

Virtual Reality for Training Pathologists: A Cost-Effective Business Model

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ABSTRACT

According to the current study, students still think that physical specimens are necessary for learning pathology, even if augmented reality may be useful for studying. It should come as no surprise that 89.2% of students said they learnt pathology better using a combination of both modalities. Therefore, students are likely to criticize medical programs that decide to switch to AR completely. There is currently less pathology content taught due to the requirement for shorter postgraduate courses and a stronger focus on problem-based learning skills. In pathology museums in particular, the amount of time spent learning with actual specimens is declining. As a result, fewer medical students believe that knowing about pathology will be helpful in their line of work. It has been determined that the pathological learning process currently in place needs some improvement. In order to solve this, AR has shown increased motivation and efficacy for studying pathology when combined with physical specimens, as well as enhanced excitement for learning in other fields. Quantitative studies showed that participants found the VR experience realistic and interesting, even if many of them preferred live exercises over VR instruction. Many government agencies as well as accrediting bodies mandate yearly exercises and drills for healthcare organizations. Healthcare organizations should practice exercises and drills in addition to just satisfying these standards since it places personnel in the best possible position to ensure safe patient care and keep guests and coworkers safe in the event of an emergency.

Keywords: Virtual reality (VR), Training Pathologist (TP), Cost-Effective Business Model (CEBM)

INTRODUCTION

The importance of science and technology can never be underestimated in our lives. Artificial intelligence has made a great place in providing services to mankind. Virtual reality is also a kind of importance of artificial intelligence. The system of virtual reality is just computer-based to create illusions that seem to be real for human beings. Virtual reality has been used in the training of athletes, better working in the healthcare sector, communication, therapies, and many other fields. Virtual reality is now also used for providing different types of training to pathologists. The pathologists are specialized for the diagnosis of diseases concerning the type of pathogen[1]. In this introduction, we are going to discuss how virtual reality can be used for providing training to pathologists. We will also discuss how virtual reality training is effective as compared to other training. There are many benefits of using virtual reality as a training method for pathologists. The first and foremost benefit of using virtual reality training can be explained in terms of less cost of training. Virtual reality training is better and more effective as compared to primitive ways of training in different aspects. The first aspect is that there is less need for physical materials and specimens in virtual reality training. The reason is that in virtual reality training, most of the materials and specimens can be explained in 3D form so there is less need for the presence of those materials in physical form[2]. In this way, the cost of virtual reality training will be reduced as compared to other methods of training. Secondly, we know that there is a need for travel, accommodations, and other services for attending any training event but by using virtual reality training, all the training can be done via video conference, and doubts can easily be cleared so there is no need for travel and accommodation expenses for training events. In this way, the cost of virtual reality training will be minimized. The other benefit of using virtual reality training can be enumerated in

terms of increased efficiency of pathology Labs. As we know, the efficiency of pathology labs is dependent upon better training of pathologists. If there is poor or less training of pathologists, we cannot deny the lower accuracy of results of pathology labs. The main advantage of using virtual reality training is that training can be done again and again until it is completely understood and adopted[3]. Because it involves artificial intelligence, there is no factor of fatigue in it to repeat training. In this way, we can say that virtual reality training will help to enhance the efficiency of pathology labs by improving the performance of pathologists. The other aspect included in virtual reality training is that it does not involve any diversion of concentration from the main training. In physical training, there may be any risk of diversion of concentration but in virtual reality training, all the senses are fully concentrated and focused in this way that the topic can easily be understood. Such a type of concentration can be used to study complex cases of pathology[4]. The other advantage of virtual reality training can be explained in terms of the accessibility of virtual reality training. In primitive ways of training, only a limited number of pathologists could be trained by trainers but by the advancement of virtual reality training, a large number of pathologists can be trained in a limited time. This is because there is no limit of usage of virtual reality training systems in the aspect of several pathologists. There are some backward and remote areas in every country in which patients cannot avail of the services of pathology labs. At the same, there is great difficulty in providing training to pathologists in that remote area. But virtual reality training has solved this problem too. By using virtual reality training, pathologists in remote areas can also be trained by using Internet services. The other most important advantage of using virtual reality training is that it relies on the procedure of feedback on the performance and efficiency

