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A REVIEW OF SIMULATION STUDIES IN HEALTHCARE: EMERGENCY SERVICE APPLICATIONS

SAĞLIKTA SİMÜLASYON: ACİL SERVİS

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ABSTRACT

Managing the emergency service, including many complexities, is one of the main problems for hospitals. A simulation that is implemented health systems and medical education promote optimized and idealized function to systems. It provides effectiveness, efficiency, and equity to the health care system. In this study, the health systems problems and simulation methods were defined, how simulation adds value in healthcare clarified, challenges and issues examined by future perspectives. Optimization parameters used in the emergency department of healthcare are highlighted in all areas of the health system. In order to do those one hundred thirty-five studies were examined after removing duplicates in two hundred ten research and review articles. In addition, the main problems faced in solving the problem and areas that need to be improved are also discussed. Based on the research carried out, it can be concluded that simulation is a crucial methodology for patient care infrastructures and emergency service applications by providing an interdisciplinary framework.

Keywords: Emergency Service, Healthcare, Simulation, Optimization

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ÖZET

Acil servis yönetimi, birçok karmaşıklığı barındıran temel bir hastane problemidir. Sağlık sistemleri ve tıp eğitiminde uygulanan simülasyon, sistemlere optimize edilmiş ve idealleştirilmiş bir işlev sağlamaktadır. Sağlık sistemine etkinlik, verimlilik ve eşitlik sağlar. Bu çalışmada sağlık sistemleri sorunları ve simülasyon yöntemleri tanımlanmış, simülasyonun sağlık hizmetlerine nasıl değer kattığı açıklanmış, incelenen konular zorluklar ve geleceğe bakış açılarıyla ele alınmıştır. Acil serviste kullanılan optimizasyon parametreleri sağlık sisteminin tüm alanlarında da kullanılmaktadır. Bu derlemede, mevcut simülasyon uygulamalarının acil servis yönetimindeki katkılarını ve etkili bir model geliştirmek için dikkate alınması gereken ana parametreleri vurgulamaktır. İki yüz on araştırma ve derleme makalesinde yinelenenler çıkarıldıktan sonra yüz otuz beş çalışma incelenmiştir. Ayrıca, sorunun çözümünde karşılaşılan temel sorunlar ve iyileştirilmesi gereken alanlar da tartışılmaktadır. Yapılan araştırmalara dayanarak, simülasyonun disiplinler arası bir çerçeve sağlayarak hasta bakım altyapıları ve acil servis uygulamaları için önemli bir metodoloji olduğu sonucuna varılabilir.

Anahtar Kelimeler: Acil Servis, Sağlık, Benzetim, Optimizasyon

1. INTRODUCTION

Hospital management systems are becoming more complex day by day, with a plethora of factors affecting success and patient care. Managing variability, recognizing its effect through departments and organizations, and implementing process changes can be tricky (Buschiazzo, Mula, & Bolarin, 2020). Simulation in healthcare provides the ability to test "what-if" experiments that virtually apply the change to safely assess the impact of changes in a unit, hospital, or the entire healthcare system (Thoma et al., 2018). For the implementation of simulation, various models have been created. These simulators can be used to examine patient care pathways. They can deal with the device complexities of multiple runs, sensitivity, and test and care phases, all of which create potential risks for precision medicine (Marshall et al., 2020). Although simulation is an essential tool for strategic management (Şen et al., 2019), it is mainly used to learn and train in the health sector. It has become essential due to improvements in our perception of patient and employee safety in today's healthcare environment, as well as changes in society's perceptions of healthcare facilities, the structure of healthcare professions' education programs, and changes in teaching methods. Simulation is at the top of the list of revolutionary teaching methods (Feldman et al., 2019). Simulation experts are trying to direct health education in a new direction by making the simulation the heart and soul of future health and health education like never before and reinforce a cultural change to enable the student to become competent (Mohd H. Isa, 2020). Errors in the software

implementation of the mathematical model presented have been eliminated with a method used in a simulation system used in the health sector. The cause of this error has been investigated. And after the individual trial of these reasons, this problem has been eliminated with a previously used method, and this simulation has been made closer values to real-life (Zijlmans et al. 2009).

