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► To cite this version:

Danijela Lalić, Dunja Bošković, Bojana Milić, Sara Havzi, Jelena Spajić. Virtual and Augmented Reality as a Digital Support to HR Systems in Production Management. IFIP International Conference on Advances in Production Management Systems (APMS), Aug 2020, Novi Sad, Serbia. pp.469-478, 10.1007/978-3-030-57993-7_53 . hal-03630864

HAL Id: hal-03630864

<https://inria.hal.science/hal-03630864>

Submitted on 5 Apr 2022

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Virtual and Augmented reality as a digital support to HR systems in production management

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Abstract. Digital transformation has disrupted every domain of production management, as well as the human resource management as one of the production manager's most important responsibilities. Besides of product and process design and issues involving planning and control of quality and capacity, production management also includes responsibility for organization and supervision of the workforce. In new industry operations, it is important to anticipate human resource requirements, as well as to translate them into recruiting and training programs in order to develop a base of highly skilled and qualified workers capacitated for installed machinery and equipment.

According to the relevant literature review, integration of virtual and augmented reality technology in any business process has a proven potential for employee engagement improvement and memory retention capacity.

The aim of this research is to provide a comprehensive summary of using VR and AR technologies as a digital support for managing human elements in operating systems. This study found that VR and AR can be successfully used in improving workers' productivity, enhancing employee training, reducing costs, making worksites safer and closing the skills gap more effectively and efficiently. This study could encourage both academics and practitioners to seek innovative use of VR and AR technologies in a particular industry as digital tools that saves time and costs in human resource management.

Keywords: VR and AR technologies, human resource management, production management

1 Introduction

Combining different digital technologies with production and business processes represent one of the pillars of industry 4.0. In order to support digital transformation initiatives, many industries adapt a technology-driven approach in their function and activities, by creating "smart" working environment within production system [1].

In order to overcome the shortage of fit workforce, long-time adaptation and defective work, production systems are taking advantages of technologies to better recruit and preserve new employees. Engineers and technicians of the 21st century must be

equipped with highly advanced skills in their function area and they must be sharp in process fault diagnosis and decision making. Human resource systems are responsible for recruiting, developing and managing of skillful labor force, and those systems need a digital support in order to keep production and other operational activities running with minimal disruption. Each year, *Gartner* identifies the “*Top 10 Strategic Technology Trends*” and some of the key trends published for 2019 are related to autonomous things, augmented analytics, immersive experience etc. This research [2], for example highlights the fact that AR technologies will be embedded in enterprise application (eg. HR, sales, marketing function etc.) in order to optimize the decisions and actions of all employees within their context. In addition, *Gartner* has presented the latest technological innovations that are transforming HRM: VR and AR application in corporate learning, learning experience platforms, VR assistants in human capital management, AI in talent acquisition, employee experience tech, VR recruiting assistants and so forth. [3].

The purpose of this paper is to analyze the current state of implementation of virtual and augmented reality in a field of human resource management in production systems. The research focus is to review the literature in Directory of Open Access Journals (DOAJ) and provide a comprehensive summary of potential opportunities of VR and AR technologies as a digital support for managing human elements in operating systems.

2 Theoretical and conceptual perspectives

Digital technologies have transformed every domain of production management: planning and production approaches, business development models, use of technologies, shifts in traditional operational tools and processes etc. As one of the strategic fields in production management, human resource management (HRM) is also experiencing a digital transformation in its working approach.

This section highlights the importance of human resource in production management as well as the importance of virtual and augmented reality in modern industry.

2.1 The importance of human resource in production management

The multidimensional and fundamentally disruptive character of change causes problems in maintaining the characteristics of workflows and structures in production systems [4]. The increasing intensity of technological shifts necessitates finding a solution that will provide the ability to adapt the structures of the company and thus mitigate the effects of change. The production manager must plan and control the process of production so that it moves smoothly at the required level of output while meeting cost and quality objectives [5].

A more than century-old theory of work measurement and time study introduced by Taylor and the Gilbreth's, still have an application in today's fast-paced, technology-driven world. In his publications on production management, Taylor set the scene for developments in many business functions and disciplines including *human re-*

sources [6]. One of the Taylor's most important contributions are incentive systems for motivation and rewarding high levels of worker output, as well as the identification of new functions for managers relating to the selection and training of new employees [7-8]. These HRM tendencies are still relevant and ongoing. According to Beatty and Schneier [9], the main areas of strategic choices in HRM are: *work design, performance measures, selection, development, rewards and communication*. Therefore, HRM is linked to strategic choices of quality, flexibility, investment and cost reduction by the use of a functional and performance approach [10-11], which means that manufacturing strategy and production management are usually related to performance appraisal, work design, career management, training and development etc. Today's biggest challenge to HR profession is to learn more about the effective application and appropriate use of new technologies in order to improve their working processes [12].

2.2 The usage of Virtual and Augmented reality

There are many scenarios of industrial application of VR and AR solutions, from visualization of prototype technology components to the complex development of interactive workshops for personnel at hazardous industries [13].

