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Henri Pirkkalainen
Osku Torro
(eds.)

Global Information Systems Management – The view on Smart Transformation

Consolidated Assignments from Spring 2019

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FOREWORD

Digitalization changes the world. Information systems, software applications and other technologies are in a central role in this change. They enable new work practices and processes, new business models and opportunities, initiate changes in how technologies are used, perceived and interpreted, and ultimately force individuals, organizations, and even societies at large to respond to those changes. Individuals, organizations, and societies have to somehow transform and adjust their old ways of doing things.

These views pose several questions for information systems and information management research. The Global Information Systems Management-course (TLO-35306) was arranged for the third time in Tampere University in Spring 2019. The students of the course were dealing specifically with these aforementioned issues that were framed as *Smart Transformation*. This document contains the group exercises of the course. The course theme for this year is specifically aligned with *the 42nd Information Systems Research Seminar (IRIS 2019) in Scandinavia and the 10th Scandinavian Conference on Information Systems (SCIS 2019).*

Each group collaborated on finding a common topic of interest. They focused on the adoption and/or use of a particular emerging technology in a setting of their own choosing. As you are about to see, the findings of each group emphasize different perspectives. These range from the negative effects of technology use to the opportunities and delights of information systems.

We hope you take a moment to read about the state of the art research in Information Systems and Information Management. Enjoy.

12.4.2019 Tampere

Teachers –

Assistant professor Henri Pirkkalainen

Doctoral candidate Osku Torro

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AUGMENTED REALITY IN MEDICAL TRAINING

TLO-35306 2018-01 Global Information Systems Management
Group assignment

Henrikki Lehtola
Patrik Nieminen
Tuomas Nuutila
Veeti Pulkkinen

ABSTRACT

AUGMENTED REALITY IN MEDICAL TRAINING

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Keywords: Augmented reality, education, medical training

Augmented reality is not much used in today's medical training, but the importance and benefits it could bring to the field are significant. In this paper we studied what is AR-technology and how it could be utilized it medical training. What different benefits implementing it could bring to medical education and what challenges does it face in doing so. The paper also gives examples of how AR-technology is currently used in medical field and how that could be integrated in medical training, as well as what future applications AR might have in medical training. We studied multiple papers about AR-technology, AR in education, in medical training and AR in the medical field in general from different sources to give us insight about the subject. We also conducted interviews of medical students to give us a practical view of the subject. After analyzing our sources, we can say that AR still has some challenges we discuss more in the paper to be fully implemented in medical training, but the potential it has is immense.

1. INTRODUCTION

Augmented reality is gaining more and more popularity, and it is expected to have major impact on society in 5- to 10-years (Gartner 2018). Looking at other use cases of AR, we can see that it is being used in growing amount of industries for example to enhance technical documentation of machines. Organizations providing solutions for technical documentation, have realized that AR can be used to make instruction manuals more visual, and replace huge amounts of text by adding interactive virtual solutions. (Etteplan 2019 & TCWorld) Augmented reality solutions have been creating a buzz, especially in technical documentation (TCWorld), and in education in general (Radu 2014), so we believe that AR-technology is about to reach the level of maturity, where it can start to have an impact on the medical field as well. Therefore, the benefits as well as challenges, and future possibilities of AR in medical training should be studied.

The objective of our research is to find out how augmented reality can be used to futher improve the training of medical professionals. We will look into the current state of AR-technology, and look into the specific benefits that AR brings to medical training. To bring more validity to our research we have interviewed a couple of medical students from Tampere University about the challenges they face in their current education. As AR-technology is not yet mature, there is still need for product development, and development in the ways of working. Because of this we will also point out the challenges related to using AR in medical training. In the end we will present some applications of how AR is being used in medical training, and how the future of AR looks like. As an outcome of this research we hope that the reader has an understanding of how AR can benefit the slowly changing field of medical training.

Our research lens is a mix of the current and the future. Based on studies and other sources about the current use of AR, we will draw our presented benefits and challenges. Still, as the medical field is slow to adapt new technologies and is altogether slow to change, the presented use-cases are future oriented.

1.1 Research Method

This research is mostly based on current literature sources. In addition to that we conducted interviews to two fourth-year medical students at the Tampere University. We also contacted a professor at the Tampere University who is in charge of the medical studies. The email questionnaire was forwarded to two other people, which gave us a little more insight. The conducted interviews and email questionnaire were short in nature, and the

goal was to get an understanding of how AR-technology could be and is being used in Tampere University.

2. INTRODUCTION TO AR

Augmented Reality (AR) is a technology which is a variation of Virtual Reality (VR). In VR technologies a user is inside completely synthetic world and user can't see what happens in the real world. In contrast, AR makes for the user possible to see the real environment, where different digital or computer-generated information is added (Kipper & Rampolla 2013). Communication with the real world through AR happens in real time. AR technologies' advantages in different demonstrations and training scenarios are based on that imaginary digital objects, pictures and other visuals that might be difficult or expensive to try in real life – some even impossible, can be utilized in AR. Countless number of different situations can be created and experienced through AR.

AR is always somewhat interactive from user's point of view. For example, some movies that include photorealistic virtual objects blended with a real world in 3D, like in "Avatar" movie, don't constitute AR (Kipper & Rampolla 2013). In AR applications usually the user is able to make, in addition to visual observation, physical actions like move objects or change the size of them.

When discussing Augmented Reality, the hardware that makes the various applications possible to be used can't be forgotten. Augmented Reality Systems utilize various tracking technologies including digital cameras, optical sensors, accelerators, GPS, Radio Frequency IDentification (RFID) and wireless sensors (Mainzer 2017). Nowadays the most common AR device that comes to mind is AR glasses that are quite widely used when using AR applications. At the time AR glasses also need to be connected to a computer. A simple monitor or a screen and a computer would also make the same AR application work. Over time Augmented Reality as a technology has come up with technical breakthroughs of processors, sensors and input devices (Mainzer 2017).

Looking at figure 1 of the Gartner hype cycle from 2018, we can see that AR is expected to have major impact on society in 5- to 10-years (Gartner 2018), so the possibilities for the use of AR in the medical field should be considered seriously. Barsom et al. (2016) points out that medical educators should search for possible use cases of AR, but still be critical while judging the use of AR.

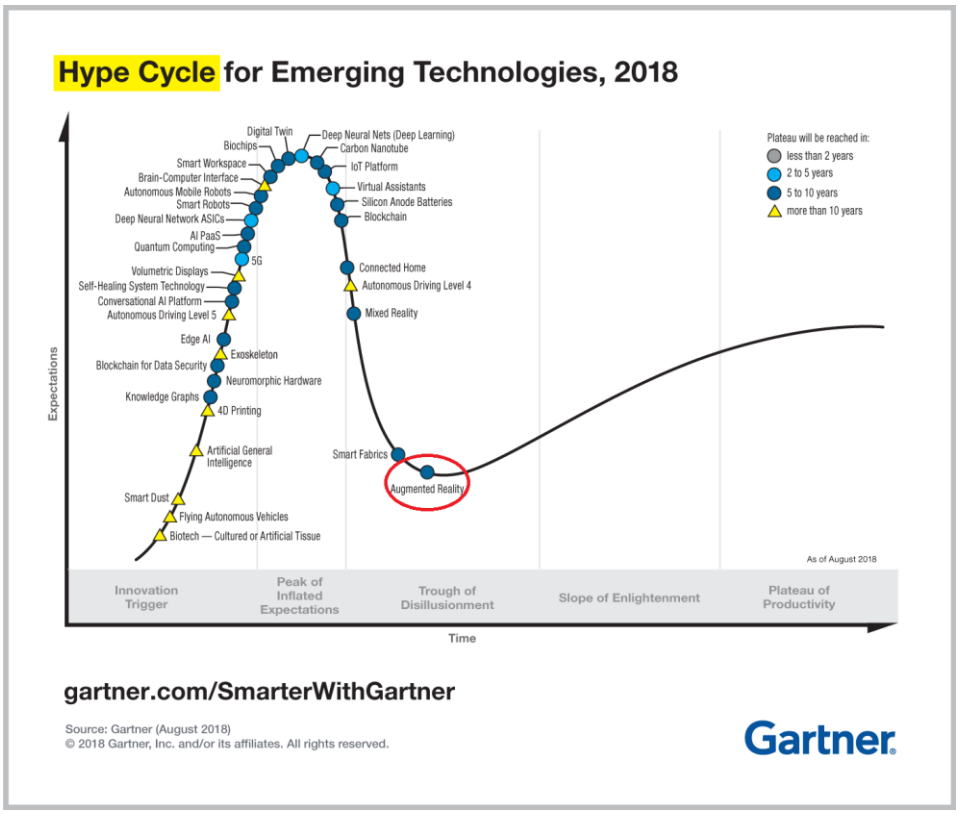

Figure 1: Gartner Hype Cycle 2018 (Gartner 2018)

3. AUGMENTED REALITY IN MEDICAL TRAINING

Around the world different applications like augmented reality applications (ARAs) are being used more and more in training of medical professionals. For educational use, AR creates new opportunities as it blends together digital and physical environments. Few examples of how AR is currently being used are improving navigation during procedures, improving the visualization in operating rooms and as therapeutic tools to treat patients. (Barsom et al. 2016) Zhu et al. (2014) lists that AR is being used in medical training to provide feedback to students, provide simulator practice and visual navigation tool to improve training. The research by Zhu et al. (2014) shows that the use of AR in medical training can improve learning by acquisition of skills and knowledge, providing timely feedback and improving the performing of different cognitive-psychomotor tasks. All together it can be said that the use of AR in training helps to shorten the learning curve of students (Zhu et al. 2014).

Generally medical training consists of practice-based learning, problem-based learning, team-based learning, eLearning and simulation-based learning. Virtual reality environments are actively being used for training purposes, but VR only offers a representation of a certain task in reality. As medical professionals require skills to adapt to changing situations, AR applications offer better training possibilities compared to for example, VR applications. (Barsom et al. 2016) In this chapter we will describe the current use of AR and the benefits as well as the challenges AR brings to medical training.

3.1 Current use

Nowadays, there are plenty of different AR-devices/applications on the market. Even though the AR feels very new technology, it has already been used for years. However, the applications were different than most of the people have used nowadays. For example, one of the first device utilizing Augmented Reality in a medical field was AccuVein which works by projecting real time picture of patient's veins onto his/her skin, so it is easier to find the veins and helps the user for instance to vaccinate. (AccuVein 2018) The use of AccuVein is represented in figure 2. It is not the typical modern AR-application where digital information is augmented to the environment around us via AR-glasses or phone, but it is still widely used.

Figure 2: AccuVein (AccuVein 2018)

More typical AR-application in medical field is for example PerSim which uses Microsoft HoloLens to simulate patient behavior (PerSim 2018). Image of the use of Persim is represented in figure 3. Comparing to traditional simulation training where mechanical mannequins are used, PerSim is possible to use basically anywhere, like ambulances, so it enables to train in the working environment. According to Pantelidis et al. (2017) AR is been used in various educational fields at the moment. These fields contain for example preclinical teaching, surgeries, endoscopic procedures and neurosurgery. According to Pantelidis, ImmersiveTouch is an AR simulator used in the field of neurosurgery for training for example spine surgery, ENT surgery and ophthalmology.

Figure 3: Persim (Persim 2018)

As said, Augmented Reality has already its place in the medical field and there are different applications available, but still the current applications in the medical training are not very popular and precise and AR has a lot of potential that we cannot even realize yet. In the chapter four we discuss some possible future applications.

According to our conducted interviews and email questionnaire, AR is not used basically at all at the Tampere University. One of the professors at the Tampere University mentioned that the school has a license for a software called *Visible Body*, that the students use to enhance their anatomy studies. *Visible Body* has recently been updated with an augmented reality feature that currently only works with Apple-products. It was mentioned that the feature is still so new that it hasn't been tested in education, but it will be used in the future. The interviewed students were vey exited to test the AR-feature as soon as possible. The interviewed professors mentioned that AR-technology has received a lot of attention in different conferences, but no suitable products to be used at Tampere University have been found. It was mentioned that AR-technology could be especially suitable in anatomy and surgical studies. Figure 4 shows the AR-function of *Visible Body*.

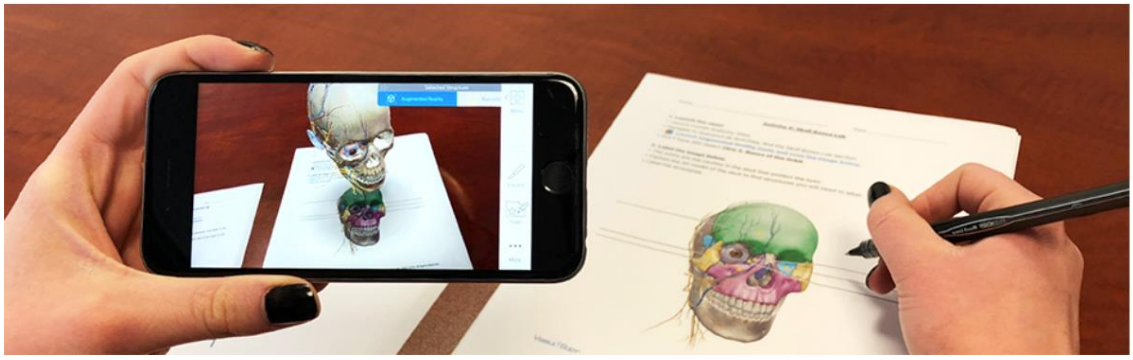

Figure 4: Visible Body (Visible Body 2019)

3.2 Benefits

One comment that arose from our conducted interviews was that even though the practice-based learning is very beneficial, it means that the education is not always standardized. Since the students take turns working in different sections of a hospital and with different doctors, the procedures the students participate in are always different. The interviewees mentioned that the possibility of having some kind of AR-models could help to standardize the education, and help students prepare for different situations in a safer environment. Zhu et al. (2014) mentions that AR helps to provide authentic learning experiences that are suitable to different learning styles, that create the possibility for personalized and explorative learning experiences. Also, AR supported education eliminates the chance of making vital mistakes on actual patients, and so offers a safe learning environment.

Another problem that came up during the interviews was the lack of corpses for anatomy education. A big part of the anatomy education is done by performing autopsies on actual human corpses. These corpses have been donated for medical use, so the availability of the corpses cannot be guaranteed. The interviewees mentioned that they don't think technological solutions could fully replace the use of actual human bodies, because of the psychological-side of the education. Still they mentioned that AR could provide a very

usable solution to enhance the anatomy education for example in cases when actual bodies are not available. Another situation where the interviewees mentioned they believed that AR could provide usable solutions, was for cases of the patient having different body structure like the amount of fat, that may cover organs. Being able to prepare for example to a situation where organs might be covered by layers of fat could help prevent mistakes in the actual procedures.

In a study by Radu (2014), Radu analyzed 26 publications about student learning in AR vs. non-AR applications. It is worth noting that Radu's study is from 2014, and the analyzed publications wary from the early 2000 to 2013, after which AR-technology has improved. Radu mentions that in most of the analyzed papers, the result was that AR-technology was more effective in teaching students compared to other media like books, videos or computer applications. Only some of the analyzed papers were focused on the use of AR in medical training, but still focused on areas that have possible benefits in the medical field as well. Radu found that AR enhances for example the learning of spatial configuration of human organs. According to Radu's research learning with the help of AR enhances the students' long-term memory retention. Since medical students must remember multiple diseases and connections between symptoms, this is a noticeable benefit of AR. Radu also mentions that the use of AR in education improves the performing of different physical tasks compared to traditional media. (Radu 2014)

According to Lee et al. (2018) AR can be used to visualize and localize critical anatomical structures, like blood vessels and nerves, of a patient before starting a medical procedure. For a naked and untrained eye detecting something like blood vessels can be hard. In a case of a tumor that is located in an organ, AR offers a chance to visualize a safe surgical margin of the location of the tumor. This type of data can be used to create a preoperative plan, and also as educational tool for students. (Lee et al 2018)

Bridget & Kuehn (2018) mention that medical students find the use AR-technology to be interesting since it's more interactive and life-like. From a study where medical students were interviewed, it was found that studying from a textbook or tablet felt like a "chore", whereas the use of technologies like AR made the studying more enjoyable. The students we interviewed also mentioned that the use of new technologies would make the six-year-long training period more interesting. Especially in learning anatomy, it is beneficial if the students can enter a virtual world and look inside the brain for example to better understand the structure. The controlled environment of AR applications therefore makes the learning more interesting and more visual, which in turn boosts learning. (Bridget & Kuehn 2018; Radu 2014)

Taylor et al. (2018) study the use of AR in training medical professionals for the army. Especially in the army, the medical professionals face a lot of fatal wounds and the procedures have to be done in difficult conditions. Still a big part of the training is done inside classrooms, and the role of the instructor is to describe the situation, and make

comments like “the patient is moaning in pain”, and see how the students reacts. The instructor also may need to use material like fake blood to simulate blood flow, which interrupts the training, and workflow. Taylor et al. point out that the current AR solutions may not be perfectly suited for the fast pace training required in the army, but still offer a lot of possibilities. For example, the use of AR would make the training situation more life-like and would eliminate the need to interrupt training to squirt fake blood. As the training would be more realistic the trainee would be better prepared in a real-life situation, where the environment is difficult. (Taylor et al. 2018)

In their work doctors sometimes have to give bad news to the patients and go through difficult conversations. These kinds of social situations are a big part of a doctor’s work and should not be neglected. Our interviewees also highlighted the social side of the work, and how it has lately gotten more and more attention. Learning the required socials skills is hard, and the best way to learn is through practice. Bridget & Kuehn (2018) mention that with the help of modern technology it is possible to create artificially intelligent virtual patients that can be used to train the social skills of the students. The virtual patients can act just like a real human with real emotions and personalities. This type of use of AR-technology enables the students to practice difficult conversations about topics like substance abuse, mental illness, or sexual assault. Bridget & Kuehn mention that the students need to learn their own script or a way to act in difficult situations. Learning this often means that you are going to make mistakes, so it better to make the mistakes with a virtual patient instead of a real one. The use of virtual patients has been proven to enhance the doctor’s skills and confidence in the situations. This leads to doctors being more active in taking part of difficult conversations and being able to help the patient in more ways. (Bridget & Kuehn 2018)

3.3 Challenges

Augmented reality does certainly bring many advantages to medical training, but as medical students they are training to become doctors who treat real patients. There is a challenge to ensure that students that are trained with the help of AR technology can adapt to the changing environment of a real operation or other medical procedures (Barsom et al. 2016). Barsom et al. (2016) tells that predictive validity of the ARA must be assessed. Situation where an augmented reality application used to train students has a fault in some of its training programs may misguide the student. Considering the use of AR-technologies in training for surgical operations there is a question of precision. Can the camera used to track hand movement in the augmented reality view be precise enough to be used in training for example in brain surgery?

Other challenges in implementing AR to medical training includes platform friction with current technologies used in the training. Schools have already invested in other media and technologies to improve and help the training of students, so the research must be done to identify the curriculum topics that would benefit from the use of AR-technology

(Radu 2014). Radu also describes how designers must understand how to create experiences that integrates into multiple points along the curriculum. The training of teachers to able to fully utilize the technology in their training and the costs of it is also a notable point that Radu makes in his publication.

To list challenges of implementing AR in medical training, number one challenge is monetary and funding issues. In Finland most of the funding for medical training comes from the government and for that reason limits the possibilities of implementing such technologies. AR being a new technology the amount of available AR systems is limited. Finding a suitable system for medical training is challenging and the costs of making one for such precise needs is costly. The costs include product development, research and marketing (Kolo et al. 2017).

There are clinical organizational issues as healthcare is not the fastest industry to adapt to new changes (Kolo et al. 2017). Healthcare training might not be that restricted by bureaucracy as healthcare industry itself, but there are regulations and committees that must decide whether or not to include such technologies in their training.

In addition to various technical related challenges, Augmented Reality will face social, or non-technical, challenges. Maybe one of the biggest social challenge is general skepticism towards AR technology. In case of AR utilization in medical training, clinicians, who participate in trainings, are often initially skeptical about for example interacting with computer or some digital character (Kuehn 2018). Especially in this case where AR imitates real persons, patients, it is understandable that participators may have difficulties to empathize into conversation with computer. This kind of challenges arise from people's own mind.

The issue of privacy is also a challenge for Augmented Reality. Since camera is one of the main components of an AR system, it gathers a great amount of information about everything a user points the lens at. AR applications often use also facial recognition technology, geo-location and augmented data. Kipper and Rampolla (2013) describe that issues mentioned above might lead in an unpleasant situation where real persons will in a way become part of the "Internet of Things". They explain that in that situation, for instance, it would be possible to look at people in the street, identify them and after that view private information about them. This is very good example about the importance of security in Augmented Reality systems.

4. FUTURE APPLICATIONS OF AR IN MEDICAL TRAINING

Healthcare and Medicine are industries where new technologies are used constantly and when the new technologies are used it means medical training also could adopt those technologies at some point. The Augmented Reality is one of these technologies that is already used in healthcare and medical training, but future applications could change drastically the way of training and education. New AR-applications are released all the time, but they have not still reached the full potential that AR could offer to the medical field. According to Gartner (2018) Augmented Reality will reach its plateau in five to ten years so it shows there will still be years before medical training will adopt AR-technology.

One big driver of AR in the medical field is a medical imaging and the Grand View Research (2017) mentions that medical imaging's market size will be worth over 55 billion by 2025. The medical imaging means visual representations from inside the body (Wikipedia 2019). Most of the currently used medical imaging technologies provide two-dimensional information. For example, tumor location and size. However, with the help of AR, it is possible to see tumor's 3D location and orientation, for instance. So, the use of AR can give a whole new perspective for the medical imaging. (Borad 2018)

Augmented Reality has a big role in medical imaging which means that the future potential of AR in medical industry is also huge. According Grand View Research (2016, 2017) the whole AR-industry will be worth over 100 billion by 2024 and Augmented and Virtual Reality in healthcare over 5 billion by 2025. Augmented Reality in education and training is expected to be the fastest growing prolific segment so it can be said that AR will have its own place in medical training now and in the future.

One potential technology utilizing AR-technology could be so called Holographic Augmented Reality that is basically augmented reality but a 3D hologram model which user can interact and manipulate. For example, a doctor could see a real time hologram of patient's heart and rotate and zoom it too see it in different perspectives. This kind of device, RealView Holoscope (2019) (figure 5), has been released lately. These kinds of holographic devices allow to do much more in comparison to traditional AR-devices but are, however, very pricey and therefore unlikely to be in a wide use soon, especially in training use.

Figure 5: RealView Holoscope (2019)

Also, if thinking AR (and VR) in "a big picture" rather than a single application, future use cases of AR could be medical schools that are mainly focusing on these technologies. One of this type of school is opening in the USA in 2020. Kaiser Permanente School of Medicine will have for example a Simulation Center where students have possibility to practice important skills with a real-world settings. (Eddy, 2018). Maybe this is the way where medical schools are going in the future. All in all, our group sees that AR has a very big potential in medicine. Augmented Reality maybe has not yet reached the same hype as VR, but we see that the future applications could be even larger than with the Virtual Reality, because it is important to see the patient in the real-world rather than in a model. All in all, both technologies will be big things in medical training in the future.

5. CONCLUSIONS

The aim of this paper is to introduce how AR technologies are utilized in medical training today and what could be the next future applications of AR in that field. In this paper first Augmented Reality is introduced on general level. After that Augmented Reality in medical training, and what are its benefits, challenges and current use, are discussed. In the last part a couple of future applications are presented. There is also discussion about what are the possibilities of AR in medical training in the future.

We have listed the benefits and challenges we considered most important in this paper in a table 1. Color red means that the benefit/challenge is more technical and blue means that the benefit/challenge is more on the social side. As seen from the table 1, there are many benefits and challenges considering AR in medical training and more are sure to come as technology develops and different applications come in to use. As we overcome the challenges, we now consider the most difficult ones to solve more are sure to rise, but as they do so do the amount of different benefits the technology offers.

Table 1: Benefits and Challenges of AR in Medical Training

Benefits	Challenges
Visualization of critical anatomical structures	Precision of the AR procedure
Life-like training situations	AR implementation with existing training technologies
Preparing to different situations	Finding suitable solutions
Standardized education	Privacy issues
Supports different learning styles	Adapting from AR to real world situations
Enhanced long-term memory retention of the students	Industry adaption
Safe learning environment	Skepticism
Makes studying more enjoyable	Funding
Improves the performing of different physical tasks compared to traditional media	

To conclude the situation of Augmented Reality in medical field right now it can be said that the maturity of technologies is not a barrier for AR's development anymore. More recent challenge is that it takes time to medical industry to assimilate the AR technologies. For example, employees on medical industry might see AR a bit strange even frightening technology as they haven't use it before. This challenge will partly solve itself over time when young people who may have used AR technologies their whole life start working in medical industry. Despite that the industry is a bit slow to assimilate the AR constantly arising and developing new AR applications will eventually make AR become more and more popular in that field.

Some of the existing educational AR applications seem a bit childish. They are often targeted to younger, maybe elementary school -aged, people. To make AR more acceptable in medical training the applications should be made more professional. Based on various sources presented in this paper the programmers and application developers are mainly creating AR applications for medical training. If medical professionals were participating more in new AR applications' planning and development, the new applications would be seen more useful and professional.

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VIRTUAL REALITY IMPROVING COMMUNICATION AND TEAMWORKING

TLO-35306 2018-01 Global Information Systems Management
Group assignment

Laura Malmivuori
Saija Jokela
Susanna Lehtonen
Nico Ylirönni

ABSTRACT

Virtual reality improving communication and teamworking
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Keywords: virtual reality, teamwork, training

The study aims to find out a phenomenon and present findings and solve the problem related to the phenomenon. The problem for this study is how organizations can use virtual reality in social training, teamwork and communication.

For this assignment the theory about virtual reality and virtual reality training has been gathered. In theory part, the benefits and challenges what occurs when organizations utilize virtual reality in social training and teamwork are presented. With this theory, we defined the problem more precisely, making it easier to solve it.

As solution the study presents four use cases. These use cases are related to the areas in which virtual reality can be utilized in social training and communication to make better results. The use cases are using virtual reality in police forces, architecture industry, maintenance and when person is training to perform in front of people. In the solution is also presented how to improve these use cases in the future.

1. INTRODUCTION

Many have heard of virtual reality as being a part of entertainment industry and of its use to simulate different experiences, such as travelling around the world or being on a roller coaster via virtual reality. Virtual reality has been used in gaming and simulations recently but one of the most influential utilization in the past has been flight simulators after World War II and through the 1990s, when the military realized that it was cheaper and safer to train pilots with the help of VR (Virtual Reality: History 1995). Since computers in the present have more power and different technologies are cheaper, VR has gained popularity and organizations search for ways to utilize it and they have found a way to use it for training purposes.

Virtual reality is commonly quite known technology. As told, VR can be used for a wide range of things, such as training and entertainment. What this study aims to solve is what happens when VR and social training are combined. We don't know what benefits or negative effects this has. The purpose of this study is to gain a better understanding of VR technology and gather together the various good and bad aspects of using VR in social training.

We aim to find ways of using virtual reality on training and especially on social communications and teamwork training. The context is the current state and new opportunities on training in social communications and teamwork by using virtual reality. By doing this research, we are trying to find applications to virtual reality in our context. We are collecting use cases and considering use of those in the future and in that way showing the possibilities of virtual reality in this context.

We aimed to explore and understand the virtual reality perspective of communication and teamworking. In this study we tried to find the latest solutions, why they are used, what are the benefits and challenges and also predict a little bit the future. What could be coming or what could be the next step using the virtual reality in our context? We interviewed some experts from Finland to get more insight what is happening at the moment in virtual reality training and tried to find the solutions also in literature and latest publications. The research aims at finding the solutions for training social skills and team working. When the remote working and social skills are more and more important, new ways of training are also important. Virtual reality is a possibility for many new solutions.

This study has four parts. First, the theory of the virtual reality and virtual reality training is presented in the study. Here is described the definition of virtual reality and virtual reality training and also the most benefits and challenges of virtual reality training are raised. Second, the problem is presented. In this part, the reasoning behind the research and the research method are presented. In the third part, the four use cases are presented.

The use cases are based on theory and interviews that were done during the research. The use cases have also some future aspects to anticipate the future applications. In the final part, the conclusions are presented with the references and appendix.

2. VIRTUAL REALITY AND TRAINING

Virtual reality (VR) uses computer hardware and software to generate an immersive environment that humans can experience and also interact with it. Virtual reality software generates the images for the user and also executes users' commands. The displays range from head-mounted displays to walk-in rooms with projected walls, floor and ceiling. In the VR environment user can execute commands by pointing and selecting objects using gesture controls or data gloves. (Clamann 2017) VR has been defined as providing "a more intimate interface between humans and computer imagery" (Woolley, 1992).

VR includes four elements, which are virtual world, immersion, sensory feedback and interactivity (Sherman & Craig 2002). Immersion means that the user is immersed in the virtual world and is protected from real world distractions. Interaction includes not only visual and auditory channels but also smell, taste and haptic. (Burdea & Coiffet 1994) According to Clamann (2017) to provide an immersive experience, VR must communicate to other senses in addition to visual experience, such as hearing and touch. Audio through headphones or carefully placed surround-sound speakers provide a sense of VR environment that feels like physical environment. Control is also important part of interaction and the data gloves are used for gesture-based controls and for example wands can be used for pointing and selecting objects. There are also more advanced controls that communicate a sense of touch in the form of shape, weight and texture. Interfaces that include physical sensing and manipulation are haptic interfaces. (Clamann 2017)

VR is used for variety of applications, such as entertainment, education, design and simulation in training environment. (Clamann 2017) Training of employees has always been a difficult subject. How learners can be prepared to make good decisions in dangerous or difficult situation? It is not effective to provide learning materials like books and classes when the real situation is completely different. Neither is the live situations a good option because of the high costs and low safety. Virtual reality training solves the problem of these hard situations. It is a method of training that can provide effective training in safe and cost-effective environment. (DeMarinis et al. 2018; Oesch 2017) Virtual reality training has been used by companies, schools and military and the initial idea is to put the trainee in a 3D environment which is relevant to the subject. (Baptiste 2018) It gives ability to present realistic situation many times and build the expertise on real-like conditions. For many people the experiences help to create better reasoning than found in a book. VR is also ability for the learners to learn in new ways. (DeMarinis et al. 2018)

2.1. Benefits and challenges of virtual reality training

Volkswagen Group has been one of the first major multinational companies to announce that they will train 10 000 employees in virtual reality in 2018. Workers at the German automaker are wearing VR headset to learn for example logistics, transport and vehicle production. (Holger 2018) With VR training the company can enable more effective training, lower costs and less time compared to traditional learning methods, but it has also some challenges and cons which are now presented in the following chapter.

With VR training can be achieved better learning. VR improves the time taken to learn, decreases the number of errors and increases the amount learned. (Fletcher et al. 2017) In virtual reality training workers can repeat the task again and again which improves the learning outcomes. (DeMarinis et al. 2018) When learners can practice their skills as many times as needed, the knowledge starts to become part of their muscle memory (Baptiste 2018). According to Petrock (2018, cited in DeMarinis et al. 2018) virtual reality is also faster way to learn.

VR makes learning more visual. When subjects feel presence, learners feel like something is actually happening in real life. According to Schöne et al. (2017, cited in Dinsmore 2018) learning is more efficient with VR environment. In this study learners were tested by memory test and the results showed that virtual reality group performed better than the video group. VR training allows also the tracking of the trainee's actions and inputs which means individual feedback and possibility to determine the causes for an error. Learners are able to realize where they went wrong and fix it. (Fardinpour et al. 2018, cited in DeMarinis et al. 2018)

VR training can save money. For example, in aviation industry virtual reality is huge advantage because the flying hours are very expensive and in the virtual reality environment the same skills can be learned than in a physical environment. (DeMarinis 2018) Though virtual reality is an excellent opportunity to save the money, there should be a discussion if VR is really needed in training. If the tasks are complex and involve doing synthesis with knowledge, VR is a good bet. Otherwise there might be cheaper ways for training. (DeMarinis 2018) Of course it is possible that some situations are difficult to simulate at least with currently available technology (Seymour & Røtnes 2006, cited in Waleed 2012)

VR training is also safer environment to learn. If the learner is overwhelmed, he can just leave the virtual reality. Virtual reality environment can't hurt the learners. (Dinsmore 2018)

Virtual reality technology brings also problems. Virtual reality sickness means symptoms like nausea, headache, disorientation and vomiting. (LaViola 2000) Sensory information is not always precisely same timing or manner as it would be in the physical world which

causes symptoms that are similar to motion sickness experienced in for example vehicles. (Clamann 2017)

It is also important to remember that VR is tool and there should be a careful planning in program design and learning goals like in any other training too. It is also important to understand the knowledge that learners need to acquire and what they do with the knowledge. (DeMarinis et al. 2018) Also businesses should consider whether the training will be easily replicated in a virtual environment. Hand gestures and motion control can be an issue of complex actions. (Fade 2019)

Virtual reality is also a possibility for a whole new learning like shared scenarios which means a situation where members can practice individual actions and communication within a team. Another possibility could be testing in virtual reality environment. This does not only allow the testing of ideas but also sharing these ideas to others. Third possibility is a “seeing the unseen” which for example model of molecules in virtual reality environment. (DeMarinis et al. 2018)

3. PROBLEM INTRODUCTION

In this research, we will focus on how virtual reality could be used while companies are training their employees to communicate better with each other and work as a team. We are searching for the possibilities to use virtual reality with multiple users at the same time to make social communication and teamwork better and also possibilities to train individuals alone to gain better skills in social interaction or teamwork. We aim to find examples of current situation, then we search and create new, possible ways of using virtual reality in social communications.

