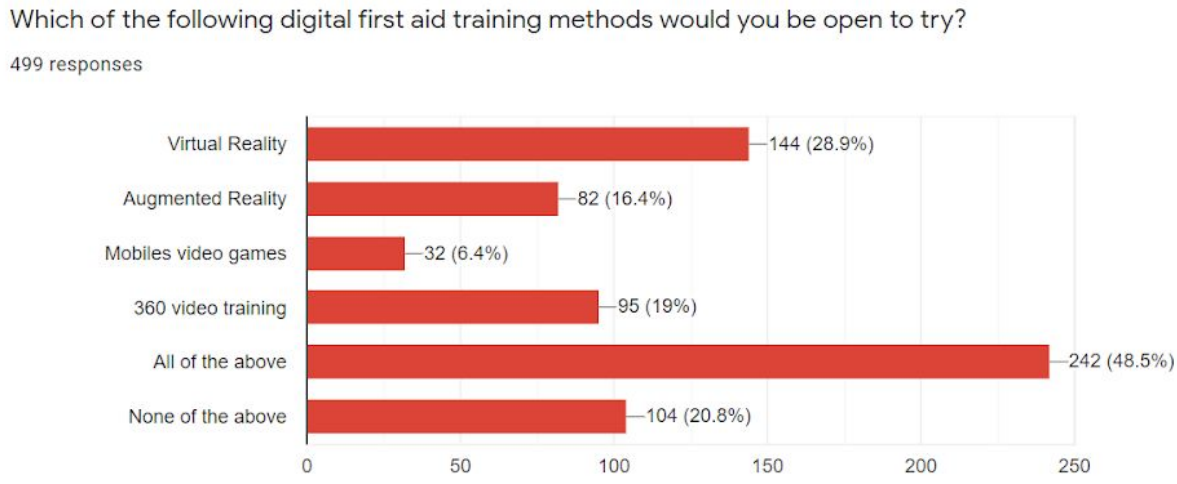

Figure 8: Preference of first aid training method

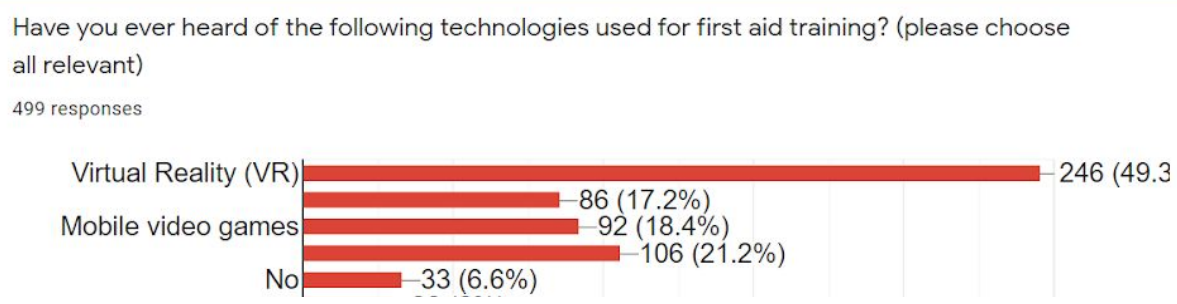

Figure 9: Awareness of VR technologies for first aid training

A very surprising finding of the survey results was the difference that gender played in the willingness to adopt new technologies for first aid training. The survey featured in this research paper had a relatively equal split between female and male participants with 56.5% female, 42.1% male, 0.8% preferred not to say, 0.4% non-binary and 0.2% transgender participants. While previous literature has largely ignored the impact that gender might have on the diffusion and adoption of VR/AR technologies the findings of this study showed that female participants ranked higher in a number of different factors when compared to the male counterparts.

CHAPTER 5: DISCUSSION

The discussion chapter is split into two parts. The first part will briefly cover the findings of the author's research that confirmed some of the theories and hypotheses covered in the literature review. The second part will go into more detail of some of the new conclusions that were drawn from both the primary research (interviews) and the secondary research (data survey).

What did the research confirm?

As often referred to in the literature review the design and development of diffusion of VR/AR technologies is a gradual process (Diebolt, Mishra and Parhi, 2016) that is largely driven by the users themselves, not just in terms of technology development but market demand as well. This was also the case for the ICRC. The adoption of VR technology dated back to 2012 where the organisation largely focused on computer generated products. It wasn't until 2017 when they started to venture into the immersive virtual reality and headset technology. Not only was the development of such technologies a gradual process, but the demand for it as well grew over time as users' familiarity increased. 'It was only in 2017 that there was more demand for this kind of technology, especially from outside of the ICRC,' explains DT1CR. The ICRC tends to operate as a supplier that supports the IFRC and all other Red Cross societies across the globe with specific projects, such as VR. And indeed the first ever project executed was not for the ICRC, but the South Korean Red Cross where additional support was needed in further developing and increasing the quality of an existing VR training product. The decision making was 'a very slow process of starting with simple computer generated tools and then as people were more familiar and interested we introduced more interactivity, until the time we could introduce the full immersive experience', said DT1CR. The adoption of VR in the example given by DT1Cr was not the result of a big study and robust planning, but it was the result of a very slow process of integration of the technology in certain departments. DT1CR compares the adoption process to a diesel engine; 'it needs warming up, it can't start straight away.'

As mentioned in the literature review one of the main reasons for the successful use of VR for training purposes is its ability to train users on compex topics which may include information that no longer exists or information that is too enormous to process by the human brain, such as big data (Arnaldi, Guitton and Moreau, 2018). The example of the ICRC also confirms this theory. ‘It all started with frustration, the frustration of not having proper training tools that were neutral and that were up to date,’ says DT1CR. At the time when DT1CR was working for the ICRC’s Law and Policy Department, trainees were still using audio and visual materials from the Korean Conflict or World War II, because almost everything else was considered too sensitive and there were political associations attached to the images. ‘It’s hard to take examples from past conflicts that are sometimes 50-60 years old and use them to highlight present day international humanitarian law issues,’ highlights DT1CR. So these frustrations lead to the utilisation of computer generated videos that represented modern warfare without any legal implications, the real need for VR training being driven by a requirement for up-to-date materials for teaching of international humanitarian law.

Another product developed by DT1CR’s team puts the user in the shoes of a person, an adult, that needs to save a child while going through different steps in a war zone. The representation is so realistic that people who have come from conflict areas couldn’t finish the 10min video because there was too much similarity with the real experience. Therefore, DT1CR confirms that ‘this kind of VR immersive experience does have an impact on people’s empathy and is really touching people's feelings at an emotional level.’

This level of realism and impact that VR can offer, as suggested in the literature review other resuscitation science organisations such as the American Heart Association (AHA) have already identified the need and called for innovative solutions to help increase public CPR training rates through the use of digital strategies such as virtual reality (VR) and mobile applications (mApps) (Leary, et al, 2019), because such technology can offer a level of understanding of what certain first aid emergencies look like, such as a hemorrhage or a sudden cardiac arrest,

that face to face training won't be able to provide, which will also contribute to the retention of knowledge that can be drawn upon in real life scenarios. For DT2PC, one of the most important factors for the utilisation of VR is because it offers the nearest representation to reality. Another important factor that makes VR and AR technologies appealing for the use of first aid training is the wide scope of the technology and the types of content that can be produced to meet needs of different societies. As Ramirez-Correa, et al (2020) highlights, 'to facilitate a technology which is used in western countries and then apply it to non-western countries that show considerable cultural differences without taking into consideration the social, organizational, individual and cultural factors is useless'. And this is in fact part of the decision making process for the utilisation of different VR technologies by the ICRC and IFRC. For example, less expensive mobile applications utilising computer generated content can make the knowledge widely accessible across the world, even in developing countries and poorer regions, such as Africa. Other regions where Red Cross societies operate in more developed countries could have more advanced VR materials and tools, but these would still be much harder to disseminate due to the impracticality of the equipment which is still very voluminous and expensive.

The evolution of the VR unit at the ICRC started from having to develop a product that they thought would have a market for it as a result of anticipation of what the team thought their clients might need, to now only producing products on order. DT1CR shares that 2-3 years ago there was a zero interest in VR training. However, to be able to achieve such adoption and success of VR/AR technologies you need to have a lot of flexibility, 'we work in a rather chaotic way, because we want to explore and try new methods of training which may not be entirely part of our job description... Most of the time we created new training tools that nobody thought they would need one day. And after some time of exposure people started to see the benefit, and voilà, they started to adopt the technology. It's a question of time; you have to be slow a little bit and let people integrate those technologies slowly,' says DT1CR.

One of the fundamental challenges that can result in creating a barrier for the dissemination of new technologies is the way that a society would perceive the technology and whether there will be any bias towards it. According to DT2PC there won't be a wall for the dissemination of VR/AR first aid training with the Red Cross organisation as people in the movement are quite open minded. However, dissemination still needs to be a careful process, as people are naturally opposed to resist change (Talukder, 2012). ‘We will have to approach the national societies step by step and present VR and AR as a complementary tool’ and not as something that is going to change the whole way of how first aid training is delivered and eliminate the need for an instructor, explains DT2PC. This is specifically important in organisations or societies where the diffusion of a new technology can be seen as a threat. The advantage of classical first aid training is that the instructor leading the training has been doing it for a long time and they are very confident with their skills. This is also one of the biggest barriers according to DT2PC. The new technologies can make existing first aid trainers feel like they’re losing some of their power and cause fear as they might perceive the new technology as a competition. Therefore, preparation of the network for the diffusion of the new technology and communication and education on what the technology is, as well as providing training and guidance on how to use it is crucial to ensure successful diffusion especially amongst those instructors who are quite afraid because they think they’ll lose what they know and what they do today.

DT2PC shines a light on a very interesting approach to dissemination that hasn’t been currently explored in literature, which is essentially breaking down the different adopters of technology outlined in diffusion models and creating a pyramid of development structure for the technology’s dissemination. Below is a potential representation of this model:

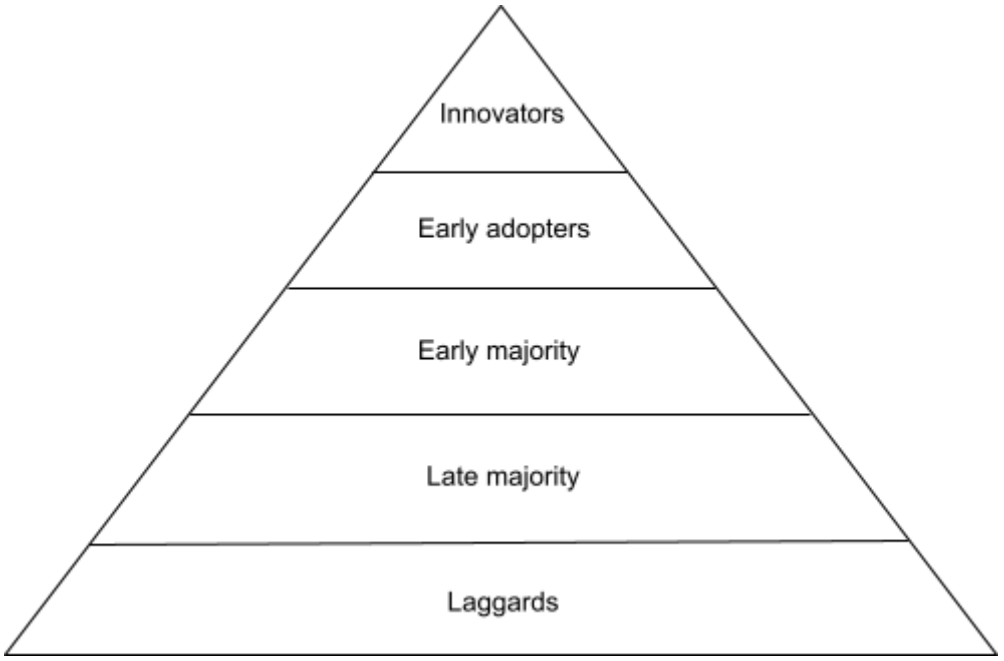

Figure 10: Diffusion pyramid

When applying the pyramid structure above to the case of VR first aid dissemination for the use of the general public within the Red Cross society, we can see the following indicative structure:

- IFRC and ICRC - Innovators
- Zone offices - Early adopters
- National societies, Trainer of trainers - Early majority
- Trainers (users) - Late majority
- General public - Laggards

Of course, this structure doesn't take into account overlaps and additional levels of complexity, for example certain users that fall under the early majority adopters and can also be early adopters when examined more closely, because they may be situated within a developed country that has more resources and capabilities to adopt VR/AR first aid training. Therefore, there are a number of nuisances that need to be explored, but breaking down and understanding each stage of the diffusion pyramid and the type of users within it can significantly help with faster diffusion, especially its strategy is aligned with a top down dissemination approach of the technology, gradually educating and bringing on board each level of the

organisational structure. This approach is very similar to the geographical models mentioned in the literature review where the diffusion of innovations is split into three stages: (1) the innovation is introduced in some major centre; (2) the innovation is spread in the neighbourhood of the first centres and transmitted to minor centres; (3) the innovation is spread in the neighbourhood of the minor centres, thus saturating the diffusion process (Diebolt, Mishra and Parhi, 2016).

