Emergency Departments

A Systematic Mapping Review

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Abstract. Emergency services are essential and any person may require these services at some point in their lives. Emergency services are run by complex management and consist of many different parts. It is essential to establish effective procedures to ensure that patients are treated in a timely fashion. By obtaining real-time information, it is expected that intelligent decisions would be made. Hence, thorough analytics of problems concerning appropriate operational effective management, would help prevent patient dissatisfaction in the future. Mapping studies are utilized to configure and explore a research theme, whereas systematic reviews are utilized to combine proofs. The use of improvement strategies and quality measurements of the health care industry, specifically in emergency departments, are essential to value patients' level of satisfaction and the quality of the service provided based on patients' experience. This paper explores and creates momentum with all the methodologies utilized by researchers from 2010 and beyond with the stress on patient fulfillment in the emergency services segment.

Keywords: Emergency department · Health care · Real time algorithm
Overcrowding · Waiting time · Systematic mapping

1 Introduction

Scoping studies [1–5] through taxonomy and input involve searching existing literature to identify certain similarities between search methods and paper collection. Emergency services or Emergency Departments (EDs) manage various types of severe emergencies through in/out-of-hospital medical care. For the assessment of health technology, it is essential to include a decision-analytic model. This technological

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analysis needs to be updated at hospitals, as modeling methods are required to manage interactions between patients and EDs staff as well as patient care pathways. System analyses are also required due to the complex nature of EDs and the various issues experienced with them. Numerous studies exist on mathematical models in health care, but these do not include mathematical models in EDs even though such models are vital to reduce the long waiting periods experienced in EDs. Major focuses for future research directions; healthcare workforce, assets to be used during emergency conditions, effective processes, patient experiences within emergency department systems near quality health care and resource allocation using real time algorithm.

1.1 Study Motivation

Defining the motivation for research and its processes is essential. Responsive bounding in collaboration and inventive problem solving allows researchers to take competitive action and approaches. Saudi Vision 2030 focuses on economic diversification to achieve national goals by valuing performance and measuring sustainable action through Saudi Vision 2030's governance model. One of Saudi Vision 2030's main goals are to implement "efficient and high-quality health care" to improve the quality of health care services by increasing the effectiveness and output of care and boosting the accessibility of health care services to citizens. Improved ED systems allow for the amplification of resources utilization, assets, and economic stability, all of which have long-lasting effects.

1.2 Knolwedge Gap

The topics studied were classified based on EDs mapping for 381860 articles from 1864–2017. Same research methodology used early this year in [32]. All EDs activity was well represented in results. The main problems and methods of EDs were classified looking for a theme. Gaps were found in the health care industry, emergency preparedness, quality of health care, performance measurement, and others, as shown in research questions answers: RQ2, RQ3 and RQ6.

2 Background

Mathematical modeling techniques exist to map industrial engineering and operation processes or systems and provide a simple structure for real-world applications. Although EDs have limited resources, they provide acute cure for a large percentage of the patient population admitted. Resource utilization, throughput, and wait times are parts of ED system behavior measurements.

Overcrowding can occur in EDs if waiting periods are long, and this may increase patient mortality risks. In addition, patients may leave without being seen, resulting in them readmitting to EDs again. Organizational, physical, and human factors must be considered in EDs patient and environments'. For instance, management systems, equipment, buildings, patient's real time algorithm, and their links must also be considered. Basic requirements include waiting areas and spaces avoiding overcapacity on

hazardous time. The following order is used to deal with patients: registration, triage, examination, X-rays and blood tests, evaluation, pharmacy, EDs bed location and EDs staff, handling, allocation, and discharging.

ED wait times may be long due to overcrowding. In addition, demand might not meet capacity, the number of beds might be insufficient, capacity management might be suboptimal, and patient acuity and service demand may vary [2]. From 2000–2009 [2], the discrete-event simulation method was the most common method used in EDs, especially in UK health care system. To a minor degree, system dynamics has also been used to improve wait times in EDs (see Fig. 1).

