THE IMPACT OF XR TECHNOLOGY IN THE AUTOMOTIVE INDUSTRY FOR TOYOTA COMPANY

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Abstract

Around the world, companies in the automotive industry are under continual pressure to reduce time-to-market, reduce costs and increase the quality of the product. Given these pressures, this study aimed to understand the impacts of Extended Reality (XR) technology in the automotive industry. Nowadays, virtual worlds provide users with a high level of immersion. XR can add a new dimension to learning environments in the manufacturing industry with a realistic and lifelike presence in production to assess how the various results interact with each other, and to give a better customer experience. Augmented Reality (AR) can be applied in many areas within remote guidance and complex tasks where Virtual Reality (VR) can be commonly used for planning the layouts and virtual training.

This documentary research investigated how this technology can help to improve customer satisfaction, reanalyze the customer experience for the vehicles of the future for safety and autonomous driving, allow innovations for better design and quality for product improvements, and enhance training processes. The results of this paper guided the overview and background of this research, reviews from the works of literature and then the findings that we had established. Finally, the recommendations and suggestions for implementation of

this study on all levels of management and other industries and limitations of the research had been presented.

Keywords: Extended Reality (XR), Automotive Industry, Toyota Company

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Chapter (1) Introduction

1.1 Research Background

In today's modern world, various kinds of technological innovations have been introduced. One of the revolutionary innovations in XR technology, also known as cross reality or extended reality. It is an all-encompassing term and relates to technologies that combine real and virtual environments for humans to interact. Virtual, augmented, and mixed reality has an increasingly major role in playing in weakening the boundaries of the physical and digital worlds for both consumers and enterprises. According to Mary Hamilton, Managing Director of Accenture Technology Labs, the digital experiences that we have with virtual, augmented and mixed reality will change the way we live and work (XRWeek, 2018).

XR is revolutionizing engineering and design work by adding new dimensions of reality into the daily work process. The growth potential and opportunities are high as XR market is predicted to rise to $80 billion by 2025. XR has been used by engineers and designers to design new products and cut costs. It is being utilized in various kinds of industries such as construction, manufacturing and automotive industries for enhancing the design, improving visualization, communicating with clients, and rapidly testing concepts with consumers (Hamilton & Webb, 2017).

The development and application of XR technology have also become a major factor in the automotive industry as it finds various kinds of ways to be innovatively applied to this industry. Examples of XR in the automotive application may include holographic augmented reality navigation system being built inside a vehicle, maintenance, manufacturing workstation optimization, vehicle design creation, and assembly training (Infopulse, 2018).

Over the world, companies in the automotive industry are under continual pressure to reduce time-to-market, reduce costs and increase the quality of the product. Given these pressures, the automotive industry is using XR applications across the product life cycle - design, production to sales and marketing. Audi is now using this technology for their cars with the Audi VR experience, offering a 'wow' factor to attract consumers into its showrooms. The brand has implemented the most realistic 3D versions of its cars possible (VRSpot, 2018). Honda used an AR experience called the Honda lens to offer customers an interactive tour of various Honda automobile features without requiring the user to look under the hood (Deal, 2018).

Toyota Company has been also adopted XR technology into their operations. Toyota used VR headsets to show people how it might be like to ride in the Toyota Comfort Ride concept car, an autonomous vehicle powered by hydrogen fuel cells. They are now relying on AR and VR technologies to improve the way dealership service the customer and to improve the product itself. Koichi Kayano, the project manager of an operations improvement department of Toyota, said that at Toyota, they have been using VR and AR tools to improve efficiency and quality in design, engineering, and training by partnering with Unity Platform (Unity Technologies, 2019).

1.2 Problems to be investigated

The automotive industry, like many other industries, is hardworking and multi-faceted with some inherent difficulties when it comes to adapting to new circumstances. Cars are typically high-involvement products and car companies like Toyota, very well know how to build strong brands, how to charge premium prices, how to keep residual values high and how to keep customers happy (Parment, 2013).

Toyota has indeed been adopting XR technology in their operations, like in the recent UK showcase of the Toyota C-HR VR Experience at VR/AR World, revealed the effect of utilizing virtual reality as part of a campaign before the vehicle's release and it received an outstanding response from representatives at the show (Bodinat, 2016). But, on the other hand, they haven't made use of the technology to the fullest extent. There are still many improvements that can be made with the use of XR technology in Toyota compared with other automotive companies.