3.1. Reasoning behind the research focus

Often, virtual reality is considered to be used alone but it is not the only way of using it. Virtual reality is suitable to be applied both individually or to groups allowing participants to interact with other users (Velev & Zlateva 2017). Using virtual reality with multiple users can help to solve many problems and make many situations much easier.

Training social communication and teamwork skills are very important in today´s businesses. Social skills are key to success in business but still many companies are focusing their effort to train better technical skills to their employees rather than improving social skills. Combination of these skills are what makes a good business person. (Ronin 2016) This lack of training might be because companies do not know how they could improve their employee´s social skills and are trusting those skills to improve by themselves while working in teams. We believe, virtual reality might bring a solution to this lack of training methods.

Another point to be considered while talking social communications, is that people are more often working remotely, and team-members might be in different places. This means that communication is a little different and new ways might be needed. One of the difficulties of remote work and communication with co-workers while working remotely is that you are not able to understand non-verbal communication as good as in face to face communication.

3.2. Research method

The methods to gather information in this study are literature review and interviews. The literature review was done by looking mostly the latest literature available about VR, but for example in theory part, where the Virtual reality as a term has been covered has also older references. The search engines were for example Andor, Google Scholar and also the latest magazines like Forbes.

The possible interviewees were found by finding suitable companies that work with Virtual reality in Finland. The companies were found from the websites of Finnish VR association (FIVR) that lists most of the Finnish VR companies or by the recommendation of the course personnel. The suitable companies worked with either VR training or VR communication tools. All in all, four companies were contacted first by email with some information about the interviewer, course and survey. Three companies were ready to answer the questions about VR training and communication and they were contacted over phone. The interviewees were the Head of Partnerships at Finnish virtual collaboration company (interview 1), Co-founder and CTO at Finnish company which develops remote collaboration solutions (interview 2) and Responsible Manager of remote maintenance project (interview 3). They were happy to talk about VR. All the interviews were held for one week and the questions were not sent for the interviewees in advance, so they were able to answer the first things that came to mind. One interview took about 30 minutes.

Five questions were asked from almost every company and some questions were tailored just for the specific company or person. The common questions were:

1. Tell a little bit about you and your company. How do you use Virtual reality? Do you use it to develop social skills or teamwork?
2. How VR could be used in developing teamwork skills and social skills?
3. What could be the advantages and challenges of using VR in this context?
4. What are the most important issues take into account when VR training is used?
5. What do you think is the future of VR?

If there was a need to control the interview somehow or some specific questions needed to be asked, some other questions might also be asked during interview. These questions can be found in the attachments as well as the notes from the interviews.

The interviews helped to understand the benefits and challenges of Virtual reality and a lot of new ideas and examples. They also innovated us to find out our final solution.

3.3 Final outcome

The outcome of our study is use cases that tell the use of virtual reality in communication and teamwork. We created these cases based on interviews and the literature and took the ideas even further to meet the future. This means that when for example the tools and the virtual reality are more developed, it is possible to create better solutions for teamwork and practicing of social skills in virtual world. Also, one important thing to consider are the experiences of virtual reality. According to first interview (2019) some people might have bad experiences of VR and based on these experiences they might not want to use it in business environment. Second interview (2019) introduced the challenge with the content delivery because it needs to be easy and scalable. When these obstacles are overcome, there are better possibilities for virtual reality to succeed. In the following chapter the

current stage of virtual reality is presented and according to our research the use cases are created.

4. VIRTUAL REALITY SOLUTIONS FOR COMMUNICATION AND TEAMWORK

In this part the four use cases based on the interviews and literature research are presented. The idea behind the use case, possible opportunities and challenges and also future implications are explained.

4.1. Performing in front of audience

One of our use cases is about stage fewer and opportunities to face this fear. For example, companies are able to train their employees to do better performances and to face their fears. In virtual reality world anything can be set up. This means that also situations that are very unreal can be created and used in training. According to first interview (2019), if person is afraid of some specific person or specific type of person, virtual reality world can be made in a way that there is a whole audience full of this feared thing. This way person can try over and over again to go in front of this fear and face it and eventually give a perfect speech into their virtual audience. Virtual environment is also safe place to rehearse performing because you can stop the training whenever you want and see afterwards how the person performed the task.

Virtual reality is being used as a therapy in many fears and phobias. Very often it is not possible to create scenarios where these fears and phobias are arising so virtual reality helps to create quite realistic scenario to face those in safe environment. (VRT news 2019) One fear virtual reality tools can help for is public speaking. One of the benefits of using virtual reality tool is that there you can control the hierarchy of the event. You can choose the audience to be for example very formal or neutral and choose how they are acting. (Gallo 2017) This kind of set up with just right audience and behavior could be very hard and troublesome to arrange in a real life.

Performing in front of audience could also be arranged in social virtual reality where your audience is avatars. Then people all around the world could also be involved to the situation and the training could be even more effective. Using social virtual reality would put the training into the new level as real people behind the avatars is more realistic and scarier situation to those who suffer stage fever.

Another application to this kind of training in the future could be using similar situation in teamwork. Whole team would be in the virtual reality and they would communicate and work there, for example team meetings can be held that way. Also, negotiations could be arranged in virtual reality and if someone is scared of going negotiations, it can be trained in virtual reality world.

4.2. Use in Architecture team project

According to second interview (2019), benefits of VR comes from spatial observation and concreteness. All use cases should be related to spatial observation, because then VR is the most useful. Architects are used to looking at building plans and interpreting what the buildings or landscapes look like. This does not necessary apply to the customers or other project members, which is why VR provides tools and powerful support for architects to explain ideas and concepts to project stakeholders. (Vandezande, 2019)

It may be difficult for architects to present their work to clients or to the team with whom they work, because it is difficult to present observation about the buildings in the paper. This is where VR can help. For example, if an architect presents something to the customer, it can try to explain it on paper, but with VR architect can get to different levels when they can "jump inside the idea" and be within the 3D model. In 3D model architect can for example show that when the sun is shining at a specific time of the day, it looks like this in the lobby. (Interview 2, 2019) This is something architects can't do with the paper.

For example, Canadian company called Real Estate in Virtual Reality (REinVR) uses VR to create realistic visualization and animation about their real estate projects. After creating a VR project, they can do whatever they want to do with it. For example, change the colours to show different options for the project and also get instant feedback from the customers and other team members. With VR architects can customize their projects to fit for the specific customers. (Submissions 2018)

Using VR in architecture has created new ways to understand designs. These new ways can be used, for example, to educate students, as it is easier to show designs with VR and in virtual environments students can try out their ideas and get instant feedback of them. Utilizing VR in architecture also makes it easier for professionals in different fields to work together in a project, because it is easier to show ideas and outcomes in virtual environment.

4.3. Team training in Police forces

One of the services where team training is important part of training program are the police forces. In police forces, teams need to be prepared to work in a variety of situations and continuous training is essential to the success and safety of the team. However, practicing dangerous real-life situations is expensive and complex and there are very few real-life scenarios that can be practices by traditional means. This is where VR can help. Teams can practice these dangerous scenarios in virtual training environments, where it is easy to practice complex collaborative tasks that are not possible to train in real situations. Sometimes real scenarios are so dangerous, expensive and takes a lot of effort that virtual training is the only choice. (Bertram et al 2014)

In the study conducted by Bertram et al (2014) there were three teams from the police, who trained for the same task, integration of police ground forces and helicopter crew. The three groups were virtual training team, standard training team and control group. The task the groups where training to was really complex, required multiple sources of information, coordination among team members, intensive communication and task relevant knowledge. Training in virtual environments fits for these kinds of situations, because with VR it is easy to replay functions and swap the perspectives within the team. In the results it presented that virtual training team performed their task with the best results, they had the best satisfaction with the training, the best subjective learning success and the virtual training team was used to the noise from the helicopter, so it didn't disturb them during the operation. In addition, members of virtual training team had stronger feelings of assurance during the task they were performing. Thus, in the study, evidence was found that virtual training in teams has advantages: they are better in complex scenarios, they feel safer during the operation and they are more satisfied with their work than other groups. (Bertram et al 2014)

Challenges for using VR in police officers training is scalability, such as how it can be translated into different languages or utilize the same environment in different contexts. (Interview 2, 2019) While there are a lot of good advantages using VR in police training, there is still the question of how efficient virtual training really is and whether the knowledge gathered in virtual training can be transferred to real-life situations. (Bertram 2014) Nevertheless, utilizing VR in police officers training provides significant benefits especially in the case of special situations that are dangerous and difficult, expensive and complex to practice in real life.

According to second interview (2019) VR can be used in the training of police officers in situations where the social situations that the police encounter in their work are simulated. In the future artificial intelligence could be added to the VR, so that it could react in the different ways depending of the way how the VR user reacts. (Interview 2, 2019) In their work police officers encounter situations that can't be predicted, and when using VR and AI in their training, they can practice these situations. In the future, VR can be used, for example, by firefighters. The work of firefighters involves essentially different environmental changes such as wind and temperature. VR technology is developed all the time, and, in the future, it could be possible to add these special environmental changes to VR environment and it could help firefighters practice dangerous situations.

4.4. Use in maintenance

VR can be used for maintenance purposes to guide repairer through the process or to teach the repair process to the repairer. Through VR it is possible to teach different processes and virtual reality environment is proven to be effective for teaching (Merchant et al 2014). Teaching via VR in this use case is useful if the machine, that is in need of repairing, is uncommon or it is in location that is difficult to access. Learning environment

could be accessed easily, learning event would be safer and it could be recorded for further teaching purposes.

Sovelto has experimented with possibilities in VR-usage for maintenance. They made a VR/AR remote support system for installation and maintenance of different processes and tried it under test conditions, reporting it as a success (Sovelto 2018). According to questionnaire sent to Sovelto, they had some tests that included indoors navigations and some simple installation processes using common equipment available for markets, such as Oculus Rift, HTC Vive, HoloLens and Meta 2 (Interview 3, 2019; Linturi & Linturi 2018). Participants for testing were representatives from different technology firms. Sovelto did not give a straight answer when asked if tests were more difficult compared to real-life experiences, but participants felt that tests were useful and test cases were not too different from reality (Interview 3, 2019).

According to Linturi and Linturi (2018) a useful case for VR and AR is remote support for maintenance operations. In their case, experienced repairer would wear a VR-set and on-site repairer would wear AR-glasses, which would have a camera. Experienced repairer would get virtual image of the repair site via AR-glasses, and he could see and give counsel to the on-site repairer. AR-glasses would display hands of experienced repairer, and AR-glass wearing repairer could mimic moves shown to him via AR-glasses. This kind of system contributes to operations with fewer mistakes and shorter operation times by allowing to send less experienced repairers to do maintenance operations if experienced repairers are out of reach of repair site.

Maintenance operations can be recorded and be analyzed afterwards. These materials offer valuable information for learning events and people watching these materials can learn from the operation. These materials can also be used for teaching maintenance operations under controlled conditions and learning these operations would be safer and possibly more efficiency. VR also offers a unique situation where teacher could teach operations from other side of world, as the teaching event relies only on internet connection.

Even though this repair operations could be guided via VR/AR -system, this system needs stable internet connection for uploading and downloading live feed. One solution for this is recorded operations, which could be played in time of need. Other solutions are to move to a location in which the internet connection could be enough to see the feed or rely solely on voice guidance, which works better than live feed in areas that have low internet connection.

5. CONCLUSIONS

In the following table (*Table 1*) the benefits and challenges as well as also future implications of the four use cases are presented. Table 1 shows very clearly that there are more benefits than challenges in virtual reality in training. According to this, can be said that virtual reality is very useful solution for social skills and teamwork training. It can be used in many different situations and contexts. With virtual reality many situations that are hard or even impossible to create in physical world, can be created and used in training in virtual reality. Virtual reality offers a safe and easy possibility to train the real situation beforehand and in very visual environment. The situations can also be recorded and analyzed later which makes the training more effective. Virtual reality can also be combined with other technologies, for example with artificial intelligence. This provides more possibilities for virtual training. With AI for example situations including interaction can be created.

Use case	***Benefits***	***Challenges***	***Future implications***
Performing in front of audience	• All kinds of situations can be set up (also unreal situations) • Safe place to rehearse • Hierarchy of the situation can be set up • Trainee can face their fears • Training situation is very visual	Feeling of real situation	Social virtual reality where the audience could be avatars (others could be part of the training/performing in virtual reality)
Use in architecture team project	• Explain ideas and solutions concretely • Make modifications is easier • Teamwork and understanding other team members are easier	User has to know how to use VR effectively	Can be used in education

Team training in Police forces	• Cheaper and safer to train dangerous situations • All kinds of situations can be created • Teamwork can be practiced (many people at the same time in VR) • Effort is minimized to create the situation • Can be recorded • Situations can be trained again and again	• User has to know how to use VR effectively • Scalability (for example language) • Is knowledge transferred into real-life situations • Efficiency	AI could be used to make more authentic situations Haptic senses (such as heat) could be added into virtual reality
Use in maintenance	• Can be recorded and analysed afterwards • Easy access and safe • Situation is very visual	Needs stable internet connection Equipment needs to endure challenging environments and they cannot hinder working	Different conditions (such as gravity) can be created and these situations trained AI could be combined with VR

Table 1: Benefits, challenges and future implications of the four use cases

The use of virtual reality in training is still quite in the beginning. This is result of the technology, the goggles, which are not easy to use or cheap but also for other reasons. Interviewees thought that there might also be some resistance towards virtual reality, because it is seen mostly as a gaming industry technology and not in working environment. Our interviewees thought that virtual reality has a future and it will rise also in working environment and training. There is need for new training solutions and virtual reality could be one of those. The advantage of virtual reality training is that it is very easy way for humans to understand the world because it is so similar as the physical world. There might not even be understanding yet, where virtual reality actually could be used in the future. (Interview 1, 2019)

When virtual reality is taken into use, it is important to think why it would be the best choice and then create a plan for training. Virtual reality has still reputation to be a “cool thing” and it is not a right reason to use it in training. The investments to virtual reality can be very high so it is important to think if there are reasons to use VR in this context.

As said before, VR is not yet in common use in organizations and few use it for training purposes. This could be explained partly by the price of VR. High-quality VR set will cost around 700€ which is not impossible price for organizations but creating a virtual environment for organization's needs will not be cheap, and this might frighten some companies. It will be costly investment to move some of organization's training to virtual environment. Also, the time needed to adjust to this change of environment might be challenging but with proper training people can adjust rather quickly to new technologies. But in the long run the benefits might outpace the costs.

The importance and relevance of this subject comes from bringing these two things, virtual reality and social communications and teamwork training, together and into more common use and knowledge. Virtual reality is developing constantly, and it is a relevant part of the future technologies. This is why it is important to consider it more relevant in this training field too. In this research we have developed further the current state and use cases of virtual reality use in our subject and tried to predict the future state of virtual reality in training purposes. This research creates new possible ways of using virtual reality in the future.

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ARTIFICIAL INTELLIGENCE AND AUGMENTED REALITY IN SMART FACTORIES

TLO-35306 2018-01 Global Information Systems Management

Group assignment

Martin Buettner
Matthew Heath
Jakub Prochazka

ABSTRACT

Artificial intelligence and Augmented Reality in Smart Factories
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Keywords: smart factory, augmented reality, artificial intelligence, internet of things, AI, AR, IoT, Industry 4.0

This assignment is aimed around exploring smart factories and the emerging technologies involved in them. We focused on developing new ideas and use cases for smart factories by looking at two of the main emerging technologies, AI and AR but also explored other supporting technologies such as IoT. There are some addressed benefits and drawbacks, along with limitations of the technology. There is prerequisites for the technology to be implemented into smart factories. The results of our work show the amazing benefits of smart factories.

1. INTRODUCTION

It was 2013 when German government published its national platform “Industrie 4.0” and enhanced R&D in the area of smart manufacturing and smart technologies. The idea of the Smart factory was presented, and it involves an almost uncountable amount of emerging technologies. We find it highly interesting to look deeper into this paradigm and find out what it brings in the future.

From all possible emerging technologies, we chose to focus on the use of artificial intelligence, augmented reality, internet of things and a combination of them in manufacturing. There are many potential use-cases of these technologies separately, but merging them is still in its infancy and subject-matter of future R&D. In this assignment, we are trying to find a potential use and advantages of the combination of AI, AR and IoT in the factory of the future which could maximize efficiency and profits of companies. In addition, there will be also mentioned limitations of this approach. This research is based on reading through a large amount of research articles about smart manufacturing, smart technologies, real use-cases and finding our ideas thanks to them. Our lenses are looking into the future, so the most important part is coming up with our own idea of the potential use of the abovementioned combination of technologies and find out major impacts on enterprises.

In the first part we describe briefly smart factories and chosen technologies - AI, AR and IoT. The following part is focused on a developing an idea of the potential use-case by combining them. There are mentioned also limitations and impacts on enterprises and individuals.

2. SMART FACTORY AND ITS EMERGING TECHNOLOGIES

Industry 4.0

Each of the previous industrial revolutions radically transformed the way of manufacturing and later, also changed the way of living for the majority of the population in developed countries. This will be no different for the fourth industrial revolution in the future. It has been new inventions giving the impulses to shift from craftwork to factory mass production since the end of the 18th century. It began with steam powered machines and went through a mass production supported by electricity and later supported by information and communications technology to the stage that we know nowadays (Lukač, 2015). The so-called fourth industrial revolution is marked by many emerging technologies as are AI (artificial intelligence), IoT (Internet of Things), IoS (Internet of Services), VR&AR (virtual and augmented reality), cloud computing, 3D printing (Chen, 2017) and mainly by the creation of CPSs (Cyber-Physical Systems).

These technologies have been developing independently but the trend is to combine them with each other while their integration can promote a strategic innovation of existing products. In manufacturing it means the creation of the smart factory which is considered to be the significant outcome of Industry 4.0 (Wiktorsson et al., 2018). Nine technologies transforming industrial production according to BCG are autonomous robots, simulation, system integration, Internet of Things, cybersecurity, cloud computing, additive manufacturing, augmented reality and Big data analysis (Melanson, 2018). It is interesting how were some of these technologies placed in the Gartner hype cycle for emerging technologies in 2018 visible in the Figure 1. A digital twin, which is one of the key technologies for the creation of CPS was last summer near to the peak of inflated expectations as well as IoT, deep learning, smart workspace and autonomous mobile robots. On the other side augmented reality is already in after-hype space even though its useful implementation should take more than 5 years.

As Industry 4.0 and smart factories are still in its infancy, definitions differ a lot and it is similar with majority of the terms linked to this topic due to the same reason. It is common that “Industry 4.0” and “smart factory” are often used as synonyms, but the SF is in fact the main expected outcome of I4.0 which is shown in the definition by Zhong et al. The

principles of Industry 4.0 also involve related topics of the smart city, smart transportation, logistics or the smart grid (KUKA, 2016).

"Industry 4.0, a German strategic initiative, is aimed at creating intelligent factories where manufacturing technologies are upgraded and transformed by cyber-physical systems (CPSs), the Internet of Things (IoT), and cloud computing." (Zhong et al., 2017)

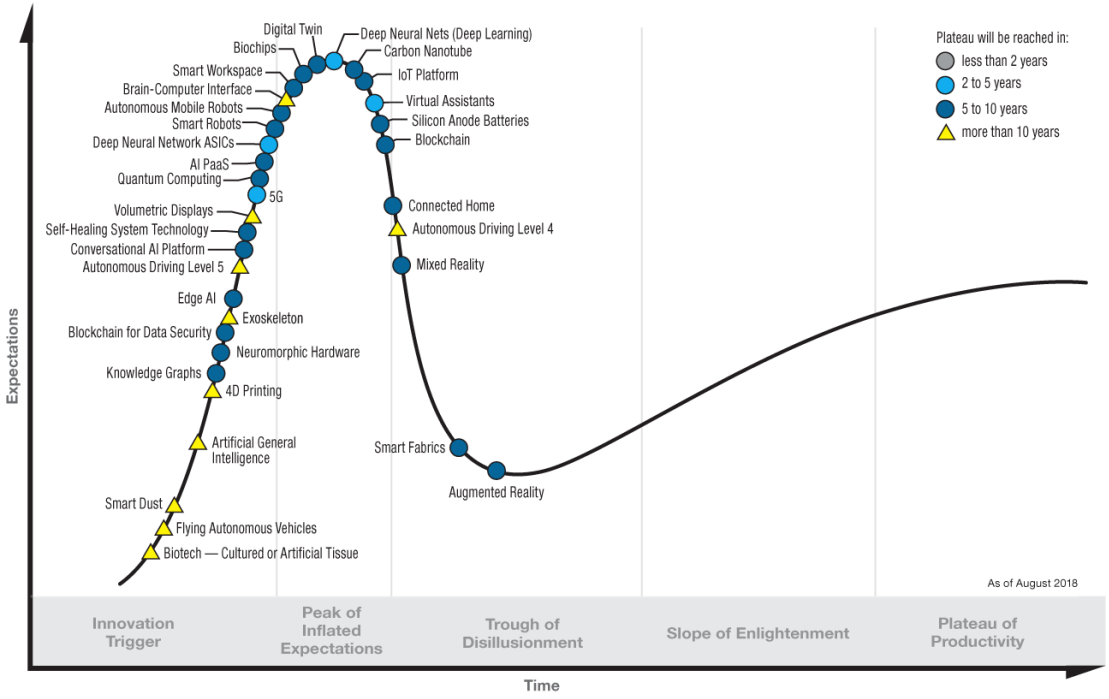

Figure 1 Gartner Hype Cycle for Emerging Technologies 2018 (Gartner, 2018)

Smart factory

Before moving deeper into the topics of AI and AR, it's essential to describe shortly the vision of the smart factory and the prerequisites which allow their implementation. It wouldn't be any surprise to find the words like "connectivity" or "integration" in almost every published article or research study about the factory of the future. The reason for it is that horizontal and vertical integration are one of the key prerequisites to run the whole enterprises. The integration will be performed primarily by the Internet of Things and Services in the meaning of creating a huge CPS covering all suppliers, manufacturers and customers which will lead to use of the new business models (Kagermann et al., 2013) which shows also definition by Gotz and Jankowska.

*"Industry 4.0 heralds the profound transformation of business models by enabling the fusion of virtual and real worlds and the application of digitization, automatization and robotics in manufacturing." (*Gotz, Jankowska, 2017)

The manufacturing in the smart factories should be very flexible, service oriented with large possibilities of the customization of the products. One of the key goals for the manufacturers in the future will be the possibility of maximizing customization of their products, its fast production and delivery to the customer. There will be also emphasis on the product itself (KUKA, 2016). In the factory of the future each product knows its origin, status and the way across the whole value chain to reach the required properties. It communicates with the manufacturing systems and the other machines or parts to get the highest efficiency of its own production. The manufacturing is transformed from the automated work cells which are working separately to the fully integrated and self-optimized manufacturing environments. A fundamental feature in these smart factories is cyber-physical system which may be able to autonomously communicate with other CPSs, trigger the actions based on the actual conditions and mutual independent control. These systems will be able to expect failures, self-configure and react on the changing conditions and demands (Mařík et al.).

There are many companies coming up with their own visions of the future manufacturing and claiming them to be *"the smart factory"*. Namely it is Siemens, Kuka, Volkswagen, Bosch, Arburg, etc., who are setting the pace. It is hard to judge which solutions are meeting some stage of the maturity level and demands to be the smart factory when the definition of this level is not sharp. There is also question how far in the vision of an autonomous manufacturing they are looking. Some of them are trying to present quite far future when humans will be mostly just watching after autonomously working machines and some of them are trying to focus on a communication between machines and humans to make the cooperation more efficient.

2.1.1 Cyber-Physical Systems

Cyber-physical systems (CPS) are the most important technology in the future smart factories.

*"The Smart Factory can be defined as a factory where CPS communicate over the IoT and assist people and machines in the execution of their tasks." (*Hermann, Pentek, Otto, 2015)

It is a combination of mechanical, electrical and software components which are able to flexibly react on dynamic changes and to get feedback for controlling the devices and data exchanges with IT systems and other CPS. They are capable of autonomous behavior and in the future they will play the key role in the optimization of the whole value chain. It is needed to ensure that each component of the autonomous unit is clearly defined,

integrated and able to communicate with the others. In other words they should be connected to the IoT. These components could be robots, machines, equipment, material or product itself. Because of this communication and partial intelligence of each component it is possible to make decentralized decisions. CPS have different levels of a maturity which is showing the figure 2 and to reach two last levels it will take some time and effort (Mařík et al., 2016), (KUKA, 2016).

Today there are digital twins (cyber twins) of machines and its equipment being created, but it is really hard to define all of the complex behavior of the machines. How to build such as CPS is described also in 5C architecture in the figure 2.

First stage is to get the reliable data from the machines and its equipment by implementing sensors or also IT systems as are ERP or MES. The second level is to transform the raw data to the information. From this information it is possible to predict the future behavior of the machines or systems. The third level is defined by creating the digital twin of a real machine or equipment and there is creation of a network of such a twins which can be used for the communication between them and also mutual self-analysis. Based on the behavior of one machine there could be prediction made about the behavior of the similar machines in this network. Forth level is the level where we are aiming with our project. Unless the human worker can understand what is wrong with the machine or what information it is trying to show him, he can't work alongside to those machines. The last level is the ultimate level of the autonomous smart factory where machines themselves can self-configure, self-adjust and self-optimize based on the changes.

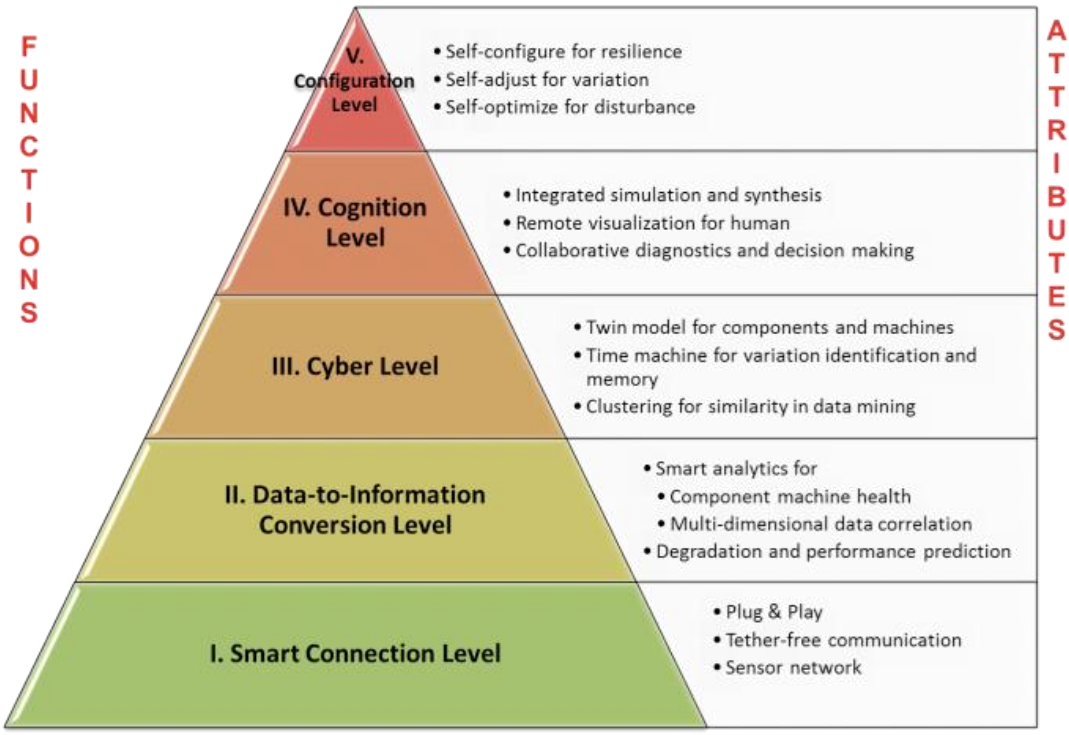

Figure 2 5C architecture of CPS

2.1.2 Prerequisites for use of AI and AR in Smart Factory

Not many of companies are digitally ready to be transformed to the smart factory and there are 5 different levels of their digital maturity defined according to Mařík et al. Fifth level is the smart factory defined by Kagermann et al in German national platform from 2013. For the companies which are not using ICT at all todays will be the way towards the SF very long and full of limitations.

- A company of the first level is starting to think about digitalization of the processes, manufacturing, maintenance or designing the product, but has no digitalization strategy defined. Passive internet presence (webpage).
- A company of the second level is using management software and understands the value of data. It is running first integration projects, partial automation and starting to think about a digitalization strategy. This company is joined to the information flows of supplier-customer chains (interactive digital catalogues, semi-automatic orders, etc.)
- A company of the third level has the defined digitalization strategy and is integrating a data architecture - integrated automation controlled in real time (MES), customized products by virtual tools.
- A company of the fourth level has distributed and customized digitalization strategy. Data architecture is integrated in the whole production chain and there is a possibility of communication and data sharing with suppliers and customers in real time.
- A company of the fifth level is connecting off-line and on-line worlds into the one integrated system - CPS. It allows customers to define their products by using a variety of virtual tools or assistants which are later communicating with a company during the whole lifecycle of a product. Automation is fully integrated and a company is using the newest approaches and technologies. A company provides digital services to its partners and suppliers for better cooperation.

Horizontal integration

Horizontal integration is a digital integration of the various IT systems which are used in the different stages of the manufacturing and business planning processes (Kagermann, 2013). Its task is to connect all the processes between suppliers, logistics, manufacturing, distribution up to the customer-service to make their cooperation possible. Because of this binding of the value chain, it is possible to increase an efficiency in the enterprise due to an access to the information and good overview of machines, products, stocks, etc. in real times. Based on this AI has an access to the information which could be used in the

decision-making tasks heading to the autonomous manufacturing. AI will be planning and managing the manufacturing of the customized products and for example if it finds out the lack of parts needed in the warehouse, it can order new ones by itself from the supplier whose products will be also connected to the IoT. Horizontal integration should be firstly focused only to IT systems within the company and later it should be extended to integration with the other business partners.

Vertical integration

This kind of digital integration is concerning about all the various IT systems of different hierarchical levels. These hierarchy could be explained as the actuator and sensor in the bottom level, through control, production management and manufacturing to the top level of ERP. This step will allow the decentralized decision making when even machines in the shop floor can make decisions and behave autonomously based on different situations. To make this vertical integration more clear, see the figure 3.

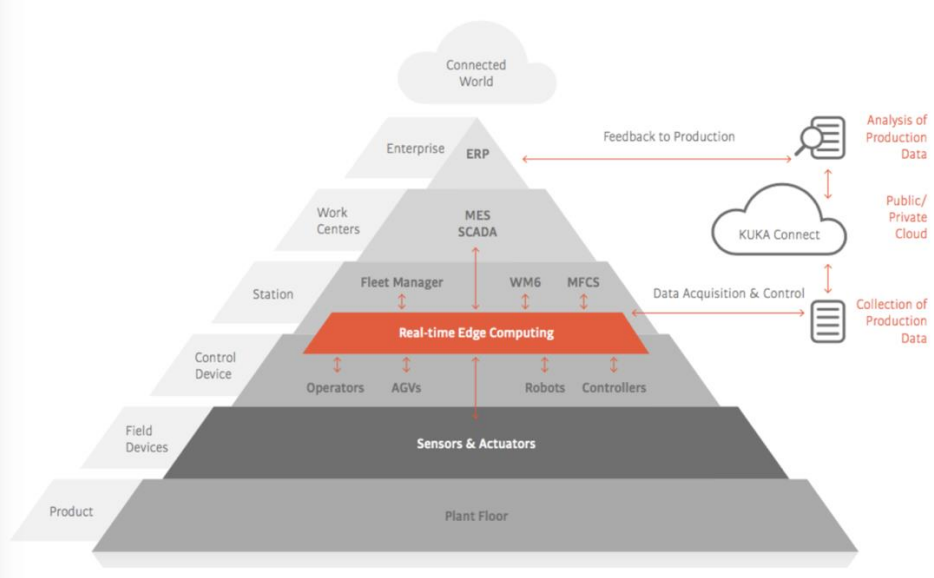

Figure 3 Vertical integration of enterprise hierarchy (KUKA, 2016)

Data Analysis and Visualization

This massive integration is linked to an enormous growth of produced data and the need of its analysis in real time which is also necessary for an autonomous behavior. Usability of the majority of gathered data is still low, but disciplines like Big Data analysis and cloud computing are on rise todays. These technologies are also needed for full-potential use of AI, providing later the information to the human being through AR.