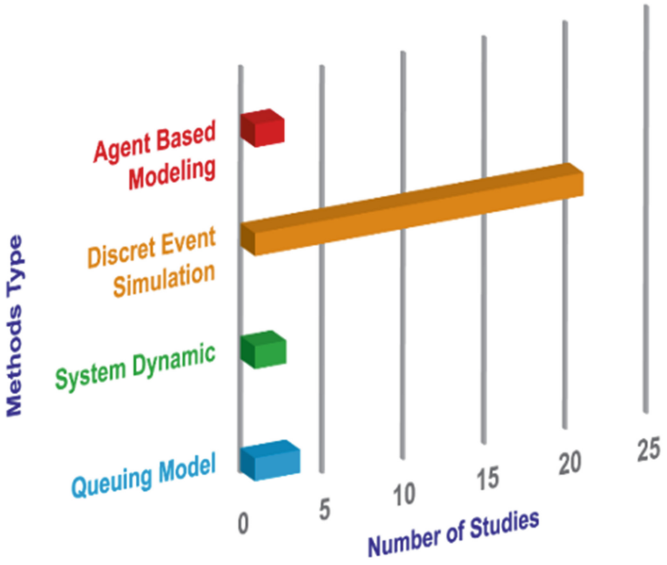

Fig. 1. Methods used to solve EDs problems from 2000–2009.

EDs aim to meet an important health care objective, which is why they are considered the most critical part of system. It is necessary for EDs to develop rational solutions and procedures in normal and disaster scenarios.

The Simulation software's aim to address prevention-related issues, reduce wait times, and predict variables related to disaster situations in EDs. The simulation model identifies issue that occur in real situations, including those pertaining patient flow, arrival patterns, and the infrequent extraction of optimal resources in emergency response domains. The sources used for gathering data include direct sampling, historic data, hospital databases, and observation. Simulation method applied to enhance resources and reduce wait times by implementing a cost analysis and introducing strategic policies [7].

3 Methodology

The information is taken from recent updates to suggest and guide. Mapping a system is only used as a starting point to evaluate existing studies by subject and classify them in order to conduct a thematic evaluation. This systematic study comprehensively details previous research. A systematic mapping study is used to summarize a research area and detect research gaps. Up-to-date sources are used for this study. Systematic mapping is a preliminary study that allows researchers to review papers related to a certain theme [3] and classify research, conduct a thematic evaluation. The systematic review process characterizes and summarizes existing research following a predefined protocol [4]. Therefore, offering an indication of a research field and distinguishing study gaps are the key targets of a mapping study.

3.1 Research Questions

The intelligence of this study, the monitoring strategies used in [1, 3–6, 8, 32] were used to define the problems in EDs. The following research questions (RQs) were addressed:

- RQ1: Which techniques are used in EDs research?
- RQ2: Which topics are introduced in EDs?
- RQ3: When/where were studies published?
- RQ4: How do studies visualize their results?
- RQ5: What problems were addressed in existing studies?
- RQ6: How are studies classified/clustered?

The management of our research area is performed through mapping studies. RQs in this research area are developed to meet aims systematically. Our aims for this systematic mapping study are (a) to obtain a general idea of issues that require addressing in EDs, and (b) to review the approaches used in existing research.

3.2 Search for Primary Studies

The search was conducted in the following databases resulting in: ABI/INFORM [9, 10], Emerald [15, 16], IEEE Xplore [17–21], and ProQuest Dissertations and Theses Global [22–27]. These were chosen because they are comprehensive databases containing millions of publications, especially on EDs, engineering and computer science. Moreover, these databases are user friendly and have advanced search features.

The identified keywords were as follows: *Emergency department*, *emergency medical care*, *emergency clinics*, and *methods*. These were used to develop the following search strings:

- Set 1: Search terms related to scoping research on EDs (i.e., *emergency department*).
- Set 2: Search terms related to the string (e.g. *emergency medical care* and *emergency clinics*).
- Set 3: Search terms related to techniques (e.g., *methods*).

The keywords were classified based on the RQs and grouped into these sets. Each set was identified in the databases, and each search string can be found in (Table 1). This study was systematized based on the date it was conducted: early 2017, late 2016. (Table 2) shows the number of search results per database.

Table 1. Database searches

Database	Command search
ABI/INFORM	("emergency department" or "emergency medical care" or "emergency clinics") and ("methods")
Emerald	
IEEE Xplore	
ProQuest Dissertations	

Table 2. Number of studies per database

Database	Search results	Date
ABI/INFORM	103,025	1864–2017
Emerald	12,313	1898–2017
IEEE Xplore	891	1924–2017
ProQuest Dissertations & Theses Global	265,631	1897–2017

3.3 Study Selection

We ignored items based on several database features, as shown in Fig. 2. Quality assessment was based on an article's citations at first place; articles without citations were excluded in some cases. The following inclusion criteria were considered: studies focused on the research methods for studying EDs, studies published between 2010 and 2016, and studies in the field of EDs. Finally, the following exclusion criteria were considered: studies not presented in full text, studies not reviewed, studies duplicating other work, and non-English studies. The numbers of included and excluded articles in search process for database are given in Fig. 2 and final selected content in Table 4.

