A STUDY OF APPLICATION OF THE VIRAL REALITY TECHNOLOGY IN VIETNAMESE SUPPLY CHAIN

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ABSTRACT
Although being used for many years in different research applications, the viral reality (VR) technology has only recently been universally applied in supply chain management. Its application brings many remarkable breakthroughs in the whole supply chain from its production, distribution and operation. This paper focuses on analyzing the operation of a VR supply chain, the benefits of applying this technology in supply chain and giving some examples of its models around the world. The paper is also the first research applying VR supply chains in Vietnam. It is shown that VR technology has boosted sales configurations by giving customer complete and detailed experiences before making any purchase decisions, simplifying and improving the speed and quality of the order fulfillment cycle, and thus helping the companies to increase its sales and profitability. An important contribution of this research is that it examines factors affecting VR applications in Vietnamese supply chain to propose solutions for the development of this technology in the future.

Keywords: VR technology, VR technology, VR supply chain, application, production, distribution and operation of VR supply chain, Vietnam.

Introduction

Industry 4.0, referred to as the "Forth Industrial Revolution", with main trends such as digitalization, the internet of things (IoT), internet of services (IoS), and cyber–physical system have been transforming industries by transforming the way goods are designed, manufactured, delivered (Bauernhansl, 2014). This industrial revolution is predicted to have a direct and lasting impact on global logistics system. In particular, Industry 4.0 brings opportunities in terms of decentralization, self-regulation, and efficiency. With the use of Industry 4.0 applications, Just-in-Time/Just-in-Sequence systems, reduced bullwhip effects and integrated supply chain as well as the improvements of production planning are among the potential benefits. Besides, implications of Industry 4.0 help companies optimize value–creation in terms of real time information flows, end–to–end supply chain transparency, and improvements in flexibility (Hofmann & Rusch, 2017). Nevertheless, impacts of this revolution on logistics systems are different among countries, depending upon the level of economic development.

VR is one of important advanced formations and communication technologies which are widely applied in the era of Industry 4.0. This technology has been developed since the early 1960's. However, rapid advancement in the development of VR has not been seen until the first fifteen years of the 21st century. Computer technology, especially small and powerful mobile technologies, have exploded while prices are constantly driven down. The rise of smartphones with high-density displays and 3D graphics capabilities has enabled a generation of lightweight and practical VR devices. The unique features and flexibility of VR give it an extraordinary potential for use in work-related applications (Brown, 2017). It permits users to experience and interact with life-like models or environments, in safety and at convenient times, while providing a degree of control over the simulation that is usually not possible in real life. These characteristics make it indispensable in applications where planning and testing are necessary for decision making. Applications that appear to be most promising are those that employ VR for visualization and representation, distance communication and education, hands-on training and orientation, and navigation.

VR is already used in various areas such as entertainment, design, psychology, and simulation training. In fact, VR technology has been used in logistics system in numerous forms. Logistics is the process of planning, implementing, and controlling the cost effective processing of materials and human potential. In logistics, the adjustment of time, place and capacity plays a central role. Insight on dependency and risks is essential for high-quality decisions. VR plays a key role in these decisions. Fields of interest for VR in

logistics include layout planning and concept creation, production simulation, training of operators and operational use. In fact, VR applications in logistics are becoming more and more popular and significant, so researches on logistics should gain a greater understanding of VR to take advantages of the opportunities that it presents.

This paper explores the primary uses for VR within supply chain management, evaluates the actual situation of applying VR to the supply chain in Vietnam, analyzes factors affecting VR applications in Vietnamese supply chain to solve the chief questions and challenges related to VR integration into supply chain and suggests some ideas for future research. The numerous-supply chain-related uses for VR are illustrated through a description of VR technology for four sub-areas of supply chain: planning and management, manufacturing, distribution and customer services, and transport and warehousing. VR will certainly influence many other aspects of supply chain but the abovementioned sub-areas were selected because those appear to bring about apparent benefits. The potential development of VR technology in Vietnamese supply chain is analyzed by examining factors that affect VR application, therefore suggesting solutions to innovate this technology. Finally, some ideas for future research are presented.

What is Virtual Reality?