1.3 The objective of the study

This research aims to identify the impact of XR technology in the automotive industry, especially the Toyota Company. The research also intends to examine what kind of improvements can be made to Toyota with the use of XR technology.

The objectives of this study are:

a) To create a better customer experience for better sales,
b) To redefine the passenger experience for the vehicles of the future
c) To reveal creativity for better designs and quality to improve the product, which will be faster through design visualization,
d) To speed up knowledge transfer in training and guidance

1.4 The scope of the study

This study was done in a documentary research format to research the impact of XR technology in the automotive industry and what kind of improvements can be made in Toyota with the application of XR technology to give a better customer experience, creating better design and quality, and accelerating training processes. Although there is the utilization of XR in Toyota Company, the coverage of this study is on processes that can improve the company to get a competitive advantage over other companies in this competitive automotive industry.

For this study, the researcher has reviewed literature from published papers and studies in the EBSCO database, articles, and websites which are referenced at the end of this document. From these references, the research ideas have been built up and create a structure for the research and then going to suggest recommendations for real-world application of XR technology in the automotive industry especially Toyota.

1.5 Research Significance

XR is an exciting innovative technology, but it can also mean that only a few people have experience with it. Today, many manufacturing businesses are interested to do interactive training on VR and have 3D models appear in front of technicians in AR, but yet they don't have the knowledge of how to do it. In virtual worlds, it turns out to be possible to show things specifically from impossible angles and let workforces train in settings with unlimited freedom and flexibility, which drive industries to keep trying to implement XR (Wannerberg, Löfvendahl, Larsson, & Stridell, 2019).

This study of the use of XR technology can be beneficial to the automotive industry to enhance the manufacturing and operational processes. The study's goal is designed to help improve customer satisfaction, reanalyze the customer experience for the vehicles of the future for safety and autonomous driving, allow innovations for better design and quality for product improvements, enhance training processes. The use of VR is becoming more common in the automotive sector, with many firms, significantly at the high end of the industry, utilizing the technology to provide prospective customers a taste of the vehicle layout and look (Nathan, 2015). This way, the customers can experience a car before it even exists as they are able to customize the vehicle to their preference such as color or interior materials. There have been uses of virtual showrooms in automotive companies that immerse customers in the product experience and buying process, driving higher levels of emotional engagement (Foxall, 2017). This can reduce costs for dealerships that spend endless amounts of cash on showroom space (Akopyan, 2016).

The XR technology can offer visualization that enables rapid prototyping and iteration on designs, at scale, and in an immersive, interactive 3D environment. It can ensure that product designers and engineers can gain a deeper understanding and ability to seamlessly collaborate on the common virtual ground and nothing will get lost in between (Unity Technologies, 2019). This application of visualization can be found in virtual laboratories allowing the designers to explore basic parts of the automobile by comparing and contrasting. The advantages are a cost-effective way to get a high-quality laboratory, flexibility, and multiple access and damage resistance (Kroupa, Tuma, Kovar, & Singule, 2018).

Using virtual reality can engage in the process of training as it can build up richer and more dynamic learning experiences where they are appearing for further study with the content. It can facilitate the understanding of difficult concepts to comprehend and demonstrate in the real world because these worlds have the potential to be a useful training tool (Stenger, 2017). With the XR technology tools, user acceptance can be assured, as the game-based user interaction offers an engaging and intuitive user interface and increase user involvement and knowledge transfer while eliminating dependency on physical proximity or materials, resulting in reduced training and travel costs (Gorecky, Khamis, & Mura, 2017).

This research topic is significant due to the fact that XR technology can help in the achievement of several objectives such as creating a better customer experience, redefining the passenger experience for the vehicles of the future, such as safety and autonomous driving, revealing the creativity for better quality and design to improve the product, and speeding up knowledge transfer in training and guidance.

Chapter (2) Literature Review

2.1 Cross or Extended Reality (XR)

"XR" is a term stating to all real-and-virtual combined environments and human-machine interactions generated by technology and wearables. It includes representative forms such as Augmented Reality (AR), Augmented Virtuality (AV), and Virtual Reality (VR), and the areas interpolated among them (ArtXRperience, 2019). It comprises a wide-ranging variety of hardware and software, as well as sensory interfaces, applications, and infrastructures that enable content creation for VR, mixed reality (MR) and AR. With the use of these tools, users can create the new nature of reality by taking digital objects into the real world and taking real world objects into the digital world (Wikipedia, 2019).