of trainees[5]. In primitive ways of training, there was no method of feedback to trainees so the performance could not be accurately measured. But by using virtual reality training, feedback is taken from people relevant to pathologists and their performance so that such changes can be made in the training system which can be proved effective for trainees. If we want to develop a cost-effective Business model for virtual reality training, there must be some important steps. The first and foremost step will be investment in virtual reality training development. Although it is cost cost-effective model some sorts of investments are required to develop a system of virtual reality training[6]. The second most important step will be a revenue model related to this virtual reality training system. This is also an important step because it is directly involved in the reduction of cost in virtual reality training systems. The next step-in cost-effective Business model of virtual reality training is proper channel design for delivery and maintenance of Such system of training. As we know we have to make this system of training cost effective so we have to use such means and ways by which less cost will be used[7]. The next and last step of cost-effective Business model of virtual reality training will be increasing the value of revenue by certification programs. If these virtual reality training systems are certificated, people's satisfaction will increase in such systems which will also increase revenue value for these systems. The other advantage of using a virtual reality training system is that it is continuously updated to meet the emerging needs of technology to give suitable results[8]. After the adoption of such a virtual reality training system, we have seen that the professional abilities of pathologists have been improved. They got a chance to study rare and complex cases which gave them in-depth knowledge and experience in their professional field. All of these aspects explain that the virtual reality training system is cost-effective as compared to primitive ways of training for pathologists[9, 10].

Research Objective

The main objective of this research is to understand the virtual reality training system for pathologists. This study also enumerated different steps for formulating cost cost-effective Business model of the virtual reality training system.

LITERATURE REVIEW

Researchers claim that AI technology works using the intelligence system to provide real-life applications in different fields. The field of medicine of one of the most recent fields that have adopted AI use for medicine production. The present applications of AI in the medical field provide a source for improving its future applications[11]. Studies reveal that a virtual reality-based medical learning environment provides medical students with real medical stimulation. Conventional teaching methods have been replaced by virtual reality-based methods. To promote effective medical learning processes the use of virtual relit technology is increasing in medical teaching sectors[12]. studies suggest that students student surgery are provided teaching sessions using advanced technology. The knowledge related to microsurgery procedures is taught to surgery students using AI in the field of ophthalmology new students learn the technique of ophthalmological-related surgery through videos of experienced surgeons[13]. Studies show that the HMD model is based on the combined applications of VR, AR, and mixed-reality technology. Using this model in medical teaching eases the process of medical knowledge sharing in some medical institutes, the HMD provides medical students