3.4 Data Extraction

The extracted data form used the modified template given in [32], which was updated to suit this study, as shown in Table 3. Each data area includes the item and value. Data extraction was completed by the first author and reviewed by second and third authors for validity and quality control.

3.5 Verification and Validation

The data collected has strong degree of objectivity. This kind of validity is exposed to less risk than data obtained from quantitative analysis. To shrink this risk, data compilation table was adapted to back the documented data; the table used in Data mining

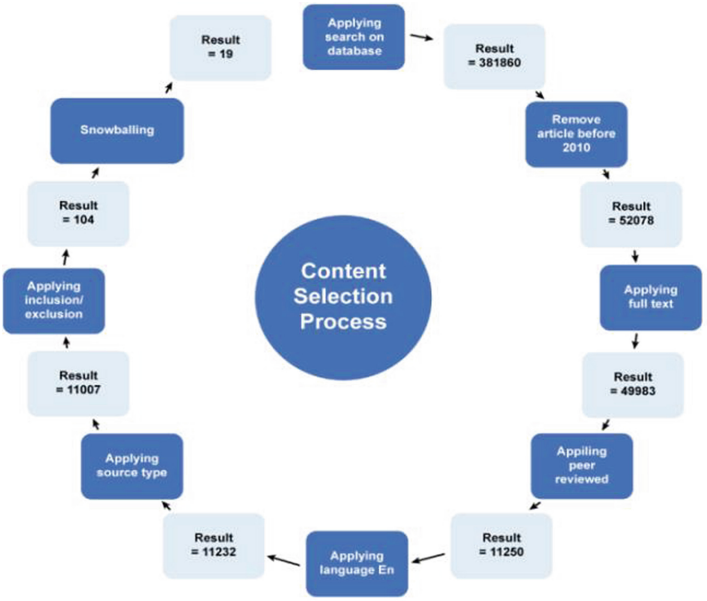

Fig. 2. Study selection process.

Table 3. Adapted data extraction table

Item	RQ result	RQ
Study ID	Number	
Author Name	Name(s)	
Year of publication	Calendar year	RQ3
EDs area	Knowledge area in EDs	RQ2, RQ6
Venue	Journal name	RQ3
Method	Method used	RQ1
Problem	Problem identified	RQ5
Visualization type	Style of presentation	RQ4

[32] to allow for reexamination. Data collection table are used to document data and reduce risk. Further, data extraction can be rechecked, which also reduces risk. In this study, two different authors took these steps independently; when a common understanding is accomplished, risk to validity decreases [3]. In this study, the information gathered was accurate and objective thus, risk was limited [1–8].

4 Results

Several publications were identified and reviewed between 2010 and 2017 in each database. For more details see Table 4. Other related data are given below to answer the RQs after Table 4 in Sects. 4.1–4.6.

4.1 RQ1: Which Techniques Are Used in ED Research?

Approximately more than eight different methods and techniques were found to be used in EDs research. According to the ABI/INFORM database [9–14], literature reviews, interviews, and questionnaires are the main methods used in EDs research. According to the Emerald database [15, 16], queuing theory and focus groups or interviews (problem trees) are the main methods used in EDs research. According to the IEEE Xplore database [17–21], image processing/machine learning, neural network machine learning, and clustering and logistic regression algorithms are the main methods used in EDs research. According to the ProQuest Dissertations and Theses Global database [22–27], mixed methods, descriptive research, experimental research, and qualitative research are the main methods used in EDs research.

4.2 RQ2: Which Topics Are Introduced in EDs?

The topics screened were categorized based on EDs research topics. All EDs activities are well presented. The main problems in EDs and the methods used to study them are covered by mapping [9–27], and they are not influenced by a specific topic. Thus, research gaps were found in emergency preparedness, health care quality, patient satisfaction, performance measurement, and health care industry, as shown in Figs. 3 and 4.

4.3 RQ3: When and Where Were Studies Published?

Many publications were identified that were published between 2010 and 2016 in each database. The earliest study identified was published in 1864. Interest in this filed increased between 2010 and 2014 and significantly dropped in 2016.