On the other hand, there is mixed reality (MR), also known as hybrid reality or Augmented Virtuality (AV), which is the combination of real and virtual worlds to produce new environments and visualizations where physical and digital objects coexist and cooperate in real-time. MR takes place not only in the physical world or the virtual world, however, the mixture of reality and virtual reality, covering both Augmented Reality and Augmented Virtuality via immersive technology (TimesofBell, 2019).

2.1.1. Virtual Reality (VR)

In Virtual Reality, users are completely immersed in a virtual world and cannot see the real world around them. VR allows a user to step through the computer screen into a three-dimensional (3D) world. The user can look at, move around, and interact with these worlds as they were real (Lawson, Salanitri, & Waterfield, 2016a). VR can be used in different phases in manufacturing. It is most common in product development and marketing, but it could also be used in training, ergonomics, and visualization of digital factories like in design phase (Berg, &Vance, 2016).

2.1.2 Augmented Reality (AR)

Augmented Reality can be defined as a technology used to "augment" the visual field of the user with the information necessary in the performance of the current task. With the use of the camera on a smartphone, AR adds digital elements with a live view. It is mostly used for remote guidance and visualization of instructions used in complex assembly, disruptive tasks or training in an existing environment. It can be differentiated into three types, i.e. handheld device (smartphone or tablet), head-worn like glasses and spatial (projector, hologram) (Syberfeldt, Danielsson, & Gustavsson, 2017).

According to (Bacca et al., 2014), AR applications can be used in different learning scenarios, such as explaining and evaluating topics, simulating lab experiments, educational games, augmenting information, explorations, etc. It is also found that AR can give instant feedback, which makes it almost impossible to assemble wrong and result in high quality. This advocates the AR technology for more advanced and longer tasks within manufacturing, such as complex setups, operations with many tasks/long cycle time and advanced maintenance (Fast-Berglund, Gong, & Li, 2018). It also has the potential to support driving-related activities.

Cyber-physical systems are growing and is a big part of the industry 4.0 evolution (Lee, Bagheri, & Kao, 2015). XR technologies have application in almost every industry, such as architecture, automotive industry, sports training, real estates, psychological health, medical treatments and health care, merchandising, space exploration, industrial design, architecture, engineering and construction, entertainment, advertising, marketing, education, broadcast and music (Boesch, 2018). The market is exploding with both the technologies such as apps and wearables and consulting firms that could perform the service of using VR and AR (Syberfeldt, Danielsson, & Gustavsson, 2017).

Augmented-reality devices can augment the driving experience by highlighting other traffic and objects (e.g., objects that the car is unsure about), and can thereby provide a tool for designers to increase user trust in automated vehicles. On the other hand, augmented-reality devices can allow drivers to transform vehicles into places for productivity and play (Kun, Meulen, Van der & Janssen, 2018).

Thanks to expanded and virtual reality, new possibilities are opening up in sales such as online car configurators, and virtual showrooms can immerse customers in the product experience and buying process, driving a higher level of emotional engagement and increased sales. As for example, customers can design the car according to their own personal taste on their smartphones which allows them to get closer to their dream vehicles and then thanks to enhanced reality, they will be able to view their customized cars on the street. Moreover, AR can play a major role in making driving safer. Human errors are perhaps settled soon by self-driving cars, at the same time, modern AR technology is already helping to reduce accidents. Thanks to the well-known “Head up” displays, for example, visibility such as road lanes and traffic lanes are highlighted and improved by 3D mapping and positioning technology (MyBusinessFuture, 2019).

The use of mixed reality will accelerate and increase the efficiency of knowledge transfer with immersive, and collaborative training applications that maximize safety while excluding the dependency on physical proximity or materials, resulting in reduced training and travel costs (Abbruzzese, 2018). Also, insertion of errors into physical hardware may destroy the prototype or lead to a system state that may cause safety issues for the worker. Additionally, in a virtual prototype (VP), it is much at ease to detect the effect of the error on the system and track the error propagation. Even more significantly, VPs can help find unanticipated error effects early in the design process, which is one of the stages that costs the most in time and money in car manufacturing. Whenever a team introduces any alterations to a current mock-up, they have to generate a new model. So, in VP, measures to keep, the overall system, safe can be included at an early stage of the design phase, therefore, avoiding costly redesigns. (Oetjens et al., 2014).

