Risk Assessment and Analysis of Healthcare System Using Probability-Impact Matrix

Al-Zuheri A[1,3,*], Amer Y[1] and Vlachos I[2]

[1]*University of South Australia, School of Engineering, Mawson Lakes 5095, Australia.*

[2]*La Rochelle Business School, La Rochelle 17000, France.*

[3]*Ministry of Science and Technology, Baghdad 10070, Iraq.*

***Correspondence:**
Atiya Al-Zuheri, Adjunct Research Fellow, University of South Australia, School of Engineering, Mawson lakes 5095, Australia, Tel: +9647711128922.

ABSTRACT
This paper aims to introduce a better and more comprehensive overview of the main risks within healthcare organisations. By prioritising several dimensions of these risks, this paper and based on data collected from a sample of patients in three public Australian hospitals, contributes to the research work in healthcare risk management. The probability-impact risk matrix is used to calculate and determine the consequence of a case where an event is considered to be at risk. This matrix can be considered as a useful tool for risk mangers as well as researchers engaged in exploring the design of health care risk factors (HCRFs) analysis models. It can also be used to highlight critical risk factors which are crucial in today's healthcare environment.

Keywords
Healthcare, Risk assessment, Probability-impact matrix.

Introduction
Currently, in most countries, the major challenge within the health sector is to achieve a high quality healthcare service with limited available capacities [1]. Although healthcare expenditure has steadily increased over recent years, healthcare services are mostly characterised by bad quality aspects [2]. This is often related to the enormous risk impact on performance. Therefore, these organisations are keen to identify and analyse a set of risks that can have the potential to disrupt their operations and consequently put patient safety at high-level of concern. In this context, some research efforts have focused on measuring patient experience with the quality of care given by the hospital.

Beattie et al. [3] presented a systematic review to measure the patient experience of hospital quality. They accounted for 11 different international measures for this care. However, they ignored measuring patient satisfaction which was not dismissed in the research of Roy et al. [4] who considered determination a prevalence characteristic and physician awareness of test results which were received after discharge of the patient from the hospital. This is considered as one of the most vital points of the patient safety problem.

Recent research presented by Safaeipour and Amer [5] introduced a conceptual model that can be used as a systematic and integrated method for weighing the related measures of patient satisfaction. Additionally, the proposed method is used as an evaluation tool when considering the competence of the hospital as well as a performance ranking tool based on some key indicators. Patient complaints have opened dedicated research on satisfaction levels and this is now considered to be one of the most important aspects of the healthcare sector. Clearly, receiving complaints is considered to be a high alert for increased risk management episodes and consequently deserves early corrective action [6].

To date, no previous research has specifically focused on these risk types when relating to quality of service. This paper aims to present a tool for assessment and analysis of these risks within the healthcare system and the probability-impact matrix is the proposed tool used to prioritise and develop an effective strategy to address these risk effects.

The remainder of this paper is structured as follows: Section 2 gives a description of the research method and findings of the survey questionnaires. Section 3 presents the development of a healthcare risk matrix. Section 4 discusses the outcomes of the risk-matrix and finally, in Section 5, the conclusions of the paper are presented.

Methods
Risks and survey instrument
Risk mangers work proactively and reactively to address risks using various practices. However, managers should conduct effective and innovative risk assessment and analysis strategies. Healthcare organisation services present different risks when related to staff and patients and are required involve both parties when disciplinary action is necessary to tackle a problem. Within this context and based on the proposal of Donabedian [7], this project considers two main types of risk; i) Risk to the patient, and ii) Risk to the organisation and staff and involves certain items which were used to measure these risks.

The empirical part of the research work starts with reporting the results of a questionnaire survey, which was conducted to identify whole risk factors related to the operation within a healthcare organisation. The constructed matrix resulted from a combination of probability where severity was used for estimating the likely risks. The considered case study in this research relates to the Australian hospital system.