What new findings did the research achieve

Storytelling, immersiveness and realness of the environment

According to DT1CR there are two factors that play part of the adoption of VR/AR training, for 80% of people it's the novelty of it. 'People get bored of Power Points and there is an increasing lack of interest from the general public for a certain training approach, so you have to offer something new to bring the sparks and the glitters,' says DT1CR. For the remaining 20% there is a real understanding of the value of the tool and a real understanding of the additional retention of information, about the concept.

As Shin (2018) highlights 'despite high expectations and popularity, it remains unclear whether users genuinely feel presence and flow during immersive experiences, whether immersion influences cognition, and in what ways the user experience is improved by new forms of heightened immersion'. One of the most important results that came out of the digital first aid training survey was the fact that 61.1% of participants found the effectiveness of the training method the most important part of the experience, followed by ease of use with 18.8% and level of interaction and ability to be an active participant with 12.6%. Realness of the experience was second to last with 3.8% and immersiveness and the storyline earning only 1.2% of responses.

Fuchs, Moreau and Guitton (2012, p.29) write, 'it is completely absurd to naïvely expect, if possible, that the behaviour of the virtual world would be exactly identical to that of the real world. If we want to create a "virtual'' reality, modifying the aspects of the "real'' reality is well within its purpose.'

As we found from the survey, the realism of the environment and experience in terms of VR first aid training is very low on the list of priority for users, with only 3.8% of respondents saying that they think this is an important factor that would impact their willingness to utilise the technology. Therefore, we can find a gap in past research in the fact that sometimes a high degree of realism may not be necessary or suitable for the purpose of the training and may impact the quality of the VR product, therefore, resulting in lower levels of adoption.

Another important aspect is thinking about the user and protecting their psyche when developing VR products. Therefore, the ability to reach a balance between having a virtual reality environment, which is close enough to reality, so that it prepares the trainee for what they might face, but still feels as a virtual world is important in order to protect the participant's mental health. When designing products for people in conflict areas 'where access to technology is less common and where modern art, such as video games, is less popular, having a VR product that is very realistic is extremely important otherwise people will not recognise themselves inside this product and take it seriously', explains DT1CR. One can ask the question, if we're looking for something incredibly realistic why are we not filming real people? Because in certain training scenarios, less is more. For example, for the malnutrition awareness project that the ICRC worked on they needed to represent children essentially dying from malnutrition. In this example too much realism would disturb and distract the trainee from the purpose of the training evoking too much emotion. Therefore, 'it's important to say that we don't want to show certain aspects of warfare, in order to respect the dignity of people or to avoid political issues,' shares DT1CR. This goes to demonstrate that the pursuit of realism needs to be carefully considered in the context of the training in which VR would be utilised in order to maintain its original purpose and effectiveness.

As DT1CR highlights, 'certain training is aimed at preparing people for harsh conditions or a job that is going to affect their brain, that can hurt their feelings'. Therefore, while it's good to expose people to the reality of what they might face in the future, an even more important part of the training is to create an automatic response to a situation. 'You don't want people to feel for the person that has had a

car accident and is lying on the side of the road,' says DT1CR. 'You don't want a first responder to feel because it will suddenly affect their judgement. That's why we put a screaming baby in our first aid VR training, because we know some people will straight away go help the baby. You have a screaming baby, it's natural to want to go and help the baby first, but this is not what you should do. This happens because you let your emotions guide your actions. If you just look at the situation coldly and you try to save a maximum number of people, then you don't go to the baby first, and this is again what training is about, creating automatism so when you are a first responder you want to put aside the emotional aspect and focus on the technical aspects.' This is an example of how emotional stimulus can actually be used to try and derail people, distract them, so that they learn what to do and what not to do when facing a real first aid emergency.

Therefore, as we can see to ensure that a future rollout of VR is successful, it is important to understand how the average users encounter VR stories and how they react overall (Shin, 2018). From the findings above, we can draw a conclusion that all sectors utilising VR and AR technologies are different and there isn't a one size fits all. Therefore, while we can take learning from past research, specific technologies need to be designed and validated by their potential users to ensure that their specific criteria of value is met and the successful diffusion of products.

The role of age

As mentioned in the literature review Manis and Choi (2019) believe that 'younger generations value technology usefulness more than older generations when deciding on use intentions' and that there is a negative relationship between age and perceived ease of use of VR/AR technology.

Therefore, one of the most important findings that came out of the utilisation of the Technology Readiness Index is the overall TRI score which came back as 4.88 readiness for the adoption of the new first aid training technology. The reason why this is especially significant is because of the age range of participants in the survey. 80.2% of participants in the survey were older than 45 years, putting them in an age range which previous studies have considered to have low levels of acceptance of

new technologies. DT1CR also confirms that according to his experience age doesn't play a part in the diffusion and acceptance of VR/AR technologies. 'I have had people that I didn't expect that would show that much interest because my pre-conception is that it's mostly young people that would be interested. But I was very often surprised,' says DT1CR.

There are two important factors that need to be taken into consideration when considering the adoption of VR, the concept behind the technology and the delivery. When it comes to the delivery and implementation, 'there will be more resistance from people that are not familiar with computers and don't have a good feeling about technology than people who grew up with smartphones in their hands,' says DT1CR. So, DT1CR does confirm that when it comes to the ease of use there is a bit of a generational difference, but in terms of understanding the concept or interest in the development of the technology people of 60 years and older have been more motivated by such tools than younger people. According to DT2PC**,** it all depends on the open mindedness of the participants, some people can be quite afraid of new technologies and others are not.

One of the biggest areas of difference in attitude based on the age of participants in the survey is in terms of whether they would be confident learning first aid through digital methods. 40% of participants who were in the age group of 35-44 said that they strongly or somewhat agree with this statement, followed by 33.34% for the 25-34 age bracket, 32.86% for the 65+ age bracket, 30.44% for the 45-54 age bracket and 24.26% for the 55-64 age bracket. As we can see, even though there is a slight decline in confidence as the participants get older, the difference between the responses is marginal with the majority reacting positively towards the idea of utilising digital technologies to learn first aid.

The results below showcase that the areas where the older participants ranked higher are indeed the areas which are linked to the concept behind exploring and implementing new technologies for the delivery of first aid training and the openness to learn through digital first aid methods if their effectiveness is proven. Where we can see a significant drop is of participants 55 and older in terms of their confidence

in learning more practical first aid skills through digital training, with a drop from 75.15% of participants in the age bracket of 45-54 years old saying that they strongly agree or somewhat agree with this statement to 24.26% and 32.86% for participants in the 55-64 and 65 and older age brackets respectively.

Table 3: Survey responses segmented by age of participants

	25-34	**35-44**	**45-54**	**55-64**	**65+**
In general, I am among the first in my circle of friends to acquire new technology when it appears	44.45%	25/35%	28.57%	23.07%	28.57%
I can usually figure out new high-tech products and services without help from others	83.28%	61.34%	56.52%	49.71%	45.72%
I keep up with the latest technological developments in my areas of interest	72.22%	53.33%	53.8%	63.32%	54.28%
There is a need for alternatives to classroom based first aid training	72.22%	65.33%	75.15%	61.54%	71.43%
I would be confident learning more practical first aid training skills through digital training	33.34%	40%	75.15%	24.26%	32.86%
Have you ever heard of VR for first aid training?	22.22%	52%	47.83%	49.11%	57.14%
If research showed digital FAT is as effective as F2F training, would you be interested to learn this way?	83.33%	72%	58.39%	53.85%	57.14%

Gender

A parameter that showed significant difference in survey responses and was never mentioned in previous research is the role that gender might play in the adoption of VR/AR technology. While this topic has been covered in more generic literature that looks at the trends of adoption of technology in general or technology in specific industry sectors, such as agriculture (Theis, et al, 2018) where it was found that given equal access to technology, men and women are often equally likely to adopt technologies, Dirin, Alamaki and Suomala (2019) also highlight that the 'research into gender differences in the use of VR and AR technologies is scant' and they needed to resort to prior research on gender differences in the use of mobile technologies to provide some insight into the phenomenon in their research paper. On the other hand, according to Kotze, Anderson and Summerfield (2016), 'past studies on gender differences in computer-related technophobia have concluded that significant differences in levels of technophobia actually do exist, with a higher percentage of women exhibiting high to moderate levels of technophobia.'

The survey featured in this research paper had a relatively equal split between female and male participants with 56.5% female, 42.1% male, 0.8% preferred not to say, 0.4% non-binary and 0.2% transgender participants. Due to the extremely low volume of participants from the non-binary and trasngender groups, the survey has only focused on analysing the results from the female and male audiences.

The results discovered by the survey not only contradict the statement that female users are less willing to adopt digital technologies, but actually present a very different picture with females ranking higher on the TRI index than men in terms of readiness to adopt new technologies for first aid training. From the survey results we can see that:

- 69.51% of women compared to 53.9% of men said that they either strongly agree or somewhat agree that new technology contributes to a better quality of life

- 27.66% of women compared to 19.5% of men said they either strongly agree or somewhat agree that new technology that they are among the first people in their circle of friends to acquire a new technology
- 54.96% of women compared to 40.78% of men said they either strongly agree or somewhat agree that new technology that they can usually figure out high tech products on their own without help from others
- 38.65% of women compared to 27.30% of men said that they either strongly agree or somewhat agree that new technology keep up with latest technology developments in their area of interest
- 41.84% of women compared to 36.53% of men said that they either somewhat or strongly disagree that they won't feel confident learning more practical first aid skills through digital methods

In terms of openness to try VR/AR first aid training, the results were relatively aligned with 44.33% of women compared to 42.86% of men saying that they would be open to try all of the different types of VR/AR training available, including AR, 360° video and mobile video games.

However, one area where men do take the lead in terms of VR/AR first aid training is the awareness of existing technology used for the delivery of first aid training. 53.81% of men compared to 46.10% of women said that they have heard of VR specifically being used for the delivery of first aid training.

CHAPTER 6: LIMITATIONS

There are a number of limitations that this study came across both in the process of collating primary and secondary data, as well as in the methods used to analyse the data and the results.

Interviews

Initially the author of this study was planning on utilising only interviews for the collection of primary data. However, due to the coronavirus pandemic and national lockdowns this proved to be quite challenging especially for small businesses, such as those operating in the niche market of virtual reality first aid training. Due to these unprecedented challenges a lot of the experts in the field declined participation, therefore, leading to a limited number of interviewees all part of the Red Cross organisation.

This posed a challenge not just in terms of the volume of data that the author could collect, but also raises a risk of the survey results being biased by the processes and way of thinking of a single organisation.

Taking a semi-structured interview approach was also challenging as one of the interviewees took a more general first aid training focus rather than specifically looking at the utilisation of VR technology and the potential diffusion strategies. The high demand that Covid-19 has placed on the entire Red Cross organisation which has been closely supporting medical and emergency service providers around the world also prevented the author following up the interviews to gather more information due to all participants (author included) having significantly increased workloads and other competing priorities.

Survey results

Another area of limitation are the survey results. As the majority of participants that took part of the survey are of an older age group we can't effectively draw a comparison between the answers that younger people have given and the

participants who were aged 18-24 years old had to be excluded from the analysis. While we can confirm with certainty that older people are still ranking high on the Technology Readiness Index 0.2 and are open to trial innovative VR/AR first aid training methods, we can't effectively prove whether the percentage of younger people would be higher and there will be even more willingness for adoption.

As confirmed in the literature review and the discussion section, location, geography and availability of technology in developing countries would play an important factor in the adoption of new technologies. Therefore, another limitation is that the survey participants were all based in the UK, therefore, the view presented in this survey will be specific for an audience of a Red Cross society in a developed country. There is still a need for a survey to be completed with participants from countries across the rest of the 192 Red Cross societies and a comparison to be drawn between developing and developed locations.

Technology Readiness Index 0.2

TRI 2.0 in itself has some limitations that need to be acknowledged. Specifically, 'TRI 2.0's subscales for the inhibitor dimensions of discomfort and insecurity are somewhat weak on some psychometric criteria... Their conceptual core is challenging to represent as a set of homogeneous attributes' (Parasuraman and Colby, 2014).

The author also made some mistakes in the design of the study where they took out or amended two of the questions proposed in the TRI 0.2 guidelines. This posed issues in the calculations of the final technology readiness score and two questions needed to be converted from a positive to a negative value by reversing the results in order for the author to be able to complete the 10 item scale calculations. As the two questions added are not part of the official 10 item scale and have been assigned negative value by the researcher, the final score can't be treated to be as reliable as a score that would have been generated by closely following the TRI 0.2 guidelines.

CHAPTER 7: CONCLUSION

Looking back at the literature review and the findings from the primary and secondary research, there is a strong indication that with the right strategy in place to assess the needs for VR/AR first aid training and the technological capabilities of different users across the globe, the Red Cross movement can successfully develop and diffuse a VR/AR first aid training solution.

While comments can't be made about the readiness for adoption of users outside of the UK, the findings from this study indicate that we could make a reasonable assumption that other developed countries such as the UK are ready to adopt a new method of training and would be open to accept a suitable VR/AR technology as long as its value and effectiveness is demonstrated clearly.