Big data are produced by the enormous amount of the sensors, smart devices, social networks, financial transactions and many other sources. This amount is growing up continuously and the data experts are speaking about 40 zettabytes of existing with an exponential growth in the future (Price, 2015). For better understanding it is 40 billions of 1

TB hard drives. When there is such an amount of data, it's very complicated to analyze them and find the useful information which could be helpful and presented to the human workers by visualization – on pc screens, tablets or later in VR. This fast data analysis with appropriate visualization to human will be one of the critical tasks in M2H communication.

Artificial intelligence

"$4.8B, value of the market for AI in manufacturing by 2023"(MarketsandMarkets, 2017)

Artificial intelligence is the theory and development of computer systems able to perform tasks normally requiring human intelligence, such as visual perception, speech recognition, decision making and translation between languages.

"AI in manufacturing promises massive leaps forward in productivity, environmental friendliness and quality of life, but research shows that while 58 percent of manufacturers are actively interested, only 12 percent are implementing it." (2018 / Mikael Puittinen)

Artificial intelligence plays a big part in smart factories, it acts as a base for most of the collaborative Technologies and is the main driving force behind what makes the factory "smart". When looking at figure 1 you will see the different elements that make up industry 4.0 and see that AI will be responsible for most if the sections outside of augmented reality and internet of things.

The AI will be completely imbedded within the factory. As far as each machine. Once each machine has its own brain, this will enable full communication throughout the factory along with non-stop data collection and adjustment.

The artificial intelligence will allow the factory itself to communicate to the humans operating it through the use of the other emerging technology known as augmented reality. Also because each machine operating on the production line is embedded with AI, then they will be able to communicate with each other, making the factory completely connected (IOT).

While the AI is communicating and completing its tasks, it will make a collection of big data that will be used in the future to optimize the factory and keep each machine up to date. While collecting the data, it can be visualized, so that the human operators will be able to view it in real time.

The AI would allow the factory to be completely autonomous and operate 24/7 especially with the ability to make changes to the manufacturing process in real time if there is an error somewhere.

AI would reduce the human error created by the workers, human error cost business millions every year and most mistakes that happen in the workplace are due to human error. “The simple reality is that you purposefully need to create standardized systems, processes and methods else you will always have high failure rates and poor performance. The typical failure rates in businesses using common work practices range from 10 to 30 errors per hundred opportunities. The best performance possible in well managed workplaces using normal quality management methods are failure rates of 5 to 10 in every hundred opportunities.” (Mike Sondalini, 2019)

Artificial intelligence would reduce workplace error significantly and increase the safety of the human workers. On top of reducing human error, the AI would also reduce the waste created by the factory.

“Putting sensors to work can save steel companies millions every year by reducing the use of ferroalloys, an expensive material, and preventing “mill scaling,” the unwanted oxidation of steel. Fero Labs is able to predict mill scaling with an accuracy of 78-100 percent, according to Kucukelbir, reducing it by 15 percent.” (intel 2019)

Use cases of artificial intelligence:

1. Traditional factory: Machine breaks down unexpectedly and production stops and repair men are brought in to repair the machine or replace it in order to start production again.

   Smart Factory: AI will use it multiple inbuilt sensors (IOT) to pinpoint needed repairs and visually show them to humans via AR. The AI will be able to tell when parts are going to fail and how long repairs should take. The AI will then communicate with other machines to allow instant readjustment to the manufacturing process to continue without the need of the broken machine.

   “Smart factories like those operated by LG are making use of Azure Machine Learning to detect and predict defects in their machinery before issues arise.” (2018 / Mikael Puittinen)

2. Traditional factory: Machines need to be studies , upgraded and the process improved manually over time.

   Smart factories: AI will communicate improvements to humans, to better the ways they complete their jobs through machine learning while completing their tasks.

3. Traditional factory: Humans test end products and if there is a continued issue then production is halted and the adjustments are made.

   Smart factories: AI will perform testing on end products and will communicate changes to the assembly line in order to perform improvements.

4. Traditional factory: data can be hard to analyses and can be very time consuming.

   Smart factory: The data is collected as jobs are completed and are visualized in real time.

"Hitachi has been paying close attention to the productivity and output of its factories using AI. Previously unused data is continuously gathered and processed by their AI, unlocking insights that were too time-consuming to analyse in the past." (2018 / Mikael Puittinen)

"Symbiotic autonomous decentralization allows sensing of a site's various status (sensing), analysis of issues and planning of countermeasures based on various collected and archived information (thinking), and feed back of the results obtained to the site (acting), thus enabling the optimization of value chains inside and outside the factory".(Naohiko Irie, Dr . Eng. 2016)

Augmented Reality

Augmented Reality, AR for short, is the computer-aided extension of the perception of reality. This information can appeal to all human sensory modalities. Often, however, extended reality is understood to mean only the visual representation of information, ie the supplementation of images or videos with computer-generated additional information or virtual objects by means of fade-in / overlay.

Augmented reality could be used in virtually every aspect of everyday life. Workers could be shown the next step directly into their field of vision, viewing additional information can help him with complex tasks. Soldiers or human aid workers could see targets and danger zones in the field and designers could work with actual and virtually present colleagues on the same three-dimensional model. As technology advances, futuristic application scenarios can be explored: electronic devices that exist only virtually but respond to real touch, artificial sensory enhancements such as the "X-ray Vision" and computer games in open terrain.

The collaboration of locally distributed teams can be facilitated. For example, through video conferences with real and virtual participants. But the joint work on simulated 3D models is also supported. (Peddie 2017)

Figure 4 Potential use-case of AR – service maintenance (accessed March 2019:: https://www.i-scoop.eu/wp-content/uploads/2017/08/Augmented-reality-Industry-4.0-concept.jpg)

3. USE CASES OF SMART FACTORY

In classic factories, a delay of certain parts that are needed, adjustments to the production line have to be figured out by workers and engineers to keep the production running and maximize the profit. This takes time, manpower and therefore money to fix the problem, while the solution is often not the best. In our SMART factory, the AI is supposed to recognize delays of parts early and find the best way to handle the situation. Instructions on how to adjust processes are then communicated to workers and engineers through augmented reality. This helps to save time and lower the risks of human error and allows the factory, to rearrange process lines, for example to clear another low priority job first, where all the needed parts are available. This reduces the down time of machines, where they don't produce and just cost money. Forecasts can be made much better and more promptly on the basis of smart data. It is therefore possible to respond immediately to major disruptions

Another case where the combination of AI and AR is useful is, when one machine breaks down and it needs to be fixed. Again, the AI can figure a way out, which machine can take over for the broken machine or how the order of jobs should be rearranged. Furthermore, the AI is supposed to be able to tell, which part of the machine needs to be replaced. Through AR again, the AI can tell workers exactly how to replace the needed parts to resume to production as soon as possible. In addition, the sensors in the machine should be able to tell tear and wear on all parts, so the machine can be serviced and parts be replaced even before it comes to a crucial failure.

But not only in unpredicted events can AI and AR help in the process of machining an order for a customer. Before the production starts, the order from the customer has to be processed. AI can help to recognize mistakes in the shapes and forms of the desired products that are unable to be machined by the factory. Through the AR the engineers, designers and customers can then work on the order without physically being in the same room. This helps to increase the flow of new orders and creates a great customer experience.

Limits and concerns

First of all, as mentioned above, all of our described scenarios are very futuristic. A big factor in the development of new SMART factories is the current progress of the used technologies and the cost of implementing this technology into a factory.

Industry 4.0 and with that smart factories as well hold opportunities and risks. It is advantageous in addition to efficiency and effectiveness gain, adaptability and mutability of the economy and improvement of working ergonomics. The disadvantage is that the complex systems and structures are vulnerable. The real problems may arise where the economy can no longer live up to its original concern of securing a safe livelihood. (Gilchrist 2016; Möller 2016)

Individualization can lead to losses in informational autonomy. Personal data of the customer, which accumulate massively in the industry 4.0, are used in the production. For marketing and sales reason, they may possibly be passed on to third parties illegally. In addition, staff may be able to access and misuse the data as well. A central aspect is that the customer is integrated into the processes. The data with which he shapes the product reveal much about him and his preferences. (Gilchrist 2016; Bartodziej 2017)

Manufacturing facilities can be monitored and maintained worldwide. Connected are production facilities, cyber-physical systems, stationary and mobile robots and components of the Internet of Things, as well as databases and information systems of all kinds. An important aspect here is the hacking of systems. Networking tends to increase vulnerability, as there are more vulnerabilities and open gates. The hacking can lead to the adoption of systems and privacy concerns. The interlinking of people, systems and things is constantly to be checked and partially resolved, for example when hackers gain personal data or take over factories.

Automation means the omnipresence of technology. This dominates the factory halls and reduces the interactions between people or even substitute people. In extreme cases, it brings isolation and loneliness. It also includes increasing the dependency on technology. Those who are still present are dependent on the technology at every step of the way. Important is the absence of unjustifiable risks and hazards to people and the environment through the operation of the system and the creation of safety. Automation also implies the replacement of human labour in Industry 4.0. The majority of people who are affected are simple workers whose movements and abilities can be imitated by machines, while computer- and management personnel remain indispensable, at least in the first stages of the revolution. However, automation also implies that machines and people cooperate in work cells, resulting in a lower possibility of human error with the desired side effect of physical relief and increased safety. (Gilchrist 2016)

Autonomous systems can make the wrong decisions, either because they follow inappropriate rules or interpret situations and procedures incorrectly. They can hurt people and cause accidents. This is mainly about socially acceptable machines, for example, that they adequately react and act in the work cells and on their way through the halls, so they don't endanger workers. Ethic committees should examine the consequences of decisions for people. Here questions are asked about safety, such as the extent to which the decisions of the machines are good for the employee and whether he is exposed to risks and burdens. It also deals with partially autonomous or autonomous decisions affecting the customer. (Gilchrist 2016; Bartodziej 2017)

In the context of automation, the safety of people is to be ensured in terms of liability and life security. Strict security policies and periodic reviews can help. Regarding liability issues, it is necessary to work with philosophers and lawyers. The decisions of the machines, as long as they have an impact on people and their jobs, must be constantly called into question and, if necessary, adjusted by changes to the rule set. The management of the smart factory must familiarize itself with the findings of machine ethics and AI in this area and enter into cooperation with universities and research institutions. It must be asked regularly about the wishes and needs of employees and customers, for example, with the help of surveys. There should be the greatest possible transparency of information, so you can react and adjust processes if necessary. (Bartodziej 2017; Gilchrist 2016)

Profits

With the SMART factory, production becomes highly flexible, highly productive and at the same time resources can be used more effectively. The production of individualized products at the cost of a mass-produced product becomes a reality. This objective is supported by the parallel, massive progress in the development of 3D printing. The concept of a digitally controlled production will play an important role. Unlike conventional methods, the 3D printer can be used to produce both small quantities and complex products more cost-effectively. (Möller 2016; Bartodziej 2017)

The ability to resist and recover from disruptions caused by economic crises or infrastructure failures, is increased, because forecasts can be made much better and more promptly on the basis of smart data. It is thus possible to respond immediately to major disruptions.

In addition, the interfaces in and between the systems and smart data open up a wide range of potential for new services and innovative business models. Ultimately, the shortage of skilled workers can be cushioned by facilitating the work of older workers, for example through intelligent assistance systems, thus enabling longer working lives.

Intelligent networking through IoT in SMART factories also means more efficient and gentler use of resources. For example, in the smart factory, intelligent processes such as

start-stop functions on machines significantly reduce the energy consumption of a factory. Finished products that do not meet the acquired standards, are significantly reduced by detecting errors earlier and therefore less waste is produced. (Bartodziej 2017; Gilchrist 2016)

4. CONCLUSIONS

To conclude, smart factories bring amazing benefits to society in the form of reduced waste, less emissions, and energy consumption. They also bring many benefits to organisations in the form of reduced costs, consistent quality, flexibility and consistent improvement.

Smart factories are in their concept stage and are still far from reality, with the above reference, most manufactures are looking at smart factories for the future, but very little have actually implemented the technology for them. Most of the implementations are made by large enterprises which are the leaders in this revolution thanks to their funding but also start-ups and SMEs are trying to move towards the future by implementing partial solutions which could be meaningful for them.

Smart factories always require multiple new and emerging technologies in order to reach their full potential. These technologies are not only working alone, but are combined and work together. Possibilities of combining AI and AR are highlighted with several use cases in this essay. With the new emerging technologies and smart factories also come certain concerns regarding ethical and safety problems. These concerns need to be addressed and mustn’t be ignored.

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USING ARTIFICIAL INTELLIGENCE TO MANIPULATE PEOPLE ON SOCIAL MEDIA

TLO-35306 2018-01 Global Information Systems Management
Group Assignment

Mikko Vaaranmäki
Joonas Schroderus
Saana Saarteinen
Lauri Mäntysaari

ABSTRACT

Manipulation through Artificial Intelligence
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Keywords: Social Media, Artificial Intelligence, Manipulation

In this report, we discuss artificial intelligence and machine learning based technologies that can be maliciously used to manipulate users in social media. Through technological innovations and rise of social media combined with poor media literacy skills of some groups of people, this topic is becoming more and more important issue in society. Our discussion addresses some key means of manipulation and some mitigations for them, either existing or under research or development. At the end of this paper we discuss possible worst-case scenarios wide societal scope related to intentional manipulation in social media.

1. INTRODUCTION

The rise of technological innovations and the internet has allowed us to access, collect and process information in quantities like never before (Sas.com, n.d.). We are given the chance to make informative decisions based on vast amount of facts and figures, but both technologies and people have their limitations: while our own biases and both unintentional and intentional behaviour limits our ability to make informed decisions, technologies such as artificial intelligence can similarly have a severe effect on how we see the world through social media (Anand, 2019). Social media sites such as Facebook, has constantly been alleged to take advantage of user data in marketing purposes (Kaput, 2017), while heated political discussions online raise the question of whether we see all that we should on our news feed, or simply all that the AI behind the algorithm thinks we should see (Watts, 2018).

Today, we are aware of some of the limitations of human behavior on social media. As technology and social media has become more common, people are also more aware of the ways in which AI and different algorithms can change what we see, sparking changes in companies such as Facebook (Ayres, n.d.). The objective of this research is to investigate and pinpoint different technologies that can be used in social media to manipulate the user, whether it is a question of limiting the amount of information given to us or maximizing profits by targeted advertisement. Looking at the psychological aspects behind the use of these technologies, we intend to map out the ways in which manipulation can occur and consequently how these types of manipulation can be fought against by acknowledging the psychological factors behind them. First, we intend to analyze the different types of technologies used in social media manipulation, leading to the investigation of the relevant psychological factors and finally suggestions on how one can fight against it themselves, looking also at the worst-case scenarios.

Our approach is based on the dark side of technology with a focus on AI and the social media. Social media is a global phenomenon that has become a significant part of many of our lives and seeing the polemic discussion related to for example elections (Watts, 2018), we can see that social media manipulation can have a massive effect on a vast amount of people, or even whole nations. As a topic, AI and human behavior on social media is thus a relevant one and while to some extent known, it continues to be a somewhat uncharted area.

2. ORIGINS OF WORLDWIDE SOCIAL MEDIA MANIPULATION WITH AI

Social media has the power to connect individuals from around the world. Not only has social media connected humans at the click of a button, to some extent it has become a way of life. (The Nation 2012) Individuals are constantly fascinated and distracted by the complexity and endless possibilities of social media. Within just minutes of scrolling through a social media application, an individual can be up to date with anything taking place around the world. Facebook currently ranks as the top social media application, as it contains the most active users (Global Social Media Ranking n.d.). Immense amounts of information are shared through social media applications. On a daily basis around 300 million photos are uploaded, and 8 billion videos are being viewed on Facebook (Stout 2019). In other words, users are prone to all types of information online, ranging in the form of images, memes, videos, advertisements, articles and more.

Technology has provided a platform for the growth of different types of social media. In addition, technological advancements have the tendency to be extremely rapid, which has resulted in increasingly cutting-edge social media applications. Oftentimes it is hard to keep up with these advancements, as well as predict which way the future of technology and social media may be going. Artificial intelligence has become a very major topic of discussion globally. Features and functions, such as digital marketing on social media applications keep improving, as technologies including AI are used to impact user experience in a positive manner. (Pierson 2018) Content that is relevant to the user can be identified with the use of AI, creating a unique experience for the user, resulting in brand loyalty (Martin 2018). Continuous improvements in technology and social media platforms will most likely ensure user engagement and a growing interest in social media in general.

As social media is a global phenomenon, end users range from all types of backgrounds, forming a very diverse user base. Social media has the power to draw all walks of people to use it and instantly connect with others around the world (Fuentes 2018). Even though AI can be used as a means to improve social media and attract more people to use it, the consequences of integrating this growing technology into social media can create immense problems that often go unnoticed by the users. Users are put to test psychologically, as the line between reality and illusion blurs. Social media creates a clear and easy pathway for mass manipulation. (Mind Matters 2018) The world is seen through a social media lens, as there are around 3.4 billion active social media users (Global Digital n.d.). For this reason, raising awareness on this factor is crucial. The varying user base must be prepared and educated to help prevent becoming a target of manipulation.

3. TYPES OF MANIPULATION

AI has paved the way for online manipulation. Social media has created a portal for this manipulation to reach end users. As a result, social media users are currently susceptible to different forms of manipulation (Inglis 2018). With the help of AI strategies including, selective information, false information, artificial users and different types of marketing tactics, such as product placement are used to manipulate the user. The following sections will introduce the chosen manipulation techniques, discuss how technology is used to enable the manipulation and identify the psychological factors that make each manipulation technique effective.

3.1 Selective Information

Selective exposure theory was known already in the first half of 20th century, when it was noticed during the 1940 presidential campaign in the United States: it was theorized that since people avoid the undesirable feeling of contradictory information and opinions, they tend to be motivated to select messages matching one's beliefs. Given the huge amount of information flowing on the internet today, it is consequently no wonder that selective behavior sees no end. We are given a vast amount of choices every day, and no matter how critical, people simply have no time, energy or desire to shift through every detail. (Stroud, 2014) That is what also gives AI its chance to change the way we see the world, as it can take advantage of our tendency to limit our scope of opinions.

3.1.1 Enabling technology

With the era of TVs and newspapers, people were able to select their information sources (TV channels, specific newspapers) themselves, in practice limiting their scope of opinions without the 'help' from technology (Messing and Westwood, 2012). Today, we use social media more than ever to catch up on news and different events, and while it is easier than ever to follow different channels and pages at the same time, algorithms have become more clever in the way they show us what is on our personal news feed. One could say that it is the individual her-/himself that is charge of what they choose to see online (Haran, 2017), but platforms such as Facebook are not helping the case: Facebook's algorithm is set to show us the most relevant pieces of information, potentially filtering out most of the information that could be shown on the feed (Dredge, 2014). While the updates on the algorithm are said to be more family and friends -oriented (Barnhart, 2018), the amount of information that is lost to the algorithms is still significant. After all, if the algorithm decides that the anti-vaccination movements' posts and news articles are the most relevant content to the user, what are the chances Facebook will show content related to the benefits of vaccinations?

Selective exposure in social media becomes even more polarized in the field of politics: echo chambers, where one's opinion is reinforced through the collection of opinions from the same side, can promote news story exposure to opinion-reinforcing information (Garrett, 2009). It seems that while one's behavior and personal news feed can certainly promote selective exposure in any type of opinion, political atmosphere becomes quite easily the most polemic theme there is: looking at the most recent US elections, information wars on social media were all around us even in Finland. In a sense, political beliefs can be seen as the backbone of what we see online, irrespective of whether it is intentional or unintentional (Garrett, 2009). Consequently, although it is easier to follow varied news sources in today's social media platforms, political discussion shows us that there is still room for the breakdown of selective exposure.

AI in the form of algorithms certainly offers a lot of opportunities to limit the information we see online, as an example the algorithm used on Facebook. Still, changes are being made as people are more aware of different technologies and information sources, and even Facebook has seemingly changed its algorithm to try and limit the power of companies and their advertisement on our news feeds, concentrating on friends and family (Barnhart, 2018). Moreover, although echo chambers are a legitimate phenomenon, it has been shown that opinion-challenging information is in cases only marginally less likely to be shown to us, irrespective of opinion (Garrett, 2009). Today, different applications also enable us to search for news articles for example about the economy, showing us multiple different sources on the topic. Consequently, while AI can limit the scope of different opinions, people do have a saying in what they see and what they do not see.

3.1.2 Psychological background

As said, the basis for selective exposure lies in the theory of the same name. Consequently, although technology plays a role in the way we see the world through social media, our own behavior affects our perception more than we might realize. With overwhelming flow of information, we do have the ability to choose which information sources to follow, giving us power to challenge our own perceptions and opinions. Currently, there are an increasing number of websites and applications that allow us to see content from different news sources in one place, meaning that although AI might have become wiser in targeting users, we are able to break from the habit of following a single, in our opinion trusted news source (Stroud, 2014). In that sense, technology is not only the enemy of unbiased exposure to information, but it can also serve as a tool to expand our horizons.

Ironically, trusting these new types of collective news applications, we are solving an issue related to technology with another technology that is not necessarily the best solution to the problem. Technology can certainly help us collect information from different sources, but that does not solve the psychological issue behind selective exposure: the 'de facto' limits of human behavior, as for example the tendency to avoid discussions that

challenge our viewpoints continue to exist (Stroud, 2014), meaning even the most helpful technology can be seen as a band aid for a more inherent problem. As long as we do not acknowledge our limitations, we are largely affected by the technologies in use - both in the good and the bad.

3.2 Artificial users and false information

Flock mentality is difficult to spot in the moment. As the saying goes, a snowflake doesn't realize if it's a part of the avalanche. But what if the avalanche does not even exist, can you still make snowflake to roll down the mountain?

Using artificial intelligence and social media, it is relatively easy to create an illusion that a large amount of people has a specific opinion. This can take form as a legion of a social bots, fake accounts that are controlled by an individual or an organization, who post wanted opinion to targeted platform. This organization hopes to manipulate real users to change their opinion towards the wanted direction. (RoBhat Labs, 2017)

Trust can also be achieved by making it appear as if someone else that people trust is saying what you want people to believe. False information can be hard to differentiate from legitimate information, and this can require good media literature skills. False information can be spread by some individuals who can even be influencers, or with the aid of different technologies, such as machine learning based deep fakes (Benjamin 2019).

3.2.1 Enabling technology

Social media is key enabling technology for this type of manipulation. Social media, which is usually meant for individuals to share their comments, allows you to present yourself as hundreds or thousands of users. This can take form as a group of unique looking posters on a public forum, Facebook-group or comment sections of a specific article. As these social media platforms usually gain their revenue through having maximum number of users, they are often likely to automatically promote content that gains any sort of popularity. However most likely when they start to promote news article or group which's popularity is gained through artificial users, it is often done unintentionally.

Managing a group of artificial users can be done with practically no artificial intelligence. However, this requires the manipulator to manually choose targets for these bots. It is a lot more effective to use artificial intelligence to search social media for articles or posts related to the topic of manipulation. For example, searching news sites for specific types of political articles, this can be done manually, but then you are unable to consistently find all matching articles. (RoBhat Labs, 2017)

For optimal effectiveness this can be done by collecting data, in this example the article's text, from given social media platforms API or by emulating a browser and scraping the

sites directly. Then this data can be analyzed by several techniques, like simply searching for keywords or through machine learning algorithms, trained to recognize specific topics. Once you are able to send your artificial users to not just directly related posts but also to posts that can be directed towards your agenda, will the bot legion look more like a real users who are really passionate about something.

Technology can also play a part in choosing what the bots post. Simplest solution is to have large amount of pre-written comments and have every bot to select one of these randomly. This will however run into the risk of looking repetitive and sometimes separated from the context. Especially if target for the post is chosen algorithmically and not manually.

Artificial intelligence can be used to drastically improve the quality of these comments. AI based text generation is already at such a level, that it can create texts that are distinct able from a real human writing, even without knowing much about the topic beforehand. This can make manipulation even more dangerous as you can make your bots to insert the opinion automatically into places where readers won't suspect them, like side mentions in seemingly unrelated posts. (Zack Whittaker, 2019)

Artificial intelligence or machine learning can also be used in video manipulation, for example in deep fakes. With this technology someone can convincingly make it appear as if someone else is saying what you want them to say (Benjamin 2019). At the moment this still requires good impersonator for sound, as the algorithm produces only the video, but solutions for learning and generating sound are also being developed rapidly (Van den Oord et. al. 2016). Manipulating videos is still and will probably be for a while more manual process than AI based text generation, but it can also be more convincing.

Convincing deep fake based videos combined with army of similarly convincing bots spreading the video across social media can result in a grim future, where every bit of information have to be scrutinized thoroughly before it can be trusted. This group of technologies is not limited to cause only wide societal problems and only user's imagination is the limit. Deep fake technology for example can and have been used to swap someone else's face to pornographic material and this can also cause personal harm (Chesney & Citron 2018). The problem always worsens with increased publicity, which can be achieved with artificial users.

3.2.2 Psychological background

Psychological bases for this type of manipulation are undeniable. Flock mentality is scientifically proven to be effective way to guide subject towards wanted action. This can snowball a small-scale phenomenon into large movement once it gets going. Like financial bubbles or anti-vaccine movement. (Lemieux, 2003)

Other effective way to gain trust is authority. How malicious this can be in the wrong hands can be observed by looking into 2nd world war Germany. However, technology has enabled someone to capture authority and display their message as if someone that has public, legitimate authority has said it (Benjamin 2019). Combined with flock mentality in spreading this false information can result in self feeding process where unrelated individuals start to spread this information. (Riech 2010, Chesney & Citron 2018).

Raafat et al. (2009) wrote an article about the all scientific bases for herding in humans. They recognized different types of drivers for herding in their studies. They were able to separate these into pattern-based drivers and transmission-based drives. Pattern-based mechanisms focus on individual as a well-defined unit, which works by simple common rules or laws. Possible pattern-based mechanism utilized in social media manipulation could be the effect of how information spread through social network in a manner analogous to contagious disease. Transmission-based drivers are focused on the patterns in the interactions instead of the individual units. This category contains mechanisms like "emotional contagion" where emotions spread to each other within a group of people. Lemieux recognized (2003) some of these transmission-based mechanisms in financial sector, where false information cascades could be sent out by organized group to start rapidly growing cascade that is against the rationale of individuals who believe in the cascade.

Even back in 2009, where social media was still growing to its current popularity, Raafat et al. (2009) mentioned worries about how much "internet age with the increasing ease of sharing information and ideas" will make people susceptible to manipulation through herding, unintentional or intentional.

3.3 Product Placement

Social media is a crucial medium for marketing activities. Companies not only collect valuable information for analysis from social media, they also use the platform to market brands to the users. Users face all types of content when they scroll through their social media applications. Product placement is evident in a large portion of the content. The term product placement is defined as the inclusion of branded products in for instance a program (Liu, Chou & Liao 2015). Product placement however, can be in varied form such as text, video content and images. Marketing strategy wise, product placement on social media is considered extremely important, if not one of the most important marketing strategies (Liu, Chou & Liao 2015).

3.3.1 Enabling technology

Since social media has become an integral marketing strategy for product placement, companies seek for ways to improve their marketing activities on these popular applications. Furthermore, humans respond to visual content. Not only do they respond to visual content at higher rates, they also share masses of content that is in visual form. Retweets

occur more often when an image is included as well as individuals are 2.3 times more engaged to content on Facebook that contains images. (Begg 2017)

As images are a central part of social media, companies have to adapt to the ways of the consumer. In other words, in order to understand consumers, the ability to analyze visual content is vital. AI has enabled image recognition, giving more power to companies in the marketing field (Singh 2018). Wants and needs of consumers and consumer behavior are often depicted in the images shared on social media accounts and are not always expressed clearly in text form (Begg 2017). AI can identify these human wants and needs at a very detailed level. Pictures on social media are compared to extensive libraries of images at amazingly high speed with the help of AI. Companies can use this to i.e. recognize brand logos. (Begg 2017)

After conducting extensive analysis on individual's social media images, companies can gain a clear understanding of the users. This understanding can be translated into product placement that is unique and highly personalized. Users will be shown exactly what they want to see. AI will turn traditional product placement into an automated procedure. Using film as an example, AI will enable the placement of products in different scenes according to what each user would most likely want to see. (Jacob 2018) This same procedure can take place on social media. Individuals social media feeds may feature some identical video or image content however, product placement will become automated and customized according to what suites the analyzed users profile best. One user may see a can of Coca-Cola, whereas another may see a can of Sprite in the same scene (Jacob 2018).

Overall, in the case of product placement on social media, AI will most likely be used in two phases. Initially AI will be used to identify user preferences. Then it will be used to target users with ideal and customized product placement, as stated above. These thorough investigations on social media accounts lead to the possibility of manipulation through product placement.

3.3.2 Psychological background

In order for marketing to be successful, it must awaken emotion. Marketing needs to go beyond the product and ensure that people experience these positive feelings. In other words, the ability to appeal to an audience is directly linked to recognizing and understanding the importance of engaging humans on an emotional level. (Alton 2017) With AI, marketing and specifically product placement will be done on a very personal level as mentioned in the prior section. This leaves room for an immense amount of manipulation.

With the help of AI, targeting vulnerable consumers to sell more is already taking place (Artificial Intelligence 2018). As AI has the ability to analyze an individual on a very

personal level, the manipulation itself will be highly personalized. Advertising has always targeted human emotions, but AI will take this to a whole new level (Artificial Intelligence 2018). Social media accounts have data from an individual's life that date back multiple years. This data mine allows AI to harvest details that would go unnoticed with the absence of this powerful technology. By giving this machine the end goal of selling something to the target market, it will go out of its way to understand the consumers psychological side and apply the perfect methods to ensure the end goal is reached. Ethics are not taken into consideration, and human intervention is a must. (Artificial Intelligence 2018)

Consumers will feel as if they have formed some sort of bond with certain brands and products as a result of personalized product placements. AI and product placement will seemingly subtly manipulate users to make choices that seem self-made, when in fact these choices are based on extensive background analysis and algorithms.

4. COUNTER-MEASURES

Even though there are many ways to manipulate users on social media, as mentioned in previous sections, it doesn't mean you should stop using social media platforms. For each of these manipulation techniques, there are few actions that any user can take to reduce their effect. In the following chapters, we try to identify few of the most effective ones. We took counter-measures from various sources, some are from scientific articles and some are direct products designed for this specific need. Effectiveness of these counter-measures was evaluated through our own reflection without scientific study.

4.1 Tackling the issue of artificial users

Most important aspect when defending against fake users is to identify them as soon as possible. Skill to do so can be included as a part of media literacy skill. In some cases, these bots can be easy to recognize, but if manipulator has put a lot of resources into making them look like real users can this be nearly impossible mission (RoBhat labs, 2017).

Being familiar with the social platform you are reading, can be helpful. This allows you to see if some different opinion starts to suddenly emerge, that would not be against the normal values of platforms users. However, values can change, and totally new users can join platform, so this cannot be used as an absolute defense, it can however be used as a sign to look more deeply and critically into what is happening.

Social media platforms themselves have a large part in defending against bots. Through political and ethical pressure, we can push these large corporations to put more effort into removing them from our feeds. In recent years we have seen some progress in this, Facebook has announced to shift its algorithms to focus more on quality of the posts and Twitter has banned large amounts of accounts linked to Russian Misinformation (Lazer et al. 2018) Through this same pressure, some countries, like Canada, have in-directly forbidden political bots in their laws. However, these kinds of laws are not unspecific and have plenty of room for improvement (McKelvey & Dubois 2017).

4.2 Identifying false information

Counter-measures for false information are very similar to those of artificial users. Key is again recognizing the false information, but it is becoming more and more difficult. Media literacy skills are again crucial and reader's responsibility is rising but there are also some technological attempts in mitigating this problem. (Benjamin 2019).