Virtual reality (VR) represents a three-dimensional computer simulation of real world environments that can be explored and interacted through a person [14]. These simulations are interactive and are capable of responding to user inputs making it interactive in real time [15]. The VR is the computer-generated simulation of a three-dimensional image or environment that may be interacted within an apparently real or physical manner by a person with the use of a special digital system, which includes a helmet with a display screen inside or gloves outfitted with sensors [16].

Unlike virtual reality, augmented reality (AR) implements fragments of virtual reality and incorporates them into real world. Using technology it aligns real and virtual objects while running interactively in real-time [17]. Augmented reality (AR) stocks the same concept, but in place of interacting in a nonexistent surrounding (digital fact), AR makes use of the existing environment at the same time as implementing virtual elements to appear as if both are together at the same time [18]. AR is a kind of interactive, reality-based display environment that takes the capabilities of computer-generated display, sound, textual content and effects to enhance the user's real-world experience [19]. AR combines real and computer-based scenes and images to deliver a unified but enhanced view of the world.

In terms of the comparison of virtual reality and augmented reality, VR is a fully immersive and closed experience with no sense of the real world, while in AR user can see a real world with digital information overlay, which implies that a real world remains central to the experience, enhanced by virtual details.

3 Potentials of VR and AR implementation for HR systems in production management

Access to the internet and other digital technologies can further enhance the sense of human connection, especially for people facing physical and social barriers [20]. In this respect, VR and AR becomes a transcendent experience, almost mystical in its ability to permit humans to go beyond their known realities [21]. Thus, it is of great significance to examine how new trends in technology, especially VR and AR, are being used for HRM activities in production systems.

3.1 Identification of VR/AR-human resource-production management relations in journals with open access

In order to analyze the available researches about application of VR and AR in human resource management in a field of production management (PM), the journals available through the Consortium of Libraries of Serbia for Unified Procurement (KoBSON) were analyzed. The journals were divided into three groups according to the three analyzed areas: HR, VR/AR and PM. Based on the availability of the journal through the repository of KoBSON, which are also members of the Directory of Open Access Journals (DOAJ), a listing of the frequency of articles dealing with this interdisciplinary topic found in each journal are presented in the Tables 1-3. For each group of journals, the keywords of the other two research areas were used to identify the number of articles that covers all three analyzed areas.

Table 1 The frequency of HR and VR/AR articles in top listed PM journals by KoBSON

Journals	IF 2018	Launched (year)	Human resource identified	Virtual reality identified	Augmented reality identified	HR and VR and AR identified	Field of research
<i>International Journal of Operations and Production Management</i>	4.111	1980	775	9	2	9	Performance management; smart manufacturing; work organization
<i>Production and Operations Management</i>	2.171	1992	1	1	-	1	Manufacturing; individualization
<i>Advances in Production Engineering and Management</i>	2.047	2006	-	1	-	-	Product customization
<i>Anbar Management Services. Production Abstracts</i>	-	-	-	-	-	-	-
<i>Baking Management; The Production Magazine for Volume Bakers</i>	-	1996	-	-	-	-	-
<i>Brazilian Journal of Operations and Production Management</i>	-	2004	12	-	-	-	Process management; training; work performance
<i>Independent Journal of Management and Production</i>	-	2010	48	4	1	6	Organizational performance; training
<i>International Journal of Production Management and Engineering</i>	-	2013	1	-	-	-	Evaluation; modeling; human capital
<i>Journal of Engineering, Project, and Production Management</i>	-	2011	40	2	2	3	Project management
<i>Journal of Production and Operations Management</i>	-	2011	5	-	-	-	Work performance; human capital
<i>Management and Production Engineering Review</i>	-	2010	1	-	-	-	Motivation; knowledge management
<i>Production and Inventory Management Journal</i>	-	1959	-	-	-	-	-

Table 2 The frequency of HR and PM articles in top listed VR/AR journals by KoBSON

Journal	IF 2018	Launched	Human resource identified	Production system identified	HR and PM identified	Field of research
<i>Virtual Reality</i>	2.906	1995	3	5	1	Learning technology
<i>Journal of Virtual Reality and Broadcasting</i>	-	2004	5	12	-	Tracking; performance analysis

Table 3 The frequency of VR/AR and PM articles in top listed HR journals by KoBSON

Journal	IF 2018	Launched (year)	Virtual reality identified	Augmented reality identified	Production management identified	VR/AR and PM identified	Field of research
<i>Journal of Human Resources</i>	3.857	1966	-	-	-	-	-
<i>Human Resource Management Review</i>	3.625	1991	-	-	10	-	Knowledge management
<i>International Journal of Human Resource Management</i>	3.150	1990	6	1	37	1	Manufacturing; knowledge management
<i>Human Resource Development Quarterly</i>	3.000	1990	9	-	7	-	Training; job education
<i>Human Resource Management</i>	2.934	1961	4	-	16	-	Learning; work performance
<i>Human Resource Management Journal</i>	2.843	1990	2	-	9	-	Training; work performance
<i>Human Resources for Health</i>	2.547	2003	2	14	212	-	Education; work performance
<i>Human Resource Development Review</i>	2.487	2002	4	1	-	-	Training; HR development
<i>Asia Pacific Journal of Human Resources</i>	0.891	1962	-	-	13	-	Work Performance
<i>German Journal of Human Resource Management - Zeitschrift für Personalforschung</i>	0.759	1987	1	-	2	-	Organizational development

Based on this review, it can be concluded that there is a lack of research that analyzes the use of new VR/AR technologies in human resource management in the field of production management. This topic and trends require a multidisciplinary approach in research and represent an unexplored, but challenging and current field for research. Exploring this topic, we found some articles dealing with the application of VR/AR technologies in HRM in specific industries, whose key conclusions are presented in the next part of the paper.