When compared to previous research, mentioned in the discussion section, the study found that the concern about age having a negative impact on adoption is not substantiated and while older generations might have more concerns about using the technology than younger people, they are in fact a lot more open and encouraging of its development and diffusion.

There have been certain implications outside of the author's control that have prevented for the more in-depth collection of primary data, therefore, further research needs to be completed in order to validate some of the statements made in this study.

'With limited foresight and technological learning, the shorter the foresight, the later the adoption of an advanced, but currently expensive, technology' (Chen and Ma, 2014). One of the core areas recommended for future research is understanding specifically the user perception of VR and AR first aid technologies across the globe. This can be achieved by completing a survey across all of the 192 Red Cross societies therefore drawing parallels and comparisons between different countries and cultures and trying to see what role technological advancement plays in the

willingness to adopt new digital technologies for the purposes of first aid training, as well as how developing and developed countries compare.

There also needs to be better understanding, as well as trialling the concept of the pyramid diffusion approach where some elements of sales and marketing tactics such as the purchase funnel, also known as the AIDA-model (Strong, 1925), or buyer personas (Goodwin, 2009) can be utilised. A combination of the strategies used to break down the buyers funnel into specific stages can be used to break down the diffusion funnel in a similar way with the creation of in-depth adoption personas for each stage. Rogers (1983) also conceptualises five main steps in the innovation-decision process: (1) knowledge, (2) persuasion, (3) decision, (4) implementation, and (5) confirmation, which should also be included as part of the experiment of trialing this new strategic approach of thinking about diffusion. This will enable for a more focused understanding of not only the users of the specific VR/AR technology, but also the criteria that would impact their perception and acceptance, thus, enabling for any issues to be addressed ealy on and proving the best chance of dissemination.

Some of the findings of this study that contradict past literature, such as those related to age and gender are also worth further exploring, whether this is with specific focus on the diffusion of VR/AR first aid training or the diffusion of VR/AR technologies in general, as there is a similar gap in research in both cases.

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APPENDICES

Appendix A: Interview transcripts

DT1CR - Head of the Virtual Reality Unit, ICRC

How do you decide that VR/AR is the right solution for a certain project and how do you tend to approach development?

In general, I would like to say that the process was very organised and there is a lot of reason behind, but in fact it all started with my initiative to try and explore what can be done with video game technology and it slowly evolved into what it is now. But it took about 7 years to reach a point where we produce something using video game technology.

We were doing computer generated stuff since 2012, but we only started with the immersive VR and the headsets stuff in 2017. So, it's not that we started straight away, it started with simulation and videos that were computer generated. And it was only in 2017 that there was more demand for this kind of technology, especially from outside. The first ever project we had in immersive VR was not for the ICRC, but it was a request from the South Korean Red Cross on earthquake, because they already had two experiments like that for school children, and when I told them that the quality was extremely bad and we could help them to make it better. This is where we started, not knowing if we would manage to do a project in VR.

But I would say the decision making process, was not like a study, people say now let's explore this new technology, it was a very slow process of starting with simple computer generated tools and then as people were more familiar and interested we introduced more interactivity, until the time we could introduce the full immersive experience. But again it was not the result of a big study, it was a really slow process of integration of the technology in certain departments. Because it's also not something that all corners of ICRC, it started with the law and policy department, then security and stress management, protection, forensic and malnutrition. So again, it's a very step by step approach, also because we cannot expect people to welcome a new technology without a lot of.. It's like a diesel engine, it needs warming up, it can't start straight away.

What kind of questions did you ask yourself, what kind of considerations did you have when you started developing that first project?

It all started with frustration, the frustration of not having proper training tools that were neutral and that were up to date. At the time I was working for the Law and Policy Department, I was an Armed Forces Delegate and we were still using audio and visual material from the Korean Conflict or World War Two because almost everything else was considered too sensitive and there were political things attached to the images. That was very frustrating because the technology has changed. It's hard to take examples from past conflicts that are sometimes 50-60 years old and use them to highlight present day international humanitarian law issues. So these were the frustrations that lead to the creation of the first series of training videos which were created to illustrate what modern warfare was and the implications from legal perspective of modern warfare. This is where it started. The real need for an update of material for the teaching of international humanitarian law.

Do you think that you can effectively create that empathy and that feeling of being in an actual war zone through VR/AR?

Well, the experience we have with one of the, we have something that is not a training tool, we call it the escape, in which you're in the shoes of a person, an adult that is supposed to save a child and is going through different steps in a war zone. For us it's not a training tool, it's a tech demo more than anything else, but it's very very popular to use when we do different … because it's easy to use and it gives people the impression that they are really in a war zone, because there are explosions and snipers and you need to take action and take cover and so it gives a bit of feeling that you are in a war zone, like Iraq. we used it in so many places and people that now we're pretty sure it's having an impact on people. We had people coming from conflict areas that some of them could not finish the 10min experience because it was too much connection with the real experience. Some people were giving us feedback that it feels like the real deal that they have experienced. This is the kind of feedback that matters to us, because me as a Swiss, when I went to a conflict area because of the ICRC, because if I tested it on one of my sisters or brothers, the feedback won't have as much value as the feedback from someone coming from a war zone. We are pretty sure that this kind of VR immersive experience does have an impact on people's empathy and is really touching people's feelings at an emotional level.

We also have another experience that we created for the ... of Modern Affair of Vietnam this year and all the time we tested the product, people were very shocked by the story, that it was based on the real story, but the fact that they could experience form the inside and knowing that this is just a replica of real situation that really happened to people really has a deep impact on people.

Do you have a process of measuring the engagement and how people interact with it?

It's not the work of my department, what we do is to produce tailor made training tools for clients. It's the clients' job to measure the impact and what is needed for their work, it's not our job. We're not a private company that we're trying to sell something to people that basically we would have to prove and come up with statistics, if we have a 20 person more impact, we don't do that. The clients would need to decide what they want and what would be the training objectives and that's their problem.

Do you get involved in the distribution of the developed technology?

Nowaday, we only produce only on order. It was not the case when we started in 2017. Nobody wanted the virtual prison at the time, but we did it because we knew that the virtual prison would have the market for it. It was a time when we were doing a lot of R&D and we were anticipating what the client would need in the future. And if we look now the different projects that we did with this virtual prison, yeah, it's a rather large chunk of four activities, with 20 person is around detention, but again 2-3 years ago there was zero interest for it, but we did it anyway because it's in our DNA to look in the future, not looking at what people have and need now, but try and anticipate what they would need in two years time. It is why we need a lot of flexibility and we work in a rather chaotic way, because we want to explore and try different methods and things that may not be entirely part of our job description, but we have this freedom and flexibility to explore.

Next year we're probably going to do stuff related to augmented reality, maybe even streaming with a mix of VR and a real trainer using green screens and this kind of technology. It's not necessarily what this unit is designed to do but we have this capacity and flexibility to explore new methods of training. Most of the time we created new training tools that nobody thought they would need one day. After some time of exposure people started to

see the interest and voila and started to adopt such training tools. It's a question of time, you have to be slow a little bit and let people integrate those technologies slowly.

What do you think makes people start adopting and using something so new such as VR?

There are two factors. I think for 80% of people it's the novelty of it. People get bored of Power Points and there is an increasing lack of interest from the general public for a certain training approach, so you have to bring something new to bring the sparks and the glitters, for people to say 'Oh, what's that, let's have a look'. So VR is new and trendy, so 80% of the time this is the main reason for the adoption of this technology is to recapture the interest of a certain type of public. For 20% there is a real understanding of the value of the tool and a real understanding of the additional retention of information, about the concept of doing it and not just watching and listening. But I would say this ratio is 20/80. This means that in our case 20% of our clients understand how to create something like that, for 80% of our clients it takes a long time and a lot of effort from our side to explain how it works and the concept of the future of VR training.

Are there specific groups of people that are more accepting toward the technology, for example does age play a factor?

Strangely, not really. Honestly, I have had people that I didn't expect that would show that much interest because my pre-conception is that it's mostly young people that would be interested. But I was surprised very often. It's the case sometimes, but it's not the majority of the time. There are two things, there is the concept and there is the delivery. Of course, when it comes to the delivery and implementation, people that are not familiar with computers, don't have a good feeling about technology, there will be more resistance than people who grew up with smartphones in their hands. So, I think there is a bit of a generational difference, but in terms of the concept or of the understanding, of the interest, I have been very surprised to see people that are 60 years old trying more motivates for the development of such a tool than younger people. The one factor is when you have specialists, such as surgeons, forensics, lawyers, it's also a bit more difficult to work with them,not because they don't like the concept but because it's never precise enough, never good enough in terms of realism. So, there's sometimes a lack of flexibility on their side to understand that not everything can be done in virtual reality and that if you want to maximise

the impact you have to combine the old method of training and VR. And when you combine the two, you reach this point where 100% everything is covered, but you cannot just rely on one or the other methods. And this debate and discussions happens mostly with the specialists, they have fighting each other for 30 years on the details about war surgery and legal issues.

Are there any limitations when using VR/AR for training purposes?

Oh, yes, many. In the ICRC, we produce everything ourselves, so we don't really have a limitation when it comes to the production, now if you don't have, like the ICRC, internal departments doing it, the cost is very big and it's very rare to get good products. If you want something custom made for you, it costs a lot of money. Investment is the first factor.

Second is the hardware, even if the price is going down a little every year, it's a big limiting factor a lot. 0.2 people in the western world have access to VR headsets. There is a big room for improvement, but especially in time of economic crisis the likelihood for this technology to become more popular and I talk about the full VR experience, not just the cardboard mobile phones, but I mean computer and headsets, it's a limiting factor. Again, it's connected to money.

Both the software and the hardware part are connected to money.

The last one is the trainees, that they have to get familiar with the products and you have to simplify the interface a lot, you have to drop some features of the product so that people can jump in faster and start getting trained fast. If you need 30-45min to get familiar with the commands and the different interface that you have in the training, it's not going to work. So you need something where they put the headset on and after 5min they are ready to do the training you want and this takes a lot of work in terms of interface and simplification. But again, there is a trade off and the trade off is that you're losing a part of the realism. We saw it in the first aid training. The first one was super accurate where you have to do everything by yourself and do the correct gesture to put the person in recovery position, and in the last versions we used icons that is breaking the immersion but at the end you're sure that the people understand what to do, they were good examples and the interface is a simple and you look at the icon and you understand what it means and you just click on it inside of VR and something happens.

Every product we create is tailor made for a specific client that has specific objectives. There isn't one method that can cover all needs.

I read quite a few research papers that said that in some cases that the attitude of the person using the technology is more important than the immersiveness and the realness of the environment. Do you think that is the case?

I think, if you're in London or in Paris or Switzerland or Japan, you can have products that are conceptual that can look like modern art and some can look like minecraft, and people will get the point and it's not about the graphic fidelity or realism, we understand what is the training behind. But if you go to, and this is ICRC's main objective, to bring this technology to the people we're trying to help in conflict areas where access to technology is less and where modern art is less popular, having something that is very realistic is extremely important otherwise people will not recognise themselves inside this product. If we take for example the latest nutrition video that we created, but the level of realism we managed to achieve, we have never done something that realistic, because it's supposed to be used in Nigeria in areas where they don't have electricity mostly, they sometimes have mobile phones, but the villages they live in are very simple. And in this case, having something that is very realistic is extremely important to pass the message. Otherwise, people won't take it seriously. As you can see we really went down to the minor detail. And then you can ask, if we're looking at something super realistic why are we not just filming real people. It's what I advise most colleagues when they want to do VR for forensic, how to put a body in a body bag, I tell them to use a person, actors and films, and you will have a very good product very quickly. For the nutrition project, you need to have kids that are basically dying from malnutrition, we really don't want to do that, so by using virtual reality we don't have to show dying kids and this is important to say that we don't want to show certain aspect of warfare, so we don't want to film a real hospital being bombarded because there will be politics attached to this image, so we recreate that to respect the dignity of people, to avoid all kinds of political issues with our training tools. But if there are no such things then it's better to do it with real actors.

We're not doing fundraising, we don't work in communications, our aim is to teach something to someone, so it's different. We don't want to collect money from the people watching the nutrition video. If it's to teach something to someone and there is no other goal than that

again it's better to respect the dignity of the victims and just not show the people when they are in the worst situation.

Again, there are plenty of training videos on how to use and measure the level of malnutrition and we are watching them as reference to create the VR version and, I've been with the ICRC for 20 years, and I really had problem watching them, because you see those kids that are almost dead and I think it's distracting you from what you're supposed to learn from the video. Because if you stay neutral and show completely no emotion when seeing dying children I really don't think you should be working in organisations trying to help people with nutrition. So, I think it's better again, if we want a good result and we want the message to be passed, if it's completely submerging into emotional images and stimulus, I don't think it's the best. People may not remember what they are supposed to do, they will remember the dying kids that are looking like micro-skeletons. It's better to use VR for that.