with an environment in which they can implement medical techniques on patients with no chances of any severe side effects on patients [14]. Studies predict that providing students with a safe medical practice environment is done using VR. The surgical training is provided to the medical students in a controlled setting by following all the safety protocols. The spine injury surgeries are performed using the VR. These surgical procedures are usually recorded for teaching injury-related guidelines to medical students using these recorded videos[15]. scholars explain that detecting the presence of cancer in the prostate region of the body is performed using AI Diagnosing prostate cancer in AI-assisted pathology labs is a medical procedure performed in Sweden. PSA screening test is used in Sweden's digitalized pathology labs for early PC patient evaluation[16]. Scholars studies concluded that combining two AI technologies provides great applications in the health sector. Orthopedics is the field that is most benefited by the use of mixed reality technology. The process of knee arthroplasty is performed through VR to make the surgical process understandable for medical students[17]. Scholars suggest that surgical training programs are provided globally using AI-based technologies. A large number of medical platforms provide surgical training using AR and VR technologies. The accessibility of VR globally has made its use much easier than before. The outcomes related to patients' health conditions have improved by using VR in the medical and health sectors. Providing free surgical training to students is possible by making the use of AI technology common at the global level[18]. Scholars studies explain that providing up-to-date medical information and education to healthcare staff improves the overall quality of health services. VR is among the technological systems that have gained popularity because of its use in health education-based training programs[19]. Also, the applications of VR are not limited to the medical sector. Engineering and other technical educational platforms are dependent on VR for providing training to the pupils. The services of the healthcare sector are enhanced by using a Computational intelligence system in the health management systems[20]. Studies explain that surgical trainees are getting trained using video training programs. through videos, the learning process improves. the students in orthopedics are getting skills in surgical procedures using the VR training sessions[21]. Studies explain that the digitalization process of pathology labs provides economic conservation. The productivity and quality of diagnostic tests held in pathology labs have increased due to the digitalization process. By educating the pathologist about the economic importance associated with the digitalization of pathology labs it becomes easier to make pathology labs more functional[9]. Studies predict that medical sectors and laboratories provide a lot of health services to patients. These services include screening test services and tele-medication. the quality of diagnostic and screening tests is fully dependent on the use of AI in labs. Ophthalmology-based clinical tests are made in laboratories using VR [22]. Scholars studies explain that digitalized learning setting provides students with an environment in which the probability of gaining knowledge is higher. VR is one of the technologies that digitize the education processes. The surgical education students of medicine get is improvised through the use of AR as well as VR [23]. Also, surgical training is a complex procedure that requires advanced visuals to make it comprehensible for the students. Developing a synergistic training model for surgeons is an important educational framework strategy of medical institutes. data generated by these models is compiled with the help of AI technology software [24]. Study Study-based work of scholars suggests that

ophthalmology is a field related to eyes. To treat patients having eye infections and other eye-related diseases VR is used in the ophthalmology field. Training of ophthalmology students is done using a superior and well-enhanced VR-based teaching environment. To predict the eye health of patients various game models are widely used in ophthalmology labs as a diagnostic screening test [25]. Studies explain that using virtual reality technology in pathology labs proves best for diagnosing the cancer of different types. In African states the pathologist are bound to use VR in their labs for promoting the AI based cancer diagnosing approach [26]. Scholars predicts that practical training of spinal surgeon is carried out using the 3D models. The tumor removal forms spinal cord through surgical procedure is a task performed by neurosurgeons through the 3D models the unskilled neurosurgeons gets skilled and becomes capable to perform real life surgical operations [27]. Moreover, the 3D models use the digitalized extended reality technologies to enhance the efficiency of 3D training models. XR technology creates a 3D environment for the students allowing him to experience the world from a new domain. The applications of XR are widely found in the biomedical fields [28]. Studies elaborate that FMD related training sessions are provided to medical students by VR technology. Developing a cost-effective learning and training setting for students is the need of present technology-based world. The researchers studies support that FMD are common around the globe. By controlling the spread of these disease a large number of population becomes save from serious disorder and health complexities [29].

Methods

The research study determines that virtual reality for training pathologists result also describe the cost-effective business model between them. the research study based on quantitative data analysis for determine the data used E-views software and generate result included unit root test analysis, the descriptive statistical analysis, also that histogram and state analysis, the graphical analysis and also present cost-effective business model between them. Training is a basic part and a necessity in every professional field of life. The training aims to provide the trainee with such resources so that they can improve their skills to work well in their relative profession. There are different and various methods used for providing training. But with the advancement of science and technology, now there is less need and demand for physical training, and the aspect of training has been transferred to virtual reality training. The training of pathologists is mandatory to improve effective workflow in Pathology Labs. In recent years, virtual reality has been seen in use for training pathologists. The following are important implications of using virtual reality training for pathologists:

Aspect of Stimulated Diagnostic Scenarios and Personalized Training System

As we know the skills of pathologists must be enhanced to work well in pathology labs. The reason is that they have to encounter various types of pathogens every day. As the condition of the environment has been deteriorating day by day, it has given rise to new types of pathogens producing various variants that can cause high-intensity diseases. As the condition of pathogens has been changing day by day, the skills of pathologists must be enhanced according to it. Virtual reality training provides an important and effective way to stimulate diagnostic scenarios in which a pathologist has to encounter

such rare cases of pathogens which helps them to improve their experience and skills of pathogens. Virtual reality training provides such a platform for pathologists in which they can repeat the same process many times just to get experience and experimentation. The positive aspect of virtual reality training is that it is computer so there is no factor of fatigue or exhaustion so one procedure can be repeated many times. The other positive aspect of virtual reality training is that it creates such environment in which illusion seems to be reality. Most of the specimens and substances in pathology labs are very expensive which acts as an obstacle to physical experimentation but virtual reality training has solved this problem too. All the experiments and calculations done in virtual reality training seem to be real for pathologists. The other important implication of virtual reality training is that there is less risk of human error in it because there is no or less involvement of human beings. Most of the systems are artificial intelligence-based. Other trainings require a group of trainees and coaches at a time but virtual reality training can be used for personalized training programs. We all know that there is a factor of individual differences in people which make it difficult to understand all the aspects of training at a time. So, by using a virtual reality training system, any trainee may get access to this training system at any time at any place. Any pathologist can use this training system to overcome individual differences according to his needs and skills. These implications convince us that a virtual reality training system is a much more effective way of training for pathologists.

Telepathy Training, Improved Interaction, and Proper Evaluation

As we know in primitive ways of training for pathologists, there was the condition of being present at the same time at the same place. However virtual reality training has solved this problem as well. The virtual reality training system is mostly based on video conferences to meet the needs of training. So there is training of pathologists by video lectures and video conferences. There is no condition for the presence of pathologists at the same place at the same time. Pathologists all over the world can easily be engaged and coordinated by video systems. This system of training has solved the problem related to the boundaries of countries and the constraints of time. The other important implication of the virtual reality training system is that it improves the focus of pathologists and increases the means of interaction among them. As we know this is part of training for pathologists to improve their social interaction to improve skills and enhance social interaction. This aspect related to pathologists' training can easily be achieved by a virtual reality training system. The other important implication of the virtual reality training system is that it is based on the system of proper evaluation after training as well. All the pathologists who have undergone training, are properly evaluated in their performance by different methods. This aspect related to the virtual reality training system helps to improve the areas of lack in terms of individual differences. This aspect also helps to encourage those Pathologists who are quick learners and showed improved performance as a result of virtual reality training. These aspects of the implications of the virtual reality training system explain the importance of virtual reality training in our daily lives.

Cost Effective, Improved Accessibility, and Enhanced Safety Measures

The tenure and type of training are dependent upon the resources that we have for use as expenses. If the cost of the training system is high, the tenure of training will be less which will result in less

improvement in the performance of pathologists. Virtual reality training is beneficial in this way that its business model is cost-effective which means that there is less need for cost in this training and cost can be easily balanced by the revenue system. This cost-effective aspect of the virtual reality training system is also included in the implications of this training system. The other important implication of a virtual reality training system is that it is easily accessible just by using an internet system. In contrast to other training systems in which

there was a need to use expenses for transportation and accommodations, there is no such need here and the system is dependent upon the Internet only which can easily be accessed at any place at any time. Moreover, the virtual reality training system is better in this way it stores data in electronic signals so there is an aspect of taking safety measures to avoid any risk of data hacking. All these implications of virtual reality training systems make it preferable to other ways of training for pathologists.