The more critical in dentistry of the simulation used in many branches of the health area is emphasized in the dentistry of teaching agents and are said to the successful in this area (Lloyd et al. 2017). A community has been established for a simulation application in the field of health. The community has concluded that this application will meet some situations during the coding phase. It is aimed to make improvements with feedbacks by presenting it to the user. Thus, a simulation application can be made without any problems (Erdemir et al., 2020). It has been stated that the use of simulations in the health sector has become widespread over the years. Two guidelines have been published on this subject. In the first guide, a list of things to do in the process of creating and creating the simulation is presented, and the need to act accordingly. What educators should do to benefit from it at the maximum level has been explained (Motola et al., 2013). It has been suggested that escape rooms can be used to involve students in the healthcare sector, and research has shown that it would be more beneficial than the reality if it were simulation-based (Anderson et al., 2021). Different simulation models are used to solve complex problems in healthcare (Milazzo, Bown, Eberst, Phillips & Crawfor, 2011). The most common are Discrete event simulation (Des), Agent-based modeling (Abm), and System dynamics modeling (Ahsan, Alam, Morel & Karim, 2019; Çalış, 2016).

According to Tlili et al. (2018), the model's implementation steps are determined. The number of emergency patient centers and ambulances is first determined. Then, the acquired EMS and ambulances' capacities are assessed. Next, the location and condition of emergency patients are gathered. After that, a distance matrix between emergencies and ems is created. Without affecting capability, a route is assigned to the nearest emergency. Finally, a route to a designated ambulance is identified and used. Emergencies and patients can continue to recognize the path as long as the available services are not surpassed. If resources are exhausted, the route is completed, and an ambulance is dispatched.

With the covid-19 virus surrounding the world, it has been determined that the inadequacy of the necessary medical equipment is withdrawn. And the most important of these is the mask. It has been studied on the re-use of cleaning products and personal items with its contribution in simulation (Banerjee et al. 2020). It is used in many areas worldwide, and the software-defined network is also used in the health sector. However, in this formation, the necessary information of the patients is securely shared with a simulation-based communication (Hasan et al. 2020). Simulation is used in many areas and makes our lives easier. It has an important place in the epidemic that we are in: the people who do not show symptoms and carry this virus in time, and the necessary intervention is made and contagious (Mayorga et al. 2020). After the epidemic reached a certain level, different simulation methods were used to understand whether the hospitals could meet the need. Patient arrival was modeled using the Monte Carlo method, hospitalization and intensive care unit, and deaths with simvoi (Chatterjee et al. 2020). Due to the increase in the number of patients and the increase in the number of inpatients, a simulation-based system was developed, and the future density was calculated (Taboada et al., 2013).

According to the article of Atalan, Donmez (2020), When DES (Discrete Event Simulation) and DOE (Design of Analysis) are implemented in an integrated manner in a health center, controllable variables such as physicians, nurses, examination rooms, triage chairs, and clerks can effectively improve the efficiency of the health center." When certain results are obtained by using Des and Doe together, the average time a patient spends in the emergency room has decreased from 10.75 minutes to 9.83 minutes (9.36 percent improvement). The number of patients seeking care every day is currently 132. A total of 68 patients were treated, according to the combined results of all sources. As a result of the move, the number of patients treated increased to 147. Based on the total number of patients treated, this resulted in an 11.36 percent improvement and a 116.176 percent growth in the number of patients received by use. This research aimed to increase the number of patients treated while decreasing wait times for care." Atalan & Donmez, (2020),