In this study, only peer-reviewed journals, conferences, and materials were included to answer this question. Figures 4, 5 and 6 provides an overview of articles included targeted venues. Engineering, simulation, and process management only account for 2% of the total studies on EDs between 2010 and 2016.

4.4 RQ4: How Do Studies Visualize Their Results?

In this study, the visualization approaches of previous studies were identified (see Table 4). Most commonly, figures or graphs and tables are used to visualize data.

Table 4. Extraction table

ID	Author Name	Year	Area in EDs	Venue	Method	Problem	Visualization Type
1	Allnutt et al.	2010	Skills and Competencies	Australian Health Review	Survey conducted as part of quantitative research using an information sheet and consent forms sent through email	Assessment of nurse practitioner's role as observed by a client along with their satisfaction with their nurse practitioner's education, care, skill, and knowledge	Tables
2	Fulop	2012	Skills and Competencies	Journal of Health Organization and Management	Qualitative research with interactive interviews to present accounts of how health care professionals describe leadership	Investigation of how hybridity can be utilized to re-speculate authority in services, as it identifies change strategies that address initiative projects to grasp the utilization of various approaches	Tables
3	Hanson	2011	Quality	Australian Health Review	Qualitative research using a literature review	Demonstrated that health care centers need a structured strategy to enhance data quality and create a robust information culture that harnesses health information	Process map
4	Morgans and Burgess	2012	Emergency Department or Ambulance Utilization	Australian Health Review	Qualitative research using a comprehensive literature review	Defined and measured inappropriate emergency health service use in Australia	Text: Percentages and classification
5	Rosenberg and Hickie	2013	Skills and Competencies	Australian Health Review	Qualitative research using a review	Provided an ideal approach to community and home mental care	Text: Percentages and classification

(*continued*)

Table 4. (*continued*)

ID	Author Name	Year	Area in EDs	Venue	Method	Problem	Visualization Type
6	Scott	2010	Management	Australian Health Review	Qualitative research on planning, hospital discharge, patient discharge, and discharge processes to conduct a systematic meta-review of controlled trials	Determined the relative efficacy of pre-discharge interventions to reduce post-discharge problems in adults	Tables and Text: Percentages and classification
7	Lantz and Rosén	2014	Management	Health Organization and Management	Queueing theory to study the time of arrival, exact time of triage, and total number of patients and arrival rates and system capacity measures and derive average queueing times and The theoretical relation between them	Developed a technique based on a queuing model to evaluate the operational capacity of health services without process observation by appraising Skaraborg Hospital's operative capacity during the triage process in the emergency department	Mathematical equations and figures (graph), tables
8	Buttigieg et al.	2016	Quality: Process reengineering	Journal of Health Organization and Management	Multiple case study on effective strategic planning and the project management methodologies of three units in Malta's health care system, all of which are popular methods for improving the quality of health care services	Determined the root causes of quality issues specific to the three settings; objective trees were formed to suggest solutions to these quality issues	Tables, figures, charts
9	Esfahani et al. 1	2016	Quality: Engineering	38th Annual International Conference of the IEEE Engineering in Medicine and Biology Society	Segmentation methods, neural network/deep learning, and convolutional neural networks classified into three groups as tracking-, model-, and filter-based	Described vessel segmentation to ensure that the images obtained are of high quality by reducing their noise and enhancing their contrast	Figures, tables, mathematical equations

(*continued*)

Table 4. (*continued*)

ID	Author Name	Year	Area in EDs	Venue	Method	Problem	Visualization Type
10	Esfahani et al. 2	2016	Quality: Engineering	38th Annual International Conference of the IEEE Engineering in Medicine and Biology Society	Neural network, deep learning methods	Proposed a method to enhance the detection of melanoma through an analysis of enhanced images	Figures, tables, mathematical equations
11	Jafari et al.	2016	Quality: Engineering	38th Annual International Conference of the IEEE Engineering in Medicine and Biology Society	Algorithms for digital image magnification of details and extraction features to detect surfaces	Proposed an efficient pre-screening mechanism for pigmented skin lesions	Graphs, figures, mathematical equations
12	Jamali et al.	2016	Utilization	38th Annual International Conference of the IEEE Engineering in Medicine and Biology Society	Experimental use of the robust watermark method in advanced image processing and diagnostic/discrete Fourier transform	Proposed a robust watermarking method where the watermark data are hidden to prevent the distortion of the region of interest	Graphs, figures, mathematical equations
13	Kadkhodaei et al.	2016	Quality: Engineering	38th Annual International Conference of the IEEE Engineering in Medicine and Biology Society	Experimental algorithm with a method to join hybrid clustering and logistic regression	Minimized problems in brain MR images	Graphs, figures mathematical equations