Descriptive Statistic

Table 1: Result of Descriptive statistic

	VR	TP
Mean	1.634256	1.647504
Median	1.672000	1.666000
Maximum	1.902000	1.999100
Minimum	1.001000	1.111000
Std. Dev.	0.244510	0.286672
Skewness	-0.898757	-0.624099
Kurtosis	3.028355	2.144912
Jarque-Bera	3.366519	2.384556
Probability	0.185767	0.303529
Sum	40.85640	41.18760
Sum Sq. Dev.	1.434840	1.972345
Observations	25	25

The results of above table 1 illustrate how descriptive statistical analysis may be used to determine the probability level of each variable by examining mean values, median rates, maximum values, minimum values, and standard deviation rates. The primary independent variable result for virtual reality has a mean value of 1.6342. According to the standard deviation rate of 0.24, 24% of data vary from the mean. The probability value of 0.18 indicates a substantial difference of 18% between them. The result shows that the total rate is 40.85 and the sum of square value is 1.43. The dependent variable is the TP. The results show that the median rate is 1.666 and the mean value is 1.64. The outcome indicates that the probability value is 0.303, which indicates a 30% significant difference, and the sum of squares value is 1.97. Virtual three-dimensional (3D) models are becoming more and more popular around the world to aid in medical education. Medical students are now expected to acquire a variety of concepts from both virtual and actual human body structures, as well as from virtual and real simulated patients, shown on computer screens, tablets, and other digital devices. At the moment, this kind of cutting-edge technology is improving how teachers impart knowledge and how students interact with the material. In fields like anatomy, physiology, pharmacology, and neuroscience, for example, 3D models have made it possible for teachers and students to get knowledge in a more contemporary manner and to have better learning experiences. However, the study of pathology continues to be

distinct and firmly rooted in reality, even though innovative technology-enhanced learning is now integrated into many other fields. Being a clinical specialty, pathology requires certain core competencies from students. These include understanding disease mechanisms, integrating mechanisms into organ system pathology, and applying pathobiology to diagnostic medicine. These competencies are not well suited for study in a fully virtual environment. It is nevertheless beneficial for students to learn from "real" human specimens, which virtual 3D models might not be able to adequately replace. Teachers can also use the physical specimens as a catalyst to get students talking about the symptoms and signs that a patient might present with, differential diagnoses, clinicopathologic findings, and patient care. Virtual models in pathology can be created with current technology; however these representations are frequently inaccurate or do not capture the variety and complexity of disease presentations found in pathological real-life samples.

The results of table 2 shows that the t statistic values and probability values of each test statistic are described by the unit root test analysis result. There is a 2% significant difference between them, as indicated by the probability value of 0.0023 and the overall t statistic rate of -4.367. The results explain the important values at the 1%, 5%, and 10% levels. The table—2 result indicates that the t statistic values are, respectively, -3.73, -2.99, and -2.6355.

Table 2: Result of Null Hypothesis

Null Hypothesis: VR has a Unit Root			
Exogenous: Constant			
Lag Length: 0 (Automatic - Based On SIC, Maxlag=5)			
Augmented Dickey-Fuller Test Statistic		T-Statistic	Prob.*
Test Critical Values:		-4.367059	0.0023
1% Level		-3.737853	
5% Level		-2.991878	
10% Level		-2.635542	
*MacKinnon (1996) One-Sided P-Values.			

Cost-Effective Model

Table 3: Result of Cost-Effective Model

Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(VR)				
Method: Least Squares				
Sample (adjusted): 2 25				
Included observations: 24 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
VR (-1)	-0.868684	0.198917	-4.367059	0.0002
C	1.435896	0.329334	4.360005	0.0003
R-Squared	0.464345		Mean Dependent Var	0.013375
Adjusted R-Squared	0.439997		S.D. Dependent Var	0.317678
S.E. Of Regression	0.237729		Akaike Info Criterion	0.044284
Sum Squared Resid	1.243331		Schwarz Criterion	0.142455
Log Likelihood	1.468594		Hannan-Quinn Criter.	0.070329
F-Statistic	19.07121		Durbin-Watson Stat	1.705421
Prob(F-Statistic)	0.000246			