Data collection and quality service measures
To address the research aims, questionnaires were used to consider patient satisfaction at three hospitals in South Australia. This included two stages of data collection using qualitative and quantitative questionnaires: i) a questionnaire for collecting patient data, and ii) a questionnaire to gather the response from patients about their satisfaction regarding the hospital service.

Questionnaire 1: the study population and the sample
The study population consisted of 70 random patients across three Australian hospitals emergency and outpatient departments. Received valid responses were 50. Details about patient gender, age, qualification and recent time visits are presented in charts as presented in Figure 1.

Questionnaire 2: part 1- quality service
The second questionnaire was qualitative and asked patients to give their impression on hospital service. Although the healthcare industry's approach is to put patient care at the center of its concerns, it presents various problems that are considered global and multidisciplinary in nature. Since the aim is to improve patient satisfaction and shopping for healthcare has become like shopping for cars, tourism or other services by searching the worldwide network, the healthcare provider must look to new ways and methods when engaging with prospective patients. Quality service metrics, patient reviews and price comparisons are the issues that impact the selection of a healthcare organization. Quality service metrics are used in this project to assess the healthcare delivery and fall within the patient experience. However, using multiple measures is important, as no single measure can give a whole or complete view of provided and received quality of care. These measures include waiting time to see a doctor within 15 minutes of the appointment time, recommendation of the hospital to a friend or family member and the overall satisfaction of received services from the hospital. The graphical representation of patient

assessment to the quality of service at the hospitals with respect to the mentioned measures is presented in Figure 2.
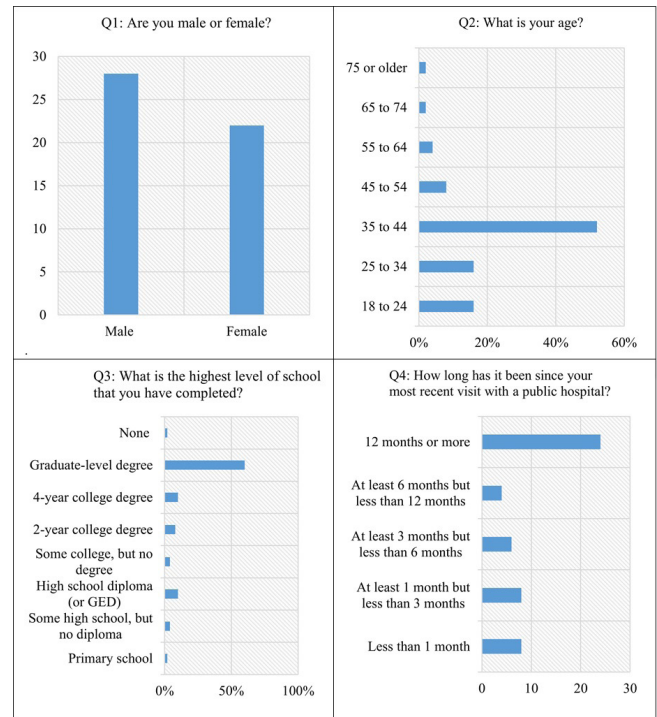