One technical solution is controlling trust with blockchain. In case of deepfake videos, this would mean ensuring the originality of these videos with blockchain. The authenticity could be verified even for certain timeframe. However, getting individuals to do this would again be a problem. The technology should be so integral and easy to use part that checking the originality of information would become second nature. This is still far away. (Martinez 2018).

Other researched solution is detecting deepfake videos using neural networks (Guera & Delp 2018). However, this being also machine learning based solution, it is complex and slow to develop and train the program, which means that viable solution can be years away and mitigation will probably lag behind new solutions producing false information. For now ensuring legitimacy of information is still relying heavily on individual and education.

4.3 Fighting against product Placement

Awareness is key. Knowing that this specific technology is out there and has the power to create content that is based on individuals' personal preferences will decrease the possibility of a user being affected by the manipulation. This however, may be a flawed defense mechanism, as product placement is usually very subtle and hard to spot (Product Placement n.d.).

A well-known application called Adblock is currently on the market and used by over 60 million users. This application helps filter out obtrusive adds and can even block out all ads depending on how the user selects their settings. (AdBlock n.d.) Although Adblock may seem like a bullet proof solution, product placement may be harder to identify in comparison to a traditional ad. With the future of product placement becoming more personalized, applications like Adblock will need to have the ability to identify when this takes place. Using film as an example once again, the film itself will most likely be filmed from beginning to end with no specific product placements in mind. AI will then add product placements into the films, which are customized according to each user. (Jacob 2018) Users must make sure they download the appropriate application in order to tackle manipulative product placement that takes place on their social media accounts. The chosen technology should then have the ability to shield the user by removing brand names, logos and other tactical product placements that AI has added to the content.

5. DISCUSSION

Throughout history, change and evolution have taken us forward. The future may be hard to predict, especially since the field of technology has a very dynamic nature, however, certain patterns are beginning to reveal the direction society may be going. The power of AI will continue to grow with the help of platforms such as social media. Even though technology will enable society to take major leaps forward, the end result may in fact have a reverse effect on mankind. Current trends related to manipulation and technology are paving the way for a very dark future. Ten years from now societies may be led by social media, big corporations may become world dominators, the end of reliable journalism could take place and authentic independent decision making may become blurred.

5.1 End of Reliable Journalism

Reliable journalism may come to an end in the next ten years. News related content is shared on social media at all times in all kinds of forms. Many individuals choose to get their daily intake of news from their preferred social media application. Increasing amounts of individuals are becoming internet users, and approximately 86% of users on social media rely on Twitter for breaking news (Schaap 2016). As social media connects individuals around the world, information travels at high speeds. Current events immediately turn into widespread breaking news on social media, and at times news organizations are not able to keep up with this rapid rate (Schaap 2016).

Moreover, humans are drawn to entertainment, and the entertainment factor of social media is high in general. Not only is the content entertaining, it is customized to what the users want to see. Technology and data work hand in hand to ensure that users remain engaged and are targeted with specific content (Bruell 2018). Breaking news can be found in addition to other content on social media. With so much varying content that is fascinating to the users, they may not seek for news elsewhere, as social media gives them an all in one type of solution. This could result in the end of reliable journalism. This however, may lead to false information, in other words unreliable news. Some of the manipulation techniques mentioned earlier, such as selective information and fake information may become a way for news to maintain its entertainment factor. Actual fact-based news will be pushed aside, as the entertainment factor will determine the success of news. The source that spreads the news will want to make sure that as many users are viewing that specific content. This leaves room for a lot of damage, as misleading news can lead to all sorts of issues. Society will not know what is true, and humans will become delusion about their surroundings. In situations like these, it is crucial for users to know and understand how to interpret what they see online. Having the ability to filter false content will become increasingly crucial in the near future.

5.2 Worst case: Social media is used to control people

Social media has grown to be important aspect of our day-to-day life without us noticing it. This combined with the advancement of technology has made all these manipulation methods extremely effective. Efforts done for improving internet user's media literacy was out-paced by improvement of manipulation methods by capital corporations and political organizations. At first laws were made to prevent manipulation, but eventually lobbyist and unstable political landscape forced politicians to use these methods instead of trying to stop them.

Manipulation was first only used to small and specific things. Like effecting what brand of cereal, we want for breakfast. Then for "small ethical" goals, like manipulating us to stop smoking and guiding us towards more ecological transportation habits. But slowly these turned into greater and greater effects. After a while all out opinions were formed through intentional manipulation.

Globalization of internet had to be reversed. After a few countries had been driven into civil war through manipulating citizens in social media, governments started to censor the internet connections crossing the national borders. In addition to preventing outside manipulation, it also gave full control to the own government and corporations working with them. Since this also limited access to foreign social media platforms, had countries themselves develop new state-run alternatives, which further enabled them to control all content shown.

Illusion of free will still exists. When you are not directly told what to do, but just manipulated to make that choice "yourself", you don't just fall in line, you stay happy while doing it. All information you see is selectively chosen, all controversial posts are flagged by AI and lot less likely to show up on anyone's feed. When needed you are shown only people with specific opinion about given agenda, even though you are not even looking for anything related. If these types of people do not exist, you are shown fake people who appear identical to other users. Authority of the state is abused to the extreme. And various psychological methods are used to ensure that your trust for their authority does not falter.

The above example strongly relates to legitimate fear, shown also through Cyberpunk type of science fiction. Cyberpunk focuses on high-tech future and blurred lines between reality and virtual spaces (Albright, 2016), which relates to the illusion of free will. If traditional governments fail to do their job, technological companies could indeed be the new norm, leading us in the absence of traditional forms of governance. In the worst case, technological innovations do not lead to exceptional advancements in society and quality of living, but diminishes our freedom to the minimum. If technology overpowers our ability to acknowledge our behavioral limitations, there is little technology cannot make us do.

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ARTIFICIAL INTELLIGENCE, AUGMENTED REALITY AND MIXED REALITY IN CULTURAL VENUES

TLO-35306 2018-01 Global Information Systems Management
Group assignment

Aapo Tanskanen
Asier Alcaide Martinez
Deborah Kuperstein Blasco
Laura Sipiä

ABSTRACT

Artificial Intelligence, Augmented Reality and Mixed Reality in Cultural Venues
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Keywords: Augmented Reality, Artificial Intelligence, Mixed Reality, Cultural Sites

Augmented reality (AR) and artificial intelligence (AI) are two of the most commented information system trends. While AR is a set of technologies hat overlay digital interphases in the physical world, AI refers to computers performing tasks by perceiving their environment and iteratively improving themselves. A combination of virtual environment with the real world is called mixed reality (MR).

There is an ongoing trend in cultural venues to use these information systems to enhance visitor experience. AI is being used in the form of chatbots and interactive guides at large museums and AR is used mostly through mobile applications that allow visitors to interact with their surroundings. In a few cases, mixed reality has also been introduced in technology museums through large, interactive screens.

The current research consists of an exploration of existing uses of AR, AI and MR at cultural venues, both indoors and outdoors. To do this, the second lens of the GISM Framework, 'Explore and Understand: the current' was utilized. To do this, a literature review on existing uses of these technologies in cultural venues was carried out. The results of this research are a set of examples of using these information systems technologies in cultural venues. Furthermore, value adding opportunities and potential disadvantages were identified.

1. INTRODUCTION

New Information Systems (IS) trends are changing myriad aspects of human lives: the way people communicate with each other, interact with their surroundings, learn, travel, make purchase decisions, among others. Augmented Reality (AR), Artificial Intelligence (AI) and Mixed Reality (MR) are some of the most popular IS trends; there's a hype around them. Artificial intelligence is a widely studied and commented topic and, in fact, it is said to be the next big revolution in computing (Niven, 2016). Artificial intelligence is changing the way we use machines to enhance our daily lives. On the other hand, augmented reality consists of a set of technologies that insert, or superimpose, digital interfaces into the physical world (Mohn, 2018). AR promises to bridge the gap between the physical and digital worlds and release unique human capabilities (Porter & Heppelmann). Furthermore, mixed reality combines the virtual environment with the real world and allows individuals to interact with both worlds (Milman, 2018); this interaction is enabled by artificial intelligence.

AR, AI and MR are disruptive technologies that are projected to not only affect individual consumers in the Business-to-Consumer sector, but also companies in almost all industries and, due to new a trend in the use of these technologies, it will also change the way people interact and learn from cultural sites. This trend is the use of information systems for cultural purposes. While AI and AI are more gaining popularity in cultural sites, little is documented regarding MR and the value-adding opportunity that this represents for those cultural sites.

Thus, the goal of this research project is to explore and understand the current and potential uses and value-adding opportunities of AR, AI and MR in both indoor and outdoor cultural venues. This will be achieved by utilizing the second research lens on the GISM framework, which focuses on explaining already existing technologies and identifying value adding cases. The intended outcome of this research is to identify existing uses of AR, AI and MR in both indoor and outdoor venues and illustrate how these provide value to both visitors and venues.

This project is organized as follows. In the second chapter, the concepts of Augmented Reality, Artificial Intelligence and Mixed Reality are briefly discussed. The third chapter identifies the current and potential uses of these technologies at indoor and outdoor cultural venues. Next, the fourth chapter presents value-adding opportunities for different stakeholders involved in incorporating these IS technologies into cultural sites. The team's findings are discussed and concluding remarks are presented in the final chapter.

2. AUGMENTED REALITY, MIXED REALITY AND ARTIFICIAL INTELLIGENCE

Augmented Reality

Augmented Reality (AR) is a technology that allows information generated from a computer to be overlaid onto a live direct or indirect real-world environment in real-time (Zhou et al., 2008). While VR systems completely block out the real world and replace it with a virtual simulated environment, AR allows users to continue to see the real world while overlaying virtual objects, characters, and information on top of the real world. Generally, AR technologies have most of the following properties (Roesner et. al 2014):

- Sense properties about the real world.
- Process in real time.
- Output information to the user, including via visual, audio, and haptic means, usually overlaid on the user's perception of the real world.
- Provide contextual information.
- Recognize and track real-world objects.
- Be mobile or wearable.

The term 'Augmented Reality' is attributed to researcher Tom Caudell (Levine, Smith, and Stone, 2010) in 1990. However, the history of it goes back to the 1960s, using an optical see-through display tracked by mechanical or ultrasonic tracker, limited by computational power in those years. Nowadays there are myriad applications and systems in the market that provide AR functionality, making it difficult to classify and name it. Sometimes it is difficult to figure whether it is AR or not, as AR is commonly defined as Virtual Reality (VR).

Mixed Reality

AR and AI are both booming at the moment but combining them, through Mixed Reality, is still rare. Sure, AI in the form of computer vision, image recognition and classification is somewhat the backbone of the AR solutions to be able show for example some 3D element on the top of your real-world elements through the AR glasses or phone screen. However, in the context of this report we are more interested in the AR experiences combined with AI for consumers in cultural venues such as museums.

Mixed reality can be used in customizing different simulations and trainings. Nowadays it is possible to have AR training simulations for example in surgery and aircraft piloting, but they are somewhat static simulations and always work in the same way. However, by

combining AI to AR training simulations those simulations can become individually customized and reactive. AI could learn the weaknesses and strengths of the surgeon and tailor the AR surgery simulation according to that certain surgeon's skills to make the training more challenging and educational for that surgeon. AR simulator could use AI to generate numerous different training scenarios which occur randomly. AI could also react to the surgeon's different choices during the surgery simulation and make the simulation more adaptive. AI would make the AR simulation more like a real-life customizable trainer than plain static simulator. (Hall 2017; Brooke 2018.)

In addition to trainings, AR and AI work together greatly in actual work of the doctors and medical professions. Doctors can for example look some samples with augmented reality microscope and AI can detect some cancer cells and other important things from the samples while visualizing them for the doctor in the AR microscope in real-time. Combining AI and AR in detecting cancers and other diseases would benefit especially those parts of the world where highly skilled medical professionals are rare and not so easily accessible. AI enhanced AR microscope would also be applicable to other microscopy tasks helping humans to detect new things from them microscopy images. (Chen et al. 2018.)

Nowadays, it is possible to have AI backed virtual assistants which have text and voice interaction in phones and devices like Amazon Alexa. By combining AI to AR, it is possible to have for example human-like AI virtual assistants in AR. The basic chat-based assistant would become more like living real assistant in your vision through AR. The AR based assistant could interact and talk with you and utilize AI to make your life easier. Virtual AR assistant could do all the things what nowadays phone-based assistants can do but it would be more real and human like thanks to the AR component. (Takahashi 2018.) AI powered technology which can create virtual copies of celebrities in AR has also been developed. These AI based celebrity characters can interact with fans in AR and fans can for example talk with their favorite celebrity character which sounds like the real celebrity. Overall, these technologies enable new ways of connection and engagement between the celebrities and their fans. (Matney 2017.)

Another current interesting example is in the cosmetics market through AR mirrors and mobile apps which enable people to virtually try different kind of cosmetics before buying them. Those AR applications use AI to detect the person's skin tone to recommend cosmetics suitable for that tone. AI would similarly suggest different kind of cosmetics like clothing and those recommendations would be highly customized to each individual thanks to AI's capabilities. (de Jesus 2018).
Finally, another example that depicts the current use of these technologies is through glasses like Google Glasses where AI is understanding the world what the user is currently seeing. Glasses can also be used by maintenance workers who could use AR and

AI to repair broken machines more quickly and easily when AI would assist them in detecting what is broken and show instructions how to repair it in AR on the real-world machine (Weiner 2018.)

Artificial Intelligence

Artificial Intelligence, (AI) is a widely studied and commented topic and, in fact, it is said to be the next big revolution in computing (Niven, 2016). AI refers to machines and programs that can perform tasks by perceiving their environment and iteratively improve themselves by processing data (Andreas et al., 2018). This has not always been the definition of AI. In the 1950s, AI was described as any task that a program of a machine could carry out that human beings would have had to use intelligence to perform (Heath, N. 2018). As technology developed and computers started to accomplish many tasks that would have before needed human intelligence, the definition of AI and tasks that counted as AI tasks changed (Maloof, 2017).

As previously stated, AI can carry out tasks that define the program or system as intelligent. Today the tasks that are considered AI tasks are knowledge representation, reasoning, learning, planning, natural language processing, perception and the ability to manipulate and move objects (Heath, 2018).

AI can be classified into two broad types of AI: narrow AI and general AI. Narrow AI is the type of AI that surrounds us in our everyday life. It means systems that are taught to do specific tasks without explicit programming of how to do so for example organizing personal and business calendars. In the other hand, general AI means machine intelligence that is adaptable like human intelligence. General AI can learn how to carry out vastly different types of tasks (Heath, 2018).

Nowadays there are many applications for AI and, in fact, an AI tool can be so disruptive that it can fundamentally change the entire competitive landscape of certain industry (Agrawal et al., 2018). For example, in our smartphones there are multiple e.g. calendars, visual inspection from video feed, applications that coordinate with each other, the list goes on (Heath, 2018). There are also many industries where the benefits of AI have been acknowledged: healthcare, automotive, finance and economics, government, etc. (Rouse et al., 2018). AI itself is helpful in multiple different ways but combining AI with another technology, for example AR, brings a completely new range of applications.

3. AR/AI/MR IN CULTURAL VENUES

Indoor venues

As it has been proven, both AR and AI are disruptive technologies that have impact in almost all aspects of people's lives. While Artificial intelligence is changing how individuals use machines to enhance their daily lives and improve their own work and knowledge, augmented reality promises to bridge the gap between the physical and digital worlds and release unique human capabilities (Porter & Heppelmann). Thus, upon introduction and broader adoption of these technologies, it became evident that both, AR and AI would influence another aspect of paramount importance for human beings: culture.

Indoor Venue digitalization

To identify how can these technologies add value to indoor cultural venues, it is important to first understand how digitalization has paved the way for these technologies in the cultural scene. Digital technologies have transformed the visitor experience in museums, they have modified the way in which curators and visitors represent the world and enable visitors to engage with one another and with objects in ways that go beyond language; overall, these technologies are shaping the entire experience (Jewitt, 2012). Digital technologies in cultural venues shape the process of interpretation, engagement and understanding. The example of the interactive digital exhibits at the Churchill Museum.

The central exhibit at the Churchill Museum is the Lifeline exhibit, which consists of a 15-meter long interactive table in which people can access information on every year of Churchill's life (IWM, 2019). Visitors can access hundreds of images, documents, animations and films. The physicality of the experience at the museum is enhanced by elements such as war rooms with no natural light and cramped conditions. Also, the museum has various multimedia exhibits, audio recordings of war speeches and touch screens asking the audience their opinion regarding key issues during World War II (IWM, 2019).

Figure 5 Churchill museum lifeline exhibit

The Lifeline exhibit is a clear example of how digital elements create opportunities for discussion and interaction; it impacts on the ways in which the visitors interpret and understand their experiences as they are become active participants in the production of the narrative through their selections and engagement with the table (Jewitt, 2012). As digital technologies have been further developed, more museums have incorporated

them as part of their main exhibitions. However, emerging technologies, such as artificial intelligence, virtual reality and augmented reality are usually introduced in the museum environment in stages depending on the progress of the field and availability of the technology (Ghouaiel et al., 2017). Myriad projects and prototypes of these technologies have been implemented for more than a decade.

Indoor Venue AI

Artificial intelligence has been used in combination with other reality-enhancing technologies to maximize the utilization of knowledge and provide an interactive experience for visitors (Mase & Nakatsu, 1996). This technology is being used increasingly by museums of all sizes across the world by means of chatbots, robots and tools that help analyze visitor data to better develop content that best fits audiences. For example, in 2018, three museums of the Smithsonian institution deployed six humanoid robots, named Pepper, that answer visitor questions, tell stories and have an interactive touch screen. Pepper is advertised as the museum's new guide. Furthermore, the Akron Art Museum encourages visitors to use their mobile phones and interact with Dot, a digital tour guide that allows visitors to 'choose their own experience' at the museum.

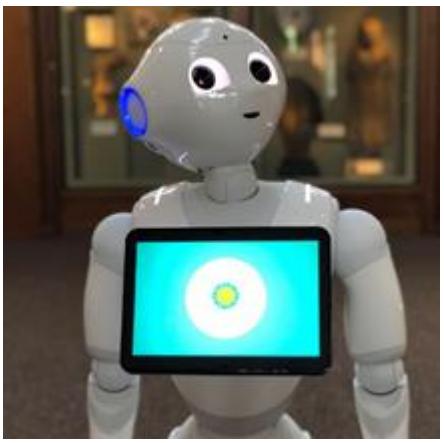

Figure 6 Smithsonian Museum AI

Indoor Venue AR

Augmented reality has also been implemented in museums to enhance visitor's learning experience. AR in museums helps visitors better appreciate and understand the contents of an exhibition (Ghouaiel et al., 2017). For example, The Franklin Institute, in Philadelphia created an AR-enhanced exhibition on Terracota Warriors that presents renderings to better understand the Terracota Army. By scanning items with the Terracota AR App, visitors can visualize AR content that provides information on history, archaeology, decay and discovery on the burial facility of China's First Emperor Qin Shihuangdi (The Franklin Institute, 2019).

Figure 7 Terracota AR

Not only can AR be used to provide information on existing items in museums, but it can also replace items that are no longer present. For example, the LDML project, a collaboration between the Louvre Museum and Japanese company Dai Nippon Printing created a guidance system and a system to appreciate works of art in a dedicated space in

Tokyo that offered a leisurely take on the same artworks on the museum in Paris (Miyashita et al., 2008). Another interesting example of this use is seen in the expo 'Hacking the Heist' at the Isabella Stewart Gardner Museum in Boston. This museum was the scene of one of the most important art heists in history in 1990, when thirteen pieces, worth more than 500 Million USD were stolen and never recovered. The museum has created an AR expo where by "Using the magic of augmented reality, the stolen art returns back to its rightful home" (Hacking the Heist, 2019). Thus, empty frames are now hanging where the stolen paintings by Rembrandt, Degas and Manet used to hang and visitors can now see the artworks by pointing their mobile devices at the original frames.

Figure 8 Hacking the Heist

Furthermore, there are myriad of smaller projects in private galleries in different locations that seek to differentiate themselves by means of these technologies. For example, Rubicó Workshop in Mexico paired up with AR/VR Startup, 'Virtual Legacy' to create an app that 'transports' visitors to past expositions at the gallery by clicking different stickers; this app adds value to the on-site museum experience.

Indoor Venue MR

As previously mentioned, combining AR and AI yields smart, interactive technologies that are able to combine the digital and physical world. This combination has also made its way to cultural venues through large, interactive screens or mirror booths. For example, the Smithsonian Institution, Florida Museum of Natural History and the Swedish National Museum of Science and Technology, among others, have used BroadcastAR to transform regular expositions into themed AR experiences. BroadcastAR is a customizable, interactive large-screen that allows individuals to interact with the digital content displayed (BroadcastAR, 2019). Furthermore, AR mirrors let users meet and interact with animated characters and items.

Figure 9 Broadcast AR

Outdoor Sites

As described above, AR experiences have been implemented to small cultural venues for example in museums. The value of AR experiences has been recognized also in large cultural venues e.g. archaeological sites. Using AR in archaeological sites has been researched since the beginning of 21st century. Technology has developed enormously since then.

Former uses of AR in archaeological sites

The value of AR was already realized in the beginning of 21st century. There was a research on how AR could be useful in archeological sites. System called ARCHEOGUIDE was developed for this purpose. ARCHEOGUIDE was a complex system that included AR experience but also guidance around the site through 3D modelled map of the area. The tour guided by the system could be personalized for every visitor taking into account visitors age, interests, education and archaeological knowledge. The information needed for the tour had to be taken before visitor was allowed to take the tour. There were many devices needed for the AR experience, to list a few: HMD (Head-Mounted Display), PC, DGPS (Differential GPS), camera and compass. In addition to the devices carried around by the visitor, ARCHEOGUIDE needed also a system, SIS (Site Information System), that provided the data for the ARCHEOGUIDE. (Vlahakis, V. et al., 2002.)

ARCHEOGUIDE was tested in Olympia, Greece, where visitors could take the tour with the system. Figure 1 (b) shows the equipment that visitors carried with them and figure 1 (a) shows the reconstructed temple of Hera that was displayed by the AR at the site of figure 1 (b). The results of the test were quite clear: the AR experience was surprisingly real but the equipment that visitor had to wear were uncomfortable and heavy. The team of researchers that developed ARCHEGUIDE had plans to improve ARCHEOGUIDE further and in future install is to major archaeological sites. (Vlahakis, V. et al., 2002.)

Figure 10 Reconstructed temple of Hera (left) and visitor wearing the ARCHEOGUIDE equipment (right) (Vlahakis, V. et al., 2002.)

However, the technology at the time turned out to be insufficient for actual installation of the system anywhere. Even with the lack of actual installation, ARCHEOGUIDE was an important first step for usage of AR in cultural outdoor venues. The research, implementation and testing of ARCHEOGUIDE has been referenced in multiple researched after its time.

Current ways of using AR in outdoor sites

The technology has developed enormously since the beginning of 21st century. Most of people have smartphones these days, and AR experiences are now available in form of applications in our smartphones. There is no surprise that currently the most common way of using AR in cultural sites is through handheld devices, that is tablets and smartphones.

AR objects can be positioned to real environment with the use of image-tracking markers and auxiliary markers that make use of multiple data sources. Image-tracking markers are being used in multiple applications for example Augmented Reality Historical Photos of Helsinki (VTT, 2015) that overlap existing buildings with an old photo of it. However, in the use case of outside cultural heritage sites, there are multiple cases where the buildings that once existed at site are no longer to be seen. Thus, image-tracking technique cannot be used by itself. In these cases auxiliary markers such as image-tracking, GPS and other sensor have to be used. The combination of different data sources was already used in the system of ARCHEOGUIDE for the purpose of realistic and dynamic reconstruction of ancient temples. ARCHEOGUIDE used multiple devices to gather the data but today all these required sensors are included in our handheld devices. Even with the rapid development of technology, creating as realistic and dynamic huge 3D object, as ARCHEOGUIDE did, is problematic. (Unger, J. and Kvetina, P. 2017)

There are several applications that provide AR experiences in outdoor cultural sites but not as many as one might expect taking into consideration how common smartphones are and how many applications there are for inside cultural venues. Most of these outdoor cultural venue AR applications are developed for one specific site only for example Empuries App in Spain (IAM EU Project, Empuries App, 2015) and augmented Giorgio da Sebenico in front of St. James cathedral in Sibenik, Croatia (Tahoon, D.M. 2017). Even though, there are problems in recreating destructed buildings, as mentioned earlier, there are impressive AR applications that recreate entire areas that are no longer visible for example Hermes Virtual Tour by aCrm Net (Wikitude, Hermes Virtual Tour) and Carnuntum application by 7reasons and LBI ArchPro (Wikitude, Carnuntum).

Even though, there are AR applications for outdoor cultural sites the number of applications that there are for inside cultural sites is much larger. The reason for the difference is probably the difficulty to accurately reconstruct and position huge 3D objects such as buildings to the users field on vision.

Future uses of Augmented and Mixed Reality

Indoor sites

The main trends affecting indoor venues are robotization, digitalization and rising cultural interest (Son et al., 2018). Thus, the future of indoor cultural venues is one in which digital technologies are used to bridge the physical and virtual worlds. Interactive museum exhibits will become more common as these technologies become cheaper and easier to create (Pardes, 2018). As these technologies become more popular, museums are increasingly turning to them to engage their visitors; augmented reality provides the chance to create more information on top of current exhibits, allowing museums to provide more information to what is already on view (Pardes, 2018).

According to members of the National Museum of Finland, digital technologies will take visitors into exceptional experiences that combine the virtual and real worlds together. Furthermore, these technologies will act as a bridge between the past and the future, by allowing visitors to travel to the past through interactive, digital exhibitions (Son et al., 2018).

Thus, the question is not if augmented and mixed reality technologies will be implemented at indoor sites in the future, but when? Currently, the main constraint for diffusion of this innovation is monetary thus, it can be estimated that wider adoption will occur as AR and MR become more mainstream, which could be between 2021 to 2024 (Yuksel, 2018).

Outdoor sites

There are applications that augment historical characters and applications that reconstructs historical buildings with AR. Vision these two experiences together, vision the experience of whole environment being augmented at site. In this environment, you could situate yourself amongst interactive historical characters surrounded by buildings at their time. This kind of experience is possible with the combination of AR and AI, more precisely MR (Mixed Reality).

There are applications that already give this kind of fundamental experience of another era e.g. TimeLooper (TimeLooper). These applications are made with VR (Virtual Reality), meaning that the real environment you are surrounded is not incorporated to the experience. Using AI properties these existing virtual objects could be implemented to real environment with MR.

Magic Leap (Magic Leap, 2019) is already using MR in applications such as Star Wars: Project Porg. There are multiple ways of utilizing MR in outdoor cultural venues. One could take a bus trip around a town and see historical events in the past as if they were

happening now. Or, one could go to archaeological sites and see, not only one ruined building reconstructed, but see how some of the buildings have been built, for example see how pyramids were built. Or, visit one interesting location, for example Piazza Venezia in Rome, and see how different eras affected the environment of that place.

Therefore, the technology already exists but the context of using it for historical events in cultural venues is missing. However, this kind of fundamental experience of another era should be experienced through glasses not handheld device. When AR/MR glasses become more popular, this is the potential and likely way of using AR/MR in cultural venues.

Figure 11 Timelooper experience in New York

4. VALUE-ADDING OPPORTUNITIES

AR and AI business analysis in cultural venues

Cultural heritage sites are among the most popular tourist destinations around the world. Historical, cultural and architectural components are crucial to keep the attention of tourists, as well as many well-structured and rich information and knowledge should be ready for visitors to perceive (Kerstetter, Confer, and Graefe 2001). With AR, it is possible to enhance this value transmission into users, letting them to fully explore and appreciate historical past events in real time. The main goal of this section of the document is to analyze how AR and AI are related with business activities and results of companies that operate in cultural venues.

AR can add much more value to consumers using and processing an aura of data on each case (O'Reilly and Battelle, 2009). Cultural venues are an enormous business areas not yet fully exploited at the moment by this technology. By providing additional information about any cultural venue, AR can enhance a customer's real-world experience in interesting ways, as it is shown in previous sections of the document. For instance, users can visit the Palatine Hill in Rome using their smartphones linked with devices like glasses in which it is possible to have a reconstruction of the ruined buildings from there, and showing through the devices information in many different ways such as audio or *pop ups* next to the buildings.

Artificial Intelligence could seize the opportunity of the use of AR in cultural venues to generate value as well. The following section explains deeply what AI opportunities are available to exploit in cultural venue environments.

By having AR and AI in different culture venues, it is clear that there is great differentiation of the final product or service these technologies. Moreover, new technologies allow new ways of having costs reduction, e.g. personnel reduction due to the AR/AI device implementation. Differentiations and costs reducing means competitive advantage, and thus generates value opportunities to business that support new innovative business models.

AR and AI business opportunities

The use of AR in cultural venues is linked with Artificial Intelligence in various ways. Thus, these two technologies can provide new business opportunities in various ways:

First, to recognize if a set of building images or videos taken from smartphones or smart glasses are one concrete historical construction, it is needed Machine Learning algorithms

that have been prepared to recognize those specific constructions previously. This technology is called image recognition, and it is becoming very useful for companies, creating new niche opportunities for many industries (Moon 2018)

Furthermore**,** speech recognition is one of the most important features in this applications, as it is better to speak with the device rather than texting it while users are visiting and enjoying any cultural venue. In AR situations, it can be as easy as say any question while the user is visiting a culture venue, and recognize it at the moment in real time. Google Duplex is one of the most revolutionary systems using speech recognition, in which it is able to keep a real conversation between machine and human as a real human in specific scenarios (Google AI 2018). It can recognize what are we saying, how can it process the information captured, and how can it transmit it using common jargon in the speech.

Finally, chatbots allow a natural conversation between humans and computers. That means that the old texting chatbots can be replaced with natural speakers that can be used and incorporated into Augmented Reality 3D virtual tourists guides.

The combination of AI and AR can also create a large amount of processed data that can be used to indirectly generate value-adding opportunities. Companies can analyze the data processed from these AR devices used by customers in many ways (Lonoff 2015). First, by creating more personalized and pleasurable experiences, thanks to the prediction from past events. Also, by retrieving helpful product feedback and improving customer services, thanks to stored data of each individual experience in each cultural venue. Finally, by generating useful information from customer data that can allow crucial business decisions and strategies (Lonoff 2015).

Disadvantages of AR/AI in cultural venues

Not only this strategy has a good point of view, but it could generate the following problems when applying these technologies:

First, it requires high initial investment and innovation costs. AR and AI are both very young and revolutionary technologies. There are few companies that provide these technologies and an incredible demanding numbers for them. For that reason, it requires high initial investment to implement and develop this software at the moment, and most companies are analyzing if this will have a high cost effectiveness or not.

Legal and bureaucratic issues and concerns. The technology can also compromise a variety of human values and has the potential to alter our society in many ways (Roesner et. al 2014). AR has the potential to record scenarios persistently, as they often have cameras to process all information. Also, it is important to differentiate between local and cloud data storage, being the latter more restricting to privacy legal issues. Additionally, AR complicates intellectual property law by gathering and potentially transforming copyrighted to trademarked material that appears in the real world.

The usability of AR and AI by customers in cultural venues has to cover every kind of customers and let them to perfectly understand the application. For that reason, companies must create the software as simple as possible but entertaining at the same time, which is not very easy.

There is a big responsibility behind using AR and AI. Of course, AR and AI has many difficulties with legacy issues because it is not yet developed and we don't really understand what possible effects they can have to the society. We should consider that AI is needed to develop always with responsibility and ethical aspects, and not for any inappropriate usage.

5. DISCUSSIONS AND CONCLUSION

Nowadays, it is possible to visit any cultural venue, be it indoors or outdoors without any technological guide. However, incorporating AR and AI into these venues enhance the way visitors perceive what is being shown thus, we consider them to be a valuable addition. Either to enhance existing elements, or to show elements that are not there, AI and AI provide opportunities for visitors to imagine beyond what they are seeing. Museums all around the world have started to incorporate these technologies into their expositions and we are certain that adoption of these innovations will continue to increase as these technologies become more common thus, cheaper.

Over time, the production and development costs will reduce due to new development technologies, and thus will allow to implement new AR and AI usage in cultural venues. Without a doubt, these technologies are a big opportunity that can generate value to many cultural venues nowadays and ever more in a short future. However, as with any other technology, it is important to keep in mind the dark side behind it such as privacy issues, in this case.