2.2 Automotive Industry

The automotive industry, all those companies, and activities involved in the production of motor vehicles, comprising most mechanisms, such as engines and bodies, but except for tires, batteries, and fuel. The industries' principal products are passenger automobiles and light trucks, including pickups, vans, and sport utility vehicles (Rae & Binder, 2018).

To remain competitive, the industry has to be constantly conversant with the latest technical breaks and must be prepared to change existing systems and procedures to deploy new and more effective and efficient ones. Indeed market requirements often demand continually increasing product quality, in less time, as illustrated within the automotive industry (Lawson, Salanitri, & Waterfield, 2016b).

The success of manufacturing enterprises depends on their capability to quickly adapt to technological, social and economic boundary conditions. The automotive industry is one of the first to embrace virtual reality technology. In recent years, virtual prototypes (VPs) have been recognized in many areas of system development processes in the automotive industry and other industrial sectors. In the automotive industry, VPs are most frequently applied as platforms for software development, in design space exploration and system verification (Oetjens et al., 2014).

Moreover, the augmented reality has broad applicability in the industry, from real-time viewing of product information and production flow, viewing kinematic simulations and displaying deformations and loads, to product design, maintenance, and logistics (Deac, Deac, Popa, Ghinea, & Cotet, 2017).

There have been demonstrations that mixed reality training of automotive service operations is preferred by trainees over traditional observation-based approaches since the workers trained by hardware prototyping is costly and limited in scale and product variants, limited hardware availability only at a late development stage. Furthermore, researches have shown that with trainings with simulations, the completion of the tasks are enhanced upon training on real equipment from the 50% to 66%. Additionally, it is learned that the preservation of information after two and four weeks is superior for contestants trained with VR than with other systems (Borsci, Lawson, & Broome, 2015).

Despite many studies that have confirmed the positive impact of virtual training on procedural learning in manual industrial tasks virtual training has not made its way into daily practice in the industry yet (Gorecky, Khamis, & Mura, 2017).

2.3 Toyota Company

Toyota Motor Corporation, in Japanese "Toyota Jidōsha KK", is the Japanese parent company of the Toyota Group. It became the leading automobile manufacturer in the world for the first time in 2008. Most of its approximately 600 subsidiary companies are involved in the manufacture of automobiles, automobile parts, and commercial and industrial vehicles. Its headquarters are in Toyota City, an industrial city east of Nagaya, Japan (Britannica, 2019).

Toyota is one of the automotive companies that use technologies in innovative ways apart from other brands like BMW and Audi. Toyota GB is embracing consumer technology by using augmented reality (AR) for the first time in its showrooms across the United Kingdom. Toyota is working with the marketing agency “Brandwidth” and using augmented reality to let customers see inside its C-HR car model across all grades and colors. “Brandwidth” worked with Toyota to develop the Hybrid AR app as part of an ongoing drive to inform the brand’s customers on their hybrid system and the benefits it offers. Besides, the app features several "hotspots" which, when clicked on, enables customers to get in-depth information on the key features of the system, such as the motor, battery, and fuel tank. (Sillitoe, 2019).

Toyota has developed a virtual reality driving simulator called TeenDrive365. With the use of Oculus Rift, students can experience driving a car in VR before they get on the real road. The application of TeenDrive365 in driving demonstrates trainees to give more attention on the road and evade any interruptions like talking or texting with irritating friends when driving with the fully immersive road environment complete with passengers, buildings, and obstacles, enabled with realistic 3D graphics, animations, noises, and full simulations of road traffic. VR realistically demonstrates what will happen if young drivers overlook safety regulations. Within the virtual environment, they can nearly feel the negative consequences of irresponsible behavior on the road (Kyselova, 2018).

Furthermore, Toyota utilizes VR as part of an awareness campaign, driving interest in the crossover ahead of the vehicle's release date. They did this by providing a highly detailed model of the car in real-time, independent of hardware capabilities. Customers will have the same capabilities as they would at the dealership in terms of access to the available options and upgrades, inspiring the same result. Due to the technology, dynamic features like the door opening and closing, add to the experience, making it more compelling to see the car in motion rather than viewing a static model (Bodinat, 2016). With a VR app, customer service becomes easier for the car dealers and the clients are more comfortable with the purchase.