For training, certain training is aimed at preparing people for harsh conditions or a job that is going to affect their brain, that can hurt their feelings. So, it's good for certain training that you expose people to the reality of what they might face in the future, but another part of the training is to create an automatic response to a situation. You don't want people to feel for the person that had the car accident and is lying on the side of the road. You don't want a first responder to feel because it will suddenly affect their judgement. That's why we put the screaming baby in the first aid VR training because we know some people will go straight away to the baby, because when you have a screaming baby it's natural to want to go and help the baby first, but this is not what you should do. This is because you let your emotion guide your action, if you just look at the situation coldly and you try to save a maximum of people then you don't go to the baby first, and this is again what training is about, to create automatism so when you are a first responder you want to put aside the emotional aspect and focus on the technical aspects.

But wouldn't the emotional aspect be part of that when you're in a first aid scenario?

Again, we use the emotional stimulus to try to derail the people, trying to distract them, so using emotion as a distraction. So, because, again, you don't want your first responder to arrive on the scene and start crying. This is bad. You don't want the person to come and when you're bleeding for them to start saying I'm sorry for what happened and it's very terrible. You want the person to put a finger into your torso to stop the bleeding. Even if you

scream and insult the person and spat blood, this is what you want from a first responder or a surgeon. Sometimes I accuse surgeons for treating people like piece of meat, I'm fine with that personally, because I know you don't let surgeons do surgery on family members, you don't do that. Because the emotional might lead to wrong decisions, and when it's matter to life and death you don't want anything emotional to come and affect your decision. Emotion is very important when you deal with people who are victims of emotional abuse. We now have a training in VR that is basically exactly that. It's to train people how to, so you play a first responder, a policeman or a humanitarian worker, and you have a person coming and talking about what experience they had as a victim of sexual violence. And you have very complex trees of questions and answers, and reactions that you can adopt and here you want the person to feel emotion but to a certain extent, because you must also follow certain procedures to make sure that you help the person the most. When I was working in detentions 18 years ago for the ICRC, I was in jail and I had many cases of sexual abuse on minors, 14-15 years old boys that were in prisons and that were sexually abused every day and that's not something that you're really prepared to deal with, so the problem is it's very hard on emotional level, but on the other side you need to be super professional to get information to do something to change that. If you just crumble and you're just emotional, it's preventing us to get all the information you need to be effective and you're not going to help them and it's a very difficult balance between showing emotions, feeling emotions, and being super professional and get what you need. It's sometimes it takes its toll on your mental health, but again this is something that VR can also help prevent a little, to prepare people to what they're going to face and see how they can sometimes just kind of yet prepare to follow certain series of steps, so they don't necessarily need to think too much. Like the forensic project, if you do it several times, you will know more or less exactly what to do, what are the steps. So, when you go to a disaster and you have 20 dead bodies around, you can basically switch off your brain and just work on a more automatic level and this will protect your mental health. It's one of the positive side effects that you can get from VR training.

Do you have any additional considerations you would take for first aid training, besides being able to switch off and do the job?

First aid is really, it's a complex thing. We all agree in the end, I had a conference call recently, I think it's the Norwegian Red Cross, and a company that we're trying to sell them VR training for CPR and they invited me to the discussions and asked me for my opinion. And I said, well I don't really see what is the benefit of doing CPR if you have a super

accurate manikin to do it in VR makes no sense. Makes only sense if it's CPR in a sinking ship because it's very difficult to recreate, but otherwise, don't waste time and money and energy to recreate something that works very very well with a manikin. It's the same that happened with the project we had with the British Red Cross with first aid, it started first by let's show how to put bandages on a bleeding person, how to do everything accurate and then we realised that it's probably not the best approach because this is the kind of things that people are learning with the trainers, how to put a compression bandage and these type of stuff. What was missing in the training that they were doing in the classroom was this decision making thing where you're suddenly with several people wounded, there is noise, there are situations that you have to apprehend quickly and make the right decision in the right order and this is where we decided to stop trying to teach first aid to go into first aid decision making and this is what was the latest decision. When we had the discussion with the federation, we have two parts, the part where we show people exactly what to do in a situation, so super precise but it's not left to do the player to try, it's just showing you exactly what to do, there's no margin for error, there's no tolerance for mistakes, it's a training video. Do this and it's fine. Probably VR, you have two things, when you give people the freedom of making mistakes and trying and explore, when you want to really nail something, like what to do when doing CPR, what to do to stop bleeding, how to put someone in a recovery position, you need to be sure it's done perfectly or someone can die. So, this is where I think there will always be a mix for this kind of training of how to make the right decisions that can be free and the other part of this is what you do in a given situation, put your finger here, press here and so on that can be done with computer animation but will be just a demonstration of exactly what should be done.

What kind of technology has been chosen for the IFRC project?

AR, no probably not, I think it's going to be full VR, because the added value of AR is great when you want to sell IKEA furniture, because people can take their phone, go to their apartment, select their furniture and they can see what the sofa will look like in their interior. It's great, it's fantastic. It's then same when buying a car.

AR would be fantastic when you have someone with an open wound and you take your phone, the phone can recognise that, scan the wound and put an overlay and explain what you need to do for this type of wound. But we are far away from this kind of technology. Augmented Reality, I don't think this is something we're going to use in this case. It's

probably going to be full VR. Everything done by computers, or maybe we can imagine other things where we film real people in a VR background, so that it's also possible to mix the two like movies are doing now with special effects, but again the additional cost, the complications, the fact that once it's filmed you cannot modify it, so if you have some actors and then you have the national societies, X, Y, Z say we would like to have more female protagonists in the simulations or we want more Asian looking people or more black looking people, if you do it with a mix of real and unreal, it's very difficult to modify. But to change an avatar and re-film a sequence when everything is done by computer is much easier and also cost effective. Because we want to reach as many countries as we can, we need to be also careful not just looking at the first version of the product, but what kind of other versions potential clients will ask in the future.

Do you think that there might be challenges in certain countries for the adoption of the technology that will make it more difficult?

I think it's more or less decided, it will be done for a mobile phone, so I don't see a problem if we use a mobile phone for this project. But of course, it's not going to be super interactive, it's not going to be super immersive, but we can reach millions. If we take first aid, we want mass dissemination of the training. We don't want 0.2% of the population trained in first aid training. To have it with full immersion, is good when you have fixed training, but for individual training, I don't see the value.

There are a bit of politics here, if you're the American Red Cross, you want something that is branded as the ARC, so we have to take this into consideration and not have one product that fits all the needs. We're probably going to get approached by the police, the army, who knows to have different versions and this is fine. At the end of the day we want the maximum number of people reached by the message.

We don't want the need for any additional equipment, it needs to be able to work on a simple mobile phone where you move around.

If you want to reach maximum people, you need something like that. Not all mobile phones are equal, so if you want the maximum graphic fidelity we need to use the latest iPhone or samsung, but if you go in the countries where the need for first aid training is the most important, the Philippines or Thailand where you have the highest mortality rate because of

road accidents, only a minority of people would have those super powerful mobile phones, mostly you need to look at not the latest but what was common 2 years ago. So, it's difficult to create different types of products that will fit different types of mobile phones, so we need to look at a product that will be a good use for phones that are 2 years old. And not all of them can accommodate full VR even when you put them in a box and it's nice to put in the carton box and put it on your head, but it's not necessarily anything else than you have anything else but a 360 video and again if you don't have the interactivity I don't see the need for a fully immersive product. Except, if you want to do communications or fundraising, show dying kids in 360, big impact.

To compare the video games that you can play on a mobile phone than you can play on a PC or console, it's day and night. If we try to make something similar for a mobile phone it will look like minecraft. And again we fall into the problem, it might work in the UK, but it's not going to work in Nigeria. There's always going to be a trade off where you have the perfect technology.

Misperception about what VR is, it's not just about all the equipment, you don't necessarily have to have all that to be virtual reality.

Virtual Reality, it is what it is, it's a reality made by computer, but a video is virtual reality if it's made out of computer. AR is a bit more clear, because there is this layer of virtual reality on top of a layer of reality, but VR is a bit of a vague concept. Most people think it's to do with the headsets and people are going to emerge into the computer programme, but I'm not sure. That's why when I talk about what we do, I often use the term computer generated video. We don't do VR video. If I talk about the training where you put the headsets, I talk about interactive, immersive virtual reality training. But without the interactive and immersive it can be anything.

DT2PC - Head of Global First Aid Reference Centre, IFRC

What are the different first aid training methods used by the national societies?

In fact, I think we can talk about the 192 because we have done a survey in 2018 with the Global First Aid Centre. Of course, not the 192, but we received answers from 117 Sociétés

Nationales. So, effectively we can say that most of the national societies are using the classical way of first aid training. In fact, it's a course in face to face education and most of them integration of many practices. Now, because in the past if we compare 10-15 years ago it was more theoretical. Now because evidence shows that for retention practice is better, more and more national societies are using that, so we can say that the average of a first aid course in the Red Cross and Red Crescent movement for the lay public is from 10-20 hours. It's the average and we can say that we have at least 50/50 theoretical knowledge introduction and 50 for case studies, practical and repetition of the gesture and of course revision of the end of the course and evolution. So, most of the national societies are using that. Some of them include blended learning, but that's not a lot. We have had some interest in national societies who are the leaders on that especially the British Red Cross, they use and try to use more and more blended learning. They use one part of distance learning to begin and to prepare participants to do the training after they have a face to face limited to do the real practice face to face and last but not least, they do distance learning to do refreshment course and when we see some evidence on the delivery, it seems that this sort of training by distance, then face to face, then by distance for refreshing the knowledge and skills is very better for retention compare to "classical first aid courses". And that's very interesting.

Of course, we have some advantage and disadvantage for this new approach. We're teaching more than 20 million people per year in the Red Cross and Red Crescent movement and we are more than 40,000 trainers. Of course, the advantage of the classical first aid is that the instructor have been doing this for a long time and they are quite confident with that and it's also a barrier to the new technologies as it's also very difficult to change minds and when first aid trainers see the technology in the distance future augmented reality, they lose some power, they are quite afraid to have that because they feel it's a competition between the new technologies and them. When national societies are including distance learning it's very important first to prepare their instructor to do that, because sometimes they can be blocked from the technology and its people.

The disadvantage is of course the problem of the retention after "classical first aid", because we know that most of the people come one time, one shot to the Red Cross and Red Crescent and they don't follow refreshing courses, so for the retention when they either have to use the gesture in the future or they have to do a cardiac massage, it's probably 10 years after they were thought, therefore, they would have forgotten a lot of things. Therefore,

distance learning is high quality to have a refreshing and to push the people to come back to the Red Cross and Red Crescent for one hour, each 1,2,3 years to practice. Of course, distance learning is for national society an economic problem and you can imagine if we talk about national societies in some region of the globe, it's quite hard for them to develop that themselves. The idea when we talked to Christian in the beginning it's really important for the Global First Aid Reference Centre to help these national societies to be able to have the tool developed by somebody. Of course, it would be great if we can adapt that with the environment of the national society because we are not doing the same first aid everywhere in the world, even the situation is the same, even the technique is probably are quite the same, but the emergency medical system, the possibility to transfer the people, the casualty to a hospital or a health centre, sometimes is quite difficult and different. It's interesting to have a virtual reality and distance learning, because we can adapt that to the environment of the national society.

Has VR/AR technology ever been used for the delivery of first aid training?

It's very clear, it could be very interesting for a national society, because it's very difficult to teach people near the real reality. When you are lay people you will use probably the techniques for wound and burn because it's quite often in domestic accidents and cooling a burn or cleaning a wound and use an antiseptic would be the most often, but cardiac arrest and stop a hemorrhage it's not so often for people and the VR opens this possibility for people to see what is a real hemorrhage, what can be the reality, because when you are in classical training sometimes you use just a red paper and you say the participants this is hemorrhage, what do we need to do and people they don't feel and they don't see the real blood and of course if you have the possibility of this real environment, it will be better for the future and also for retention to increase. Oh, yes, I saw that in my training, I know what to do. Probably the nearest presentation to reality is the most important and for that I'm quite confident with VR and AR technology. I think for that it's also because why we choose this approach, it's also because we have to develop new technologies and interest of first aid.

Because as you know first aid was born in the battlefield of Solferino by Henri Dunant, but national societies are doing first aid training very classically since a long time and now we have to give a "sexier form" of the first aid to attract the young people. Of course, VR and AR is one thing that young people are quite interested and when they use that for games or to see some intellectual software they are quite involved in the action. I think for first aid it's

exactly what we want, we want the participants to go inside this knowledge, go inside this situation and the interest of VR and AR to change quickly the environment, because of course the characters could be the same, we can have black people or Asiatic and Caucasian people but it's not the most important. I saw a very interesting VR from the Italian Resuscitation Council and it was the place of Bologna where we see this VR, the cardiac arrest, it's very interesting for people to see a real place and not an artificial one, not the place of the training, which is just a room and nothing real around. That is the interest, I think, we can have an approach of VR and AR. We also have to use tools that are not expensive and second also, which could be used by the lay people. AR in a smartphone is very interesting, because it can be used even in Africa, in a poor region because all the young people have this sort of smartphone and it's quite interesting to have simple technologies. Of course for VR we can probably develop in the national societies in the Red Cross and Red Crescent movement some place where you can have more developed material, as I saw the material used by the ICRC and the British Red Cross one time in Geneva with the receptor and gloves and headsets, but for that it's not so popular for dissemination. For dissemination it'll probably be AR in big town because training volunteers with VR could be interesting and probably we can use the technology of VR in rooms especially dedicated for that. So that could be the possibility of using differently AR for lay public and more emerging national societies and VR for other places where it's possible.