There are indeed different definitions of VR, depending on the features considered necessary to constitute a Virtual Reality experience. This paper utilizes the most popular definition that has been used in books related to this subject. As such in this paper, VR is defined as the use of computer-generated 3D environment – called a virtual environment (VE) – that one can navigate and possibly interact with, resulting in a real-time simulation of one or more of the user's senses (Vince, 2004). "Navigate" means that the user can move around and explore the virtual environment and "interact" means that the user can select and move objects within the virtual environment (Burdea and Coiffet, 2003). However, for this paper, we consider interactivity as an optional component, this more flexible definition permits a wider research scope. This paper also accepts augmented reality (AR) as a type of VR. AR is a technology that layers computer-generated enhancements atop an existing reality in order to make it more meaningful through the ability to interact with it. VR and AR do not always operate independently of one another, but, in fact, are often blended together to generate an even more immersing experience.

In every VR system, user's actions can be interpreted by some sort of input devices such as a mouse, interactive gloves, and voice recognition software. In response to user's input data, a VR system will present an appropriate view of the Virtual Reality. To do this, VR systems must account for the collision between the objects, use 3D clipping process, improve image quality and respond to user's movement in a millisecond. A VR system can stimulate different senses effectively; however, this ability varies depending upon how the system being used. Although the visual aspect of VR draws the most attraction, other elements can also be very significant in the creation of the realistic virtual enviroment (Gutiérrez et al, 2008). For example, high-quality tactile feedback would be most important for a VR system simulating surgery for doctors in training, while high-quality audio would be most important for a VR system simulating an orchestra in a concert hall. With regard to supply chain, visual and auditory aspects of VR will often be the most important.

Actual applications in Vietnamese supply chain

Research on the supply chain applications of VR and AR is definitely a strong and growing area. VR technology has been used throughout supply chain process, from planning, procurement to detriment, and customer service. Advancement in computer and communicating technologies has provided suitable interfaces to allow users to interact directly with the supplier's information associated with the manufacturing processes. AR can provide users with an intuitive way to interact directly with information in production processes. It also allows the operators to use their natural spatial processing abilities to obtain a sense of presence in the real world with virtual information.

Distribution and customer services

The VR technology has been applied mostly in the distribution of the whole Vietnam's supply chain. A lot of potential customers also have opportunities to test the VR technology in a completely different way. In particular, VR simulates the physical presence of customers in virtual space in which they have a clearer,

more productive vision and multi-dimensional interaction with the product (touching, changing position and color of objects...) in an authentic way. This experience helps shorten the decision-making time of customers and save cost effectively. For example, some leading car manufacturers such as Audi and Mercedes have adopted VR to introduce the attributes, functionality, and above all the fantastic experiences that customers will have when using their car models. Another example is IKEA, which found that consumers often find it difficult to make furniture purchasing decisions, as they can hardly imagine whether products that they intend to buy fit their homes in terms of style or color. IKEA has launched an electronic catalog application, an AR application on a mobile device that allows customers to preview furniture to see whether it matches their home before coming to the final decision. Therefore, customers simply need to launch the app on their smartphone or tablet, and use the camera functions to capture an image of a room in their home in advance. After that, they can choose different items from IKEA stores to see how they will look like when placed in their home.

Previously, VR was a less well-known technology and its application was predominantly in large companies because it required more terminals. However, in the past two years, VR has become a booming trend in Vietnam in the technology area. In 2016, Pho Xinh furniture chain store launched its 3D showroom system at phoxinhonline.com, Mini Cooper Vietnam virtualization showroom that introduces the latest models, Rever.vn 3D home sales, ALC Corp (Kitchen Casta) that does marketing activities by 3D model and a series of real estate project owners that make 3D model houses such as Vinhomes Real Estate Group, BIMgroup or FLC along with some businesses that are boldly jumping into the VR reseller market for businesses such as Holomia, Rever or Horus. In the last two months of 2016, according to a representative of Rever, a VR provider, they have implemented more than 3,000 VR scenarios for businesses and their individual customers. Moreover, their service was also used by more than 1,000 marketing staff in various fields to introduce products to their customers. Many experts have stated that VR in Vietnam will become a technological trend in the coming years with a dramatically rapid growth rate of over 20% per year.