(*continued*)

Table 4. (*continued*)

ID	Author Name	Year	Area in EDs	Venue	Method	Problem	Visualization Type
14	Clark	2010	Emergency preparedness: operations	University of Baltimore Ph.D. Thesis	Mixed quantitative and qualitative examination of data from year (2008) using action research	Evaluated public administration in real-world to identify failures and weaknesses associated with systems to reduce hazards	Tables
15	Donnelly	2013	Management	Queen's University Ph.D. Thesis	Multiple-method case study of systematic, scientific, systematic, and empirical knowledge	Co-produced knowledge about a complex problem	Tables, graphs
16	Gautam	2000	Management	Southern Illinois University Ph.D. Thesis	Quantitative, cross-sectional, descriptive, correlational survey	Determined health beliefs and knowledge to determine the factors that predict demographic variables	Tables
17	Nikolai	2014	Emergency Preparedness: Disaster Response	University of Notre Dame Ph.D. Thesis	Mixed-method study using quantitative research to observe, collect, and analyze key documents including past situation reports, after action reports, and exercise documents and qualitative research to classify informal and formal interviews with emergency managers	Coordinated new forms of collective action to solve critical problems in crises at a specific time for a specific purpose to prioritize recommendations Proposed a method to determine problem severity and used classification in the analysis of data collected during evaluation activities	Tables, charts
18	Cheung	2011	Utilization Geometric Optimization	The University of Texas at Dallas	Algorithm to simulate the process	Proposed a method to simplify problems and allow for their observation at different angles to find the shortest path to the solution with the fewest number of obstacles	Figures, mathematical equations

(*continued*)

Table 4. (*continued*)

ID	Author Name	Year	Area in EDs	Venue	Method	Problem	Visualization Type
19	Pandit	2013	Utilization: Resource Allocation	The University of California	Experimental use of Webster's algorithm, real-time optimization methods, multi-user resource allocation (content-aware networking), adaptive Webster's method, and simulation methodology	Determined resource allocation and job scheduling with processors using real-time data and proposed an online scheduling algorithm to maximize the quality of patient care	Graphs, figures, mathematical equations

[a]Extraction Table 4 with column including; ID, Author Name, Year of Publication, Area of Knowledge in EDs, Venue of Publication, Method, Problem and Visualization Type.

[b]Extraction Table 4 with column including; ID, Author Name, Year of Publication, Area of Knowledge in EDs, Venue of Publication, Method, Problem and Visualization Type.

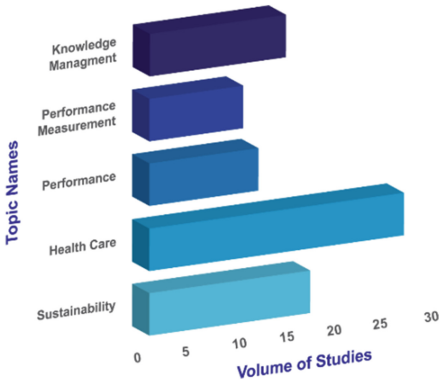

Fig. 3. Subjects with a research gap in performance measurement.

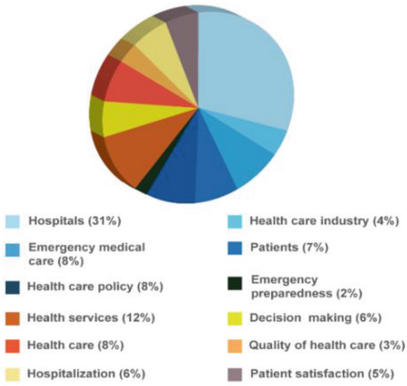

Fig. 4. Overview of topics with research gaps in emergency preparedness and health care quality.