Simulations today demonstrated that there could be a reduction in the number of coronavirus situations (Sars-Cov-2) but not as severe a shift as in socially distanced cases. In either case, it would result in a considerable increase in disease control by combining contact tracing with social distancing (Prabhakaran, 2020). The use of simulation has progressed from simplistic task coaches and bogus codes to multidisciplinary, flexible simulations for team teams and hospital systems in the last five years (Gidansky, Panesar & Maa, 2020). Various monitoring strategies have been implemented, and incidents and people have been thoroughly discussed. (Sanchez et al., 2016) New simulation techniques such as virtual reality (VR) and telesimulation are becoming more commonly used as technology progresses, expanding the spectrum beyond large academic institutions (Iwata & Miyakoshi, 2020).

The contribution of simulation to the studies in the health sector is undeniable in the design of intelligent decision support systems needed to manage big data based on the increasing population (Uslu & Fırat, 2019; Uslu, 2020). The worldwide pandemic has proved a massive crisis. Therefore, the simulators have prepared an implementation manifesto to avoid this situation and determine the basis of this manifesto as security advocacy and leadership (Park et al. 2020; Karadogan & Karadayi-Usta, 2021).

Another method explained the reasons for immunity against methicillin obtained from the street and immunity against methicillin used for therapeutic purposes. Then a mathematical model based on these reasons is turned into a reality through simulation (Ding & Webb 2017).

Discrete event simulation is used in many health fields. And it is one of the very effective methods. But it is problematic. This is because of the difficulties encountered during modeling. And here, we are investigating the differences between the other types of simulation and this method we use (Stretton et al. 2018).

In the sustainable health simulation, two situations are considered. The first is planning with continuity, and the other is preparing in case of absenteeism. This aim is to shorten the patients' dry waiting time and provide a better-quality service (Kang et al., 2019).

2. LITERATURE REVIEW

For Emergency Departments, the "chaotic GA and metamodeling approach" was used by Moslem Yousefi (2018). For Emergency Departments (ED), research is usually focused on reducing" length of stay, " expending, " waiting time in queue," etc. Other than that, GA, OptQuest, Tabu search, Linear optimization, and many more are used in healthcare optimization-based simulation models. (Yousefi & Yousefi, 2020)

Lestander from Sweden (2016) has done the research. For SBL, it was found that imitating and simulating certain situations might play an essential role in nurses' education, exploring their reactions to develop awareness and well-understanding of the importance (Husebo et al., 2018). For Visual Reality, Dyer from Australia (2018) has completed research. In visual reality-based simulations, it was aimed to enhance the empathy and understanding of users for patients with health diseases for improving the care for the patient (Wai Hin Wan, 2019). With the combination of Flipped-Classroom models and simulation, it was found that simulation was also crucial for pedagogies in healthcare education to understand and emphasize student-centered activities rather than typical in-class lectures (Dong et al., 2020). Bloomfield, from the UK (2015), has made research that in Simulation Training, aimed to enhance the ability of healthcare students to communicate with the dying patient's families (Alanazi et al., 2017). According to Bae et al., for simulation education debriefing protocol, they stated that to support problem-solving capabilities and clinical reasoning competency in Nursing education, simulation-education debriefing protocol can be very well prepared as an education method. Debriefing methods are proposed in simulation-education systems (Bae et al., 2019). The study of Kelle, et al. (2012) generated two models, and they showed that pharmaceutical expenses related to inventory could be reduced by 70% to 80%.