Manufacturing

VR as a simulation tool was first reported in the 1960s. Since then, many different forms had appeared, from 2D monitor-based to 3D immersive and sophisticated setup. In recent years, Augmented Reality (AR) technology has matured and proven to be an innovative and effective tool to address some of the critical problems to simulate, guide and improve manufacturing processes before they are launched. Activities such as designing, planning, and machining can now be done right-the-first-time without the need for subsequent re-work and modifications. In fact, Virtual and Augmented Reality have been widely applied to common manufacturing activities such as product design, robotics, facilities layout planning, maintenance, CNC machining simulation and assembly planning. Recognizing that VR technology was not only capable of rendering an exact 3D virtual copy of their vehicles produced in their plant, allowing for dynamic manipulation and visualization of products and parts from all angles, but that it also allowed for an exact rendition of production processes, Ford Motor Company have developed and applied this technology to their manufacturing process since 2012.

The most common application of VR in Vietnam is the CNC machining simulation system. This machine is used in the processing of paintings or sculpture on wood, bronze, or microscope according to the drawings already programmed on the computer. The application of this technology helps to produce high-precision products, as well as save time and labor. Augmented Reality CNC systems are becoming a trend in mechanical engineering in Vietnam. If previously, this system was mainly imported, now many companies in Vietnam have successfully researched and manufactured many machines such as 4-axis CNC machines. In addition, AR and VR technology has also been applied in assembly operations. VR technology plays a vital role in simulating advanced 3D human-computer interactions, especially for mechanical assemblies, by allowing users to be completely immersed in a synthetic environment. Many VR systems have been proposed successfully to assist assembly activities.

Planning and Management

AR and VR technology applications in planning and management are based on its simulation function. Effective simulation of an actual operation will ensure that it can be carried out right-the-first-time, eliminating many trials and re-works, saving materials, energy, and labor. VR has been used in creating

product design as it provides very intuitive interaction with the designers in terms of visualization and the interfacing with downstream processes. A hybrid immersive modelling environment merging desktop CAD was created by Stark et al (2010), Wiese et al (2009) and Israel et al (2009). They noted that the current modelling media using paper and CAD system is complementary but it lacks interaction. Digital media offers the great freedom of exploring different dimensions and features, using stored forms and shapes from the library, and the advantage of integrating a product model with associated physical properties. In addition, some downstream processes, such as process planning, machining, and inspection can be fully integrated. AR is becoming a major part of the prototyping process in product design in many industries, for example, in the automotive industry, AR has been used for assessing interior design by overlaying different car interior mock-ups, which are usually only available as 3D-models in the initial phases of development, on real car bodies (Fründ et al., 2005). However, few systems can support product creation and modification in AR using 2D or 3D interaction tools.

Transport and Warehousing

The application of AR in transportation and warehousing will completely transform logistics in Vietnam. These changes are shown in some areas including: warehouse planning, picking and packaging services, and final delivery.

- Warehouse planning: when warehouse operations change with more functionality than just storage and distribution, the layout will have to be changed to fit different business areas such as product assembling, and labeling. With AR, new arrangements can be planned on a large scale to precisely check the location and workflow before deployment.
- Selective and packaging services: for many warehouses, picking and packaging services, especially during the high season, are completed by temporary workers. Implementing an AR solution for selective and packaging activities has shown significant improvements in productivity by shortening the test curve and providing continuous validation to update WMS in real time. Operatively, AR can be used to overlay bales in the repository to display selected items and reduce the time needed to manually define them. When the package is ready for shipping, AR tools can be used to get the information of the ordering time and handling instructions whenever the carrier arrives.
- Last-mile delivery: the most expensive step for retailers in e-commerce. As the customer base grows and expands, delivering cost-effective products to customers has become a top priority for many retailers. According to a report by DHL Trend Research, it is estimated that drivers spend 40-60% of their time finding the right bales in their trucks for the next delivery. For many people, this process depends on their memory of how the truck is loaded. An AR application can be used to streamline the time it takes to identify a package for delivery and reduce the time to find out where a package is delivered.