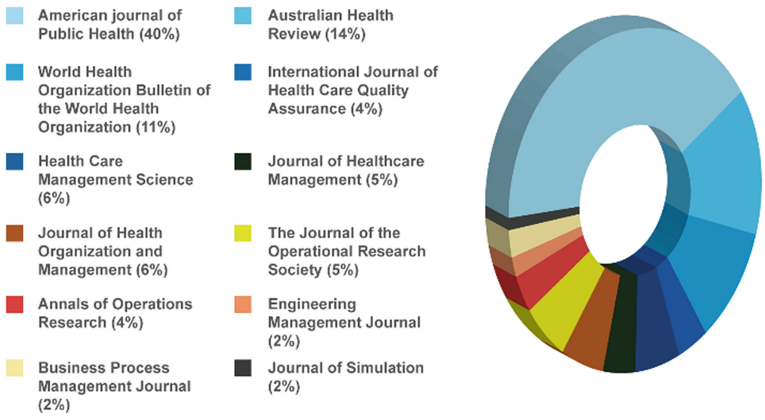

Fig. 5. Where studies were published.

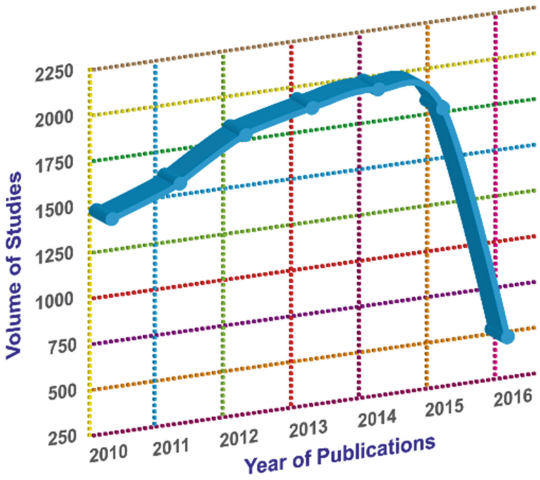

Fig. 6. When studies were published.

4.5 RQ5: What Problems Were Addressed in Existing Studies?

Dynamic and iterative processes that decrease risks and exposure may be uncontrolled in some emergency management structures. Active and repetitive processes, which include parallel computing, dissemination, exchanges, and ethically sound knowledge applications in health care systems, can result in decreased service quality or inappropriate crisis management. Crisis management requires simulation, focus, memory, exceptions, people, authorities, and resources to be brought together at a specific time for a specific purpose. ED problems can be classified into major concerns, as shown in Table 4 and Fig. 8.

4.6 RQ6: How Are Studies Classified?

Classification of content in Fig. 7 as scanned but Fig. 8 is thematic cluster we built through taxonomy of our content extracted from Table 4. That is, skills and competencies, management, quality, emergency preparedness, and utilization of EDs. Furthermore, classification of scanned content showed that the review type papers were rare. Thus, systematic mapping and systematic review papers are appropriate to be conducted.

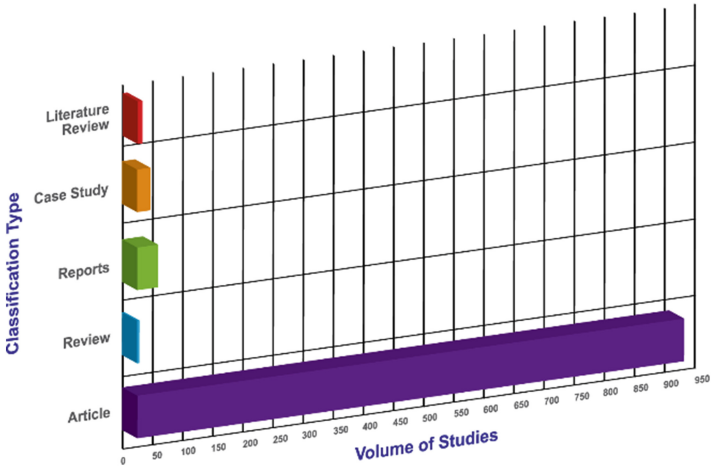

Fig. 7. Classification of studies.

Fig. 8. Study thematic cluster

5 Conclusion

Various complex factors are present in the management of an emergency. It is necessary to use an analytical decision-making process so that a health technology can be evaluated based on its performance. This analytical system needs to be regularly updated since modeling procedures are essential for the management of patient and staff interactions and patient care systems in hospitals. This need is essential due to the complicated nature of EDs and the problems that arise in EDs.