In hospital inventory management systems, two models are usually generated, the General Multiproduct Model and Optimal Allocation model, which is based on the costs of ordering and holding (Leaven et al., 2017). According to the study of Simran K. Ghoman, generating different types of games (boards, videos, simulations) is helpful to represent the experience and pressure of neonatal resuscitation to healthcare professionals (Ghoman et al., 2019). Among all the research done for healthcare, healthcare operations, system design, and medical decision-making applications are two of the most studied cases. Overall, Discrete Event Simulation (DES) and Monte Carlo Simulation (MCRLO) are two of the most common simulation methods (Salleh et al., 2017). In the reviewing article of Gomes et al. (2017), It was shown that there are various tools and techniques for generating simulations of operational processes. The most prevalent techniques are Six Sigma, Value Stream Mapping (VSM), Kaizen, 5S, Pareto, etc. (Gomes et al., 2016). In the study of Darragh (2016), simulation games are used to train home-healthcare workers for health and safety training on home-healthcare hazards. These studies have aimed to compare technology-centered and human-centered perspectives on the design and development processes of simulations for healthcare training (Persson, 2017). In the study of Reid Searl (2014), it was shown that using puppets can entertain and attract students more, therefore increasing the performance of undergraduate healthcare students (Tilbrook et al., 2017). The system was described by analyzing the data and finding ROP, order quantity, etc. After it's done, Arena simulation software (a DSE) was used, making it possible to construct the policy of medicine inventory (Al-Fandi et al., 2019). At Memorial Medical Center in Springfield, it was stated that simulation was used to train nurses on the safe placement of small bowel feeding tubes in a team of registered nurses and registered dietitian nutritionists (Rollins et al., 2018). In a study by Ian William Gibson (2007), mainly Discrete-Event Simulation was used for Facility Design, analyzing the hospital infrastructure and its effects on the operations (Zhang, Grandits, Härenstam, Hauge, & Meijer, 2018).

Simulation is one of the most practical and helpful techniques to improve efficiency in healthcare services. There are numerous examples where simulation is used as an effective tool by health care managers and professionals in healthcare services—own sentences (Kim Young-Ju, 2020). The most important reason for this is that the simulation model is suitable for dealing with uncertainties and being easily used to solve problems in the system, such as improving operational efficiency reducing cost, and improving maintenance quality (Shepherd Irwyn, 2019). With the high competition in the developing technology and service sector, studies on health systems have gained increasing momentum in recent years. Patient satisfaction and service quality can be improved while the costs of institutions are decreased with process improvements made in health institutions (Katrina M. Long, 2018). The simulation is used in multiple units in healthcare. These are Emergency Department, Operating Room, Intensive Care, and Pharmacies. Simulation studies shorten the average waiting time of the patient, it has been used to improve the current performance of emergency departments by increasing the number of medical personnel and the number of patients served (Sumanta Roy, 2020). Modeling and analysis studies for logistics systems in health services were carried out using discrete event simulation.

Patient flow and personnel management systems are also implemented into simulation technology (Zhang Chen, 2018). The use of simulation in medical education began in the 1950s. The first medical simulators were phantom models and used to reduce infant and maternal deaths (Hippe Daniel S, 2020). Electronic health records can be defined as all kinds of information recorded, stored, transmitted, accessed, associated, and processed using electronic systems related to the physical and mental health or past, present, and future diseases. Simulation applications in electronic health recording systems enable risk-free learning of the system with experimental data (Numah Joseph, 2020). The electronic health registration system systematically collects the patients' records and information in digital format. The electronic patient registration system is used to obtain accurate up to date information about the health conditions. This system also reduces the cost of the hospital. Thanks to the system, doctors have access to medical information about their patients immediately (Wilbank et al., 2020). In 2009, simulation studies were carried out with Arena and ARIS software programs to improve patients' waiting times at Saint Joseph and Saint Luc hospital. In 2007, observations were made on 517 patients using Arena software in the

pediatrics department (Deghani et al., 2017). The aim is to improve the patient's management process. In 2007, studies were carried out using discrete event simulation. In 2011, studies were carried out using separate event simulations with Arena software to improve waiting times in emergency rooms (Welsch Lauren et al., 2020).