The results of table 3 mentioned above show that the coefficient values, standard error rate, t-statistic value, and probability value of each variable—dependent and independent—represent the results of the dickey fuller test analysis. The result's R square value of 0.46 indicates that 46% of the model's fitness is related to pathologist training and economical business models. The probability rate of 0.0002 and the total F statistic rate of 19.071 indicate a 100% significant level of relationship between them. The results indicate that there is a positive 31% rate between them, with the mean dependent variable rate being 0.013 and the standard deviation dependent variable rate being 0.31.

Studies of Virtual Reality

The main areas of focus mentioned in studies on VR and medical inpatient settings were pain management, eating disorders, and cognitive and motor rehabilitation, according to a comprehensive

review of the field. Although the research showed encouraging results overall, the authors noted that further extensive, carefully controlled investigations are required. Furthermore, the authors recommended that cost-effectiveness research be done. Numerous studies on virtual reality have shown benefits for emergency and disaster preparedness training. Studies have indicated that virtual reality (VR) is linked to enhanced user happiness as well as better performance and knowledge. Simulation has been a useful tool in healthcare teaching over the years. This is notably the case in pediatrics, where a sharp increase in trend is anticipated over the next ten years. While live exercise simulation has been widely used as a training tool, there may be cost and accessibility benefits to other types of simulation. In the healthcare industry, delivering high-quality emergency training while minimizing costs is a never-ending issue. Researchers recommend that hospitals and departments perform routine cost studies of emergency training.



Figure 1: Virtual Reality

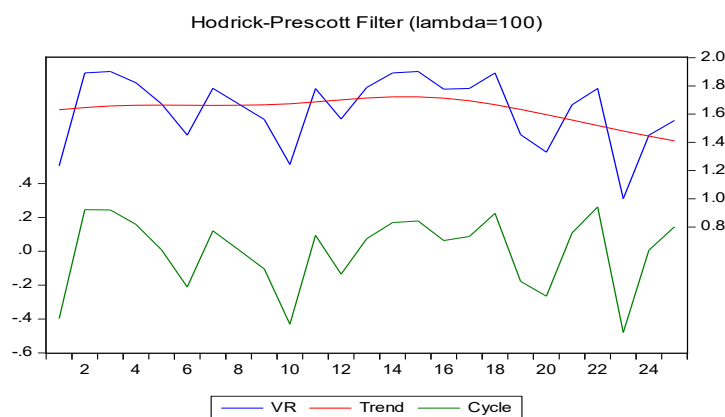


Figure 2: Hodrick-Prescott filter

The above graph of figure 2 presents that Hodrick-Prescott fitter analysis result describe trend, cycle of virtual reality. The vertical side

shows -0.6 range and end it 0.4 respectively. The horizontal side describe the positive range of trend and cycle between them.