At its headquarters in Japan's Aichi prefecture, the project manager, Koichi Kayano is experimenting with Microsoft's Hololens for a variety of tasks. He finds ways to use the 3D models across the company and is applying this Microsoft headset to accelerate the procedure of assessing the depth of a vehicle's shade and prevention of rust coatings confirming the consistent color and avoid erosion (Carlton, 2018). Normally, this process takes two people an entire day, where Hololens cuts it down to four hours which only requires one person. This headset is being used to visualize new equipments on the factorial, at scale, and in 3D, and decide where they can fit. It is also planning a similar experiment to figure out whether large vehicles can fit inside a building. While this project is only a experiment so far, the company said it's also assisting with the improvement of a automobile coming to the market in the near future (Metz, 2018).

Chapter (3) Findings

This study has used documentary research and compare the results with the articles and documents which are associated with this study of the impact of XR technology in the Automotive Industry and Toyota Company. This paper generally focused on the literature review of XR technology, including VR and AR, automotive industry and the Toyota Company. It is found that the combination of AR and VR has a huge impact on the automotive industry in terms of creating and redefining a better experience for the customers which can lead to better sales as they can immerse the customers in the product development and allowing customers to experience a car before it exists (MyBusinessFuture, 2019).

The results have shown that the application of mixed reality can speed up the knowledge transfer and training processes via collaborative training applications without depending on the physical materials, reduce errors in the design process and offer easier modifications to the design eluding costly redesign (Abbruzzese, 2018, Oetjens et al., 2014). Therefore, it creates opportunities for better design and quality of automobiles.

It is also found that this technology can be beneficial to the automotive industry to make enhancement on the manufacturing and operational processes. It is also proven that this, in turn, has an impact on the Toyota company, as the use of XR within the company can make improvements in their training and designing processes, to give better customer services, and provide opportunities for innovations.

Chapter (4) Recommendations and Conclusion

4.1 Recommendations for Executive Level

The executives can **create an innovative environment within the organization** with the openness to experience XR technology through each individual's innovativeness. With this technology, the condition of working through uncertainty to an evolving and potentially workable strategy reflects an environment in which ideas can be fluid, adaptable and transformative in their conceptualization, without necessarily having a fixed physical form or technology derived artifact (Mclay, 2011).

Moreover, top-level managers can **encourage designers to create designs with competitiveness.** Competition is important to the success of the organization, especially in this industry where most companies are implementing newest technology to get a competitive advantage. The company could implement a compensation system designed to reward “exceptional” performers at a higher-than average rate and one higher than that give below-average performers (White & White, 2017). Augmented reality for industrial allowed the company’s designers to be more innovative, improve decision making, better collaboration, as well as work faster. The role of illusion and virtuality in the use of virtual reality systems, whilst reflecting on the potential for using such tools to introduce new ideas in ways that challenge both traditional and contemporary methods of thinking (Hicks, 2016).

With XR technology, the company can **engage better communication between individuals**. AR enables symmetrical communication between two parties and the right information in the place can be displayed thanks to the embedding of them in the real scene (Martinetti, Rajabalinejad & Dongen, 2016). Workplace infrastructure has become one of the major reasons to retain smart and skilled employees and leaders should not oversee this. Executives can make the workplace truly smart as with VR in the workplaces, telecommuting and telepresence will be of great use to professionals, as it allows the flexibility to work from anywhere and conduct virtual meetings without traveling from one place to another, reducing time-consumption and cost. The use of VR extends to all departments of a company, from HR to conduct training, to engineers and designers who can design and test using VR simulators (Ahmed, 2019).

4.2 Recommendations for Managerial Level

Managers can **provide more effective training than video or test-based materials.** Elizabeth Baron, VR, and Advanced Visualization Technical Specialist at Ford Motor Company said that Microsoft Hololens can give us a simple way of understanding extremely complex information. With that being said, one of the features of Hololens is the ability to leave comments in AR, so that the other team members can access them. The process called teleoperation where the members can operate in AR remotely, this solution have become a very powerful and proficient combination (Intellectsoft, 2019).

Virtual Reality is now making disruptions on the development and learning in several ways. It is currently offering organizations to regulate and provide training at scale so everyone can get the same quality of training nevertheless of where they are or what their role. This way, it makes the companies to make cost reduction which is being spent on travel or facility when large teams are being trained (Finch, 2019). Managers can **arrange safety in training employees for dangerous and stressful situations.** As XR can also decrease health and safety risks for people who deal with conditions where risks are really high, allowing them to learn over mock-ups and gain practical experience without dangerous situations. VR can also eliminate the distance between trainer and trainee as well as concept and practice (Fraga & Mallet, 2018).