Conclusion

Augmented reality and artificial intelligence are two of the most talked-about technologies during the last years. The hype has also turned into real-world use cases. Cultural venues like museums were not interactive and for some people even boring places in the beginning of the 21st century. However, nowadays those cultural venues have started changing into interesting interactive high-tech places where people can see the possibilities of AR and AI.

Very first AR experiments were already implemented in the early 21st century in cultural venue in Greece but it was ahead of its time with technology which was not so comfortable to use. After AR technology started to work greatly with easy to use smartphones and AR glasses, cultural venues have started implementing more and more AR experiences for their customers. Nowadays you can for example see stolen paintings with AR and see how your favorite city street looked back in the history. AI has also been taken into use in cultural venues such as through robots which use AI to act as guides. AI and AR could be used together as mixed reality (MR) to recreate whole historical sites where you could interact with historical figures and places through AR glasses. Technology for all this is already available but practical implementations are yet to be seen.

AR and AI both can affect the business of cultural venues positively. Most importantly, AR and AI can add value to the cultural venues for the visitors and attract more and new visitors who can experience being more connected with the historical events. With AR

and AI there are also no risk of breaking physical historical artifacts since customers can experience them virtually. Cultural venues could also reduce cost by not hiring real guides but use AI guides with AR technology. However, there are also some disadvantages. AR and AI technologies are still quite new so their initial investment costs are still quite high so they might not be available for smaller cultural businesses. Also there could be some legal issues with for example AR since AR devices usually have cameras and they could record everything the visitor sees.

To conclude, AR and AI are technologies which are already used in cultural venues, but most likely will be used a much more in near future when the cost of investment starts to lower. Those technologies can create really interesting and valuable experiences for visitors which benefits the cultural businesses. Only time will tell what kind of cultural experiences people can soon experience with AR and AI and other emerging technologies.

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IMPROVING PREDICTIVE POLICY WITH ARTIFICIAL INTELLIGENCE

TLO-35306 2018-01 Global Information Systems Management

Group assignment

Dóra Bereczki
Julien Haslé
Daniel Ochs
Jeanne Tremblay

ABSTRACT

Improving Predictive Policy with Artificial Intelligence
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This report examines the current usage of Artificial Intelligence to predict up-coming crime areas, so called Predictive Policing. In the first part we introduce the topic and review ethnical and ethical problems that are related to Predictive Policing. Based on the problems and the current situation we suggest a more proactive approach and how-to extent the model trying to avoid the problems discussed before. The last part covers how this approach can be applied in the real world and how other private institutions and companies are able to implement a similar system.

Keywords: Predictive Policing, Artificial Intelligence

1. INTRODUCTION

The AI currently being developed around the world has many capabilities. Some AI's are used to improve the development of technology; however, many are still using for entertainment and do not provide much-added value when using AI. AI is very useful when it comes to making choices that humans are not able to make instinctively. The AI is well suited for planning complex tasks when it comes to finding the optimal solution in a large number of variants [White 2017].

Assign people to workstations, machines to tasks, develop a schedule, schedule manufacturing processes, manage traffic, cable a building, assign tracks to trains, platforms to boats... All these problems, which are faced by manufacturers, transport companies, engineering companies, and training organizations, can be summed up in a single question: find the optimal solution based on given resources. Those are problems that, if not too complex, are usually solved by hand. However, computer science and more specifically AI provide a multitude of solutions to solve these problems when they become complex [Ismail 2017].

In the context of public service interventions, but more specifically those of the police, the use of AI can be a real source of improvement. Indeed, the cyber-police strongly increases its capacities in the field of AI. An AI platform is being tested in the US police services and claims to be able to predict where crimes will be committed. The tool comes from a company called PredPol, which is short for "Predictive Policing". This company claims that the software can predict crime in an algorithmic way, based on the theory of broken windows applied to predictive fonts. Other companies such as Palantir, CrimeScan and ShotSpotter Missions, argue that the version integrating AI, at the predictive police level, goes beyond the traditional hot spot analysis, which involves reacting according to everything that has happened before, in a given place, whereas here it is more a question of anticipating what is likely to happen in the future [PredPol] [ShotSpotter]. The establishment of such an AI could represent a real step forward in combating the rate of crime and criminality.

This paper is made as an assignment for the course TLO-35306 Global Information Systems Management at the Tampere University of Technology. In the first part we will look at the use of PredPol and what they try to avoid. In the second part we analyse problems that come with use of predictive policy tools in general so we can then later look on how to avoid them. The focus in this report is on the ethnical and ethical problems because in our eyes those are the biggest issues with predictive policy. After ana-

lysing the problems that can occur, we examine how PredPol's technology can be expanded and optimized without raising those ethnical and ethical questions discussed before. In the last chapter we suggest steps to implement possible solutions and how other fields and sectors are able to use these solutions as well.

2. HOW PREDPOL WORKS

First, it is important to mention how PredPol is working so far. They rely on a machine-learning algorithm. They use only three types of data, which are crime type, the crime location and the time the crime has happened. They find the information in historical events of the city where they wish to predict crime. Then, the machine-learning algorithm is able to find the most probable location of the crime. The location can be visualized in a Google Maps interface, where red boxes point to the location. An example is presented below. [Fig.1]

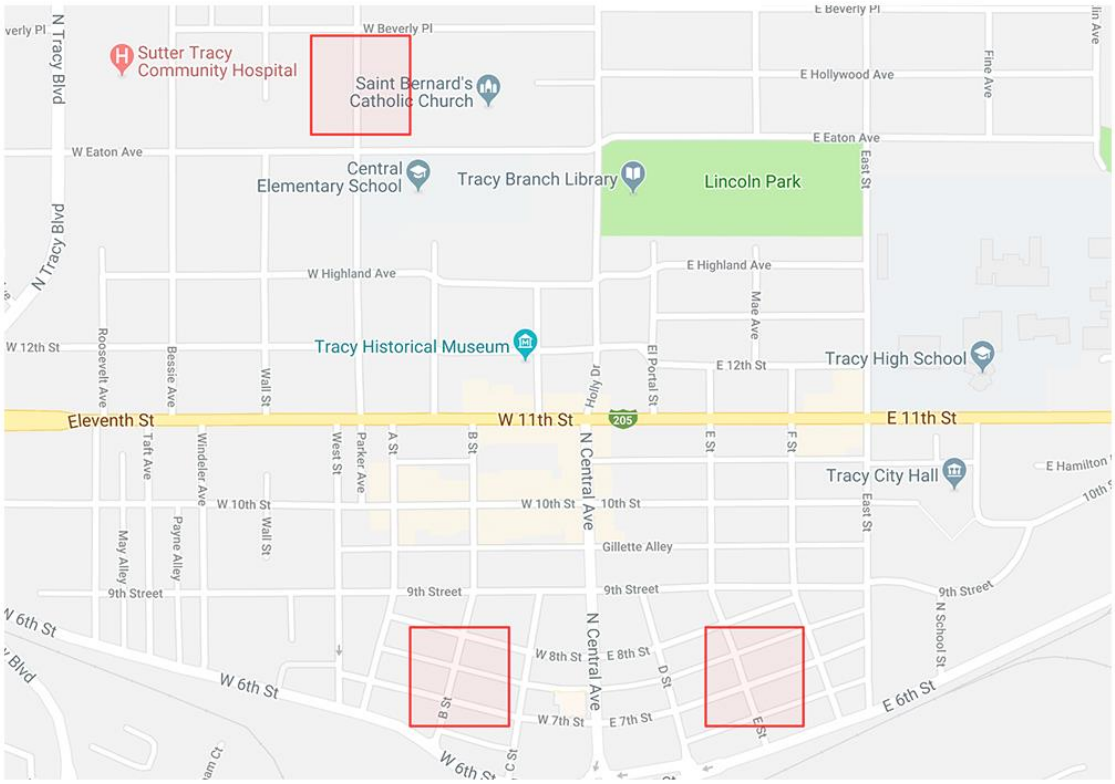

Figure 12. The Google Maps interface of PredPol

The boxes measure 150 meters by 150 meters. With this information, it is easier to see where the most important places are to send officers to patrol. Usually, the police make sure that their officers spend about 10% of their shift in the PredPol boxes, as it is still important to patrol everywhere else [PredPol].

In addition to this map, PredPol also has another program that helps with resource allocation. In fact, they created the PredPol Heat Map, which shows how much time the box is patrolled in total during the day. It can be used to see if the areas have too little officers, which could make it dangerous, or too much, which makes them lose their time. An example is shown below. [Fig.2]

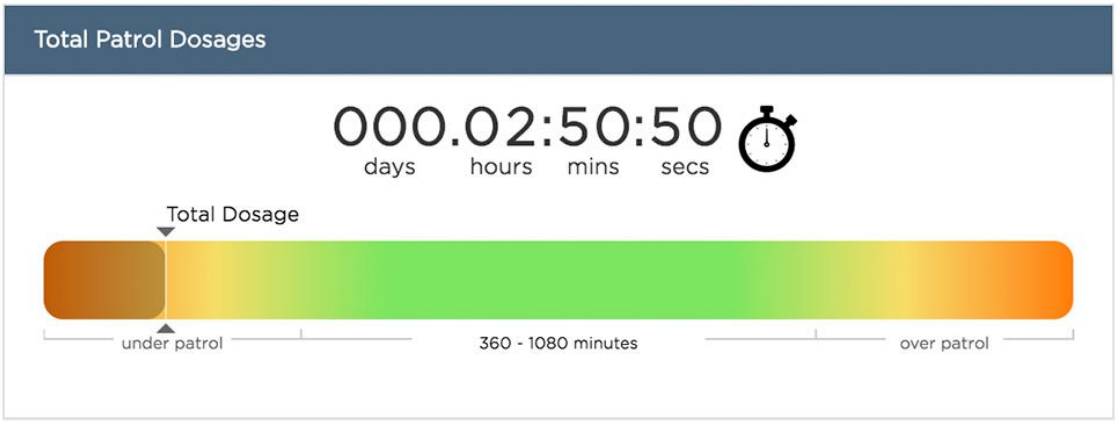

Figure 13. Total Patrol Dosages

To PredPol, privacy and information security are very important. They use cloud-based software that is secured in many ways from hackers. Still, the data is easy to read and accessible quickly for the police department. It is also possible to share it with the local government. On their website they are saying that no personally identifiable information is ever collected or used and that they believe that protecting the privacy and civil rights of the residents of their communities is as important as protecting them from crime. Therefore, they try to avoid raising questions about questions like ethical or ethnical ones are.

So far, PredPol is mostly used in the United States of America. In the state of Kent, the police department noticed that street violence has been reduced by 6% within the four months of testing this new technology [PredPol].

We think that some other data could be interesting to use in order to push this idea even further. The main goal would be to prevent crime in the locations PredPol suggests. With the data already used, it would be interesting to see if there are other links with what causes crime. By example, looking around in the highest crime zones could give clues on what kind of areas are dangerous. Are they close to a liquor store? Or not well enlightened? Finding out some links between the zones could be a way to prevent crime even more effectively than only using the three data points PredPol is familiar with. Then, the goal would be to resolve those issues in every place that has them. Hopefully, those places would become less dangerous.

General Problems with the usage of Predictive Policy Tools

PredPol tries to avoid raising ethnical and ethical problems with using just a small dataset. In this chapter we want to take a look at the ethnical and ethical problems that can occur in general with the usage of predictive policy tools.

2.1.1 Ethnical problems

To tell the truth, talking about race problems is rather difficult without any partiality or bias. What makes the views on race and crime so polarized? What are the facts about race and crime? Is “big data” discriminating? Does PredPol have a hidden weakness? To discuss these emerged questions are more complicated as we would have thought.

Firstly, important to understand the portrayal of crime mediated by society than the actual dynamics of crime. To take a look into for instance an American society it shows that, it was throughout in American history. Most of the representation of crime is predominantly committed by a Black person [Scheingold 2010]. In the UK reported by the government that the ethnic minorities people are more likely to be arrested and become a victim of a crime [Bulman 2017]. Among the society the perceptions about the identity of the assumed race of criminals might be engrained in the public consciousness and find the connection between them. It seems like, “talking about crime equal talking about race.” [Barlow 1998]. This common discrimination penetrates also in the criminal justice system. Many people believe that they biased against them [Hurwitz & Peffley 1998]. According to the studies; the survey was administered to a random sample of participants that revealed a belief that Blacks are crime prone. Approximately half of the respondents believed that a relationship exists between race and criminality, among them, 65% thought that Black people perpetrated more crimes than other racial groups [Ferguson 2017]. If we are talking about the race -and crime is regarded as a political issue and have to take a look to the distant, have to deal with poverty or unemployment, which might be propounded other unanswered, hidden questions.

Nowadays a rise of big data policing “PredPol” emerged as a new technology to predict and diminish the crime rate. In additional to become more objective and accurate against the traditional policing. But the “coin has two sides”. The way the “big data” might be discriminated is that; PredPol uses an algorithm, that phenomena try to get rid of all the anomalies which might correspond with the minority populations.

The creation of the model to predict the outputs reveals some important questions. The algorithm, instead of fixing biases in policing it blames for a new set of problems. Inputs go in and generate the output, based on the correlation. If the algorithm based on biased data, it can result in a biased output. For instance, if the police arrest people mainly from their colour from the minority districts for drugs, even if most all of the people from all of the races use the drug, it will result in the correlation between race and the uses of drugs. Additionally, the researchers examine how PredPol predicts the crime, their study proposes that the software only deals with a “feedback loop” that means the police officers being anew sent to those neighbourhoods, where the number of the racial minorities are high regardless of the true crime rate in that area.

Moreover, the correlation does not precisely show the existing criminal activity through society. Why input could be biased data? The danger is in these algorithms. The algorithm itself is quantitative, on the other hand, building the “big data” system requires human judgment, the data produced by them. The whole design of the system can be affected by human decisions. It may reflect the biases in these data, continual discrimination and negative biases about a minority group [Reynolds 2018][Smith 2016].

Researchers used 2010 reported crime data from Oakland to predict where crimes would occur in 2011. [Fig.3.] They used the data from the survey database to create a heat map showing where drug use in the city was most prevalent in 2011. As I mentioned the software deals with a “feedback loop” that means the algorithm chooses how to distribute the resources between two locations. If more are sent to one location, they willing to make more arrests there, so it leads to send more officers to that same place and the area become over-policed especially ones with a high number of racial minorities – whether of the true crime rate in that area. That happened in this case as well, the Police practices in Oakland matched up with PredPol's suggestions. Police in Oakland is already doing what PredPol's map suggested- over-policed minorities neighborhoods even if white people used illicit drugs at higher rates than minorities according to the survey [Smith 2016]. [Fig.4] In this case we could see the PredPol is not capable to predict and diminish the crime in the right way.

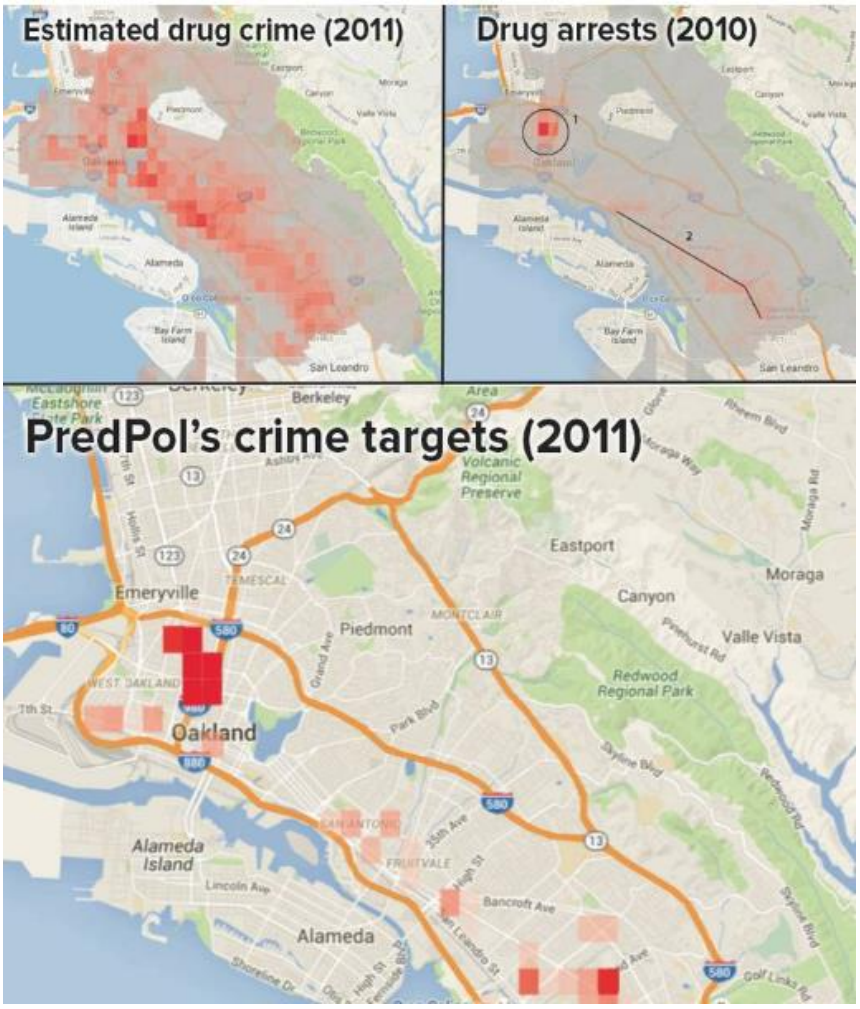

Figure 14. PredPol case study

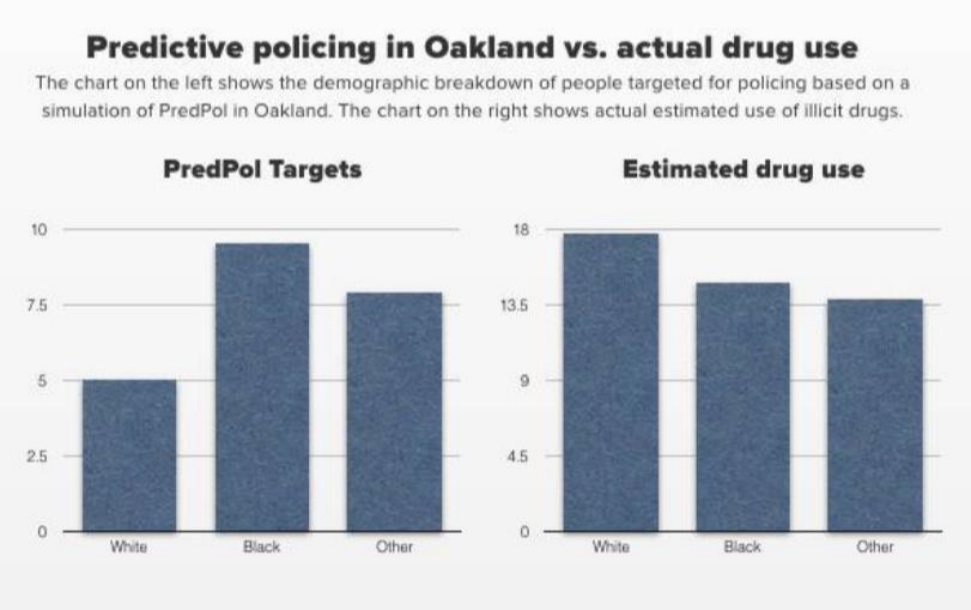

Figure 15. Estimated drug users vs. PredPol targets

Lastly, it hard to predict the future about the PredPol, whether it's able to solve or ease the ethnical problem among society. At least we have a belief in this "big data system" to predict a high chance of crimes in that are in the future without bias and bring us a more objective and accurate policing.

2.1.2 Ethical problems

Some police departments also use facial recognition and behaviour software to prevent crimes before they happen. Even if using those AI products is promising for the future, there are also some ethical problems regarding this subject.

To begin, that software is usually based on criminal records and events already reported by the police or the citizens. Since the algorithm uses the data from before, there is a risk of creating a loop, as the software will give results from previous crimes.

Artificial intelligence is also used in the justice department to develop facial recognition. In fact, mixing facial recognition with the methods PrepPol is currently using would be an excellent way to prevent crime and to also catch more criminals. Using the pictures in the database, AI is able to find the corresponding face when a criminal is caught on camera. This is, unfortunately, the main ethical problem, as facial recognition is very intrusive. People have their picture in the database without knowing it [RTLInfo 2018]. The software used to predict the criminal's face are based on social media, events, relationships… The way these tools work isn't very clear to the citizens. That makes it even scarier for them, as there are not many rules or laws regulating the use of that kind of software. In fact, the best way to stop facial recognition from being so intrusive and scary

to citizens would be to expose how the tool works and to have explicit laws detailing the rights of use.

Another interesting thing to observe would be the use of the algorithm to evaluate the penalty of the criminal. In fact, using AI, it would be possible to predict the probability of a criminal striking again, using data about the gravity of the crime, and the story of the criminal, which includes gender, age, criminal report, family issues, etc. [Forbes 2018]. Having the information about the chances of repetition of crime could help judges and other law professionals determine the length of a jail sentence or the amount of the penalty. It can be debatable to have software making such important decisions as it doesn't have the humanity that can be required in particular situations. On the other side, having a tool like this one could reduce costs and workload of the penitentiary system.

3. IMPROVING PREDPOLS TECHNOLOGY

The dataset that is currently being used includes historical data and current data [PredPol]. Our idea is to include new datasets to enhance the capabilities of the algorithm to predict crime more precisely and in the second step suggest preventive actions. In this chapter we examine which datasets could be added without raising ethnical and ethical questions discussed before.

Areas with higher crime rates changing in the future. When police are showing presence in a certain location the crime rate will drop in that area. Even though overall crime rate will fall the crime rate in some other areas may rise. The area of crime is then just shifted from one place to another. When that happens, the algorithm will send policemen to the new location creating a never-ending loop of sending troops from one place to another. PredPol is currently giving day to day suggestions where crime is going to happen and then suggests scheduling and resource distribution according to the daily crime risks [PredPol]. The algorithm should, therefore, be trained to predict in which locations future crime is likely to happen. An algorithm that tries to predict the future and then evaluates what really happened in the future can optimize itself during the years. This would then help to solve the problem of rising crime hot spots because the AI could distribute the right number of policemen to the current hot spot and the right number of policemen to a location it predicts that is going to be a future hot spot. One problem is that the further the algorithm tries to predict crime in the future the worse accuracy is becoming. To increase the capability of looking in the future adding more data is key. Like humans, a decision can be made more easily when the knowledge base is better. So which data can be added?

In the last chapter where we discussed ethical questions we already introduced the idea of facial recognition. Facial recognition could be used in many different ways ranging from surveillance in just some public areas like public transportation or really crowded tourist spots to surveillance everywhere [Schuck 2005]. To recognize someone trough facial recognition at least the face has to be stored somewhere in a database. Facial recognition could help in the way, that the algorithm could make assumptions when criminals go to areas with a high rate of criminality or meet with other suspicious persons. Every country has some kind of system storing data with information about recent criminals and what they did. So why not make further use of it? To enhance the dataset algorithms could be developed crawling through social media and searching for keywords that could indicate upcoming crimes [Malleson & Andresen 2016]. The possibilities of using personal data seem endless and there are many ideas out there to connect different datasets containing personal information to reduce crime even more. The problems that hinder its adoption are the ethical and ethnical ones. Totalitarian systems are very intrusive when it

comes to personal rights and integrity of privacy. We, therefore, think that it would be recommended staying with the approach PredPol is taking and try to not violate personal rights or raising racial bias concerns at all or just in some justified cases.

One study by Wang, Dawei, et al. [2013] tried to examine where and why certain locations are targeted. They tried to explain why certain areas are more prone to crime using a bigger set of socio-economic variables. In their model, they used variables like the number of commercial burglaries, street robberies and motor vehicle larceny but also the number of following arrests. Those variables are similar to the ones used by PredPol. In addition to those variables, they used the number of foreclosed homes, the population and housing density. Dense populations are positively related to residential burglary. Another variable is the distance to colleges which is used because during the semester break student properties are easy targets for burglars.

Thinking about other socio-economic variables one could up with for example liquor stores in certain areas or the number of streetlamps in dark areas. The use of socio-economic variables might be a better approach to increase prediction accuracy because they don't violate personal rights. Depending on the variable some of them might raise some ethnical questions which may hinder its adoption. Compared to the usage of facial recognition and social media data socio-economic variables are not so questionable and the concern of using them is not so high.

After scaling up the model and algorithm to predict the future more precisely the next step would be to train the AI system to be more proactive. Currently, AI is based on machine learning. Machine learning algorithms try to figure out patterns and rules for a given set of input variables. Usually, the variables have certain weights in this case representing their influence on the crime rate. When a variable isn't increasing the accuracy, it's going to be sorted out by the algorithm by weighing it with a low weight. This can be used to make proactive suggestions that are related to certain variables and features. To give an example if the cause of crime was influenced by alcohol intake someone could consider taking liquor store locations into the dataset and model. The algorithm could then suggest timeframes in which it is forbidden to buy alcohol in certain areas. Other drug-related actions could be suggestions about where to open new institutions that offer help with drug abuse. When the algorithm detects a correlation between crime and the number of streetlamps in an area the algorithm can then suggest adding more streetlamps in this area.

In conclusion, it can be said that there are new potential ways to increase accuracy, be more predictive in the future and maybe go into a more proactive direction. If an AI can do all this is questionable and small steps have to be taken and then be evaluated to see if such an approach can work.

4. SCALING PREVENTIVE ACTION

To apply our ideas to the real world we put together four steps that could be used as a guideline or as a blueprint to implement AI for Predictive Policy. This blueprint can then also be used in other professions and areas.

The first step is to identify existing data that has a potential in solving some kind of problem and that could help to increase the accuracy of the existing models. Most of the companies gathered a lot of data in recent years [McAfee & Brynjolfsson 2012]. The internet is one of the reasons the amount of generated data is rising up. Analytics and more specific Artificial intelligence are key to analyse this data and get insights from it. Therefore, a company should consider which existing datasets they are collecting and how to add additional data to these datasets. They should also look at other completely different datasets that they could add to their systems. Combining different datasets to get additional insights is also an option. In the case of Predictive Crime, they could use the datasets they are already using (crime time, crime type and crime location) and add facial recognition datasets if they are existing or build a new information system that is collecting the data first.

After identifying potential enhancements to the data being used by AI, those enhancements should be reviewed. Problems may occur while using the data. In the Predictive Crime example, ethnical and ethical reasons are the main problems, described in chapter 2. Here the benefits should be weighed up against the problems. If the use of Facial Recognition is a really good way to prevent crime or find criminals in public places, can the infringement of privacy then be justified? Applying current law to solve those questions should be the first step. In most of the cases, the company or private institution should ask their legal department or should consider asking some lawyer for advice. When it is allowed to use the data by law, the companies and institutions should consider their appearance in public. Using some controversial datasets may cause public outrage and leave a bad reputation. Talking about the law, ethnical and ethical questions and maybe opening a public discussion can give more insights.

After careful consideration, if it's okay to use the dataset in ethnical and ethical perspective, the net worth of adding additional data should be checked. On the one hand side, there are the costs of collecting the data, storing the data and analysing the data. For example, data that is not being used at all is just producing maintenance costs. On the other hand, there are benefits. When it costs a lot to collect the data, compared to just a small increase in accuracy then it should be considered to use data that is not so expensive and has the same impact. Ranking the options after performance increase compared to costs

could help to decide. In some cases, predicting the performance increase may be impossible. Expert interviews, logical reasoning or reviewing other or similar best practices should be taken into consideration.

The last step after making the decision of using a new dataset is the implementation itself. If needed existing infrastructure has to be scaled up to handle the new data. When all the requirements are fulfilled to collect and store the new datasets or if the existing information systems have been successfully connected then it's time to train the algorithm with the new data.

Applying AI should be an iterative process where you try to improve your algorithm and input data from time to time evaluating the improvements. The field of AI is changing rapidly, and best practices are getting outdated quite fast. Therefore, keeping an eye on new technologies that can be implemented to gather more data and new machine learning methods that can help to improve accuracy is a must.

How to apply artificial intelligence to staff people

The use of artificial intelligence can be carried out in all environments. The problem that is solved by PredPol can be viewed as a resource allocation problem. These kinds of problems occur in other sectors too. For example, in some environments where the speed and reliability of data are very important, the use of AI may be the optimal solution. The accuracy of the data requires a multitude of information and data backups. In the public sector, its data are very often stored and make it a usable source of information. In areas where emergencies are critical, resource allocation is very important. Resources must be placed in the right place to avoid unnecessary movement and non-use of resources. Let us take the example of the fire brigade. When we talk about new technology in this kind of situation we often think of the robot to perform dangerous actions. There are many possibilities to implement new technologies in a fire station. The most important thing in an urgent situation is to allocate the right number of resources but also the right type of resource. For example, for a small garbage fire, there is no need to send 3 trucks and 15 firefighters, this would put the area at risk because these firefighters could not be assigned to other emergencies. In the opposite way, if a fire projects onto an entire building, it will not be enough to send 1 truck with 5 firemen. To do this, it is necessary to have a certain mastery of these resources and a certain knowledge of the type of intervention. By combining data and analysing it, we can compare them with PredPol's technology. A project set up in partnership with the French fire brigade, in order to be able to anticipate their interventions, and thus adjust the number of personnel in time and space in order to avoid capacity saturation or excessive mobilization [Fortin 2018].

The use of the AI makes it possible to better anticipate the risk of unscheduled hospitalizations of a given patient based on his or her characteristics. The team at the George Institute of Global Health at Oxford University has developed a tool to be more proactive

in hospitals. The objective of this study is to provide a tool that allows health professionals to accurately manage the risk to their patients and, as a result, make better screening decisions and be proactive in providing care that could reduce the workload of emergency room admissions [Wunderlich et al. 1996].

The use of AI is now increasingly used in the private sector. Capgemini, a technology consulting company, has developed a system for the recruitment and allocation of human resources according to specific missions. The computer examines, on the one hand, the work to be done and, on the other hand, the available staff or potential candidates and tries to match them as closely as possible. As a result, staff with expertise in certain areas are considered experts and are used for the best they can do and not for their versatility. At this system, we can discover that there are some gaps. Indeed, having a work team that is very competent in one field but has gaps in some other fields can be very dangerous.

Let's take as an example a team composed of programming experts but having no project management or management skills. This team will not be able to complete the task requested due to its lack of competence. In this situation, it is, of course, necessary to be careful to integrate a multitude of knowledge into a team and thus can develop experts in an increasing number of fields.

There is, therefore, a multitude of areas in which resources can be allocated through Artificial intelligence. Some of these fields may have similar problems or completely different problems for example personal rights violation. It has to be checked whether each of the respective cases is suitable and which variables can be used to solve the individual resource allocation problem.

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MACHINE LEARNING TECHNIQUES FOR NATURAL LANGUAGE PROCESSING

GLOBAL INFORMATION SYSTEMS MANAGEMENT

Jaakko Varjonen

Petri Salminen

Teemu Mikkonen

Arthur Le Callonec

ABSTRACT

This course work is aimed to discover and describe the current and perhaps oncoming trends regarding utilization of text data in enterprises. The research process was divided into text preprocessing, methods of utilization and the ethics concerns that can are present when processing and analyzing natural language.

Emphasizing text data preprocessing is more than justified because the nature of the text data is not as unambiguous as e.g. numerical data, which also requires a great deal of preprocessing. This research describes data preprocessing in universal terms as well as it describes the different preprocessing steps that are usually taken when analyzing data in a text format.

As our focus on this research was the utilization of text data, this research also presents few common methods of how enterprises can use text data and machine learning methods in order to e.g. gain more insight with advanced text analytics or create new solutions and services such as chatbots and automatic machine translation.

Finally, our research includes a discussion on various ethics concerns. While machine learning powered text analytics can be very useful to an enterprise, the data used in the process must be subject to regulations such as GDPR. Privacy issues were also considered, e.g. using email correspondence for sentiment analysis.

1. INTRODUCTION

Research and advisory company Gartner is known for mapping and setting trends in the field of Business Intelligence and analytics. Already in 2017, Gartner's magic quadrant for Business Intelligence trends mentioned a "new wave of data discovery" in which Natural Language Processing (NLP) was also included (Gartner 2017). Natural language processing has risen to a prominent field in data analytics due to growing amount of computing power and the improved machine learning methods that are available (Hirschberg & Manning 2015).

Natural Language processing is an integral part of how we communicate with machines. Inventions such as Apple Siri, Google Search and automatic translations are all successful due to advances in NLP. Further research is still required in order to improve machines' grasp of e.g. semantics of words in any given place (Hirschberg & Manning 2015) Study of text analytics and Natural Language processing is therefore a cutting-edge field that lots of enterprises could benefit from, which in turn was one of the main reasons for the choice of this research topic.