Research	Type of Simulation	Waiting Times	Emergency Rooms	Arrival Time	Service Time	Cost	Physician and Nurse	Prioritization	Utilization	Transportation Time	Bed Capacity
A.Abduljabbar W. K. (2017)	Discrete Event Model							✓	✓		
Ali A.,Zachrison K. S,Hur C. (2018)	New Mathematical Model				✓	✓			✓	✓	
Brubolla E.,Wong A.,Loque E. (2016)	Agent Based	✓			✓						
Chang H. C.,Wang M. C.,Wang Y. H. (2019)	Dynamic Taguchi method					✓			✓		✓
Chavis J., Cochran A. L., Kocher K. E., Washington V. N., Zayas-Caban G. (2016)	Discrete Event Model	✓	✓		✓						✓
Cheng G.,Kinner S. A.,Stoves N. (2018)	Hybrid Model					✓					
Cimellaro G. P., Malavisi M., Mahin S. (2017)	Discrete Event Model	✓	✓						✓		
Cimellaro G. P.,Piqué M. (2016)	Develop a New Method	✓	✓						✓		✓
Guo H.,Gao S.,Xia T. (2020)	Discrete-Event Simulation Model	✓				✓					
Guo H.,Ge H.,Peng L. (2020)	Multi-Fidelity Simulation Optimization Framework	✓				✓					
Hailemariam D. A. (2016)	Develop a New Method	✓	✓	✓		✓		✓			✓
He Y.,Cai B.,Wang M. (2016)	Develop a New Method	✓		✓					✓		
Johnston M. J.,Sarmanioudis P.,Fitzgerald J. A. (2020)	Discrete Event Model	✓					✓		✓		
Kapan K. (2014)	simulation/analytical model	✓	✓	✓					✓		✓
Kaya O., Teymurtlar A., Ozturk G. (2020)	Develop a New Method	✓			✓	✓					✓
Knox L. R.,Saunders K.,Lanan J. (2018)	Stochastic Model		✓		✓						✓
Kuo Y. H., Rado O., Lupia B., Leung J. M., Graham C. (2014)	Develop a New Method	✓		✓	✓				✓		✓
Lalmuzeamian M. (2016)	Develop a New Method	✓		✓		✓			✓		✓
Lim M. E.Worster A.Goeree R.Tarride J. E. (2013)	Discrete Event Model	✓		✓			✓				✓
Liu Z. (2016)	Agent Based Simulation Model	✓							✓		✓
Liu Z.,Epelde F.,Renedo D.,Luque E. (2016)	Agent Based Simulation Model	✓									
Malavisi M.,Cimellaro G. P.,Terzic V.,Mahin S. (2015)	Develop a New Method	✓	✓						✓		
Mielczarek B.,Zabawa J. (2018)	System Dynamic Method,Aging Chain Approach										
Molina-Pariente J. M.,Hare E. W.,Fuentman J. M. (2015)	Monte Carlo Simulation	✓	✓			✓	✓		✓		✓
Neighbour R. Oppenheimer L. Makki S.N. Friesen M.R. McLeod R.D. (2010)	Agent Based Simulation Model	✓		✓							
Rajakumari K.,Madhumitha M. (2020)	New Model(Convolutional-Neural-Network ("CNN")	✓		✓							
Ren Y.,Phae M.,Asadi H. (2020)	Discrete Event Model				✓						✓
Ribeiro RA., Barangruiz EN., Vaccaro G., Schmitz PS., Fernandes AK., Colpani V., Palavigna M. (2016)	Discrete Event Model	✓					✓				
Taboada M.,Cabrera E.,Luque E.,Epelde F.,Iglesias M. L. (2013)	Agent Based Simulation Model	✓					✓				
Wu I.,Liu Y.,Shih F. (2016)	Constraint-based simulation ,Agent-based modeling,Monte Carlo						✓		✓		

Table 1. Optimization parameters for emergency service management

As seen in Table 1, the most used optimization parameter is waiting times, utilization, and cost. These parameters can be accepting as crucial in modeling and simulation to define and solve the problems. Transportation time is at least used parameter since, there is no digital infrastructure that can record the information about the transportation time to the hospitals.