You mentioned a few times young people being the audience for AR and VR. Is this the audience for this project or do you think it'll go beyond young people?

For sure, you're right. I'm convinced. I said young people because when we see for example in the French Red Cross the age of participants is under 30. But I'm totally convinced that it's also interesting for example for older or disable people for example. We have to develop training for elderly people and probably it's very interesting to do that with them, because for them it's also a possibility to learn quicker and better, so I think we have no barrier of age. It depends on the open mind of the participants, because I know that some people are quite afraid of new technologies and others are not. Now we can say that many people are aware and are confident with computers and probably it will be easy to expand the VR and AR of other parts of age, not just the younger ones, for sure.

What would be the challenges and main concerns for doing VR first aid training?

In fact, the challenge is first, if I put away the money because of course the cost is one, and also to have the right people. Because of course VR is not a habit for many national societies to have partnerships that are knowing that very well and also of course a link with a technician who apprehends the reality of first aid. It could be a very good collaboration between trainers, medical people and technological people because it's very important. Money and human resources are essential.

Second, it's to prepare our network because we can't arrive with a new tool and say to the instructor, most of them are volunteers, please use that. We have to prepare them, probably with some steps first one information that we are preparing, modernising the format of first aid training, after we can use WebEx to present the technology, we also have to present them also the guide on how to use VR. It's not replacing the instructor because as I said previously some of our instructors are quite afraid because they think they'll lost what they know and what they do today, training people. Just to explain and prepare them that VR is not new first aid trainer, it's simply a tool that can be used by the actual first aid trainers and it can be used to increase the quality, to increase the retention, to be more in accordance with the environment and that's very important, because I think it's the most important challenge. And of course the challenge with emerging national societies, because it will be necessary to see how to implement these technologies equally step by step, so that all 192 can be active in VR at the same time, but we have to think about we're working for the 192 and our main aim is not to help the most aware of VR as for example the British or other national societies, but to help the smallest ones of national societies that are not able to develop by themselves but able to use it and to understand that it could be another value in term of training and to underline effectively the added value of retention and the possibility of retraining people without the obligation of a face to face training and if we have this AR available in the Red Cross and Red Crescent, it will be possible to say, ok, I can take you since the beginning you know nothing, after you prepare yourself by the first path where you receive some knowledge after you have a AR or VR and face to face and for the future after the course you will also use this new material to refresh your mind and your skills and knowledge and perhaps to be better when you need it, your first aid in a real situation.

What do you think despite the preparations and giving a lot of support to people for adopting the technology, what do you think would be the main challenges that might prevent people from accepting it?

I think if we have the ability to work with the network, I think we can probably prepare zone offices, and after national societies and after the trainers of the national societies, so if we really want to have a development of AR and VR is to have a pyramid of development structure. It's really necessary to first prepare some entity of the Federation to receive that and after we have to convince the top of the pyramidal structure of education and that is the trainers or trainers, so we probably have to involve them with a one-step if we have a pilot project, it will be possible to involve people, to have feedback of the team because we're not to build a product without those who will be the users. So, we have an interesting challenge because we have so many volunteers, so probably we'll be able before we publish something or use a new tool to have a part of experimentation and feedback of the user who can increase the quality of the tool and for that we can of course we can select national societies, big ones and small ones, national societies of the Middle East, of the Asia-Pacific so just to have some place where we can see if the feedback is good or if they have interesting feedback to change our mind to give us advice, concerns, remarks and we can change the approach we can imagine at the beginning of the project.

We are really in a good position in the Red Cross and Red Crescent movement to have this possibility of interaction between those who are working on the project and those who will be the user of the project.

So let's say, we have the product ready to go live and be tested. What would be the process of approaching these different societies?

I think when we will have the pilot project, when we have some product that can be used, for us it's very easy because we are in a relation with the five regional offices of the Federation, so we have one in each continent, South America, Middle East, Asia-Pacific, Africa and Europe, so when we are doing something new and when we want to have some good image of our network we ask to the regional office to advise us with national societies we can include in our project and with that we have one of each part of the globe and it's very interesting. For us it's quite easy to mobilise national societies. For the collaboration with the regional offices and the national societies we will have to write a concept paper to say who would be the people that can be the first user. And probably it will be the trainer of trainer. They will be able to give us some input and some feedback and for us it's quite easy to mobilise and to make a questionnaire about the product because we have done that in the past for some of our projects.

Do you think that there might be different challenges with the acceptance and dissemination in different societies?

I think it's quite different between one to another, probably for different reasons. As I said probably some national societies will find this sort of project to difficult to implement, sometimes they don't have enough time and enough money to develop, but they think about distance learning, VR and AR and probably if we talk to them they will be very happy to see that we have a project on that and possibilities to develop a test. So for others it will be totally new and I think it will be attractive. We won't have a wall for the dissemination because I think people in the movement are quite open minded. We will have to approach the national societies step by step and include the presentation of VR and AR as a complementary tool, not something that is changing everything and doesn't need an instructor. I think the challenge we have is to give the human part and the VR/AR part in the first aid education. That is very important to prepare for that.

But after probably in some part of the globe we will have one national society that is very aware of that and very open minded. I think it'll probably be a mix of all the regions in the globe that will be interested, and it will be interesting also to see who the first field test will be. It's probably one part of each part of the globe.

Do you think that VR technology can replace face to face training down the line or would it always be supplementary?

I think both. I think probably we are expecting more and more training in first aid and one challenge of the Federation is one person trainied for first aid in each household. If we want to have that in 10 years with the strategy 2030, I think we have to use VR and AR and probably this technology would make it possible to be used as a course alone and for some part of first aid. I think at home I am able to learn about wounds, about fracture because it's not so difficult and I think AR can give me 80% or 90% of the knowledge, skills according my need. For other things it can be more difficult, for example for cardiopulmonary resuscitation, of course, it will be difficult for AR or VR to replace totally the practice on a manikin but also the human approach, because we're not stopping the bleeding, we take care of a person who is bleeding. It's quite different. People are thinking that first aid is just a gesture and if I know it, it's probably enough, but it's not because the part of the psychological aspect of first

aid is important and I'm convinced that the interaction between human is essential, so VR could be an interesting initiation for small course of one hour for example, which could be totally virtual. After we put for a complete basic first aid we need two parts, we need the virtual part and the face to face part, which is the blended learning. We can have one place alone and one place with the practice.

Would you say that if first aid training was moved to an entirely VR model that would be because of the way it can reach more people?

The interest of VR and AR is because we're able to reach more and more people and even we are teaching 20 million people per year is not enough, it's a very small part of the world. We know in all countries, if we have no more than 60% aware and able to do first aid especially in emergency cases as a cardiac arrest the chances of survival of the casualty are poor. It's very important to reach more and more people, with more and more different tools. And it's key that the new technologies are as one place, an enormous place of dissemination and probably it will be one possibility to go very far away because we're not able to train in the north pole or in a place very isolated in Africa, so of course we have the limit of the technology and the possibility to receive or to download something as an app or something like that, but after when you have this app you are then able to really be in touch with more and more people and after it could be attracted, because I think we can use VR and AR as an open door for people to come to the Red Cross and Red Crescent for other things, for other activities. It could be the aperitif of first aid, it could be used like that, but it could be also the main plate because it represents part of our first aid training, and finally it could be the desert because it could be the refreshing course to repeat what I have learned. I think VR and AR can help us to disseminate more first aid.

What would be the challenges disseminating VR and AR to the general public than to other Red Cross societies?

I think for the AR we have to probably to present and to share with some group of people what is AR and what are the strengths and the weaknesses, and as we discussed today to present a positive point on how to use AR in classical first aid training to have a new approach of the training. I think probably we have to involve people as I say of different national societies, in part of the globe and different level of national societies to help the movement to incorporate this new technology in our approach of trusted education.

I think the feeling I have vis a vis is that really it could be a new possibility for Red Cross and Red Crescent to show that we are the leader in training in first aid. It's not good to stay in a fixed position, we need to show that we are able to re-invent the approach to include the new technologies but respecting our privacy law and the human approach. I think we're in a good position to do that around the world, after that it's a question of group of people who are able to build this project because it could be for the movement, not just for the IFRC but also for the ICRC, if we talk about crisis situations, it can be very important and perhaps with the VR have an approach of crisis situations, for example, disaster of terrorist attack.

Effectively for people who have to learn what to do in case of a disaster or a terrorist attack, VR can be an interesting approach, of course, we have taken into account a psychological approach to make sure we don't scare people, but it could be really an immersive possibility of learning that we have not with classical first aid. It's possibility to use this tool in daily life but also in disaster and exceptional situations is essential.

Appendix B: Survey results & data

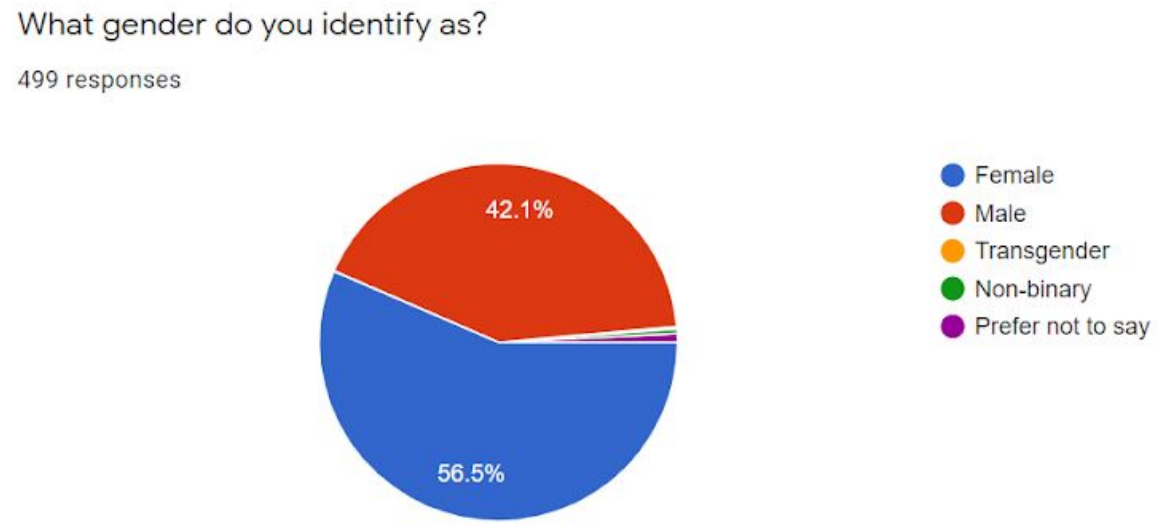
Digital first aid training

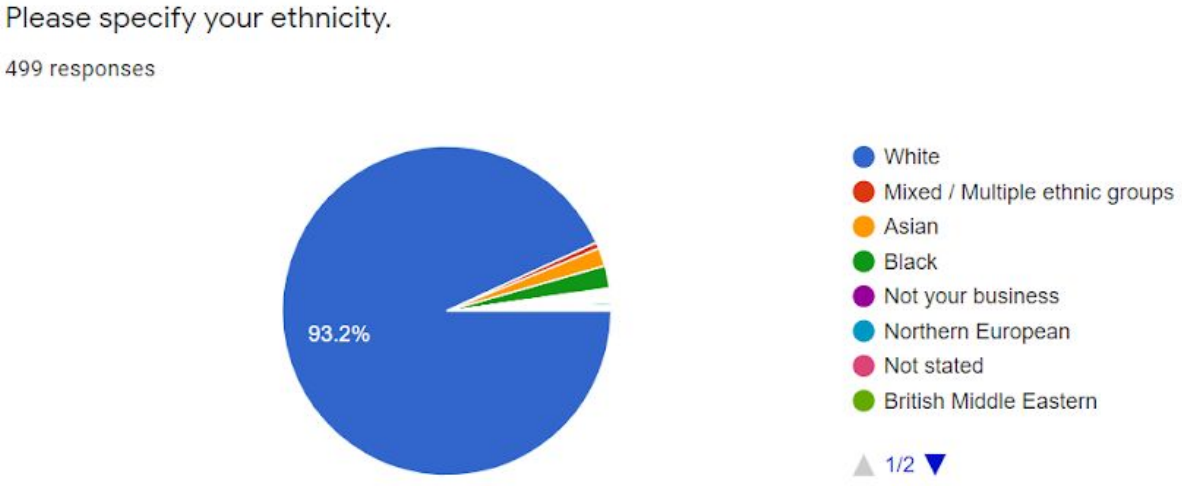
Survey results analysis

Below is a general overview of the overall results and outcomes that have come from the survey and each question part of it that are not yet split into demographic factors.