Factors affecting VR's application potentials in Vietnam

It can be seen that VR has a lot of potentials for practical application in the supply chain in Vietnam. However, in order for this technology to develop to its full potential, we need to have appropriate orientations of development. In the next part of this paper, the author went deep into analyzing and finding out the factors that affect the application of VR in Vietnam. The author then conducted a survey of a number of Vietnamese enterprises and in-depth interviews with a number of experts in this field and did a regression analysis to determine the different levels of impact of each factor on job performance. Since then, the results of research are the basis for promoting solutions to bring VR technology closer to businesses in Vietnam. After conducting the survey via the internet and distribution of questionnaire, the author has collected 178 valid questionnaires from enterprises including those operating in the product and service supply chain. The scale used for measuring the observed variables in the model is the likert scale of 5 points. This type of scale that is commonly used in many current researches is in accordance with the design of this study.

Through the process of analyzing and evaluating opinions from businesses and experts in Vietnam, the author has selected four key factors affecting the application of VR in the Vietnamese supply chain, including: level of employees, technology infrastructure, VR's development in the world and technology development policy of the government. The level of labor is a factor influencing the application of VR to the supply chain because no matter how advanced the technology is, human remains a decisive factor.

Moreover, Vietnamese workers are considered to have a relatively low level of qualifications, thus improving their level of employment is an important goal to keep pace with the worldwide technology trend. As mentioned in the previous section of the study, VR technology is always associated with endpoints and the development of technology platforms such as the internet, computer systems and the popularity of smartphones will help bring the technology closer to reality. The government policies on technology development are also an important factor. In recent years, the government of Vietnam has paid special attention to the application of advanced technologies through investment in research, organization of scientific seminars, encouragement, and support for start-ups in the field of technology. Following is the research model proposed by the author:

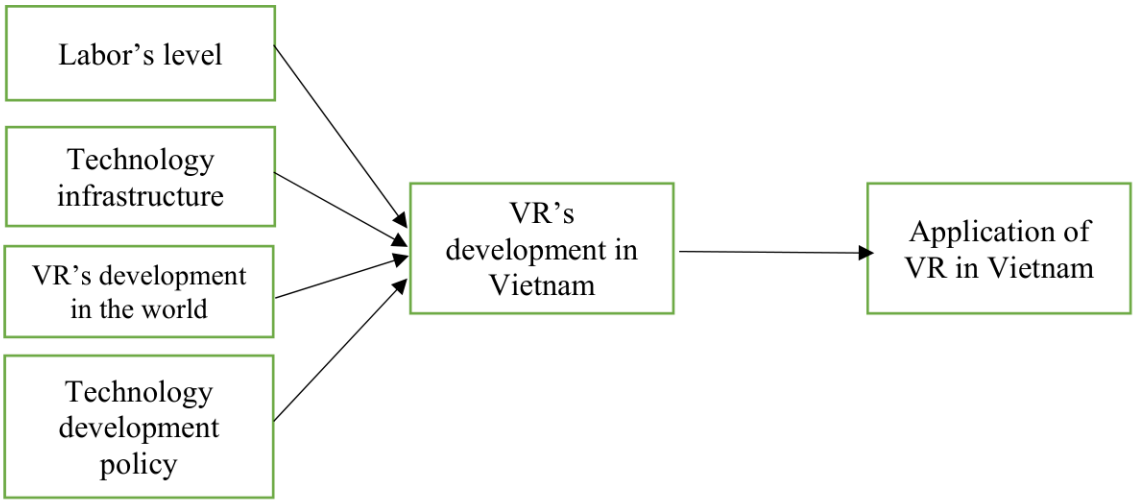

Figure 1. Key factors affecting the application of VR

The explanations of the research model include:
H1: Improving the professionalism of the workforce will facilitate the applications for VR supply chain in Vietnam
H2: Upgrading and developing the technology infrastructure will enhance the applicability of VR technology in Vietnamese supply chain.
H3: VR's development in the world will facilitate VR applications in Vietnamese supply chain.
H4: Government technology development policies will facilitate VR applications in Vietnamese supply chain.