As our research lens we have chosen a descriptive approach. In this assignment we inspect processing of unstructured data, more specifically data in a text format, such as documents, emails, tweets etc. The research is done as a literature review. This report is limited to reviewing text data processing in an enterprise context. The purpose of this study is to answer the following research questions:

1. How is text data preprocessed?
2. How can text data be utilized by enterprises?
3. What ethical considerations should be taken into account in Natural language Processing?

The structure of this assignment is as follows. First the justification for the chosen topic is covered. Next, the theory is opened behind unstructured data, text data and preprocessing methods that are required in order to achieve data that can be analyzed. The following chapter is aimed to describe some of the notable machine learning methods behind text data analysis and Natural language processing. This chapter also describes applications that enterprises can achieve by utilizing this data. Last part of this research focused to ethics of data utilization. Companies are using more and more data analyzing so they can learn more about their customers, which calls for regulation and oversight.

2. JUSTIFICATION FOR THE TOPIC

As mentioned in the introduction, Gartner (2017) has included natural language processing as a trend in their report “a new wave of data discovery”. This is a clear indicator that natural language processing is a topic worth researching.

What problem natural language processing solves is that it makes text data available for computer assisted analysis. It is claimed that unstructured data (which text data is a subset of) covers 80% of the data in the world, however we did not manage to find scientific evidence to back this claim. Whatever the proportion of the unstructured data is, there is a lot of unstructured data, that can now be used to gather insights that are relevant to organizations in ways that were not even thought of ten years ago. For example, natural language processing can be used to extract information of how aware of a mass emergency the population is on an area where an emergency is happening using just data from Twitter (Verma et al. 2011). Natural language processing can be used for several other tasks as well, such as automatic classification when hiring (Bell 2017). In the future, an artificial intelligence could be present in every business meeting and it would answer questions that are easier for it to find than to human, for example “What was the ROI on that last year?” (Bell 2017). This would save a lot of time from people to focus on interaction with other people.

In addition to natural language processing, this paper has a focus on data preprocessing. Finding, cleansing and organizing data takes up to 80% of data scientist’s time (Gabernet & Limburn 2017). This is obviously too much, because less time is spent creating value through the actual analysis.

3. DATA PREPROCESSING

Nowadays you can find almost an infinite amount of data on any almost subject. Digital data can be broken down into structured digital data and unstructured digital data (Kratochvil, 2013). Simply put, unstructured data is any data which is not stored in a structured format whereas structured data is anything that has an enforced composition to the atomic data types (Weglarz, 2004). Structured data is possible to read automatically but unstructured data needs human intervention to make the data machine readable (Weglarz, 2004). At least, that was needed at the time when Weglarz (2004) did his research.

People are unknowingly using unstructured data every day. Individuals may not be aware of how much unstructured data is used every day. It is used when making, storing and retrieving reports, e-mails, spreadsheets and other documents (Weglarz, 2004). Unstructured data can be divided into two basic categories: bitmap objects and textual objects. Bitmap objects are inherently non-language based, such as video, audio or picture files. Textual objects are based on a written or printed language, such as Microsoft Word documents or e-mails (Weglarz, 2004). Social media entries are also a good example of unstructured data, as they often include various types of unstructured data such as text, videos, or images.

3.1 Data preprocessing in general

Data preprocessing aims to solve several problems with the inputted data. These problems include data duplication, noise and imbalance. Also, feature extraction can be seen as a preprocessing step. (Zhou et al. 2017) These problems vary between different preprocessing methods of course. According to Huang (2016), the simplest preprocessing method is the removal of flawed records, which, for example, have missing values. However, this works only when there is a small amount of removable records (Huang 2016).

Garcia et al. (2016) separate preprocessing algorithms into data reduction algorithms and imperfect data algorithms. Imperfect data algorithms are removing or replacing missing records or making the data consistent (Garcia et al. 2016). An example of such operation, where data is made consistent, is making all values of 1.0 just 1 etc. Another example would be to convert all dates to the same format. This can be seen as a removal of noise from the input data (Garcia et al. 2016).

Data reduction algorithms work the other way: they try to aggregate and minimize the data in a way that it is small enough for our processing needs (Garcia et al. 2016). This really depends on the way that we consume the data in the processing step, so there is not

one right answer on how to execute data reduction on the data. An example of data reduction would be to calculate the mean of some signal every minute. If the signal would have a sampling frequency of 1Hz, that would lead to 60 times data reduction! With data reduction algorithms, the analyst should always keep in mind that information can get lost when reducing the amount of data.

3.2 Preprocessing of text data

Fixing missing fields and removing duplicates are quite easy tasks if the data is in structured form. However, the preprocessing tasks can become more complex when they are applied to unstructured data, for example text data. The preprocessing methods used depends heavily on the data and the analysis methods that are used.

Since text is usually written in some specific language, certainty about the language of the data should be achieved. It is possible to remove the text that is written in a different language (Zhou et al. 2017). Zhou et al. (2017) achieved the removal of non-English tweet by making use of Google's language detection web service.

Lemmatization is a preprocessing method, where different grammatical forms of one word are grouped together. This effectively transforms different grammatical forms into the basic form. (Nukarinen 2018) For example, the word "came" would become "come" and "dogs" would become "dog". This can be beneficial, when counting different words for example. Lemmatization is not a trivial operation, because words can have varying meanings and lemmatization can change the meaning of a sentence (Nukarinen 2018). For example, the word "record" can have different meanings in different context.

Depending on the analysis, it can be beneficial to remove special characters, URLs and names from the text (Rout et al. 2018). In Rout et al.'s (2018) research, they did a sentiment analysis to 60 000 tweets. As a preprocessing, they (2018) removed URLs, repeated letters, stop (for example for, above, about) and question (for example what where why) words, special characters, retweets and hash symbols.

Statistics and machine learning can help in the preprocessing of structured data (Li et al. 2019). Hopefully in the future statistical machine learning algorithms can help with the preprocessing of text data also.

The preprocessing is completed when the data is ready to be analysed. There is no right answer to how much preprocessing should be done. Next, the data can be analysed in a way that is preferred.

4. TEXT DATA IN MACHINE LEARNING

Pre-processed text data has various applications in the fields of Data Science. Use of text data in Machine Learning is often referred as Natural Language Processing (NLP). NLP is a collection of methods to transform natural language (language as it is written or spoken) into computable format. The rapid increase of the number of text documents in digital form is a strongly contributing factor and a motivation of development of NLP techniques (Trstenjak et al. 2014). Use of NLP opens up new possibilities for data analytics and Business Intelligence as it adds a new type of data for enterprises from where they can gather insights. (Krishnan & Rogers 2015)

There are various different ways to use Machine Learning to benefit from data in a text format. These use cases include for example sentiment analysis, text classification, keywords search, machine translation and spell checking. (Church & Rau 1995) (Trstenjak et al. 2014) (Krishnan & Rogers 2015). In this chapter, some of these applications are briefly introduced including some of the Machine Learning techniques that are used to make them.

Text classification is a way of automatically assigning a document into a group or a category that corresponds the topic of the document (Trstenjak et al. 2014). In order to classify texts, features need to be extracted to determine these groups. These features can be extracted using a technique called TF-IDF, which stands for Term frequency- inverse document frequency. This is a method of finding how important each word is to a set of texts and the most important words can be used as features for classification. This works by calculating the amount of times the word appears in each of the selected text snippets. The number is then reduced by the frequency of the snippets it appears in in order to get rid of irrelevant words that appear everywhere. (Leuhu 2015) The final classification is made by using a machine learning algorithm such as Naïve Bayes or K Nearest Neighbor, which classifies text samples based on their Euclidean distance to the features. (Trstenjak et al. 2014)

It is also possible to classify text objects by sentiment factors. Sentiment analysis is usually associated with social media data. Simply put, it is a way of determining the general feeling embedded in a text document, or e.g. a tweet. (Krishnan & Rogers 2015) Sentiment analysis can also be done with classification and utilizing similar methods, only with a focus of classifying texts by attributes that reflect emotional responses. This is achieved by teaching a machine learning classifier with examples of texts that already are predetermined to include different emotions. Classifier can be taught with these objects to later apply the learning to determine the sentiment of texts that it has not previously

seen. (Thelwall 2019) Sentiment analysis can be used by companies for example to analyze customer feedback and use this knowledge to improve and develop their products and services

An emerging technology in NLP is conversational Machine Learning systems such as different Chatbots. Chatbots are either voice or text guided systems, that react to user input and help the user achieve a (typically very specific) task. (Dale 2017) Chatbots are used in personal use in a form of virtual assistants as well as in commercial use as e.g. customer service assistants in various kinds of businesses. Although Chatbots have existed before as rule-based systems (predetermined answers for different queries), Machine Learning enables handling more adaptive and complex queries. A significant advantage of Chatbots is the reduced amount of human labour and administration, therefore reducing costs. (Androutsopoulou et al. 2018) AI based conversational systems also have their use in education, such as medical training, where the conversational system can simulate interacting with patient. (Neustein & Markowitz 2013). It can be argued that Chatbots are intelligent human-to-machine interfaces, albeit they are usually narrow and case specific to a single purpose, such as customer assistance.

It is also possible to use Natural Language processing to generate automatic summarizations of longer documents. This means automatically finding the most relevant words and sentences in a document in order to create a shorter version that still holds most if not all of the relevant information of the source document (Merchant & Pande 2018). Text summarization can be used for example to speed up research process, diminish the amount of human bias in the selection of relevant content and to diminish costs of summarization process, previously conducted by humans. (Moreno & Manuel 2014). Text summarization can be used for example to find relevant information e.g. in research papers, legal documents or even news articles (Lloret et al. 2013; Merchant & Pande 2018).

Another example of NLP is machine translation, which means translating one natural language to another (Oxford Reference 2016). Utilization of Deep Learning and Neural Networks have created a translation method called Neural machine translation. In this method, Neural Networks are used to create word vectors in order to capture the semantic context of the word. (Zhang et al. 2018) Semantic context (word vector) from the input language is then translated to another language by using a corresponding word vector of another language (Moussallem et al. 2018). Machine translation gives enterprises a cost-effective option to translate their documents e.g. technical specifications and user manuals to another language.

Technologies presented above are only some of the examples of possible NLP applications. Each technology can be adapted into a specific business case and possibilities of Natural language processing include for example market strategy development, decision

making processes, strategic analysis and opinion mining (Choi & Lee 2017). We can deduce that NLP is multipurpose set of technologies that can be used to gain business insight from text format data.

5. DISCUSSION

This assignment shows how companies can prepossess and process text data. Companies that are able to conduct Natural Language Processing may gain a competitive advantage over their competitors. However, as promising this technology is, it also raises ethics concerns which are addressed in this chapter.

5.1 Ethics of Text data utilization

Where to draw the line in a Digital Age where the data collection happens all the time? We know the customer is constantly solicitated to buy another product/service according to a specific product range defined by collection and analysis data (Ford 2015). We know that nowadays, data collection is happening in a widespread way by public or private sector which clearly asks the customer's consent in most of the cases, but also without users' knowledge. The companies collect information on the consumer in different ways from customization to an invasion of privacy. (Mark et al. 1999)

According to a new Adobe and Edelman Berland survey, with 84% agreeing that there are too many technologies analyzing and tracking behavior and 82% agreeing that companies collect too much information on consumers. 79% feel that their information is collected without their knowledge. (Jameel & Majid 2018)

When people fill out a simple registration form to have information or service, they don´t think about the fact that their data will be stored for a long time in the registration system. The GDPR (General Data Protection Regulation) in Europe allows to give privacy data rights to the consumer i.e. a set of data handling rules that must be respected by companies and enterprises. The customer can complain after noticing a violation of their rights, so he must be involved in the learning of his rights to defend his position.

Moreover, the most invasive practices happen when (Leidner & Plachouras 2018):

- Information is shared with 3rd parties
- Customer must enter his social security number or other personal information
- An ad follows them around from one website to another
- A website knows their geographic location

As previously mentioned, the information can be collected with or without the customer's consent. However, the biggest challenge is to understand who are these information used for and for what purpose. For example, many have pondered the following question: how do adverts for hotels in specific destinations start appearing in your pop-ups after chatting to your friends about their recent holiday, without you even touching your phone.

The data collection systems are very powerful, and we can nothing but ponder why and how do they perform the collection and analysis data. (Taylor 2018)

The data text analysis is also a main issue of privacy data rights. On social media, emails, text documents (or any kind of secondary data) a specific analysis is performed in order to know more about user's personality, character, emotions. (Brey & Soraker 2009) Even if the user doesn't want to share their information, the companies can extract some meaningful information about their private life through their Internet activities and website visits. In addition, by combining information, the companies can have a general idea of what personality the user has, what are their interests, hobbies and movements during a certain time. Some of this information (e.g. social media posts) are publicly available but legal consequences regarding data privacy are something that companies should consider when choosing what data to use in NLP.

6. CONCLUSIONS

The amount of text data has increased ever since the invention of a computer and exploded since the beginning of information age. This opens possibilities to gather insights from data in a text format. We concluded that significant amount of work is used to the preprocessing of the data and only a small portion is used to the value creating analysis. Most of the preprocessing methods used are very simple and further research is needed to derive a model on how to automate the preprocessing of textual data.

The analysis on text data is typically called Natural Language Processing (NLP). There is a vast amount of different NLP methods, each answering to different organizational problems and business needs. The diversity of the findings surprised us; the methods that were found from chatbots to simple word counting and from sentiment analysis to automatic summarizing.

Artificial intelligence in general brings up many ethical questions, and text data is not an exception. Although processing of personal data is limited with legislation such as GDPR, it may not be enough in the future. AI is definitely an enabler in the field of text analysis and NLP, but the question remains: where to draw the line? It is deemed acceptable e.g. to conduct sentiment analysis to enterprise data such as customer feedback or social media responses, but it is definitely not acceptable to conduct sentiment analysis on employees' email correspondence.

All in all, based on this research the field of using artificial intelligence with text data is moving very fast and the future of the field is difficult to predict. Further research is definitely needed in order to reach the full potential of Text analysis and Natural language processing. Or as Abraham Lincoln put it: "Best way to predict the future is to create it"

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THE POTENTIALS AND BARRIERS OF ARTIFICIAL INTELLIGENCE IN HEALTHCARE

TLO-35306 2019 Global Information Systems Management
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Waltteri Vuorimies
Aleksi Rosenius
Mikko Nirkkonen
Jani Haakana
Jesse Kuittinen

ABSTRACT

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Keywords: Artificial intelligence, Healthcare, Potential, Barriers

Topic of this report is the potentials and barriers of artificial intelligence in healthcare. This topic is important to discover because artificial intelligence has been in hype for many years but there have not been too many cases where the technology have been spectacular. We identified three potential artificial intelligence applications to increase doctors' productivity. These three identified artificial intelligence applications are pattern recognition, voice-to-text transcription and AI-assisted medical diagnosis. The barriers of artificial intelligence in healthcare industry that we discovered in this work are ethical issues, cultural issues and technological challenges. Other potential issues can also be found but these three are overall the most significant ones.

1. INTRODUCTION

Topic of this work is the potentials and barriers of artificial intelligence in healthcare. This topic is important to discover because artificial intelligence has been in hype for many years but there have not been too many cases where the technology have been spectacular (Uckun 2018). Healthcare is one industry that have been utilizing the artificial intelligence in their everyday practicalities and it is important to see what the biggest problems with artificial intelligence are and what are the biggest advantages of the technology (Hamet & Tremblay 2017; Gill-Cox 2018).

This work discovers the topic with lens of exploring and understanding so we discover the theory and history and then apply it to real life use cases. This type of discovery is good because it gives depth to discovered topic. (Pirkkalainen 2019) For example, in this work we discover where healthcare utilizes the artificial intelligence and what might be the weak points that people working in healthcare industry may have been already tumbled.

The structure of this work is to first introduce theoretical background where is basic theory about the technology and history of it. In this theoretical background chapter, there is also introduced the link between healthcare and artificial intelligence. After this, in third chapter, we discuss about the potentials of the artificial intelligence in healthcare. In fourth chapter we introduce the barriers of the artificial intelligence. In the last chapter is discussion about the topic and conclusion about the main findings.

2. THE BASICS OF ARTIFICIAL INTELLIGENCE

Artificial Intelligence (AI) can be explained in multiple different ways and there is not one right definition to it. Generally, artificial intelligence is kept as a technique, which enables computers to impersonate human behavior. It includes different methods and technological solutions, which all are used to create these intelligent machines. (Copeland 2019) For a better understanding of the whole AI concept, we need to look to the past and see how it has developed over the years.

The history of Artificial Intelligence

The roots of artificial intelligence were planted when philosophers in the ancient Greece and around it pondered the possibilities of intelligent machines. They were trying to model humans and their thinking and connect these ideas to machines of that time. This obviously didn't work because of the existing resources and knowledge back then, but the idea was born there. (Foote 2016) The first real attempt to generate intelligent machines happened in the 1940s, when a mathematician called Alan Turing created a machine that helped English military to crack German ciphers in World War II. After inventing this commonly known Enigma breaker, Turing wrote a paper that proposed a method for recognizing thinking machines. This method was later defined as a Turing Test, which created the base for whole artificial intelligence. (Smith et al. 2006)

In 1950s, the term artificial intelligence was introduced for the first time. Researchers back then were trying to create computer programs that could play a game of checkers on their own. They tried to make the programs learn from their experiences, although the computers were not very advanced. These efforts in computing and programming eventually, along with Turing Test, led to the birth of the concept of artificial intelligence. (Foote, 2016; Copeland 2019)

From this moment, the development and research around artificial intelligence continued for the next 20 years. The researchers were very optimistic and expected this technology to revolutionize the whole world. Different programmers and researchers tried to create a neural network, which is an imitation of human brains, for computers. However, the development failed because of resources and poor computing power. (Foote 2016) Because there was not much progress in the field, the interest for the whole technology decreased and most of the investors backed off. All these things combined led to a situation where the development of artificial intelligence was terminated for several years. (Anyoha 2017)

In 1980s, the development of artificial intelligence continued because different technologies had gone forward, and new funding was available. That led to the introduction of

expert systems and deep learning, which were both groundbreaking inventions. Expert systems are intelligent computer programs that are trying to mimic the decision-making process of a human, and deep learning is a technique where computers learn using experience. (Foote 2016; Anyoha 2017) These major steps were achieved around the world, which meant that the development of AI was global. Different researchers were trying to develop artificial intelligence in different places and when the next decade came, the technology had improved significantly. In the early 1990s, the development of artificial intelligence focused on intelligent agents. These so-called bots could be used in for example, online shopping, and are nowadays known as virtual assistants. In 1997 happened one of the biggest achievements in AI's history. Supercomputer called Deep Blue defeated a chess world champion using artificial intelligence and learning methods, and machines were finally smart enough to beat humans. (Anyoha 2017)

After these major accomplishments in the history of artificial intelligence, the development of it has been faster and more advanced. Nowadays, because of other technological revolutions, artificial intelligence is a part of normal life. Currently, big technology companies, such as Google and Facebook are using AI in several applications. There are voice recognition, different virtual assistants and even self-driving cars, which are all using artificial intelligence. (Foote 2016; Anyoha 2017) The major inventions and research findings that were found decades ago are now in use, and the plan is to develop something that could help the lives of normal people. One big trend of that is artificial intelligence in healthcare industry, where the technology is being used to save lives and cure diseases.

Artificial Intelligence in healthcare industry

Discussion around use of artificial intelligence algorithms in medicine has already been discussed already in the 1970s and 1980s (Hand 1987; Schwartz et al. 1987; Uckun 2018). The research back then was mainly focusing on using AI to automate diagnosing of diseases. However, due to the lack of computing power and reliability of the solutions the use of AI in medicine did not manage to gather widespread popularity. (Uckun 2018) As the computing power has increased and the reliability of AI algorithms has gotten better, we have started to get more viable and usable solutions for medical AI.

According to Gill-Cox (2018), artificial intelligence in medicine can be divided into two branches, virtual and physical. Virtual meaning the immaterial part of artificial intelligence, for example regression analysis, deep learning and image recognition, and physical meaning for example robots which for instance help surgeons to operate on patients (Gill-Cox 2018). The virtual part consists of mainly machine learning algorithms and the data used and analyzed varies from patient records to data gathered from the research in genetics and molecular medicine (Hamet & Tremblay 2017).

The physical part mainly consists of different kinds of robots to assist in the care of patients. Maybe the most prominent use case would be robot assisted surgery, but there are

also other initiatives such as “Carebots” which in Japan help with the care of elderly people with cognitive and mobility issues (Hamet & Tremblay 2017).

Gill-Cox (2018) notes that a large part of the startup companies in medical artificial intelligence are currently focusing on applications in business, diagnosis and treatment. It is very easy to see that AI could very well bring several improvements to the efficiency of work in medicine. We will discuss some potential solutions in Chapter 3.

According to Noorbakhsh-Sabet et al. (2019) clinical applications of AI in medicine mostly focus on disease prevention as well as diagnosis, treatment effectiveness and outcome prediction. In the public health domain, artificial intelligence can be used to predict epidemic outbreaks and finding connections between human genes and traits and diseases. In addition to this, artificial intelligence could play a part also in discovering new drugs. (Noorbakhsh-Sabet et al. 2019) In this sense the use of AI in medicine could potentially have a more widespread effect on the general health of the public instead of just helping doctors diagnose and treat people already with illnesses.

The research into disease prediction and diagnosis has mostly concentrated around cancer, nervous system and cardiovascular diseases simply because these diseases are most likely to cause death and disabilities and thus are more meaningful to try and diagnose with the help of AI. However, also diganosis and prediction of certain chronic diseases, for example type 2 diabetes, has also caught attention in the research towards disease predicting algorithms. (Noorbakhsh-Sabet et al. 2019).

One of the reasons for increase in the research around artificial intelligence in medicine could be, that the healthcare industry is going to face a dramatic workforce shortage in the coming years, and by 2030 the global shortage can amount to almost 10 million phycisians, nurses and midwives. (WHO 2019) According to Meskó et al. (2018) artificial intelligence could be a solution for the human resource issues faced by the healthcare industry. Artificial intelligence could also improve the quality of care as well as bring significant cost reductions. (Meskó et al. 2018) Some of the human resources needs could be remedied by the use of AI in both its physical and virtual form if the robots and algorithms can achieve same kind of performance in operation and decision making as their human counterparts.

3. THE POTENTIALS OF AI IN HEALTHCARE

According to Pearl (2018), applications of artificial intelligence in healthcare can be divided into three main categories: visual tools, algorithmic solutions and medical practice. From the viewpoint of increasing doctors' productivity, all these categories contain potential improvements. Labor productivity is generally defined as

$$\frac{output\ volume}{labor\ input\ use}.$$

Our research lens is to mainly look potential AI applications to increase productivity of a single doctor or nurse. We define productivity from doctor's or nurse's point of view as

$$\frac{number\ of\ treated\ patients}{working\ hours}.$$

This definition means that applications that increase doctors' productivity must either help to treat patients more effectively, or otherwise save doctors' time to be able to engage more with patients. We have identified three potential AI applications to increase doctors' productivity. These three include pattern recognition, voice-to-text transcription and AI-assisted medical diagnosis.

Table 1. *Examples of AI applications to increase productivity of a medical professional.*

AI application	Pattern recognition	Voice-to-text transcription	AI-assisted medical diagnosis
Ways to improve productivity	Examine medical imaging studies	Enable faster documentation	Help on more difficult cases
Increased productivity	5-10% more accurate results and much faster examining	Doctors can save up to 17% of their work time	Faster way to diagnose a patient

According to IDC (2013), hospitals produce about 50 petabytes of data every year, of which 90% are medical imaging such as MRI scans, PET scans and CT scans. Thanks to this enormous amount of available data stored in electronic health records (EHRs), any improvement in analyzing this data would make a huge difference. Pearl (2018) points out that diagnostic imaging, such as mammograms, rely on human eye to determine their results and that can fail even the best clinicians. Artificial intelligence can improve accuracy of these tests by pattern recognition, which is estimated to be 5-10% more accurate

and much faster than human eye. More accurate results will help to determine the condition of a patient more effectively, thus increasing doctors' productivity. Pearson (2017) estimates that in less than 10 years pre-analyzing a medical imaging study by computer will be a standard practice.

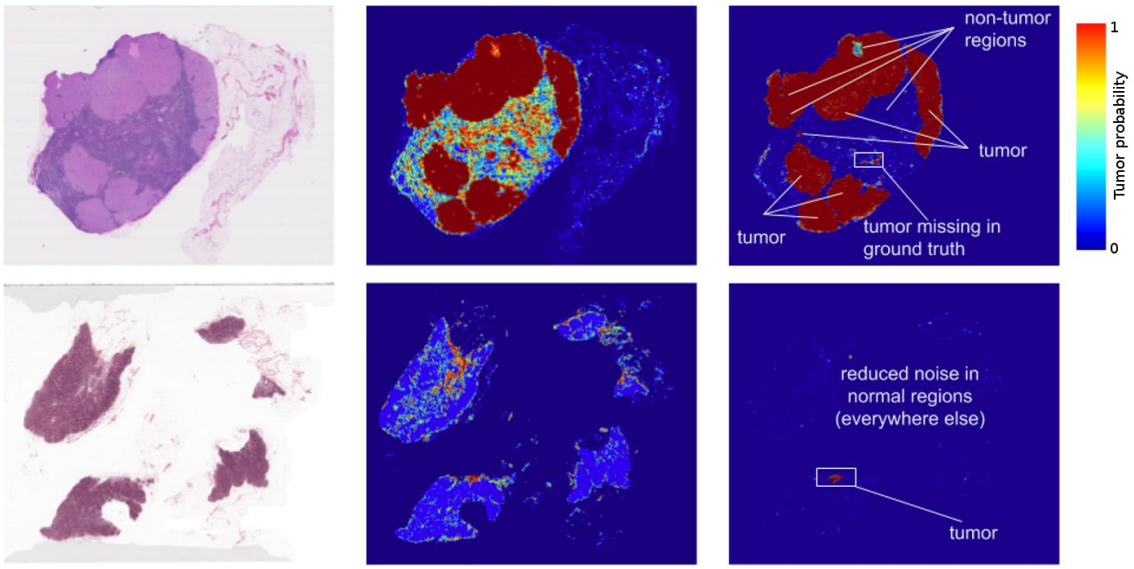

Figure 16. *Google's pattern recognition on tumor detection. (Google 2017)*

In the recent years there has been a lot of interest in collaboration between companies that have world-class machine learning and healthcare institutions. One great example of the former is Google. With the help of Google's deep learning algorithm, healthcare institutions have been able to create visual tools that are both faster and more accurate examining specific medical imaging (Google 2016, Google 2017 & Google 2018).

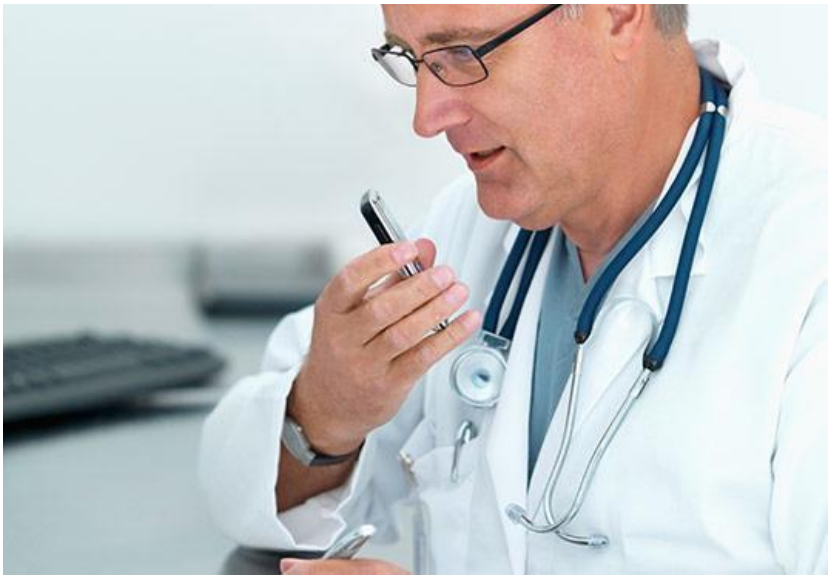

Figure 17. *Nuance Dragon Medical One speech recognition solution in use. (Pennic 2018)*

Medical professionals have a lot of non-patient care activities such as writing chart notes, prescriptions and ordering tests. With voice-to-text transcription, there's a huge potential

to save doctors' time from these activities. According to Accenture (2017) analysis, voice-to-text transcription can save up to 17% of doctors' time, enabling them to engage more with their patients. Javanmardian & Lingampally (2018) also estimate that AI applications could save up to 45% of doctors' time spent on documentation. One speech recognition software for healthcare is Nuance's Dragon Medical One. It is integrated in EHRs and has been available since 2017.

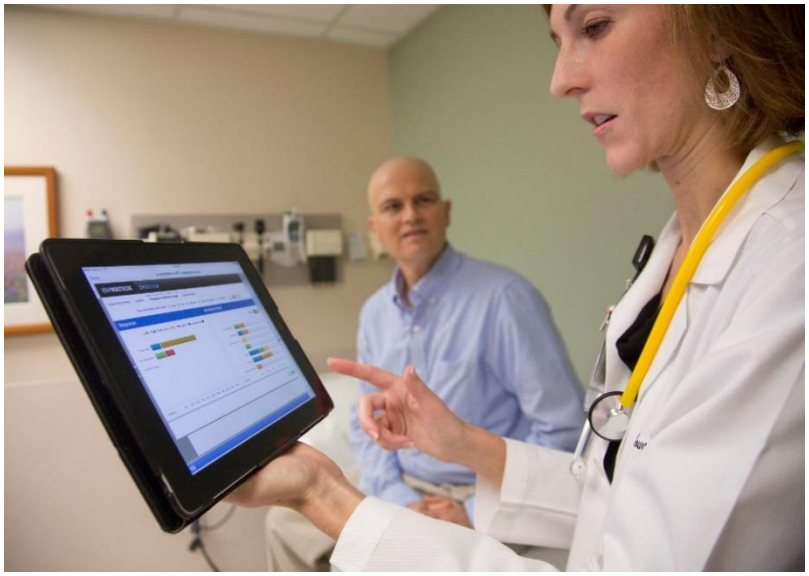

Figure 18. *IBM Watson Health in use (Lorenzetti 2016).*

Third potential AI application to increase doctors' productivity is AI-assisted medical diagnosis. With large volumes of patient data, AI algorithm can suggest diagnoses and treatment plans for patients more effectively than a doctor. This is especially valuable in more difficult cases, such as patients with multiple illnesses or cancer (Pearl 2018). At least one solution for suggesting medical diagnosis is already available, IBM's Watson Health. Watson Health can process even unstructured data and make recommendations based on its' extensive database and AI algorithm (Lorenzetti 2016). Watson Health is also capable of learning, making it better after every case.

4. THE BARRIERS OF USING AI IN HEALTHCARE

For the purposes of this work the barriers of artificial intelligence in healthcare have been narrowed down and divided into 3 different standpoints. These standpoints consist of ethical issues, cultural issues and technological challenges. Other potential issues and challenges can also be found but based on the literature review of this subject and on the references of this research these were clearly the most common and highlighted ones. These issues cause the biggest hindrance and barriers on the utilization of artificial intelligence in healthcare and they need to be recognized and overcome before artificial intelligence can be extensively and effectively used in healthcare (The Medical Futurist 2017; Bresnick 2018; Nuffield Council on Bioethics 2018).

Ethical issues

Perhaps the biggest, most discussed and most challenging issues regarding the use of artificial intelligence in healthcare are ethical ones. These are bound to rise in the field of healthcare as some decisions can literally be a matter of life and death. On the ethical side of using artificial intelligence in healthcare some of the questions can be viewed from two different standpoints. A distinction can be drawn between concerns regarding the complete replacement of human care by artificial intelligence and concerns regarding human based care assisted by artificial intelligence (Coeckelbergh 2009). The former is usually seen as much more controversial than the latter scenario. The key observations of this chapter are presented in table 2.

Table 2. *Ethical issues of AI in healthcare and their effects.*

Ethical issues	**Effects**
Who is responsible if AI makes a wrong decision?	This question needs to be answered so there is a clear accountable person.
AI does not emotionally care about patients, it just does what its algorithms tell it to do.	AI can provide the required medical assistance, but it cannot substitute the social aspect of healthcare provided by a real physician.
What if the AI is not designed ethically?	Design choices can lead to a biased AI that can treat people unequally or prioritize economic aspects over good healthcare.