Histogram and State

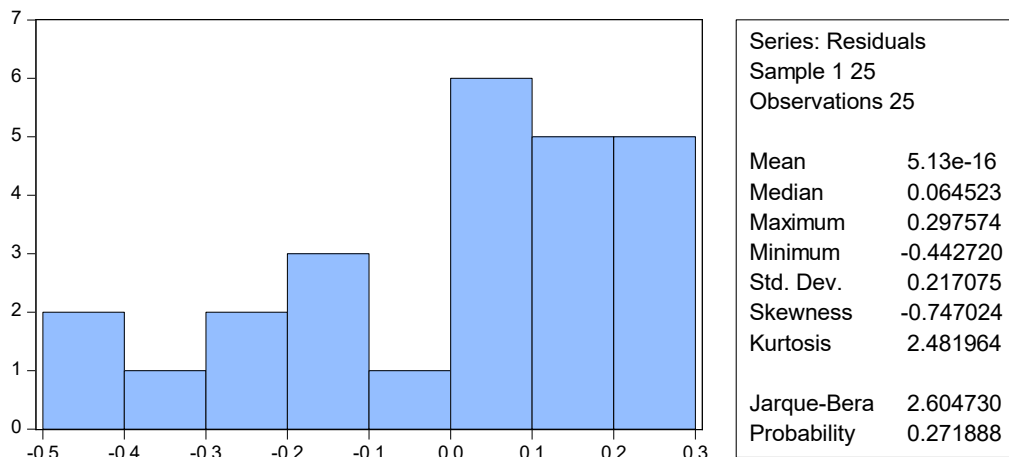


Figure 3: Histogram and State

The above graph of figure 3 demonstrate that histogram and state analysis related to the virtual reality for training pathologists and cost-effective business model. The vertical side start from 0 and end at 7 point the horizontal side start from -0.5 and end at 0.3 respectively. The above blue bar line describes that histogram and state analysis between them. according to the above graph the mean value is 5.13 the median rate is 0.06 the overall probability rate is 0.27 its shows that 27% significantly level the skewness value is -0.747 respectively.

Conclusion

After an overview of these implications of virtual reality training systems, we can conclude that they can be beneficial and cost-effective shortly for training pathologists. live exercises typically only include the staff members who are present on the day of the exercise and can be very expensive each time they are held—expenses that rise as the number of participants increases. Even when they are conducted, staff members are not directly affected by the exercises. For instance, only two or three of the 41 physician partners in an emergency department practice are able to take part in a staff exercise in the emergency room. There are a few topics that merit discussion. First, as previously indicated, early design choices can significantly influence the scope of work and the subsequent development cost of virtual reality. If development costs are lower in a particular scenario, cost savings can be realized sooner. Additionally, there was no requirement for the current analysis to take into account any income or financial advantages of VR.

Decisions about company in other sectors could have to take a demonstrable return on investment and revenue streams into account. Virtual reality (VR) can end up being the less desirable option if it has longer term costs than the alternative but doesn't generate enough cash. Healthcare organizations should take into account the opportunity costs of employing patient care spaces during emergency drills in addition to the real financial expenditures. Although the patients in this instance were able to be accommodated in other areas of the hospital, there is a considerable opportunity cost associated with taking up patient care space. The \$8901 daily revenue from the use of those beds, along with the possible opportunity expenses of two days,

result in an additional potential cost of \$17 802, nearly doubling the initial workout cost. It's possible that a larger exercise with 334 employees needed more beds or used them for a longer period of time. On the other hand, a virtual reality workstation doesn't encroach on patient space and can be implemented in staff workrooms that already exist.

RECOMMENDATIONS

Virtual reality (VR) technology is becoming more and more affordable, which means there are a lot of options for integrating it into business training, healthcare, and education. VR can't be just a gimmick, though. The potentially high upfront expenditures of virtual reality (VR) need a strong business case, especially when taking into account the creation of unique content. We have found a use case in this work where the high initial costs of VR can result in significant long-term cost savings. When it comes to replicating activities that would be costly, risky, or logistically challenging in the real world, virtual reality shines. This includes live emergency evacuations from NICUs and other healthcare facilities, for which virtual reality (VR) provides an efficient means of training a larger number of staff members, maybe at a faster rate and with more frequency. Similar cost savings may be found in various scenarios involving different sectors with comparable constraints. The most important things to consider in this case are:

- (1) how long the training will last across years that it can be implemented with low ongoing costs;
- (2) how many staff members it can reach with costs that can be split;
- (3) design decisions, particularly how to modify the simulation to make it easier to develop, like reducing the size of the virtual environment;
- (4) how much the alternative costs scale over time and staff. If training conducted without virtual reality (VR) is expected to need more resources from each trainee, result in more expenses and scheduling/logistical challenges each time it is offered, then VR might be a more cost-effective and superior option.

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