Verification of confidence coefficients of the scale (Cronbach's Alpha index): According to the Cronbach's Alpha test, the observed variables have the Cronbach's Alpha index if the variable deleted is greater than the Cronbach's Alpha index of the scale and the small crossover correlation coefficient more than 0.4, it may be considered a recommendation to remove the observation variable from the scale. The official scale will be constructed and refactored based on observable variables that are sufficiently reliable. The Cronbach's Alpha coefficient obtained according to the results of the survey of the four scales are 0.772, 0.876, 0717 and 0.731 respectively. All observable variables of four scales have Cronbach's Alpha values if the variables deleted are smaller than the Cronbach's Alpha coefficients and the cumulative variances are greater than 0.4, so all variables in this scale are accepted. In the proposed research model, 18 observation variables are considered to influence VR applications in Vietnamese supply chain. Exploratory factor analysis (EFA) results obtained KMO = 0.89 (> 0.5), which shows the appropriate factor analysis with the research data. Applying the rotation method, the results showed that all 18 variables were significant (value> 0.43) and were categorized into 4 groups of factors with a total variance of 64.493% (more than 50%).

In the model of adaptive research, the independent variable "Application of VR in Vietnam" is influenced by the four dependent variables. Therefore, to estimate the model of factors affecting the applications for

VR technology within supply chain sector, the authors use linear multiple regression equation. The regression equation has the following form:

Application of VR in Vietnam = 0.382* Labor's level + 0.273* Technology infrastructure + 0.165* Technology development policy + 0.18* VR's development in the world

From the above analysis, it can be seen that labor's level and technology infrastructure are the two most important factors affecting the application of VR in Vietnamese supply chain. Meanwhile, VR's development in the world and technology development policy have a lower impact on the application of VR in Vietnam. Identifying the different levels of impact of each factor is an important basis for the author to come up with solutions that need to be prioritized to this is a new point and also an important contribution of the thesis.

Discussion and future research

It can be seen that, despite being a developing country, Vietnam has not slowed down the deployment of VR technology as well as its application in the fields of life including the supply chain management sector. For the application of VR in the supply chain, Vietnam is still focused on some stages, especially distribution. However, the application of this technology to the entire supply chain activities will bring about greater interconnectivity between suppliers, optimization of the flow of information and products in the supply chain as well as customer's satisfaction. The constant development of new technology trends will change the current supply chain, so not keeping up with the opposite technology trends will be a challenge in this area. To facilitate this technology development in Vietnam, solutions need to focus on improving the professional level of workers as well as improving the technological infrastructure. The acquisition and application of technological advances on VR in the world will also create a premise for the development of this technology in Vietnam. This is the work of both managers, businesses and transferors in the field.

Many opportunities exist to research the possibility of VR applications and implications for supply chain management sector. For example, research could investigate relationship between VR application and optimization of supply chain efficiency, evaluate customer satisfaction with AR and VR practical applications of some enterprises or research the models that apply VR effectively throughout the supply chain to change the structure and direction of sustainable supply chain development in Vietnam. Moreover, research could investigate the characteristics of different supply chains (e.g.: service supply chain and product supply chain) influence the potential of VR applications. Additionally, research could investigate other VR applications to solve problems of supply chain management such as risk management, quality management, cost reduction, and inventory management. These researches will contribute significantly and provide the basis for the application of VR in Vietnam in the future.

Conclusion

As this paper has demonstrated, VR's applications in the supply chain management sector is significant, so the future research can provide more practical value to supply chain sector. In the explosion of Industry 4.0, emerging technology like VR will bring opportunities as well as challenges to the innovation of Vietnamese supply chain. A complete understanding of VR and its applications will take advantage of opportunities and solve the challenges that it brings. VR offers a variety of applications in the supply chain from planning to distribution; however, its role in linking the supply chain is still limited. In the future, VR offers potential to link entire suppliers in the supply chain in a more comprehensive and effective way. As new VR technologies are developed, the potential uses for VR within the supply chain sector will continue to increase in number and importance, so both policy makers and companies should have long-term plans to apply this technology more widely and effectively. In addition, it will be the job of researchers and professionals to exploit VR for more unique opportunities.

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