3. CHALLENGES AND FUTURE DIRECTION

The use of simulations in health provides quite favorable possibilities for better care thanks to its transport of reality to the virtual, often simulated and facilitated, where it is often difficult to practice. However, there are some challenges to the use of the simulation. For example, in a simulation that requires a large amount of data input (e.g., in a simulation that aims to provide an optimal early diagnosis of the disease), it will be difficult to process this data, a good recognition model will be needed for the processing of this data (*Nazır et al., 2020*). In addition, it may not always be possible for a simulation to lead to successful results in an intended way. An incorrect sample data selection may have been made for the targeted audience. Still, the results may also be affected by the awareness of simulation participants that this is not a real clinical environment (*O'Donovan & McAuliffe, 2020*). This can be overcome with a scenario very close to reality, but there is no certainty (*Stretton, Cochrane, & Narayan, 2018*). Training scenarios are produced for health workers with simulation. The continuity of these scenarios requires a good simulation trainer; problems will arise without this (*Dale-Tam & McBride, 2019*). To mention another difficulty, important topics such as effective collaboration, interoperability, effective performance are also critical for simulation. The lack of these distracts the simulation from a healthy operation *(Kumar, Sharma, Nayyar, Singh, & Yoon, 2020*).

Simulation of healthcare gives the workers many advantages, but having these advantages has some difficulties and challenges. Simulation has its challenges, but also, creating simulation has its challenges. Creating a simulation from zero has lots of challenges.

Some of them know IT, programming, and completing simulation in perfect status, knowing all details of the type of simulation's actual probabilities. (Adarsh Kumar,2020). For example, knowing Swiss Cheese theory has vital importance for creating a medical simulation-like surgeon experience. Because it works like a chain, explaining chain rule if one error happens in simulation and the user didn't avoid this error causes different problems in the other simulation parts (Michael Galaup,2018). Also, simulation is essential in healthcare education, but healthcare workers are not thinking about its benefits. They prefer the classical evaluation of decision-making tools (Abdullah. Alrabghi,2019). Nowadays, simulators can imitate human behaviors perfectly and give accurate results to perform a real-life situation to students. Still, providing this effective method, the biggest challenge is creating the simulation truly and comprehensively. This situation's only solution is finding qualified and foresighted programmers.

The issue of natural disasters has always been urgent in the world. Especially after a disaster, meeting human needs, rescue activities, and the supply of medical supplies are within the scope of health services. Considering that there are not enough simulation studies in this field, it can be said that there will be simulation studies directed here in the future. Modeling studies will be conducted to facilitate overcoming the destructive effects of natural disasters in the future (*Syahrir, Suparno, & Vanany, 2015*). The simulation activities that are currently being carried out can also be expanded in the future. For example, a simulation study targeting an optimum number of daily patient visits (which means a higher number of daily visitors and shorter meetings per visitor is targeted) can provide optimum daily earnings by including revenue management (*Demirbilek, Branke, & Strauss, 2019*). Simulation is also used for training healthcare professionals. Some diseases are presented to the perception of healthcare professionals through computer-based games. New diseases will be added to these diseases in the future, and especially chronic diseases will be simulated (*Johnsen, Fossum, Schmidt, Fruhling, & Ashild, 2018*). Epidemics are also an important problem for the world. There are currently studies in this area, and it is thought that these studies will expand in the future *(Smith et al., 2018*). Finally, as mentioned in the literature, simulation studies addressing problems in the emergency room may be encountered in the future (*Salmon, Rachuba, Briscoe, & Pitt, 2018*).

The simulation method spreads to almost all areas of human life in the 21st century. The simulation method can be used for predicting all probabilities of most of the events. Nowadays, simulation methods can be used in the military, aviation, industry, and newly in healthcare sectors. To start with, laboratories are slowing down the treatment of patients in hospitals. Also, laboratories cost is significant for hospitals budget. So, lab causes loss both in money and operation of the hospital (Lacuanda T. Leaven,2015). In this situation, knowing and making the best decision for the incoming probabilities "simulation" involved in the event. As an example, simulation gives scenarios, and hospital workers choose the optimum conditions to the best way to earning maximum profit in the fastest way.