Reliability and safety issues are the key issues with artificial intelligence in healthcare (Nuffield Council on Bioethics 2018). The most often presented ethical questions are related to reliability and safety. What if artificial intelligence causes physicians to make the wrong decisions? Whom would be responsible? And what should be done if the physicians disagree with the artificial intelligence, who makes the last call? These are important questions that need to be addressed while utilizing artificial intelligence in healthcare. However, they are highly situational, and it is impossible to give a general answer to them.

A recurrent objection according to Coeckelbergh (2009) is that care provided by artificial intelligence systems is not seen as good as care provided by human. This comes ultimately to the fact that in the end even the smartest artificial intelligence systems are only programs and machines. They do not see the world as people do and they lack the feelings that humans have. Artificial intelligence systems can be capable of providing good healthcare, but they won't really care about the patients (Coeckelbergh 2009). They are capable of providing the required medical assistance and right decisions but that might not always be enough as people also have emotional and social needs that cannot be satisfied by the artificial intelligence, at least not in the near future. In the end, artificial intelligence only does what its algorithms tell it to do. Artificial intelligence monitoring systems can also be seen as intrusive or even privacy violating causing the feeling of constant supervision (Coeckelbergh 2009).

Artificial intelligence applications have the potential to reduce human error and bias related to treating different people, but they can also reinforce and reflect biases of the data used to train them (Bresnick 2018; Nuffield Council on Bioethics 2018). This can happen for example when the images originate from a small local sampling (The Medical Futurist 2017). Biases can also be inadvertently built into the healthcare algorithms thus making them possibly unequal to patients (Weintraub 2018). There can also be ethical problems with the design of the algorithms. It is possible that they are designed for example to save money instead of offering the best care available (Weintraub 2018).

Cultural issues

Now that some of the core ethical issues have been addressed let's touch on the cultural ones. This is another major barrier that is slowing down the spreading of artificial intelligence in healthcare. Some even consider it as the single biggest barrier (Pearl 2018). The key observations of this chapter are presented in table 3.

Table 3. *Cultural issues of AI in healthcare and their effects.*

Cultural issues	**Effects**

Medical culture values doctor intuition and physicians value their independence.	Physicians are not keen to support the use of AI if they feel that it will have a negative impact on their autonomy.
Resistance to change as AI can alter the daily work of physicians and the skills needed in the work.	People tend to resist changes that have an effect on their daily routines and on the way they are used to work.
Automation by AI can lead to less staff needed. Decision making done by AI can lead to less expertise required from staff.	Physicians are not ready to support AI in healthcare if it changes their position and status. Lower expertise can also lead to more ethical issues.

According to Pearl (2018) medical culture values doctor intuition over evidence-based solutions. Physicians highly value their independence and they are not ready to give it up. They also dislike the idea of being told what they should do. (Nuffield Council on Bioethics 2018; Pearl 2018) Therefore getting them comfortable with the idea of artificial intelligence being involved in their work and possibly even completely making their decisions can be very difficult. Physicians might feel that their authority and autonomy is compromised if artificial intelligence is making their decisions and possibly even challenging their expertise (Nuffield Council on Bioethics 2018).

There is also the common issue of general resistance to change. People tend to resist change because they fear the unknown and do not like changing their usual routines (Rick 2011). Utilizing artificial intelligence more in healthcare can have big impacts on the industry and the way that work is done. The introduction of advanced artificial intelligence systems can also mean that the skills and expertise required from healthcare professionals will change (Nuffield Council on Bioethics 2018). Such applications of AI like voice-to-text transcription and AI-assisted medical diagnosis can enable automation of tasks previously carried out manually by these professionals. This means AI could free up more time for physicians that they can spend to engage directly with their patients. On the other hand, this also means that the social work and skills have an even higher importance and role in the work than before while simultaneously decreasing the possible importance and role of analytical brainwork. Medical professionals would also need new skills and know-how to properly operate the new artificial intelligence systems. There are also concerns that introduction of automation by AI might be used as justification of employing less skilled staff as the AI can perform the more complex tasks (Nuffield Council on Bioethics 2018). It is also possible that automation done by artificial intelligence might lead to having overall less staff than currently and therefore leading to worse employment rates in healthcare.

Overall the general attitudes related to IT are not too positive either. According to Bresnick (2018) physicians and nurses see health IT use as an unavoidable obstacle that is mostly just getting in the way of work and face-to-face time with the patient. Therefore, it can be quite hard to get them comfortable with the idea of introducing even heavier focus on IT in healthcare. This resistance can partially be solved by making the medical professionals understand that the intention of artificial intelligence is to enable more use of time with patients and other work instead of lessening it. Artificial intelligence can also help in reducing the workloads of individual physicians, for example via automation and decision making, thus giving them less stressful and more pleasant working environment (Bresnick 2018).

Technological challenges

Some of the core issues also involve the technological aspect of artificial intelligence and its development. However, these issues are generally seen as easier ones to come by than the previous ones as they do not involve changing the attitude of people (Pearl 2018). The key observations of this chapter are presented in table 4.

Table 4. *Technological challenges of AI in healthcare and their effects.*

Technological challenges	**Effects**
AI is not yet developed enough for extensive use in healthcare.	More time is needed for AI and its applications to evolve.
AI is dependent on data and healthcare data is highly regulated.	Data needs to be available and standardized for AI to reach its full potential.
Information security of patient data and AI algorithms.	Information security must be properly handled so the algorithms and datasets cannot be breached or altered.
Use of AI in decision making requires significant computing power.	Investments are needed to get the hardware capable of supporting the use of AI.

Artificial intelligence of today is still quite basic and far from its full potential (The Medical Futurist 2017). The technology is constantly evolving but the current technological state of artificial intelligence is one of the limiting factors of its use. Doctors do not see AI applications such as IBM Watson Health ready for proper use yet (KevinMD 2018). However, artificial intelligence is evolving at a rapid phase (Reichental 2017; The Medical Futurist 2017).

Due to its nature, artificial intelligence is highly dependent on digital data. This is partially problematic as data related to healthcare is highly regulated by legislation which hinders its use in training of artificial intelligence. Currently, there are legal limitations on access to medical data and this restricted access causes a barrier to development of good and reliable health-focused algorithms (PokitDok 2018). To use machine learning in teaching the artificial intelligence, it is necessary to train it with patient health records, healthcare statistics and other personal information related to medicine (Infosys 2018). This causes technical issues as well as ethical ones with the material required. Quality of the data and inconsistencies in its availability restrict the potential of artificial intelligence (Nuffield Council on Bioethics 2018). Using artificial intelligence effectively would also require streamlining and standardizing medical records to a format from which the algorithms can utilize them. (The Medical Futurist 2017; Nuffield Council on Bioethics 2018) Analysis of large and complex data sets also requires significant computing power (Nuffield Council on Bioethics 2018). This means that medical institutions need to make investments to expensive hardware capable of supporting the use artificial intelligence properly.

There is also the problem of data security (Bresnick 2018). What if someone can breach the datasets related to the AI algorithms? Of course, data security is a valid concern even without the use of artificial intelligence, but its widespread use would make this concern even more significant, especially if the algorithm data is stored in a single repository. Alternating the datasets or even the algorithms via hacking is an issue that should not be understated. New technologies like Blockchain may help with these issues in the future but currently they are not used extensively (Bresnick 2018).

5. DISCUSSION

Artificial intelligence is the technology that people have been talking about for many years and history of artificial intelligence starts from as early as 1940s. Healthcare industry is one industry that utilizes artificial intelligence significantly and we found that artificial intelligence gives the biggest advantages to productivity in healthcare. We defined productivity in healthcare in a way how many patients doctor can treat in her/his working hours.

In this work, we identified three potential artificial intelligence applications to increase doctors' productivity. These three identified artificial intelligence applications are pattern recognition, voice-to-text transcription and AI-assisted medical diagnosis. Pattern recognition can help doctors to examine medical imaging studies and this artificial intelligence tool can give 5-10% more accurate results and much faster examining. Voice-to-text transcription enables faster documentation and it can save doctors time up to 17% of their work time.

Artificial intelligence -assisted medical diagnosis helps in more difficult cases and this way it saves doctors time and helps them to give faster diagnosis for patients. These productivity-improving findings are important because they increase doctors' productivity a lot and that way more people can be treated in less time. With new technologies, there are also lot of thing to be worried about and things that can be challenging for technology to solve. The barriers of artificial intelligence in healthcare industry that we discovered in this work are ethical issues, cultural issues and technological challenges. Other potential issues can also be found but these three are overall the most significant ones.

Artificial intelligence can be seen in two ways, it can assist human in healthcare processes or it can replace human in those processes. The biggest barrier in ethical standpoint is that who is responsible if and when artificial intelligence makes a wrong decision. Issue in cultural standpoint is that medical culture values doctors' intuition so the change resistance for utilizing more artificial intelligence in healthcare processes is inevitable. For many people, it is hard to trust something other than doctors when they need medical diagnosis and treatment.

The last main issue for the artificial intelligence in healthcare is the technological aspect. There are few things to consider from this standpoint. There are inconsistencies in the availability and quality of data restrict the potential of artificial intelligence. It is also needed to discuss that do the medical staff and patients have enough know-how to use artificial intelligence. In technical aspect, it is important to see that this kind of technology needs lot of power from computers because they utilize a lot of data and that can be also the barrier for better use of the technology in this industry.

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AUGMENTED REALITY

Global Information Systems Management TLO-35306
Group assignment

Annamari Koskiniemi
Inari Bergius
Samuli Määttä
Arttu Kukkonen

ABSTRACT

This assignment was written for the course TLO-35306 Global Information Systems Management in the spring of 2019. The assignment was to choose a technology topic and focus it with the GISM (Global Information System Management) framework, with a certain chosen context and research lens and to explain the global implications. The chosen technology was augmented reality (or AR) and the chosen context was why AR has so few useful applications. The research lens that was chosen is critical and focuses on the dark side of AR. Research lens also focused on unintended use and the use of AR when it is not needed and does not provide any additional value.

Augmented reality equipment and software have improved quickly during the last few years. It has been described as a technology of the future for many years, but still there are only few actual practical applications live. In this assignment we tried to find the reasons for the question why there has not been any breakthrough yet in the field of augmented reality, even though the hype has been big.

Assignment described first the fundamental features of augmented reality technology and differences between augmented reality and virtual reality. How the technology dimensions meet human needs was also discussed. Assignment introduced both negative and positive use cases of artificial reality solutions, and the possibilities of artificial reality value creation. Augmented reality in a global scope was also discussed with its significance and possibilities in a changing world of technology management.

At the moment AR technology development is in a sort of a standstill. The most innovative and useful adaptations are yet to come. The ethical implications of AR technology and its applications also need to be better understood by society in order to avoid threatening situations.

1. INTRODUCTION

This assignment was written for the course TLO-35306 Global Information Systems Management in the spring of 2019. The assignment was to choose a technology topic and focus it with the GISM (Global Information System Management) framework, with a certain chosen context and research lens and to explain the global implications. The chosen technology was augment reality (or AR) and the chosen context was why AR has so few useful applications. The research lens that was chosen is critical and focuses on the dark side of AR. Research lens also focuses on unintended use and the use of AR when it is not needed and does not provide any additional value.

Augmented reality equipment and software have improved quickly during the last few years. It has been described as a technology of the future for many years, but still there are only few actual practical applications live. In this assignment our group is trying to find the reasons for the question why there has not been any breakthrough yet in the field of augmented reality, even though the hype has been big.

Assignment describes first the fundamental features of augmented reality technology and differences between augmented reality and virtual reality. How the technology dimensions meet human needs is also discussed. Assignment introduces both negative and positive use cases of artificial reality solutions, and the possibilities of artificial reality value creation.

Final chapter discusses augmented reality in a global scope and its significance and possibilities in a changing world of technology management.

2. AUGMENTED REALITY TECHNOLOGY

Augmented reality can be defined as a real-time interaction with real-world environment that can be direct or indirect in nature. The purpose of augmented reality is to enhance, or *augment*, the reality by adding a virtual layer to the user's visual range. (Furth 2011) The end goal of augmented reality is not to create something superficial, but instead, to better understand real-world with the knowledge gained from the computer vision's virtual layer (Hugues et al. 2011). That is, augmented reality can never be truly separated from the real-world.

2.1 What is augmented reality

Augmented reality uses computer vision to enhance real-world environment. The technology consists of a display (usually head mounted, but also handheld and spatial displays). The display is a see-trough display, which can show the computer vision as well as the real-world at the same time. In addition to the display, an AR device usually consists of some input device, which can be some kind of joystick or hand/eye tracking sensor. AR device must also have a powerful enough computer unit to process the computer vision. This can be a workstation, but in recent years handheld devices such as smartphones can be utilized in augmented reality. (Furth 2011)

2.1.1 Features of augmented reality

The features of augmented reality in this assignment is done by using Hugues et al. (2011) proposed feature taxonomies for augmented reality. The purpose of describing characteristics and features of augmented reality is to justify good and bad examples later in this assignment.

According to Hugues et al. (2011), their proposed taxonomy for different functionalities of augmented reality consists of two different categories. The first one is *augmented perception of reality*, in which the AR technology is used as a tool for decision-making. This can be done for example by displaying relevant information to the user (i.e. manual for kit furniture). Another functionality of augmenting perception of reality is the integration of virtual objects to real-world. (Hugues et al. 2011)

The second category proposed by Hugues et al. (2011) is to create a completely new artificial environment. This can be achieved in two ways: First by perceiving the reality with added virtual elements, ie. so that the environment is a mix of both reality and virtual environment. (Hugues et al. 2011) An example of this would be portraying city skylines with upcoming constructions. Another way of creating artificial environment is to create a completely new and impossible reality as there are no limits of what computer vision

can produce (Hugues et al. 2011). Many examples of this are found in entertainment industry.

The different features of augmented reality can be seen as follows:

- Augmented perception of reality
    - Displaying relevant information to the user
    - Integration of virtual objects to real-world
- Creating artificial environment
    - Perceiving reality with added virtual elements
    - Creating an impossible reality

2.2 Augmented reality meets human needs

Maslow's hierarchy of human needs was created at a time when augmented reality was just a wild thought and probably considered as witchcraft. Even though Maslow's hierarchy has faced criticism, Kellermann has created a model of human need and virtual spaces based on the hierarchy (2014). Hierarchy of needs is a triangle model, where the most important need to satisfy is the lowest one. Needs from bottom to top are physiological, safety, love/belonging, esteem and self-actualization. Kellermann states that the less important the need is, the more possibilities virtual spaces hold to satisfy the need (2014, s.542). This is of course possible to understand with pure induction: as augmented reality does not add anything physical to the real-world environment, it cannot add any value to the core human needs: having air to breath, water to drink and food to eat.

However, augmented reality has a lot of possibilities on the higher human need levels. For example, augmented reality could work as an enhancing factor in the need of love/belonging in multicultural relationships. Augmented reality glasses could translate the foreign language real-time and forming strong relationships over the language barrier would become a lot easier. Real-time augmented reality translation would also bring all the content in the world closer to individual: all the news, concerts, entertainment and published research paper are accessible without the effort of translation. The big volume of content could support the development of self-actualization, which contains creativity and personal growth for example.

The use of augmented reality can also affect to the need of safety. Lockheed Martin's F-35 jet fighter helmet is using augmented and virtual reality to enable fighter pilot's situation awareness (Collins Aerospace 2019). Increased situational awareness increases the pilot's feeling of safety, but the advanced technology used in warfare can also increase the safety feeling of the citizens of the country acquiring new technology.

In addition to soldiers, also other officials can utilize augmented reality in safety critical environments. Company called Qwake Tech develops helmets for firefighters helping

firefighters to see in zero-visibility environments (2019). This solution has also a double-sided effect on the safety human need: firefighters working in a hazardous environment get more information about their surroundings, and citizens may sleep their nights better knowing that firefighters are able to perform their work better in case of fire.

3. EXAMPLES OF AR

While AR can be defined as just adding a digital layer on top of the user's visual range like was mentioned before in this assignment, AR should be able to provide some added value with the added digital layer. AR must be more as a whole than just the sum of physical and digital worlds (Schols 2018). A study from Purdue University for example discovered that a printed advertisement retained 82% of the information compared to the 59% information retained of the AR version of the same advertisement (Connolly et al. 2010). This proves us that AR does not automatically enhance a product.

While AR application are most certainly capable of creating value for the users, they are also capable of destroying it. For example, Lintula et al. (2018) discovered many cases of value destruction caused by the mobile AR game Pokémon GO, like value contradictions, unmet expectations, technical challenges, personal or social norm conflicts, effects of constant mobile use, absence or loss of resources and insufficient perceived values. (Lintula et al. 2018) Value destruction can lead to increased costs, customer loss, loss of brand value via negative word-of-mouth and customer dissatisfaction (Smith 2013). This means that companies should not release bad AR applications for just the sake of having one and trying to appear tech-savvy, because there are serious drawbacks if the application fails. In this chapter we are going to go through some good and bad examples of AR applications.

3.1 Good examples

An example of a case where AR technology is used as a decision-making tool could be any sort of case where data overlay is utilized. This could for example be a repairman on a manufacturing plant's floor wearing AR glasses which show them real-time information about the condition of each machine, which is acquired from sensors inside the machines. (Bakkers 2017) Another example of showing real-time information could is the helmet that the pilot of a F35 wears, which shows the pilot flight information and sensor data and even lets them see through the bottom of the plane (Collins Aerospace 2019).

Another situation where data could be displayed on the AR glasses is where a person receiving training is wearing the goggles and the trainer can in real time guide them through the tasks or mark something noteworthy in their field of vision. This sort of thing could also be utilized in customer service, where the trained professional could walk and talk you through with setting up a certain device, for example. (Bakkers 2017)

The AR technology that falls into the first category can also be utilized without the AR glasses. Google Maps has an AR application for people traveling on foot. In addition to the "usual" Google Maps –map, which can be found on the bottom quarter of the screen,

the application shows the user the view that the phone's camera has and adds road signs, like arrows, to that view and so helps guide the user to their destination. (Schols 2018)

The second category focused creating new realities, either ones that are a mix of both real and virtual environment or ones that are completely impossible. AR can be used to portray upcoming construction projects and how they will look like when they are finished, but it can of course also be used to portray what used to stand there. This can be utilized for example in tourism industry with AR applications in old ruins where the rubble can be replaced with buildings that were there. (Schols 2018)

Ikea has launched an application called IKEA Place, where customers can try what certain pieces of furniture would look inside their home with just the touch of a phone. A business-to-business application with the same basic idea was brewed up by Coca Cola. They created an app which enables retail store owners to see how different kinds of Coca Cola-brand beverage coolers would look and fit in their stores. (Ciklum 2018) AR can also be used to showcase prototypes of products that have not been physically produced yet. Research & development teams can produce 3D-modules easily and ask feedback about them, which is easier and more cost-efficient than producing an actual physical prototype every time a new version is developed. (Bakkers 2017)

Scholz (2018) argues that physically being able to touch the products is the strength of brick and mortar and free returns are the cornerstone of e-commerce, but neither of them are as strong as being able to visualize the product where it is going to be placed. Both the customer and the business benefit from the use of AR in this way, because they both save time and money when they don't have to handle returns or waste time at the store when the customer wonders what color their new sofa should be, for example. So, the use of AR to visualize things before customers buy them will increase customer satisfaction and save the resources of the business.

Portraying things can be used for example in training how machines work. An example of could be portraying how fuel runs through a car engine. AR technology enables people to even walk inside the machines, which you could not do in real life. The models can of course be used anywhere at any time and they can be sized up or down according to what is needed.(Bakkers 2017) The things observed via wearing AR glasses can also be used to complement traditional transmissions, like sport games, where they can for example show visualizations on the studio floor during breaks in the game to complement the commentators' analysis (Futurism 1.0 2016). They can also be used just for their plain entertainment value, like for example to show what characters players have picked in a video stream of a videogame tournament (Scenthouse 2016).

3.2 Bad examples

Augmented reality applications are not instantly executable and useful to the user, since new technology takes many iterations to find the right solution. In fact, many of the augmented reality solutions were there just to make customer experience more unclear compared to simpler technologies such as basic QR-code. Now augmented reality markets seem to be in a stage of trial and error, where technology is used in multiple different fields, just to see how consumers and businesses react to it.

According to Engine Creative -website, brands don't really get all the benefits from augmented reality. The use of technology can even withdraw consumers from the brand. Engine Creative states that there are five reasons for it:

1. Augmented reality platform is not owned by the brand
2. Technology is not accessible with all mobile devices
3. Consumers don't trust augmented reality -related products
4. Using augmented reality as a short-term solution
5. Limiting the use of technology to face recognition (2019)

It seems that even brands are not taking augmented reality seriously. Creating funny cat and dog faces and doing small advertising campaigns with augmented reality shows that the use of AR is not implemented to their strategy and not seen as something worth long-term investing. If brands are not courageous enough to believe in their technology, it is not going to convince the consumers either.

Mobile phone manufacturers Samsung and Apple took augmented reality entertainment even further creating their own cartoon-like avatars from mobile phone users. AR-emojis were fun curiosity and acted like a representation of modern mobile phone's computing power, but they didn't break through to consumers daily use, which seems to be common divisor within new augmented reality applications. We think the problem with AR-emojis lies within both technology and user experience. The fact that Apple's AR-emojis were not representable with Samsung device narrowed remarkably the user-friendliness. Also, AR-emoji was not as expressive as basic emojis: sometimes a 2D cat emoji says more than a 3D-representation of your face.

ZDnet article Sick and disgusted: The worst tech failures of 2018, claims augmented reality is one of the big technology failures of 2018, especially because of the user experience:

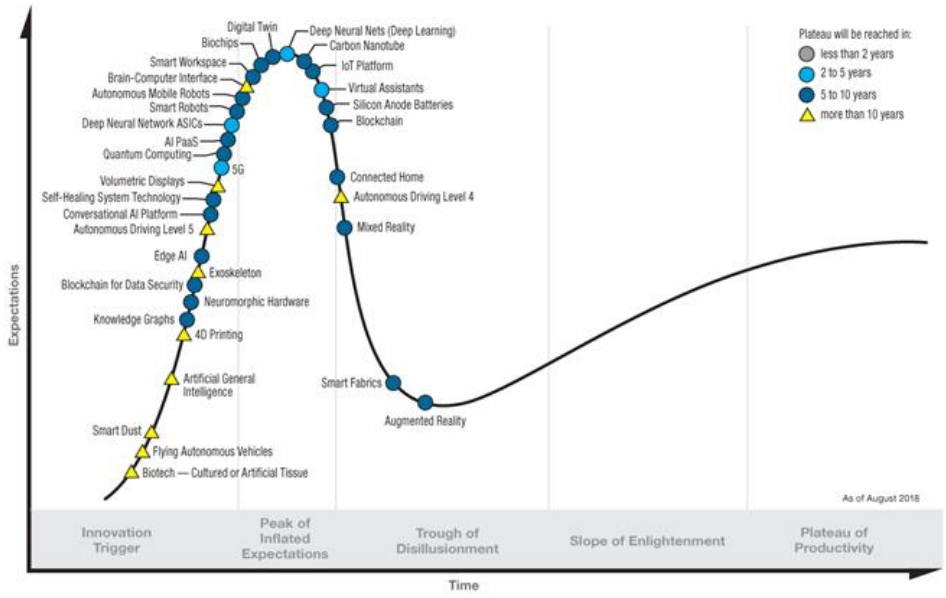
> *" Apple makes a big deal of AR, especially with respect to the iPad, but having to awkwardly hold a smartphone or tablet in front of you is a terrible user experience. AR is a technology that's just begging for smart glasses to take off, but that market is still stained by the initial reaction to, and subsequent consumer failure of, Google Glass"(2018)*

In addition, that using AR applications with mobile device feels clumsy and impractical, it is also not safe. According to TechTalk article one of the few AR applications that have secured a place in consumers hearts, PokemonGo, has caused accidents and even deaths when people have not paid their attention to the world around them while playing the game. (2018) It shows that there are many ethical problems with AR technology that need to be discussed.

4. GLOBAL IMPLICATIONS

Globally AR technology has not yet reached its full potential. It is still perceived as very clumsy and one of the most known examples is Google Glass (Rhodes 2018). In the future the technology needs to be utilized in situations where it can bring extra value to the process instead of being superimposed and pointless. There has been disappointment to the current situation with the development of AR. In the bigger picture it has declined to the level of snapchat filters (O'Donnell 2017). Pure AR technology is proven to be hard to execute in an appealing way in bigger scale.

For AR to become more relevant there must be time for the technology to evolve naturally. AR technology is still searching for more popular and easy uses. Snapchat and Facebook filters aside, AR is yet to find its dominant design. In the 2018 Gartner's Hype Cycle (2018) it can be found from the Trough of Disillusionment. After the Peak of Inflated Expectations AR has sunk before reaching the Plateau of Productivity in 5 to 10 years according to Gartner. This means that after being one of the most promising new technologies it has failed to reach the high expectations for it and is just on its way to more useful and applicable innovations.



Picture 1. Hype Cycle for Emerging Technologies (Gartner 2018).

Right now, there are a lot of AR applications being developed. Some, like Pokémon GO, are celebrated by the crowds, others do not really bring anything that new or exciting to the world. AR needs to develop from ASTTW (add something to the world) to ASBTTW

(add something beneficial to the world). Considering the darker examples of AR there also needs to be rules to prevent accidents from occurring because of people's divided concentration to the real situation and the AR world around them. With AR possibly coming more common in the future, people need to be trained to use it to reduce the risks involved in it. (Sabelman & Lam)

When looking from the economical point of view Google, Microsoft and Apple seem to control most of the development with AR (Ganguly 2018; Taulli 2018; Neiger 2018). This means that also the direction that AR development is taking is mostly in their hands. It is interesting to see where this development is taking. Will there be more challengers for the big companies or is the future of AR the result of their competition.

As predicted in the Gartner's Hype cycle, AR will become a bigger part of people's life's in the future. Exactly how is still unsure. What we do know is that the next generation is always a head of the one before in adopting new technologies and applications. As this happens there needs to be some responsibly and understanding involved to prevent some horrible scenarios from happening.

5. CONCLUSIONS

We set out to explore Augmented reality as a technology with interesting aspects and unlimited possibilities. What was also clear was the dark side of AR and the not-so-impressive course its development has taken in the few years. It was also known that it has yet to answered people's expectations as much as wanted. We started with this presumption and found out more about AR technology, its applications and implications with human needs in mind.

Interestingly there are a lot more uses for AR than many could expect. It can be utilized in making multicultural relations work better by using augmented reality to for example make people feel closer to each other besides of distance. AR glasses could help translate speech, making communication easier. Augmented reality can also increase safety for example with pilots or firefighters who can work with more certainty with the help of AR technology. Other good uses of AR are different training situations, construction of buildings, design and furnishing.

On the side of good examples comes also more useless features. These are different avatars and filters that many applications provide. The development has sadly in most cases been left to that. In the other end of the spectrum there are however some more dubious uses and ideas that can cause a lot more harm than good. One of the most shocking findings is people neglecting to pay attention to the surrounding world when engaging to an AR experience such as Pokémon GO. This has led to accidents and even death.

At the moment AR technology development is in a sort of a standstill. It is still waiting for the most innovative and useful adaptations. It is in most ways on the right track and people are finding beneficial ways of utilizing it, but a little more time needs to pass for it to really go mainstream, disregarding Snapchat filters and avatars. There is also a huge issue with the ethical side of AR technology and people need to understand the dangers of AR to use it so they can avoid threatening situations.

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MOBILITY IN A SMART CITY: HOW CAN THE INTERNET OF THINGS IMPROVE PUBLIC TRANSPORT?

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Group assignment

Axel Batossi
Arthur Grimont
Christina Tscheckl
Luca Zanchi

ABSTRACT

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In the 20th century, there was a huge development of public transportation all over the world. It was mainly the railways transportation system, the bus network, the bicycles and cars to rent and, nowadays, the car sharing. The management of those systems has usually taken benefits from the current technologies. In the recent years it is Internet of Things which is changing and evolving smart cities, and in particular, the public transportation system. The Internet of Things (IoT) is one network throughout the objects are able to communicate together. In the case of the public transportation system, IoT refers precisely to the possibility to monitor all types of data produced by the users in order to improve the system.

As a result, different uses of IoT are done all over the world to improve the public transportation system. In some cities like Barcelona, it is the use of the GPS technologies to give in real-time the location of one bus. Adding to that, smart bus stations have been implemented in Barcelona to give the users exact and up-to-date information of their buses. Taking benefits from the GPS, different platforms in the cities have been created giving the users best routes to go from one place A to another place B. For this case especially, there are different devices implicated like the user's devices, the transportation machines (metro, bus, or the bicycle etc). However, in the same time some issues are appearing like big data and artificial intelligence. The first is due to the fact that the data collected is really important. The second is that these data need to be analyzed unless they are not useful and require too much energy to store them. That is why the cities, try also to manage all those data as they belong to only one system. In a city like London for example, the collected data aims to help the managers of the transportation system to understand the users better. As a result, they could easier manage one incident in the transportation network and give the best solution for the users according to their needs. Moreover, London is not obviously the only city which tries to take profit from IoT.

Consequently, this document is trying to tackle some clues about what IoT really is and its role into a smart city, why an improvement of public transport services is important, what IoT has already brought to the transportation systems all around the world, which are its advantages and challenges, and finally, with a real case, compare this technology with another one, used for a transportation service.

1. INTRODUCTION

The concept of a smart city aims to advance urban concepts by inclusion of technological innovations. Since 2000s more and more cities are trying to become a smart city. Some have already established a deadline for this goal. Smart cities mostly include good infrastructure and a working public transport. Public transports are an important factor to reduce the traffic and the resulting pollution in cities. That's why an innovative and efficient public transport system is a major step in order to reduce motorized private transport. There are multiple ideas how to revolutionize public transport but one of the most promising is the IoT, the internet of things. IoT "[…] is a computing concept that describes the idea of everyday physical objects being connected to the internet and being able to identify themselves to other devices" (Techopedia Inc., 2019).

To implement IoT best in cities a lot of prototypes and test runs for self-driving public transport vehicles are done nowadays. With the help of IoT all these vehicles can be connected with each other and also with the network of the city. But solutions for safety and security especially cybersecurity are still in development (Federal Transit Administration, n.d.).

Currently cities are trying to improve by finding better solutions for connectivity, consistency and infrastructure. Sensors are integrated in the cities and the networks are improved (Maissin, et al., n.d.). However, a smart public transport system will only work if it is accessible online. Hence, tickets or the schedule must be available online and without interaction of the driver. To make a working smart public transportation, all things connected to it, like buying tickets or the schedule, have to be available online and without interaction of the driver. In this text we aim to analyse the existing technologies for the public transport with Internet of Things in order to how the current and future use of IoT can improve public transport.

We have chosen the "Explore and Understand" lens because we study the current existing technologies of public transport and try to understand how different cities have implemented their public transport systems. To achieve a good solution everything concerned with the public transport has to be connected. But since data manipulation is a great threat to those systems, securing that very data is an importance. Finding a general solution which can be applied in all cities would be the best outcome, but it will be difficult to achieve because it will take international efforts.

2. THEORETICAL BACKGROUND

2.1 Smart city

Nowadays, technology is changing the way to work, interact and communicate. According to this, many cities all over the world are changing and evolving their services in order to improve the efficiency and effectiveness of citizens' life, adopting new technologies and, so, becoming smart cities.

We can define a smart city as "a municipality that uses information and communication technologies to increase operational efficiency, share information with the public and improve both the quality of government services and citizen welfare" (Rouse, 2017).

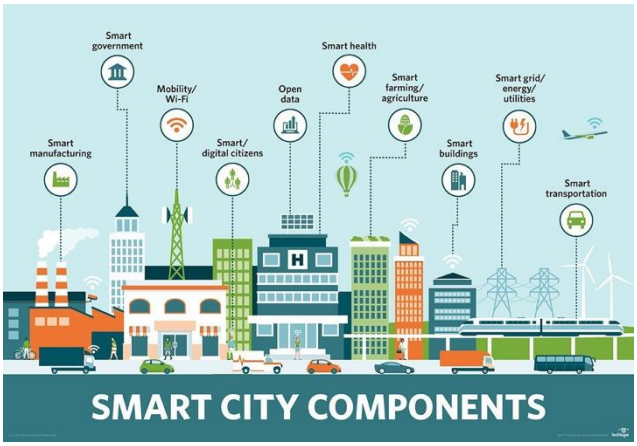

Figure 19: Smart City Components (Rouse, 2017)

Using information and communication technology (ICT) and various physical devices, smart cities allow city officials to interact with their citizen and infrastructures, optimizing the efficiency of city services and monitoring the changes and evolution of the city. According to this, smart transportation, manufacturing, government, health and energy are only some parts that compose a smart city. Today there are many examples of them:

- Amsterdam that every year promotes a challenge for app. In this way since 2009 it has included more than 170 projects collaborations that improve public safety, save energy, and reduce traffic. (Deakin, 2013). So, for example, thanks to smart lighting, municipality can control the brightness of street lights. (City, 2015)
- Barcelona where, for example, thanks to sensor technology, implemented in the irrigation system of the Parc, the authority can receive information about level of water and manage it only with a button. (Laursen, 2014)

- Or finally New York, that, providing services like free WiFi, phone calls, device charging stations, and local wayfinding is a perfect example of smart city.