Demographics

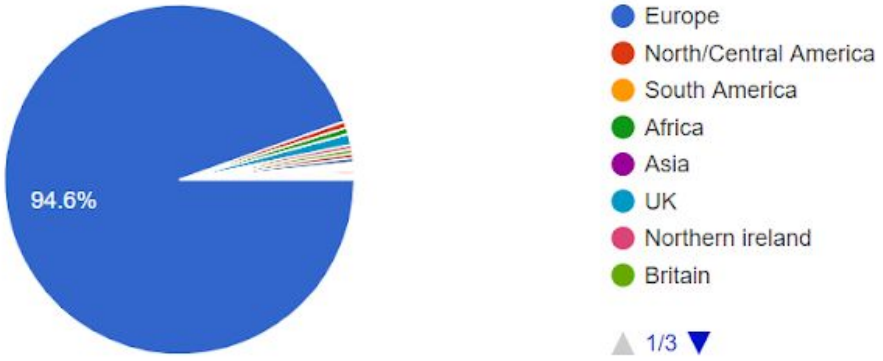
We asked the following demographic questions to try and understand the type of audience that had submitted answers to the questions of the survey, as well as try and identify any trends in attitudes towards the use of technology.





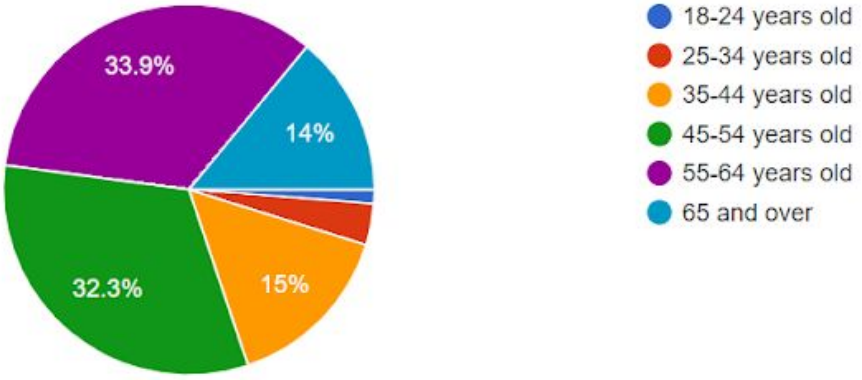
Location

499 responses



What is your age?

499 responses

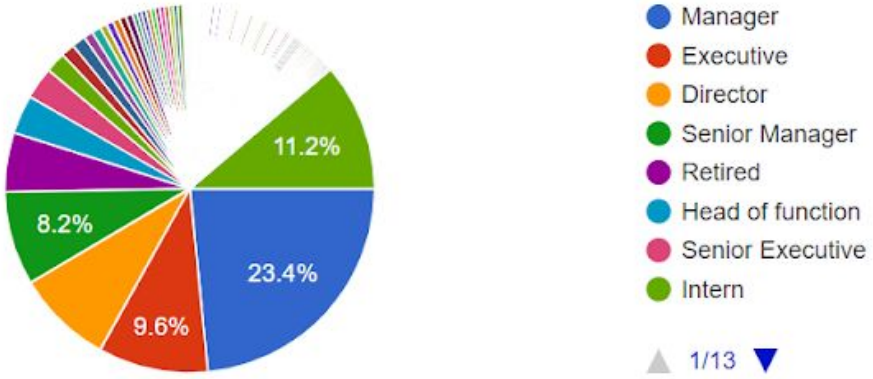


Education

499 responses

What is your current job seniority level?

499 responses



What is your involvement with first aid training within your organisation? (please choose all relevant)

499 responses

Understanding attitudes towards digital technology

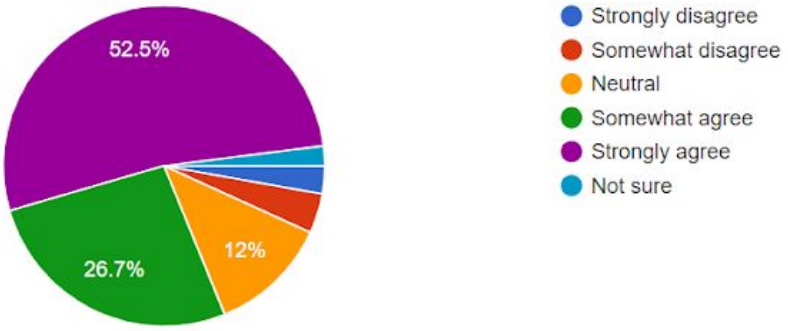
Questions based on the Technology Readiness Index.

Technology Readiness is measured with the Technology Readiness Index (TRI), a multi-item scale that has been extensively evaluated for reliability and validity. Work on the TRI started in the late 1990s, including multiple pilot studies in consumer and b2b contexts.

TR is a mindset, not a measure of competence or knowledge. TR has proven to be a stable characteristic that does not change easily for an individual. TR is multifaceted, including two dimensions that are motivators and two that are inhibitors.

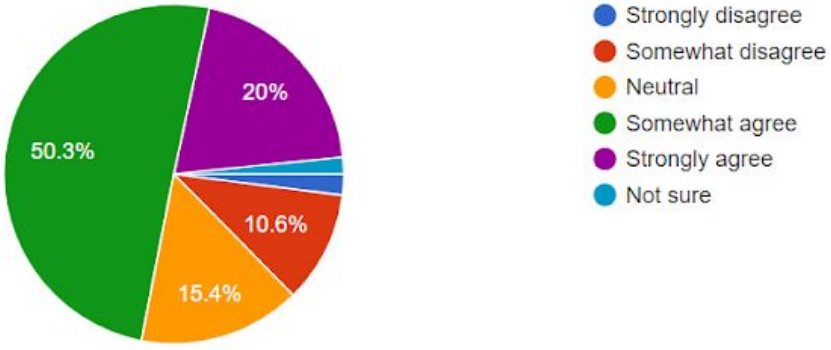
Technology influences my life. Please indicate how much you agree with the following statements.

499 responses



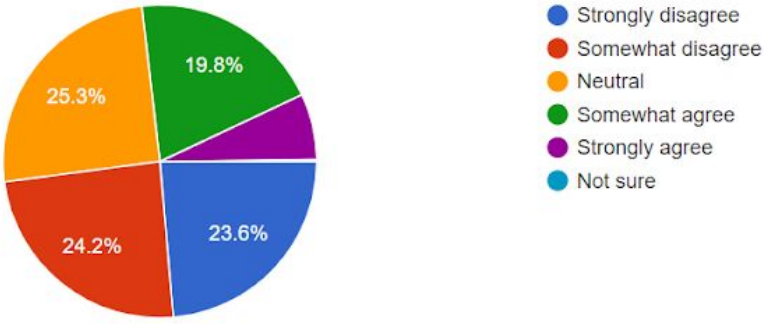
New technologies contribute to a better quality of life

499 responses



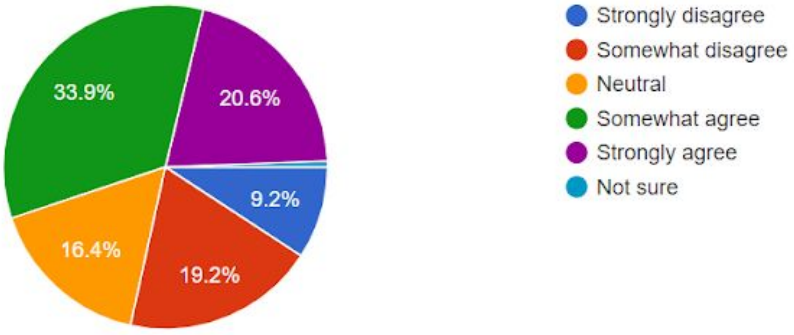
In general, I am among the first in my circle of friends to acquire new technology when it appears

499 responses



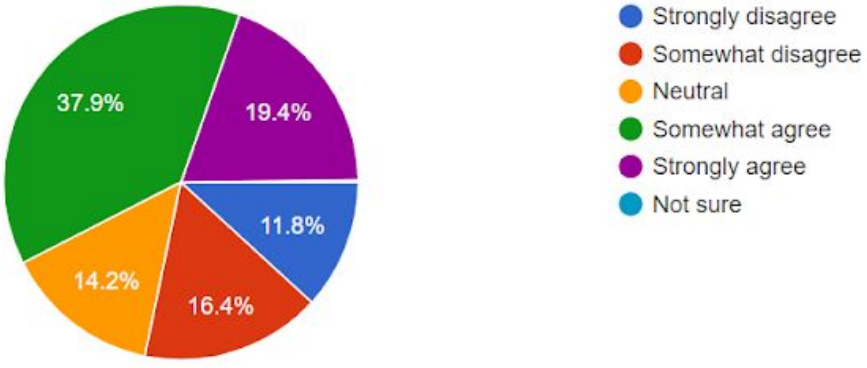
I can usually figure out new high-tech products and services without help from others

499 responses



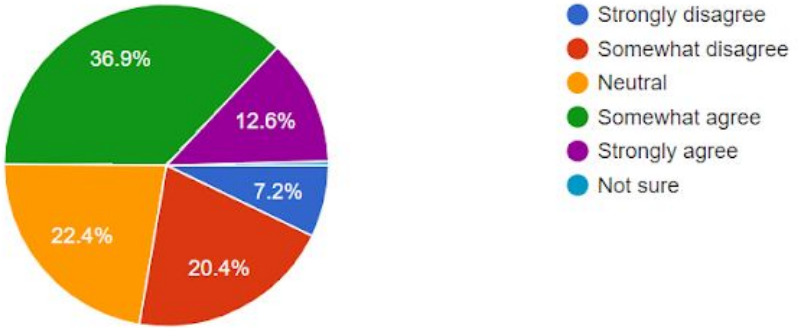
I keep up with the latest technological developments in my areas of interest

499 responses



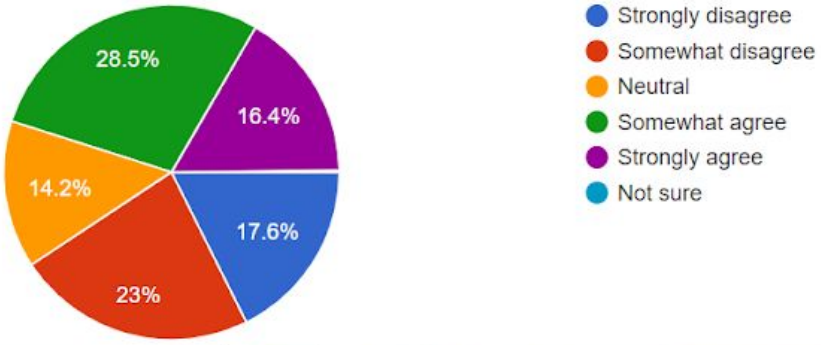
Sometimes, I think that technology systems are not designed for use by ordinary people

499 responses



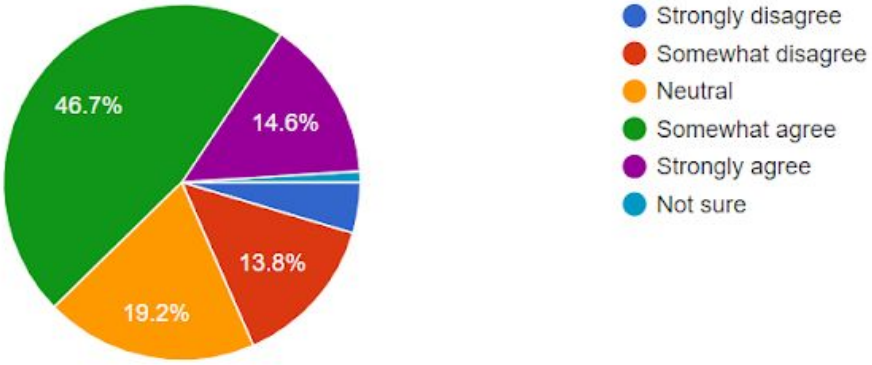
I do not feel confident doing business with a place that can only be reached online

499 responses



Too much technology distracts people to a point that is harmful

499 responses

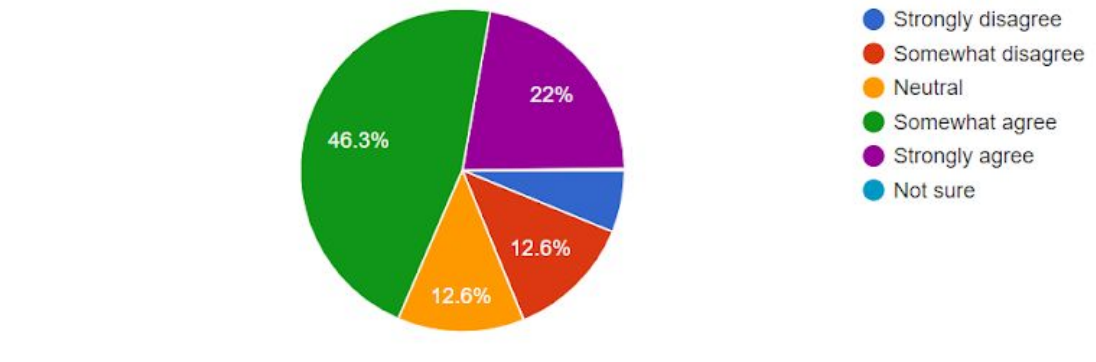


Digital first aid training

This section asks questions around the different methods of delivering first aid training and the users expectations.