Another example is educating healthcare workers. Simulation helps significantly to adaptive learners. In adaptive learning, conditions change based on students' answers. Simulation and adaptive learning are compatible because both conditions are shaping depending on the user's decision (Lineberry Matthew,2018). It is also proven that patient centered simulation is an effective way to educate healthcare students (Jennifer L Arnold,2018). On the other hand, education in simulation systems gave practitioners decision-making ability and teamwork skills before they started in the field. In short, nowadays, simulation using to educate futures healthcare worker nominees (Yang YingYing, 2019).

It was mentioned that the use of simulation is of great importance in the training of nurses and other healthcare professionals. Simulations have an important place in nurses' gaining experience, minimizing their anxiety, and maximizing their self-confidence while caring for patients (*Raman, 2019*). However, the role of simulation in education has become invaluable these days when face-to-face training is interrupted due to pandemic conditions. The training, which was disrupted in quarantine conditions caused by the Covid 19 virus, was supported by realistic models (*Jiménez-Rodríguez & Arrogante, 2020*). Pandemic conditions have energized hospitals. Simulations have been crucial to tackle the intensity of patient care activity in hospitals. As mentioned in the literature which examines a child

hospital, has contributed to the preparation of the hospital against covid 19 with simulation in the pediatric field (*Hazwani, Al Hassan, Al Zahrani, & Al Badawi, 2021*). It should also be said that some side variables that cannot always be put into practice, such as working under stress or fatigue, can be practiced and then represented by simulation models, and that's why new methods can be developed (*LeBlanc et al., 2011*). Finally, as mentioned in the article, simulation modeling is critical in purifying non-value-added transactions with a method study (*Crema & Verbano, 2019*).

Simulation has become an inescapable thing in the healthcare sector because doing experiments becomes more costly and unethical. The cause of unethical is using animals in the experiments and using animals in the experiments more costly because doing experiments with animals requires some expensive necessities such as fully equipped laboratories, qualified scientists, animals, etc. Using simulation allows escaping all these costs, doing more effective and ethical experiments (John Pawlowski,2018). Another example is following patients from online with sensors and gadgets brings companies and hospitals time because patients' diseases can be solved without patients coming to the hospital (Venkatasamy et al., 2019; Uslu et al., 2020).

In short, benefits, advantages, profit, and reducing expenses possibilities of simulation prove the importance of the simulation for the companies (Omar Hussein Salman,2020).

4. CONCLUSIONS AND EVALUATION

This extensive study analyzing literature demonstrates that simulation methods which are operations research methods, can be applied to a wide range of health systems, educational aspects in medicine, and healthcare applications**.** The healthcare system is not only including patients and diseases but also includes many complex systems. These complex systems include physicians, nurses, health staff availability, patient, environmental factors, and interactions between these complex systems. It is difficult to predict that system components cause improved technology, the complexity of diseases, diagnostic processes, and workforce shortages leading to increased risk and error.

In the healthcare management system, simulation-based health education has been widely used in recent years. Frequently used simulation methods are Monte Carlo simulation, which is kind of static optimization technique, Discrete Event Simulation used in modeling emergency, System Dynamic Method used in modeling Epidemics and Disease Prevention, and Agent-Based Simulation in forecasting and intelligent decision making. There are difficulties, challenges, and issues in healthcare simulation caused by processing big data and the adversity of creating a model. This study highlights that emergency departments are main problems in hospitals cause of time factor importance and unknowns, and emergency parameters are also used in almost all healthcare simulations. Simulation is an effective and efficient way for healthcare to manage many complexities, unknowns, and infinite possibilities.

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