4.3 Recommendations for Operational Level

Complex Assembly

In the future, since industrial products will become more and more complex, implementing this technology in the design phase will be very favorable as when XR is integrated into the design phase, it enables remote collaboration and interaction, where mechanical designers can create models together and modify the model features at the same time with suitable human-computer interaction while avoiding useless and confusing situations and visualization. Moreover, the application of AR technology could overcome complexity barriers and dispersion (Elvezio, Sukan, Oda, Feiner, & Tversky, 2017). When designing and assembling the automobiles, the workers can digitally experience an asset design, and operation, test, and model changes before the completion (Cohen et al, 2018).

Maintenance

The technicians performing maintenance sequences under an AR condition were able to perform tasks faster than when using baseline conditions. Moreover, the instructions visualized in an AR platform are easier to manipulate than a traditional baseline. The support of AR in time-saving is also extremely relevant for knowledge acquisition and transition from skilled experts to new technicians (Henderson & Feiner, 2011).

4.4 Recommendations for Other Industries

XR is not just beneficial for industrial and field service employees handling with complex workflows, it can also be used by healthcare professionals, pilots, police, and professionals in many other industries to learn faster while adapting to stressful and even hazardous job scenarios. XR offers companies with a platform that aids people to do their jobs better. As an alternative of delivering information through a five inch mobile screen, the combination of AR and VR can deliver enterprise workers with an immersive, 360-degree, three-dimensional view that can reform an on-the-job problem-solving and training (Ortiz, 2019).

4.4.1. Education and Training

In classrooms, XR is being used to to enhance student learning and engagement (Babich, 2018). It can be applied for educational purposes for creativity, visual learning, emotional reactions, and practical learning. Another opportunity for XR is learning is that it provides trainees with harmless virtual contexts to try unsafe equipment and scenarios, and it makes it easier for supervisors to evaluate video recordings of training periods to monitor progress and modify lessons to particular employee needs (Kunkel & Soechtig, 2018). With this technology, social workers can be exposed to virtual difficult situations before facing the actual one to handle, and surgeons can be trained to operate surgeries on virtual bodies (Deloitte, 2018).

4.4.2. Industrial Design, Architecture, Engineering and Construction

In the designing and architecture industry, the architects can use XR to build models without using pencil and paper. This can also be used to build cars, airplanes, or other complex models. The designing of the virtual model can be seen in 3D visual where a proposed design can be placed into an existing space using mobile devices and 3D models (Vertexplus, 2018). It can be used for design analysis to identify the flaws or errors by virtually walking through the completed model. It can help the architect and contractor to collaborate on changes that happen between design and construction due to constructability problems and assist with the prefabrication of building components (Yoders, 2018).

4.4.3. Healthcare

On the healthcare sector, XR is expected to have a transversal impact. As previously mentioned, VR can be used as a training tool for surgeons and physicians (Storchi, 2018). Nonetheless, it can also be used as a control and diagnostic support where surgeons can use AR headsets to monitor information on the conditions of patients throughout the surgery or to visualize procedural steps before planning surgeries (Deloitte, 2018). AR devices can intersect medical images as CT scans directly on patients' bodies. XR devices and software can train people on their health and fitness, presenting virtual representations of how a particular diet or workout could benefit their bodies, which is an feature that could effect on health plans and life insurers as well (Merry et al. 2017).

4.5 Conclusion and Research Limitations

This study examines the impact of XR technology in the automotive industry today. The main focus is on the how the technology can help in giving better experiences to the customers which can lead to better sales, how it can redefine the passenger experience for the vehicles for the future, how it can provide opportunities for creativity for better designs and quality to improve the product and how it can make it easier for knowledge transfer in training and guidance. There are many benefits this technology can offer to the automotive industry and automotive companies have to keep up with these developing technologies since this industry is also growing rapidly and there are many competitions among these companies.

This study has some limitations, which suggest several directions for future research. It is true that in order to remain competitive, the industries have to be constantly conversant with the latest technological breaks and must have the willingness to change current systems and procedures to implement new and more effective and efficient ones. The researcher cannot ensure the effectiveness of the use of XR technology, as this study was only done with the available resources from previously done research papers within a limited amount of time.

This limits the research considerations and assessment techniques. So, the researcher had to prove this study via previously established assumptions from researches, and works of literature. Therefore, this study cannot be assumed as the complete study of the impact of XR technology in the automotive industry. For the future study, it is recommended to perform quantitative or qualitative research to confirm the impacts affected on the industry and find out more about the other additional impacts as this technology is evolving rapidly.

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