3.2 A literature summary of using VR/AR technologies for HR systems in production management

In recent years there has been an active development and growth of investments in VR and AR business, and the number of VR users is growing around the world [13]. Transformation of the role of VR and AR is evident as well: from gaming technologies, used mainly for entertainment purposes, to modern and effective tool applicable in the business environment (both for managing employee training, recruiting purposes, marketing, branding, and for main operational business processes, for example, measurement, 3D visualization, and modeling) [22]. Zhao et al. [13] indicate that VR and AR allow managers to improve their current technologies, identify weak points, reduce risks and time for testing, rather than using real objects and processes.

VR offers HR employees a new way to provide an interesting experience for candidates and employees through basic HR processes – hiring, adapting, training and organizing work [23]. Its interactivity allows not only assessing the competences and skills of a candidate or employee, but also identifying his strengths and weaknesses.

Analyzing the modern possibilities of VR and AR tools, it is clear that these technologies can become an indispensable assistant and support in HR management.

By using VR and AR technology, companies can develop simulations, a type of game for *attracting and hiring talent*, or an *interactive course* for an employee and in general everything that a given workplace can offer. This can be a *great way to attract people* and a useful working approach in *teaching* them some of the skills they may need to succeed [24]. Also, through these technologies many companies could *collaborate with remote employees*. With VR and AR technologies, companies can *conduct recruiting and staff selection* more efficiently, by presenting their employer brand to potential employees through an immersive experience.

In new operations particularly, it is important to anticipate human resource requirements and to translate them into recruiting and training programs so that a nucleus of appropriately skilled operators is available as production machinery and equipment are installed [5]. Integrating VR and AR technologies in this type of HR planning *reduces the chance that expensive capital equipment will stand idle* and that effort, time, and materials will be lost during startup and regular operations.

In addition, VR and AR can *contribute to team building activities*, significantly *reduce the economic and time costs of staff training* (especially travel cost and hotel accommodation) and improve staff adaptation in general. It allows *distance meetings* with remote employees or business partners located anywhere in the world. It is possible to *demonstrate in detail and visualize* the innovations, projects and its advantages, to attract the attention of the colleagues and audience etc. In production systems, the special value of VR and AR application in HRM can be a *vivid insight in the flow of the main operational processes in production, visualization of potential weaknesses, operations that can and should be automated*, etc.

Many studies show that through immersion in VR and AR, individuals can get “a contextual visualization of the environment to assist with an event or task while remaining within the bounds of the system” [25]. Contextual learning and interactivity based on engagement has a much higher contribution for learning [26], which is approved by an experiment of comparison of traditional training methods (TTM) and virtual reality-based training systems (VRTS). This experiment compared attributes between TTM and VRTS, such as comfort, ease of learning, ease of use, interactivity and engagement, and the results showed that VRTS are *easier for learning and use and more engaged* [27].

4 Conclusion

As a new technology trend that marked a last decade, virtual and augmented reality is increasingly being used for work simulation, but still it is not widely used in all functions and all areas of production management. This is evidenced by the very small number of articles published in journals on the SCI list (*Science Citation Index list*) that deals with this interdisciplinary topic. A literature review indicates that introduction of modern technologies, such as VR and AR, can support the design, engineering, management, and delivery of services, as well as employee engagement and memory retention capacity for working processes. In that manner, represented technologies meet the needs of the workforce as a significant stakeholder category in a business system, in a new, intelligent and innovative way.

Summarizing the results of the research analysis, we can draw a conclusion that VR and AR technologies are not used only in entertainment sector. Moreover, these are proved to be effective and useful tools in managing corporate business processes, in our case, primarily observed in HRM activities. Empirical studies suggest that companies are starting to realize that VR and AR can be used in simultaneously training, recruitment, employee engagement and knowledge retention, in increasing productivity, reducing costs and time and in ensuring safe and secure working condi-

tions. Also, numerous studies show that VR and AR will reduce costs, improve the performance indicators of the company as a whole, and take a strong competitive advantage. It is clear that VR and AR can become HR digital support in main operational activities in production management. The coherence among production management and HR strategy systems is substantial for the attainment of business success.

However, despite the existing successful examples and results of using VR and AR in the labor market, as well as their benefits in the work of HR specialists, if we consider the cost and complexity of technology implementation, this trend still poses challenges and questions. Therefore, this study could stimulate further research of new potential fields of VR and AR application in particular companies, sectors, industries, or even countries.

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