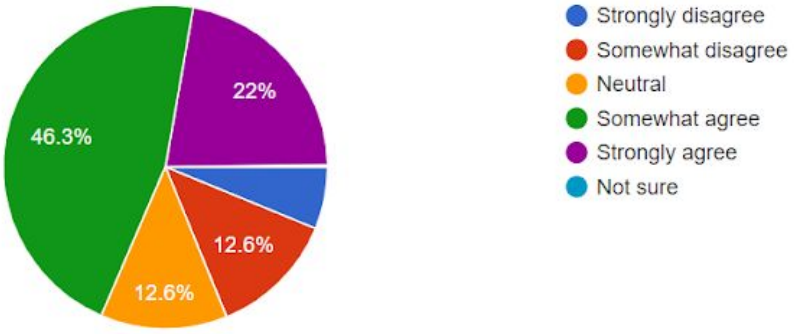
There is a need for alternatives to classroom based first aid training. Please indicate how much you agree with this statement.

499 responses



There is a need for alternatives to classroom based first aid training. Please indicate how much you agree with this statement.

499 responses

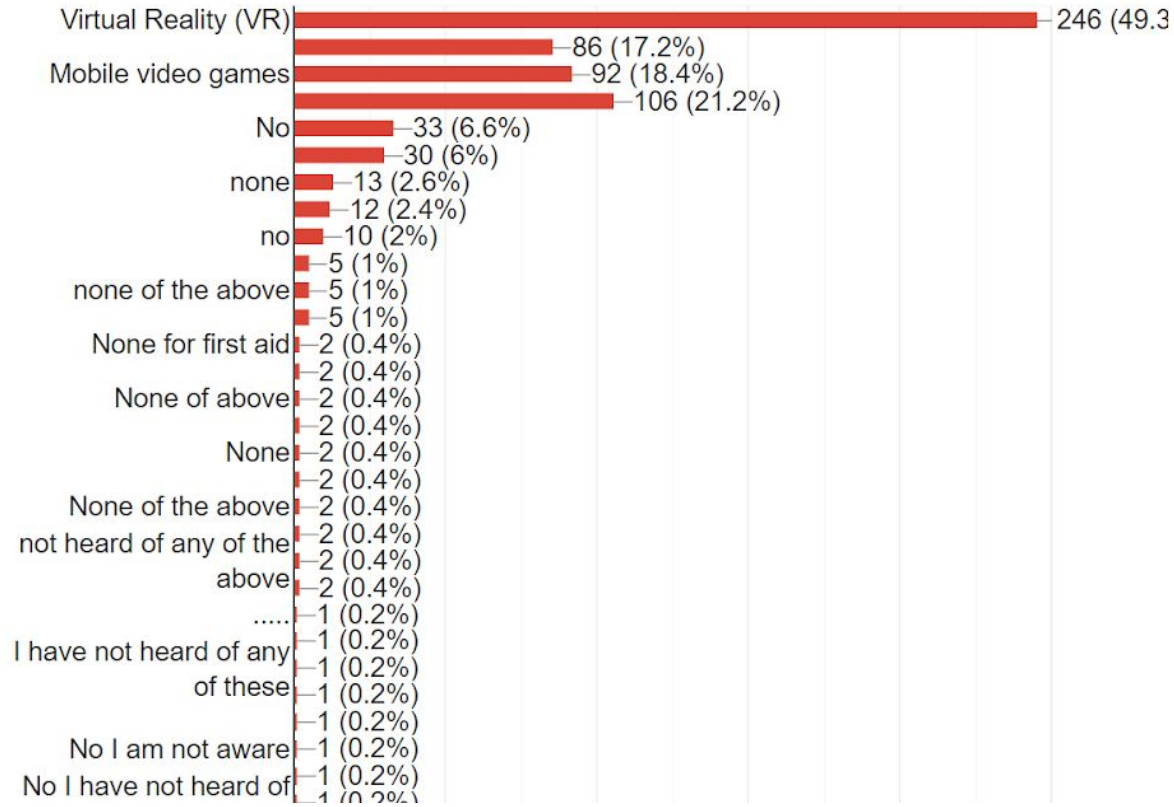


Do you think digital first aid training can be as effective as face to face first aid training?

499 responses

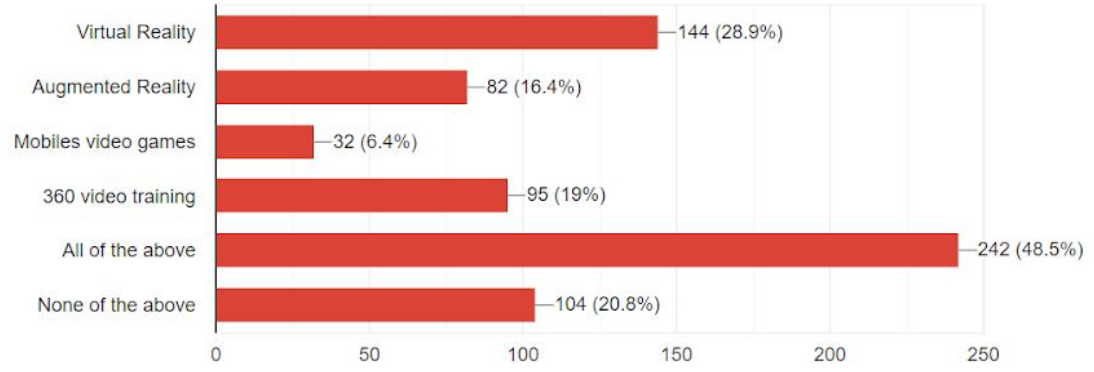
Have you ever heard of the following technologies used for first aid training? (please choose all relevant)

499 responses



Which of the following digital first aid training methods would you be open to try?

499 responses

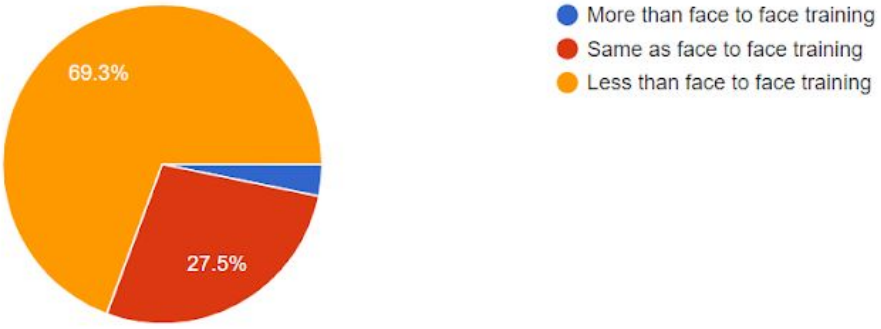


If you were to consider learning first aid with the use of new technology, which factor would be most important to you?

499 responses

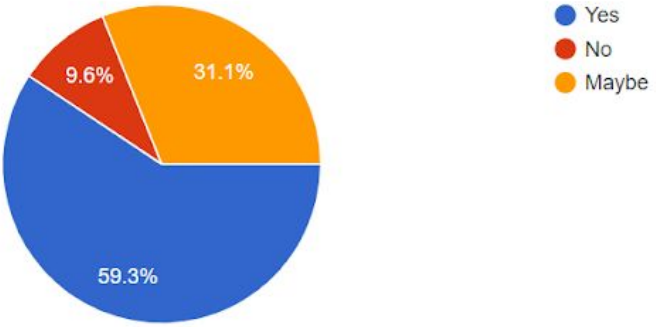
If you were to learn using new technology, would you expect the cost to be:

499 responses



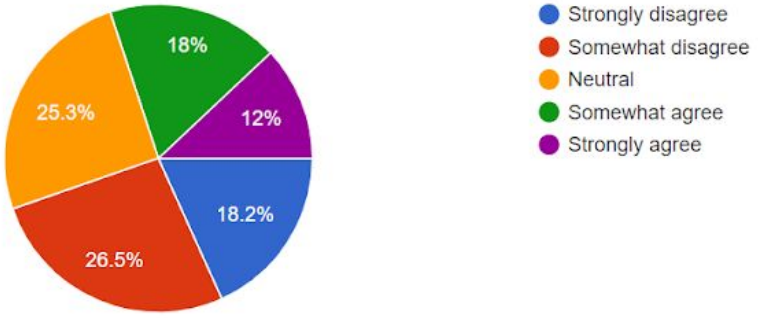
If research showed that digital first aid training was as, or more, effective than face to face training, would you be interested in learning this way?

499 responses



I would be confident learning more practical first aid training skills, such as putting someone in recovery position and CPR, through digital training. Please indicate how much you agree with this statement.

499 responses



TRI calculations

	Technology infl	New technologi	In general, I am	I can usually fig	I keep up with t	Sometimes, I th	I do not feel cor	Too much techi	There is a need	I would not be c
Strongly agree	262	100	34	103	97	64	82	73	110	91
Somewhat agree	133	251	99	169	189	184	142	233	231	132
Neutral	60	77	126	82	71	112	71	96	63	126
Somewhat disagree	20	53	121	96	82	102	115	69	63	90
Strongly disagree	14	10	118	46	59	35	88	23	31	60
Not sure	10	8	1	3	1	2	1	5	1	0
	499	499	499	499	499	499	499	499	499	499

	Technology doe	New technologi	In general, I am	I can usually fig	I keep up with t	Sometimes, I th	I do not feel cor	Too much techi	There is a need	I would not be c
Strongly agree	70	500	170	515	485	320	410	365	550	455
Somewhat agree	80	1004	396	676	756	736	568	932	924	528
Neutral	180	231	378	246	213	336	213	288	189	378
Somewhat disagree	266	106	242	192	164	204	230	138	126	180
Strongly disagree	262	10	118	46	59	35	88	23	31	60
Not sure	30	24	3	9	3	6	3	15	3	0
	888	1875	1307	1684	1680	1637	1512	1761	1823	1601

	Points
Strongly agree	5
Somewhat agree	4
Neutral	3
Somewhat disagree	2
Strongly disagree	1

Final TRI	488.00
Positive	8369
Negative	7399

Gender results

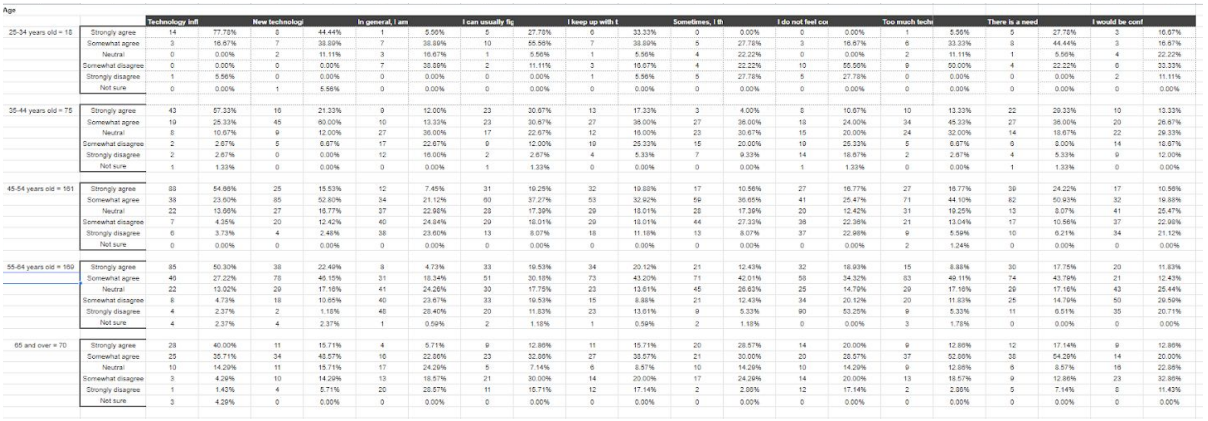
Gender		Technology infl		New technologi		In general, I am		I can usually fig	
Female = 282	Strongly agree	144	51.06%	51	18.09%	23	8.16%	66	23.40%
	Somewhat agree	76	26.95%	145	51.42%	55	19.50%	89	31.56%
	Neutral	33	11.70%	50	17.73%	70	24.82%	59	20.92%
	Somewhat disagree	16	5.67%	25	8.87%	70	24.82%	49	17.38%
	Strongly disagree	8	2.84%	6	2.13%	63	22.34%	16	5.67%
	Not sure	7	2.48%	5	1.77%	1	0.35%	3	1.06%
Male = 210	Strongly agree	119	56.67%	49	17.38%	11	3.90%	37	13.12%
	Somewhat agree	56	26.67%	103	36.52%	44	15.60%	78	27.66%
	Neutral	24	11.43%	25	8.87%	54	19.15%	20	7.09%
	Somewhat disagree	3	1.43%	26	9.22%	48	17.02%	45	15.96%
	Strongly disagree	6	2.86%	3	1.06%	53	18.79%	30	10.64%
	Not sure	2	0.95%	3	1.06%	0	0.00%	0	0.00%