Many studies have been conducted on mathematical models; however, few have been conducted pertaining to mathematical models in EDs. Such studies are vital to reduce wait times in EDs. Mapping research extracts vital issues and methods to devise

solutions [2]. Some mapping studies are currently being conducted [7]; however, less are being conducted on EDs research [17–21]. Important aspects for analysis include the study selection quality and continuous research updates [8]. We have defined and explained the dynamic problems in EDs and approaches to manage these issues to attain positive outcomes from our mapping study. The objective of this research was to present the brief foundation of a systemic literature review input as in [8]. It is only to be used as secondary research.

In developing nations, health care systems are quite poor, so it is important to manage issues and meet demands for the acute hospital-based health care. It is also necessary to manage the implementation risks of activity-based funding. The following are the solutions derived in this study. Emergency preparedness systems require continuous training and simulations along with information assessments. The primary factors are the people involved in, authorities of, and assets to be used during emergency conditions. Patient experiences, patient satisfaction levels, effective procedures, patient safety, and quick response programs should be major focuses.

6 Future Work

For ED simulation modeling, researchers should assess the present scenario and the research gaps in our study and [7]. Multi case studies of health care personnel should be carried out to determine workforce competence in terms of skills and capabilities [30]. EDs require leadership [10] within management [28] to ensure control in EDs [29]. Managing EDs and providing personnel with knowledge regardless of the ED's policies, structure, capacity, network, etc. is important to ensure informed analytic decision making through real time algorithm and the effective management of emergency cases in normal and disaster situations using simulation model with decreased and controlled crowding. Analyzing techniques and utilizing the correct one to practice emergency procedures allow for their efficient implementation.

Health care quality standards must be updated according to this systematic review. Figure 8 presents the features of and insights to the theme of the research to be conducted in the future within the context of emergency and risk management [31]. Future research should focus on the sustainability of implementing real time data monitoring in EDs as well as the performance measurements of emergency systems.

References

1. Petersen, K., Vakkalanka, S., Kuzniarz, L.: Guidelines for conducting systematic mapping studies in software engineering: an update. Inf. Softw. Technol. **64**, 1–18 (2015)
2. Lim, M., Nye, T., Bowen, J., Hurley, J., Goeree, R., Tarride, J.: Mathematical modeling: the case of emergency department waiting times. Int. J. Technol. Assess. Health Care **28**(2), 93–109 (2012)
3. Elberzhager, F., Münch, J., Nha, V.: A systematic mapping study on the combination of static and dynamic quality assurance techniques. Inf. Softw. Technol. **54**(1), 1–15 (2012)