2.2 Mobility and transportation

In every city the mobility and connection between people is a key issue and a motor for freedom, growth and progress. Nowadays, a half of the world's population lives in urban areas and the experts forecast that by 2050 this number will grow up to 70%, transforming the transportation into one of the most important challenges of the cities. (Öberg, et al., 2017)

Urbanization, economic development and growth of cities not only create benefits, but they have also some negative aspects, increasing, as for example, the average commuting time in Stockholm by over 20 percent in 18 years (Öberg, et al., 2017). For this reason, cities have to find, develop and create new solutions for mobility, becoming smarter, in order to make the life of their own citizen more efficient and effective.

As the Fraunhofer Institute for open communication systems said, "Intelligent traffic planning, the promotion of public transport and the improved interconnectedness of all road users in a city-wide communication infrastructure comprise the mobility characteristics of a smart city" (Fraunhofer FOKUS, 2019).

Today, there are many examples of cities that improved the concepts of mobility of their citizen, developing new solutions for public transport, car, traffic and, also for pedestrians or cyclist.

For example, Barcelona, analyzing the data regarding traffic flow, created a new bus network or, thanks to use of GPS and traffic management software, when there is an emergency, the approximate route of the emergency vehicle is entered into the traffic light system, setting all the lights to green. (Anon., 2015) Instead, the Dubai authority installed many projects and one of these is the Smart pedestrian signal: sensors connected between the ground and the traffic light. They measure data regarding pedestrian traffic and adjusted the signal time, basing on waiting time and size of pedestrian traffic, in order to make safer and more straightforward the crossing. (penalosa, 2015)

However, the real heart of the mobility in a city is the public transportation system that carries everybody to destination through a controlled flow of people. So, cities can develop, and efficiently improve, the public transportation system, promoting its use and using green public transport, in order to give a significant contribution to the reduction of traffic congestion and its impact on the environment and quality of life, reducing the emissions. In fact, for example, increasing use of public transport by only 10%, there is a reduction of CO_2 emissions of up to 19% (Öberg, et al., 2017). Nowadays, there is an

increase of cities, like Stockholm or Copenhagen that want to make their public transport service more efficient and the passenger experience different, in order to increase its attractiveness, by investing on Smart public transportation.

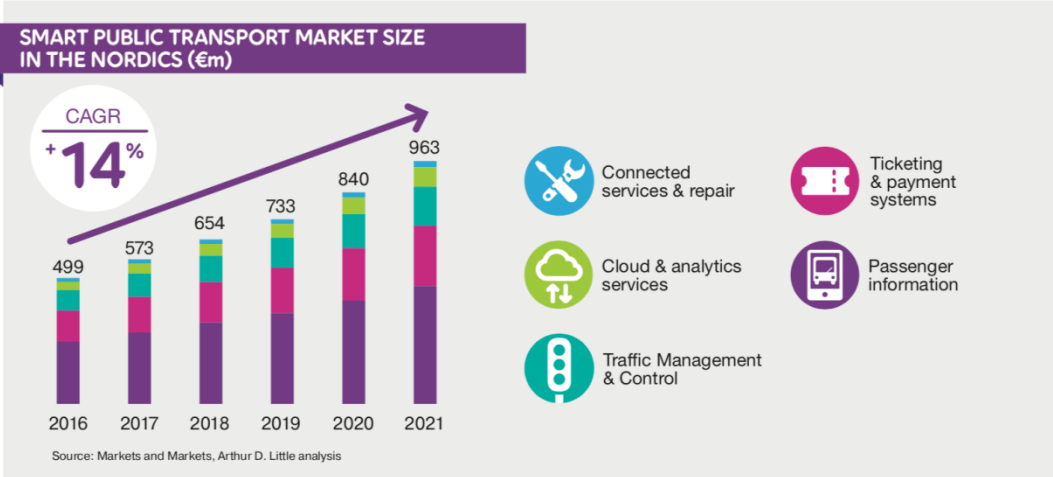

Figure 20: Smart Public Transport Market Size in the Nordics (Öberg, et al., 2017)

Smart public transport can be defined as "Connected solutions for shared passenger transport services such as buses, trains and ferries. Includes applications for connected vehicles and related infrastructure, such as passenger information, ticketing & payment system, cloud & analytics services as well as traffic management & control" (Öberg, et al., 2017).

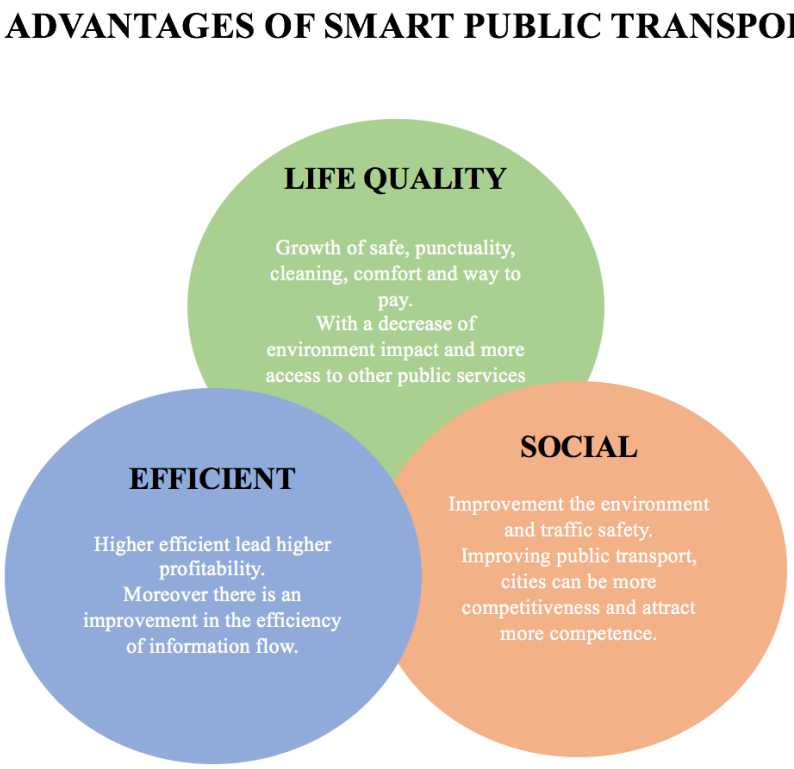

Figure 21: Advantages of Smart Public Transport (Öberg, et al., 2017)

2.3 Internet of Things and transport

There are many technologies that can make smarter public transportation and that are changing the concept of mobility: Self-driving trucks, Autonomous vehicles, Artificial intelligence, Augmented and virtual reality, Smart track and etc. However, one important contribution can be given by Internet of Things.

In the 1982 Carnegie Mellon University introduced a modified Coke vending machine, that was able to report its inventory and identify the temperature of drinks, and, for the first time, the concept of a network of smart devices, connected over internet, was discussed (Anon., 2014). However, the term “Internet of Things” was introduced, for the first time, by Kevin Ashton in 1999 (Ashton, 2009). Since that moment there have been many definitions of this technology, but nowadays we can define the Internet of Things as “the network of devices such as vehicles, and home appliances that contain electronics, software, actuators, and connectivity which allows these things to connect, interact and exchange data” (Wikipedia, 2019). According to it, this technology allows devices to communicate and interact with each other over the internet, being monitored and controlled.

In these years there is an increase of devices that use the IoT technology in very different ways to be connected and controlled by the internet, integrating the physical world into computer-based system, in order to have efficiency improvement, economic benefits and reduced human exertions. According to this, in 2017 the number of IoT devices increased by 31% (Köhn, s.d.) and the experts forecast that there will be 30 billions of them in 2020, with a market value of $7.1 trillion (Nordrum, 2016).

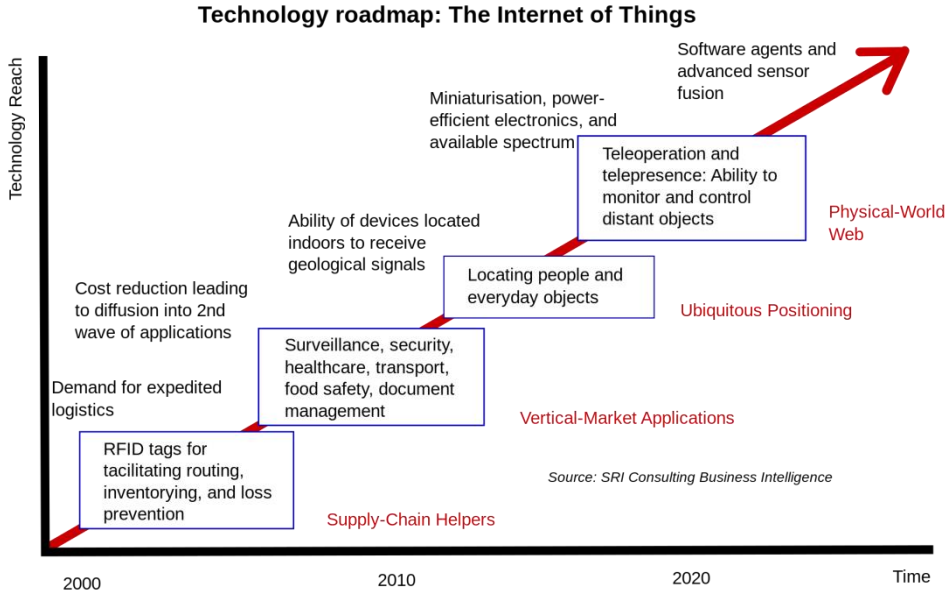

Figure 22: Technology roadmap: The Internet of Things (Wikipedia, 2019)

The growth of IoT is leading towards also a development and improvement of smarter public transportation, creating a network of connection between vehicles and infrastructures into a city.

Combining this technology with the increasing connectivity, like 4G or 5G, and the use of smartphones, it can be the engine of development of new public transportation system, helping authorities and operators to make a more efficient plan and to reduce the cost of fuel, in order to create smoother and cheaper rides for the passengers.

According to this, with the use of WiFi, guidance in case of disturbances and new smoother payment system, public services providers can offer a new costumer experience: for example, passengers can be informed when they are late to a meeting, thank to integration between applications, like trip planners, and passenger's schedules, or like in Stockholm, with a communication among bus and traffic lights, the public transports have always the priority in the traffic. As Jonas Kempe, Nobina's chief marketing officer B2B, said in an interview, the Smartization of public transportation is a complex process that could require many phases. Nowadays, connectivity has allowed integrating a system

with travel planners. But in a latter phase, IoT will make the public transports more efficient, integrating them with each other and external systems, and will help to develop new technology and type of vehicles, like individually connected vehicles or autonomous public transports (Öberg, et al., 2017).

As Johan Oberg, Telia's head of marketing and partner management, said "A digitized system for public transportation is at the core of our future society. Unlocking the full potential, requires players to rethink their positions in a new ecosystem, built on open platforms, leveraging scalable and reliable technology together" (Öberg, et al., 2017). Consequently, we decided to understand how Internet of Things has changed the public transport services and how it can improve this sector in the future, being the starting point for the development and implementation of new technologies.

3. ANALYSIS AND RESULTS

3.1 Analysis

As more and more cities are growing, public mobility creates more important problem and challenges. There are examples in many cities, like in Paris, where there are two peak of attendance in a day, one in the morning between 8am and 9am, and another one in the afternoon, from 5pm to 6pm (SNCF, 2015). Travelling in Paris during these two periods can be very difficult, because there are traveler's accidents, for example who fall in the subway rail tracks, or travelers who have ailment. Precisely, Parisians spend about 1 hour and 32 minutes per day in transports, which is a huge waste of time, and an important source of stress (Le Journal du Dimanche, 2017). These issues cause a waste of time and also a waste of money, because it can cause many worker's delays for example.

Internet of Things can bring an answer to these issues, because it permits to make the public transportation smarter, with a better safety for passengers and all urban dwellers with less traffic congestion, with a route and journey optimization, and lower infrastructure cost.

Actually, there are many examples of the use of IoT in the public transport service of cities and the explanation of them can be an important tool in order to understand the way with which this technology can improve the public mobility in a smart city.

First of all, IoT can do important improvements for safety and traffic congestion. In case of bad weather, road closures, or any else incident, public transports can be disrupted. IoT can bring an answer to this, because it can give to the authorities the real-time insights that they need to implement alternative roads, or contingency plans for example. This can be possible with cameras, connected devices, or connected sensors in the bus. The cameras can detect an accident, and then immediately warn the authorities with 5G, for a high-speed transfer of data. Connected sensors in the bus can detect if the bus got a problem, such as breakdown, or accident, and immediately warn the authorities, or the public transportation company. Moreover, IoT allows to give buses traffic priority like, for example in Sweden, using a radio beacons that send a signals to traffic lights or "sending information about the individual buses in real time to the central traffic-light hub, giving priority based on which line the bus is driving and whether it is on time or not" (Öberg, et al., 2017).

Today, with mobile devices as smartphones or smartwatches, we are able to know how the road traffic is: for example Waze, a mobile app for GPS navigation, is able to know just with connected devices, if the traffic is fluid or not. In fact, if for example there are

more than 20 connected devices which does not move forward, Waze says that there is traffic jam in that place. This example could be applied for public buses, in order to improve the routes taken by public buses. However, a lot of people would not to have their location constantly monitored, but the solution to this privacy issue can be sensors which can detect connected devices anonymously.

However, today, public authorities are understanding that digitalization a way to increase the use of public transports is to enhance the attractiveness of them, and IoT can represent a big tool to aim this objective. Peter Viinapuu is the CEO of MTR, one of the largest railway operators in the world and responsible for operating the Stockholm metro and also the train between this city and Gothenburg. He stated that "there is a high correlation between operational efficiency and customer experience. For example, digitalization has helped us drive trains more efficiently, reducing energy expenditure and giving passengers a smoother ride with very high punctuality" (Öberg, et al., 2017). For this reason, MTR created an app that, thanks the use of Internet of Things technology, enables drivers to know exactly how many seconds they have per stop and also passengers to receive real-time information about congestion in order choose less-crowded sections. Moreover, now "MTR is working on connecting its trains to relay technical status in real-time, enabling prediction of time to failure and providing information to service depots on what needs to be repaired, before the train even arrives" (Öberg, et al., 2017).

For the same reason, Barcelona City has created new digital bus stop, making the waiting more interactive. The passenger can have information about the city through his or her smartphone with QR-Code: if he or she is a tourist it can be very useful for him or her, and it created value for the city in the same time. Passenger can also reload the phone with USB charging stations and use his or her smartphone with a free Wi-Fi. Also, the customers have real-time information about the bus, with its exact location, the exact waiting time. (Adler, 2016).

Furthermore, as Jonas Kempe said "the traditional analog timetable is gradually playing out its role. Today, passengers get more exact information directly on their smart phones". (Öberg, et al., 2017). Nowadays, Nobina wants to provide a new and innovative services, improving the integration of different systems. According to this, thanks the use of IoT, applications, like trip planner or calendar, can be integrated and connected with the passengers' schedules, informing hosts about the delay of person to a meeting. However, in order to do this, Nobina has changed its business model, moved towards volume based contracts, increasing the share of volume based contracts from zero to a third of revenues in ten years, having a positive impact on costumer experience (Öberg, et al., 2017).

Internet of Things can be also a tool used in order to spread and have faster access to data. In Dublin, the bus company work with Real Time Passenger Information (RTPI), which

is an IoT-based system. It permits to have real-time information on departure and arrival times, and also on service disruptions, to help passengers to have more efficiently journey.

This schema represents the way it works:

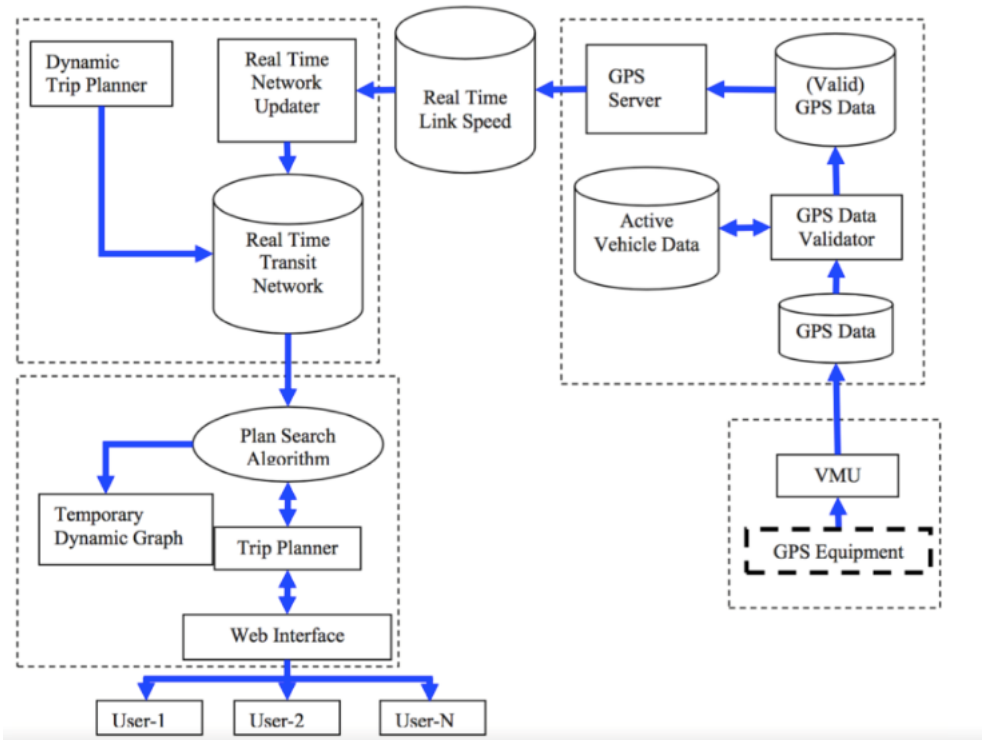

Figure 23: Schema of RTPI (Khil, 2017)

We can see that the RTPI system leans on GPS equipment to have data on the traffic, and to have the user informed at the end. With that system, Dublin Bus is able to provide personalized travel advice to passengers, based on these data, and it can communication delays, and real-time information about which bus will pass in which stop, at what time. This is possible thanks to bus equipped with GPS, radio, and onboard computer for the driver, which transfer data to a central computer (in the same way as the previous schema). This technology permits to make the public transportation more efficient and effective.

In order to prove the relevance of public transportation service in the development of a smart city, in the graph (figure 6) the different IoT projects launched by cities all around the world are classified by groups and the traffic segment is the most frequent. In addition, Utilities can be considered as a segment related to the public transportation, because often, public transportation in a city is managed by the city council. Moreover, Public Safety segment can also be related to the public transportation, and this confirms that mobility is one of the biggest challenges for cities in the world.

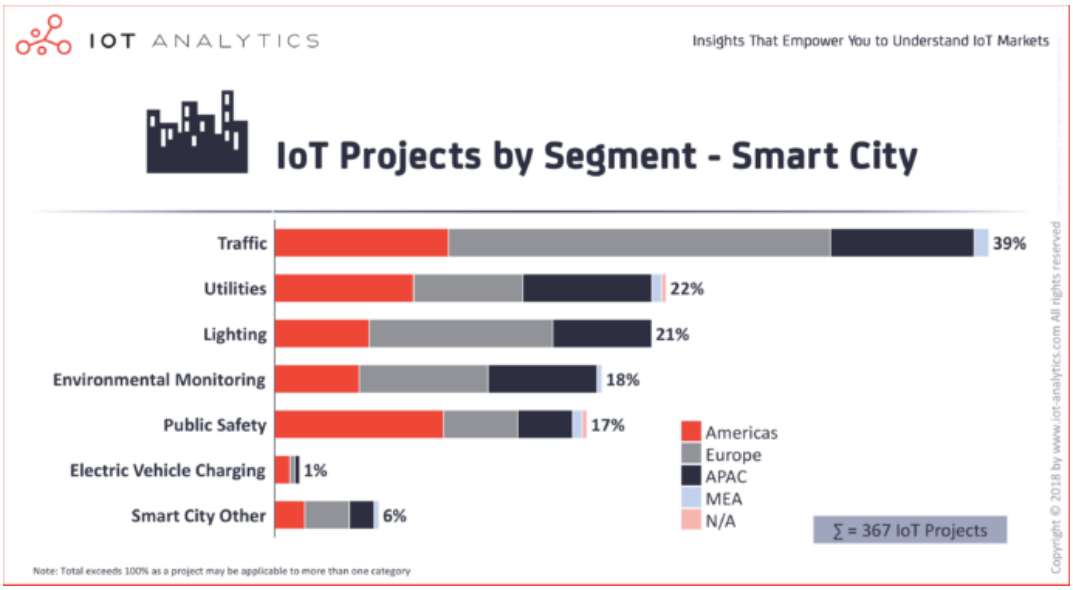

Figure 24:IoT Projects by Segment – Smart City (Scully, 2018)

Lastly, nowadays, the integration of smart services is very limited, due to the characteristic of current smart public transportation of operating in "silos". However, Internet of Things can "drive public transport from individually connected vehicles to Intelligent Transport System (ITS)" (Öberg, et al., 2017) and the integration of IoT and ITS creates a new kind of transportation system: Smart Transportation System (STS) (Zhang Mina, 2011). In this way, integrating multiple modes of transportation along with physical and digital infrastructure, public institution can redefine public transport. First of all, it become more passenger centric, like, for example in Vienna, where thanks to a newer and more integrated ticketing systems, they can pay-as-you-go system. Then, public transport system will become increasingly autonomous, like in Copenhagen, where subway trains are already fully autonomous and this can bring also efficiency advantages: as Öberg, Johan; Ribe, Jan; Glaumann, Martin; Gjelstrup, Andreas; Leifland Berntsson, Gabriel stated " self- driving vehicles can help operator save up to 70 percent of labor costs, and possibly enable operators to drive more frequent trip" (Öberg, et al., 2017). Finally it can become more integrated, in fact the combination of IoT and 5G enables more interaction between different services in society, and thanks to this "when public transport systems understand how and when people move, it can adapt in real-time, re-routing traffic using heat maps of where people are located" (Öberg, et al., 2017).

3.2 Results

As developed above, IoT is becoming more important in society especially for common transports. The numbers of actors implicated in it is growing from the companies specialized in IoT, the States, the cities and so on. So, in order to analyze the results of use of IoT to improve public transports, results of some use case will be analyzed first. Then from these results, some advantages and challenges from this case will be deducted. And in a last part, probably results of new actors and technologies some cutting-edge technologies will be discussed.

3.2.1 Practical and concrete results of the use of IoT in common transports

The drastic improvement of public transport in London

IoT is at the helm of the current improvement of the public transport network in London. In fact, since several years, the Tfl (Transport for London) use big data to improve the information gave to users and understand users (Objectsconnecte.com, 2015). For that, big data is mainly provided by a huge broad of IoT devices like smartphone, machine payment, bicycles booked, research of the users (Objectsconnecte.com, 2015). For Lauren Sager-Weinstein Analyst Responsible for Tfl interviewed in 2015 “data collected by IoT devices are linked to commercial operations” (Objectsconnecte.com, 2015). As a result, IoT help Tfl authorities to get the more relevant information to be able to make right decisions in the most critical moments. One example identified by Lauren Sager-Weinstein, is the ability to refer to big data when a station is going to be close. In fact, they can know where the people are mainly going and then propose them a new road.

Use of smart digital bus station and smart parking in Barcelona

Smart digital buses are plenty of opportunities for the users. They make the user’s waiting more comfortable, improving the quality of user’s experience. In fact, their attractive and eco-friendly design and the enhanced communication giving real-time information (zicla.com, 2017) are probably well seen for by citizens. Another hand, the installation of sensors around the city detecting free parking place (Madden, 2017) will probably reduce traffic congestion. Consequently, people will send less time, will probably less angry and frustrated and spend better days.

3.2.2 Advantages and challenges from the use of IoT of public transports

Advantages

From the previous examples and in general one advantage of IoT once can return first that IoT gives relevant information. In fact, the devices could be every kind of devices

like smartphones, laptops, sensors, payment machine or rent bicycle machines as it is for Tfl in London. Consequently, the authorities are closer to the right information. The second advantage once could identify is that IoT can make the communication easily by using the objects. Objects by the moment that they are "alive" can monitor something and send the information without any human interaction. It represents real saving of money on the long term and permit to human to focus more on other activities. However, behind these advantages are some challenges and difficulties

Challenges and difficulties related to IoT

Practical aspects

As a new technology IoT still need sometimes to be fully integrated in the habits. For that, engineer and software developer should be more aware to this reality. Also people in general should have an understanding of what is IoT. In addition, even though there are more and more data, these one should be assessed in a rational, logical and realistic way in order to give good results. Moreover, even if the data are well-organized, the question of the safety remains. In the recent days, data is considered as "the new oil". Therefore, the data collected by each kind of devices for public transportation should be safe especially when these data concern the citizens. However, the problem is that currently some IoT devices do not have a strong internal safe system which can protect them for hacking (ALE International, 2018). Also, by involving objects in a network, this one becomes huger and then more vulnerable to attacks (ALE International, 2018). Consequently, the further IoT system, should take into consideration some aspects of security like the fact that in an IoT network, there are a lot of isolated devices which should be protected to prevent attacks to one device and the propagation to the other devices.

People

With IoT, people are known "alive". They can communicate together. But what about the people? The first element is that several jobs will be probably hugely or not impacted by IoT.

Thus, now objects are talking together: what the place could be of people and if people are going to become more passive. For the moment, the IoT in public transportation is mainly used for monitoring, people remain principal actors. However, in a long-term perspective, the use of data gathered should be vividly controlled. In fact, everything could be done with data from good to bad. Also, people should be informed to the information collected.

New players are appearing in the game

With the progress of IoT market in general, there are more of companies which are working on IoT questions related to transports transportation. Some companies like Faltcom which develops a lot of different apps for public transport in smart cities (Fältcom, n.d.)

or Connecthings (for geofencing apps) and also big players like Cisco, Alcatel and Ercison.

Also the cities are particularly implicated because they are at the initiative and the one which can allow the implementation of captors or everything else. Then in most of the cities founded, the development of an IoT strategy is generally an official issue. In all smart cities, the role of the authorities is always very important because they are the only one which can set the tone of this new initiative. They are at the helm for different projects like the installation of captors and sensors in the street, the development of roads for bicycles and the improvement of the internet connectivity in those cities.

4. DISCUSSION

As analyzed in the previous chapters, smart cities approach at different places around the world. In this chapter, in order to prove the consideration made previously, we want to focus on what is the future impact of Internet of Things on public transportation services in a real case, comparing this technology with another one. At the end we will give a short overview about the security and the safety for smart public transport.

4.1 Comparison of IoT technology with another one

Menon and Sinha (2013) in their research about the implantation of Internet of Things in the public bus services of the city of Singapore, tried to estimate the future impact due to the implementation of a new application for the bus service of the city, based on the IoT technology. In this research, conducted also through interviews with the industry experts, they identified six major factors, also comparing them with one of the widely uses bus app in Singapore, Iris Nextbus. The main impacts are:

- **Better time management:** Providing an alarm, that is not implemented as in Iris as in any other bus applications used in the city, the application with IoT can make the life of users very convenient, warning costumer about the arrival of the buses. "It gives flexibility to users as they could now reach the bus in exactly the same time that the bus would take to reach" (A. Menon, 2013)
- **Savings in time:** Basing on the direct communication between the buses, the new applications provides "the highest possibility of providing the most accurate real time information" (A. Menon, 2013), optimizing the customer's use of time. Instead, Iris Nextbus does not take in consideration the traffic conditions, providing, in this way, "accurate real time information only if the interval between query time and arrival time is minimum" (A. Menon, 2013).
- **Bus efficiency:** Nowadays, Iris does not provide any information to the bus operator, but with the used of IoT, application can give real time information about the arrival time of the buses to them. So, data can be used to find and analyze possible significant pattern "in the crowd in buses at any particular time or routes" (A. Menon, 2013).
- **Cost:** While Iris application can be downloaded for free, the new application has a price of 1.63$.
- **Crowd management:** While "Iris currently does not provide any such solution that would help in managing crowd in buses" (A. Menon, 2013), having real time information about the occupancy status of the next and upcoming buses, users can make the better decision according with their current situation.

- **Choice:** The new application offers a wider range of different option than other ones, in term of the buses and the routes toward a particular destination, allowing user to choose from depending upon his or her preferences at a particular time.

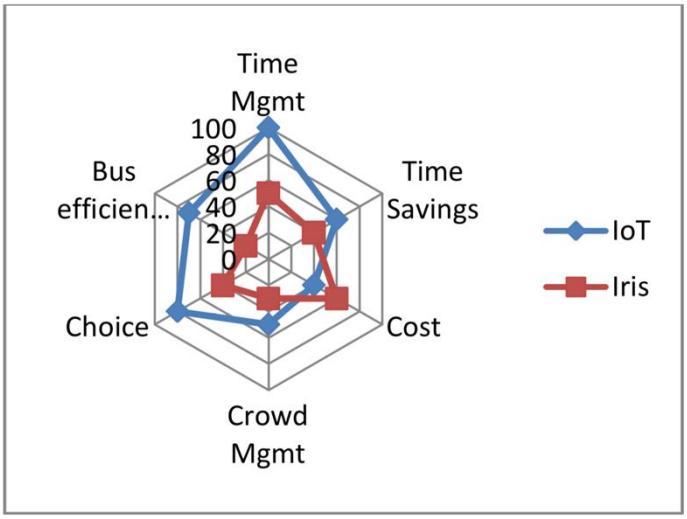

Figure 25: Impact and competitive analysis of IoT application with Iris NextBus (A. Menon, 2013)

4.2 Security and Safety aspects

Safety and security are very important aspects for a good smart public transport system. In some articles it is said that safety is more important than security (LÉVY-BENCHETON & DARRA, 2015). But for systems connected with IoT both have the same importance because if, for example, the systems get hack, there might be a lot of accidents. So, without security there is no safety. But still there have to be a lot of safety functions especially if the public transport system drives autonomously. There also has to be a safety solution if the system gets hacked, in order that not all vehicles crash.

Smart cities do not want to share their security methods because they are afraid that if they share it, it will be easier for hackers to get access to their systems. On the other hand, it could be very useful for other cities to get this information so they can use the best solutions to protect their systems.

So, cities have to prioritize the security and safety aspects in order to be able to implement a good working and safe autonomous public transport system.

5. CONCLUSION

The Internet of Things is playing a central role in improving public transport systems. Most cities have implemented different technologies and are trying at different spots how the residents of the city interact and react to those technologies. The best example is the smart bus stop in Barcelona, mentioned in the previous chapters. For big cities it is especially important to have a working transport system in order to reduce traffic jams. Obviously, traffic jams cause a lot of lost time for public and private transport. Though it will take some time to implement self-driving-public-transport-vehicles IoT can still improve the public transport and make the traveling more comfortable. A very useful improvement could be a permanently updated schedule in order to let people know about any delays.

IoT has the lot of advantages but there are also some emerging disadvantages which have to be considered. To make a perfect working network, the capacity has to be improved which lead to the introduction of the 5G network. When it was tested in the Netherlands birds suddenly fell dead from the sky because of the radiation (Kasprak, 2018). Therefore, the influence of the 5G to the environment is questionable and a lot more research has to be done before it can be implemented in more places. The security aspect has to be considered as well, because every online data can be hacked. The users of the public transport are monitored. But those circumstances could lead to questions of privacy. The system might not work without input of its users to provide up-to-date data. Additionally, it could be a challenge to get the official approval of implementing IoT, since not every authority may be willing to use such technologies for various reasons.

In this document it was explained that a lot of cities have a few implementations for their public transport system in combination with IoT. But in order to improve the existing technologies cities would have to work together and share their knowledge. If the best technologies are combined, a good smart public transport system can be implemented. It will take some more years until this will happen because in some cities the infrastructures have to be changed. Finally, it cannot be avoided that IoT will be introduced in all public transport systems, even though for some it will take more time than for others, depending on their existing technologies and the willingness to implement IoT. Nowadays, the integration of smart services is very limited, but “a digitized system for public transportation is at the core of our future society. Unlocking the full potential, requires players to rethink their positions in a new ecosystem, built on open platforms, leveraging scalable and reliable technology together” (Öberg, et al., 2017).

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