I keep up with t		Sometimes, I th		I do not feel cor		Too much techi		There is a need	
52	18.44%	31	10.99%	38	13.48%	32	11.35%	68	24.11%
109	38.65%	105	37.23%	84	29.79%	134	47.52%	136	48.23%
49	17.38%	65	23.05%	41	14.54%	61	21.63%	33	11.70%
38	13.48%	60	21.28%	65	23.05%	37	13.12%	31	10.99%
33	11.70%	19	6.74%	53	18.79%	15	5.32%	13	4.61%
1	0.35%	2	0.71%	1	0.35%	3	1.06%	1	0.35%
45	15.96%	31	10.99%	42	14.89%	40	14.18%	40	14.18%
77	27.30%	78	27.66%	58	20.57%	97	34.40%	93	32.98%
22	7.80%	44	15.60%	30	10.64%	33	11.70%	29	10.28%
40	14.18%	41	14.54%	47	16.67%	32	11.35%	32	11.35%
26	9.22%	16	5.67%	33	11.70%	6	2.13%	16	5.67%
0	0.00%	0	0.00%	0	0.00%	2	0.71%	0	0.00%

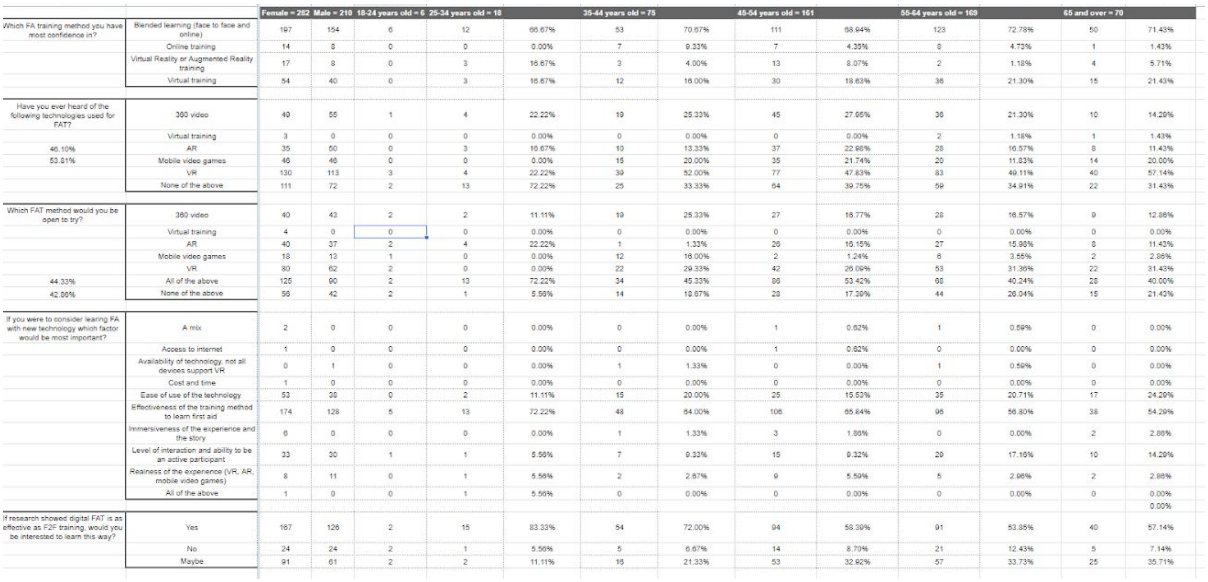
I would not be c		
28	9.93%	
55	19.50%	
81	28.72%	
77	27.30%	41.84
41	14.54%	
0	0.00%	
31	10.99%	36.53
34	12.06%	
42	14.89%	
54	19.15%	
49	17.38%	
0	0.00%	

Age results

(If zoomed in, the results would become visible)



Age		Technology infl		New technologi		In general, I am		I can usually fig		I keep up with t		Sometimes, I th		I do not feel co		Too much techi		There is a need		I would be conf	
25-34 years old = 18	Strongly agree	14	77.78%	8	44.44%	1	5.56%	5	27.78%	6	33.33%	0	0.00%	0	0.00%	1	5.56%	5	27.78%	3	16.67%
	Somewhat agree	3	16.67%	7	38.89%	7	38.89%	10	55.56%	7	38.89%	5	27.78%	3	16.67%	6	33.33%	8	44.44%	3	16.67%
	Neutral	0	0.00%	2	11.11%	3	16.67%	1	5.56%	1	5.56%	4	22.22%	0	0.00%	2	11.11%	1	5.56%	4	22.22%
	Somewhat disagree	0	0.00%	0	0.00%	7	38.89%	2	11.11%	3	16.67%	4	22.22%	10	55.56%	9	50.00%	4	22.22%	6	33.33%
	Strongly disagree	1	5.56%	0	0.00%	0	0.00%	0	0.00%	1	5.56%	5	27.78%	5	27.78%	0	0.00%	0	0.00%	2	11.11%
	Not sure	0	0.00%	1	5.56%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%
35-44 years old = 75	Strongly agree	43	57.33%	16	21.33%	9	12.00%	23	30.67%	13	17.33%	3	4.00%	8	10.67%	10	13.33%	22	29.33%	10	13.33%
	Somewhat agree	19	25.33%	45	60.00%	10	13.33%	23	30.67%	27	36.00%	27	36.00%	18	24.00%	34	45.33%	27	36.00%	20	26.67%
	Neutral	8	10.67%	9	12.00%	27	36.00%	17	22.67%	12	16.00%	23	30.67%	15	20.00%	24	32.00%	14	18.67%	22	29.33%
	Somewhat disagree	2	2.67%	5	6.67%	17	22.67%	9	12.00%	19	25.33%	15	20.00%	19	25.33%	5	6.67%	6	8.00%	14	18.67%
	Strongly disagree	2	2.67%	0	0.00%	12	16.00%	2	2.67%	4	5.33%	7	9.33%	14	18.67%	2	2.67%	4	5.33%	9	12.00%
	Not sure	1	1.33%	0	0.00%	0	0.00%	1	1.33%	0	0.00%	0	0.00%	1	1.33%	0	0.00%	1	1.33%	0	0.00%
45-54 years old = 161	Strongly agree	88	54.66%	25	15.53%	12	7.45%	31	19.25%	32	19.88%	17	10.56%	27	16.77%	27	16.77%	39	24.22%	17	10.56%
	Somewhat agree	38	23.60%	85	52.80%	34	21.12%	60	37.27%	53	32.92%	59	36.65%	41	25.47%	71	44.10%	82	50.93%	32	19.88%
	Neutral	22	13.66%	27	16.77%	37	22.98%	28	17.39%	29	18.01%	28	17.39%	20	12.42%	31	19.25%	13	8.07%	41	25.47%
	Somewhat disagree	7	4.35%	20	12.42%	40	24.84%	29	18.01%	29	18.01%	44	27.33%	36	22.36%	21	13.04%	17	10.56%	37	22.98%
	Strongly disagree	6	3.73%	4	2.48%	38	23.60%	13	8.07%	18	11.18%	13	8.07%	37	22.98%	9	5.59%	10	6.21%	34	21.12%
	Not sure	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	2	1.24%	0	0.00%	0	0.00%
55-64 years old = 169	Strongly agree	85	50.30%	38	22.49%	8	4.73%	33	19.53%	34	20.12%	21	12.43%	32	18.93%	15	8.88%	30	17.75%	20	11.83%
	Somewhat agree	46	27.22%	78	46.15%	31	18.34%	51	30.18%	73	43.20%	71	42.01%	58	34.32%	83	49.11%	74	43.79%	21	12.43%
	Neutral	22	13.02%	29	17.16%	41	24.26%	30	17.75%	23	13.61%	45	26.63%	25	14.79%	29	17.16%	29	17.16%	43	25.44%
	Somewhat disagree	8	4.73%	16	9.65%	40	23.67%	33	19.53%	15	8.88%	21	12.43%	34	20.12%	20	11.83%	25	14.79%	50	29.59%
	Strongly disagree	4	2.37%	2	1.18%	48	28.40%	20	11.83%	23	13.61%	9	5.33%	90	53.25%	9	5.33%	11	6.51%	35	20.71%
	Not sure	4	2.37%	4	2.37%	1	0.59%	2	1.18%	1	0.59%	2	1.18%	0	0.00%	3	1.78%	0	0.00%	0	0.00%
65 and over = 70	Strongly agree	28	40.00%	11	15.71%	4	5.71%	9	12.86%	11	15.71%	20	28.57%	14	20.00%	9	12.86%	12	17.14%	9	12.86%
	Somewhat agree	25	35.71%	24	45.57%	16	22.86%	23	32.86%	27	38.57%	21	30.00%	20	28.57%	37	52.86%	38	54.29%	14	20.00%
	Neutral	10	14.29%	11	15.71%	17	24.29%	5	7.14%	6	8.57%	10	14.29%	10	14.29%	9	12.86%	6	8.57%	16	22.86%
	Somewhat disagree	3	4.29%	10	14.29%	13	18.57%	21	30.00%	14	20.00%	17	24.29%	14	20.00%	13	18.57%	9	12.86%	23	32.86%
	Strongly disagree	1	1.43%	4	5.71%	20	28.57%	11	15.71%	12	17.14%	2	2.86%	12	17.14%	2	2.86%	5	7.14%	8	11.43%
	Not sure	3	4.29%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%



		Female = 282	Male = 210	18-24 years old = 6	25-34 years old = 18		35-44 years old = 75		45-54 years old = 161		55-64 years old = 169		65 and over = 70	
Which FA training method you have most confidence in?	Blended learning (face to face and online)	197	154	6	12	66.67%	53	70.67%	111	68.94%	123	72.78%	50	71.43%
	Online training	14	8	0	0	0.00%	7	9.33%	7	4.35%	8	4.73%	1	1.43%
	Virtual Reality or Augmented Reality training	17	8	0	3	16.67%	3	4.00%	13	8.07%	2	1.18%	4	5.71%
	Virtual training	54	40	0	3	16.67%	12	16.00%	30	18.63%	36	21.30%	15	21.43%
Have you ever heard of the following technologies used for FA?	360 video	49	55	1	4	22.22%	19	25.33%	45	27.95%	36	21.30%	10	14.29%
	Virtual training	3	0	0	0	0.00%	0	0.00%	0	0.00%	2	1.18%	1	1.43%
46.10%	AR	35	50	0	3	16.67%	10	13.33%	37	22.98%	28	16.57%	8	11.43%
53.91%	Mobile video games	46	46	0	0	0.00%	15	20.00%	35	21.74%	20	11.83%	14	20.00%
	VR	130	113	3	4	22.22%	39	52.00%	77	47.83%	83	49.11%	40	57.14%
	None of the above	111	72	2	13	72.22%	25	33.33%	64	39.75%	59	34.91%	22	31.43%
Which FAT method would you be open to try?	360 video	40	42	2	2	11.11%	19	25.33%	27	16.77%	28	16.57%	9	12.86%
	Virtual training	4	0	0	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%
	AR	40	37	2	4	22.22%	1	1.33%	26	16.15%	27	15.98%	8	11.43%
	Mobile video games	18	13	1	0	0.00%	12	16.00%	2	1.24%	6	3.55%	2	2.86%
	VR	80	62	2	0	0.00%	22	29.33%	42	26.09%	53	31.36%	22	31.43%
44.33%	All of the above	126	90	2	13	72.22%	34	45.33%	86	53.42%	68	40.24%	28	40.00%
42.86%	None of the above	56	42	2	1	5.56%	14	18.67%	28	17.39%	44	26.04%	15	21.43%
If you were to consider learing FA with new technology which factor would be most important?	A mix	2	0	0	0	0.00%	0	0.00%	1	0.62%	1	0.59%	0	0.00%
	Access to internet	1	0	0	0	0.00%	0	0.00%	1	0.62%	0	0.00%	0	0.00%
	Availability of technology, not all devices support VR	0	1	0	0	0.00%	1	1.33%	0	0.00%	1	0.59%	0	0.00%
	Cost and time	1	0	0	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%
	Ease of use of the technology	53	38	0	2	11.11%	15	20.00%	25	15.53%	35	20.71%	17	24.29%
	Effectiveness of the training method to learn first aid	174	128	5	13	72.22%	48	64.00%	106	65.84%	96	56.80%	38	54.29%
	Immersiveness of the experience and the story	6	0	0	0	0.00%	1	1.33%	3	1.86%	0	0.00%	2	2.86%
	Level of interaction and ability to be an active participant	33	30	1	1	5.56%	7	9.33%	15	9.32%	29	17.16%	10	14.29%
	Realness of the experience (VR, AR, mobile video games)	8	11	0	1	5.56%	2	2.67%	9	5.59%	5	2.96%	2	2.86%
	All of the above	1	0	0	1	5.56%	0	0.00%	0	0.00%	0	0.00%	0	0.00%
														0.00%
If research showed digital FAT is as effective as F2F training, would you be interested to learn this way?	Yes	167	126	2	15	83.33%	54	72.00%	94	58.39%	91	53.85%	40	57.14%
	No	24	24	2	1	5.56%	5	6.67%	14	8.70%	21	12.43%	5	7.14%
	Maybe	91	61	2	2	11.11%	16	21.33%	53	32.92%	57	33.73%	25	35.71%