4. Paz, F., Pow-Sang, J.: A systematic mapping review of usability evaluation methods for software development process. Int. J. Softw. Eng. Appl. **10**(1), 165–178 (2016)
5. Petersen, K., Feldt, R., Mujtaba, S., Mattsson, M.: Systematic mapping studies in software engineering. Eur. Assoc. Sci. Editors **8**(26), 68–77 (2008)
6. Li, Z., Liang, P., Avgeriou, P.: Application of knowledge-based approaches in software architecture: a systematic mapping study. Inf. Softw. Technol. **55**(5), 777–794 (2013)
7. Gul, M., Guneri, A.: A comprehensive review of emergency department simulation applications for normal and disaster conditions. Comput. Ind. Eng. **83**, 327–344 (2015)
8. Kitchenham, B.: Procedures for performing systematic reviews. Keele University, Keele (2004)
9. Allnutt, J., Allnutt, N., O'Connell, J., Middleton, S., Hillege, S., Della, P., Gardner, G., Gardner, A.: Clients' understanding of the role of nurse practitioners. Aust. Health Rev. **34** (10), 59–65 (2010)
10. Fulop, L.: Leadership, clinician managers and a thing called 'hybridity'. J. Health Organ. Manag. **26**(5), 578–604 (2012)
11. Hanson, R.: Good health information: an asset not a burden! Aust. Health Rev. **35**(1), 9 (2011)
12. Morgans, A., Burgess, S.: Judging a patient's decision to seek emergency healthcare: clues for managing increasing patient demand. Aust. Health Rev. **36**(1), 110 (2012)
13. Rosenberg, S., Hickie, I.: Making activity-based funding work for mental health. Aust. Health Rev. **37**(3), 277 (2013)
14. Scott, I.: Preventing the rebound: improving care transition in hospital discharge processes. Aust. Health Rev. **34**(4), 445 (2010)
15. Lantz, B., Rosén, P.: Measuring effective capacity in an emergency department. J. Health Organ. Manag. **30**(1), 73–84 (2016)
16. Buttigieg, S., Gauci, D., Dey, P.: Continuous quality improvement in a Maltese hospital using logical framework analysis. J. Health Organ. Manag. **30**(7), 1026–1046 (2016)
17. Nasr-Esfahani, E., Samavi, S., Karimi, N., Soroushmehr, S., Ward, K., Jafari, M., Felfeliyan, B., Nallamothu, B., Najarian, K.: Vessel extraction in X-ray angiograms using deep learning. In: 38th Annual International Conference of IEEE Engineering in Medicine and Biology Society, Florida, USA, pp. 643–646 (2016)
18. Nasr-Esfahani, E., Samavi, S., Karimi, N., Soroushmehr, S., Jafari, M., Ward, K., Najarian, K.: Melanoma detection by analysis of clinical images using convolutional neural network. In: 38th Annual International Conference of IEEE Engineering in Medicine and Biology Society, Florida, USA, pp. 1373–1376 (2016)
19. Jafari, M., Samavi, S., Karimi, N., Soroushmehr, S., Ward, K., Najarian, K.: Automatic detection of melanoma using broad extraction of features from digital images. In: 38th Annual International Conference of IEEE Engineering in Medicine and Biology Society, Florida, USA, pp. 1357–1360 (2016)
20. Jamali, M., Samavi, S., Karimi, N., Soroushmehr, S., Ward, K., Najarian, K.: Robust watermarking in non-ROI of medical images based on DCT-DWT. In: 38th Annual International Conference of IEEE Engineering in Medicine and Biology Society, Florida, USA, pp. 1200–1203 (2016)
21. Kadkhodaei, M., Samavi, S., Karimi, N., Mohaghegh, H., Soroushmehr, S., Ward, K., Najarian, K.: Automatic segmentation of multimodal brain tumor images based on classification of super-voxels. In: 38th Annual International Conference of Engineering in Medicine and Biology Society, Florida, USA, pp. 5945–5948 (2016)

22. Clark, L.: Implementation of the National Incident Management System in New Jersey. Ph.D., University of Baltimore, School of Public Affairs, Baltimore, Maryland, USA (2010)
23. Donnelly, C.: Evaluation as a mechanism for integrated knowledge translation. Ph.D., Queen's University, Faculty of Education, Kingston, Ontario, Canada (2013)
24. Gautam, Y.: A study of assessing knowledge and health beliefs about cardiovascular disease among selected undergraduate university students using health belief model. Ph.D. Southern Illinois University, Health Education, Carbondale, USA (2012)
25. Nikolai, C.: SimEOC: a virtual emergency operations center (VEOC) simulator for training and research. Ph.D. University of Notre Dame, Computer Science and Engineering, Indiana, USA (2014)
26. Cheung, Y.: Optimization problems in weighted regions. Ph.D., University of Texas, Computer Science, Dallas, USA (2011)
27. Pandit, K:. Real-time resource allocation and optimization in wireless networks. Ph.D., University of California, Computer Science, Davis, USA (2013)
28. Hjortdahl, M., Ringen, A., Naess, A., Wisborg, T.: Leadership is the essential non-technical skill in the trauma team: Results of a qualitative study. Scand. J. Trauma Resusc. Emerg. Med. **17**(1), 48 (2009)
29. Pinkert, M., Bloch, Y., Schwartz, D., Ashkenazi, I., Nakhleh, B., Massad, B., Peres, M., Bar-Dayan, Y.: Leadership as a component of crowd control in a hospital dealing with a mass-casualty incident: lessons learned from the October 2000 riots in Nazareth. Prehosp. Disaster Med. **22**(06), 522–526 (2007)
30. Harding, P., Prescott, J., Sayer, J., Pearce, A.: Advanced musculoskeletal physiotherapy clinical education framework supporting an emerging new workforce. Aust. Health Rev. **39** (3), 271 (2015)
31. World Health Organization: WHO's six-year strategic plan to minimize the health impact of emergencies and disasters: 2014–2019. World Health Organization, Geneva, Switzerland (2015)
32. Almozayen, N., Othman, M., Gani, A., Alharethi, S.: Data mining techniques: a systematic mapping review. In: Saeed, F., Gazem, N., Patnaik, S., Balaid, A., Mohammed, F. (eds.) Recent Trends in Information and Communication Technology, pp. 66–77. Springer, Cham (2017)