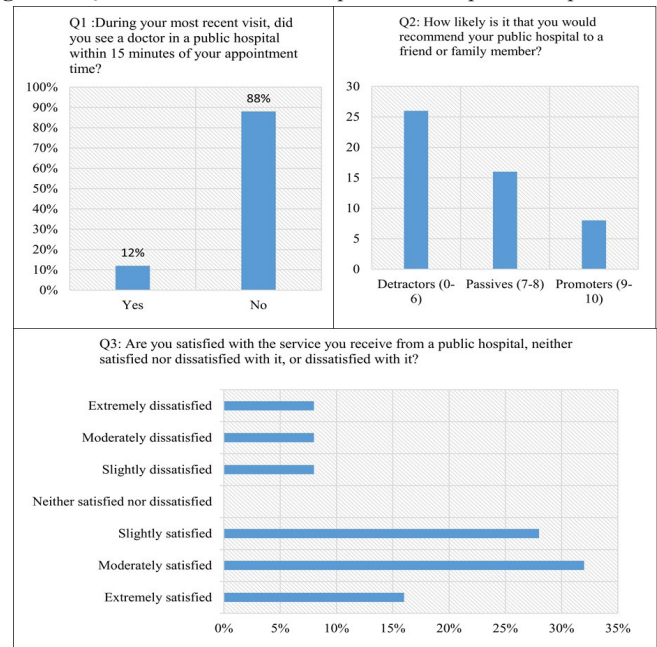**Figure 1:** Questionnaire considered questions and patient responses.

Figure 2: Graphical representation of the patient's assessments to the quality service at the three public Australian hospitals.

Questionnaire 2: part 2 - risk comparison
To determine which of the aforementioned risk factors and their ranking are most important, typically requires comparing the risks in respect of their importance to the individual patient. The patient chooses their response on a scale which compares the types of risks given in pairs and judges which one of each risk is important.

Consider these risk comparisons, now ranked in a list and presented as a pair-wise comparison matrix in Table 1. Obviously, PR1 is the most important risk in this situation.

Development of a healthcare risk matrix

Based on the conducted questionnaire using a sample of patients at three Australian hospitals and the outcome risk ranking presented in Table 1, the probability of occurrence and impact of each risk type is presented in Table 2. The rating given for human impact should be considered when the hazard has/is:

- Unlikely to cause injury, illness or death to staff or patients.
- Low probability of injury, illness or death to staff or patients.
- Medium probability of injury, illness or death to staff or patients.
- High probability of injury or illness to staff or patients with low probability of death.
- High probability of death to staff or patients.

	PR1	PR2	OSR1	OSR2	OSR3	Total Scores	Ranking
PR1		5.40	5.68	4.25	4.83	20.16	1
PR2			3.82	3.45	4.18	11.45	2
OSR1				3.65	3.83	7.49	3
OSR2						4.92	4
OSR3						0.00	5

Table 1: Pair-wise matrix of risks based on the comparison.

	Code	Risk factor	Probability	Impact
Risk to the patient	PR1	Waiting Time for Emergency Department Care	5	5
	PR2	Waiting Time for Elective Surgery	4	4
Risk to the organisation and staff involved	OSR1	Cost per NWAW	3	3
	OSR2	*Staphylococcus Aureus* Bacteraemia in Public Hospitals	2	2
	OSR3	Accreditation of Hospitals and Beds	1	1

Table 2: The constructed risk matrix.

Table 3 is a conclusion of averages in probability terms and impact amongst the two stages of classified healthcare risks.

Risk Type	Probability	Impact
The Patient	4.5	4.5
The Organisation and Staff Involved	2	2

Table 3: Probability and impact averages in the undertaken Australian hospitals.

To formulate the risk consequences, a formula presented by Dani [9] and other researchers is used for this purpose: $Ci + Pi \times Ii$

Where Pi represents the probability of the risk occurrence and Ii is the expected impact. Figure 3 shows the results of combing risk impact rating and risk probability.

This risk matrix presents the identification of healthcare risks at the three Australian hospitals, where the questionnaires conducted. It starts with the probability increasing from the top to down, and for the impact, it moves toward the left corner (grey zone) and the greater is the HCRF consequence (Figure 4).

Probability	Score	Impact				
		Negligible 1	Minor 2	Moderate 3	Major 4	Extreme 5
Rare	1	1	2	3	4	5
Unlikely	2	2	4	6	8	10
Possible	3	3	6	9	12	15
Likely	4	4	8	12	16	20
Almost certain	5	5	10	15	20	25

High   Moderate   Low

Figure 3: Risk rates at the sampled Australian hospitals.
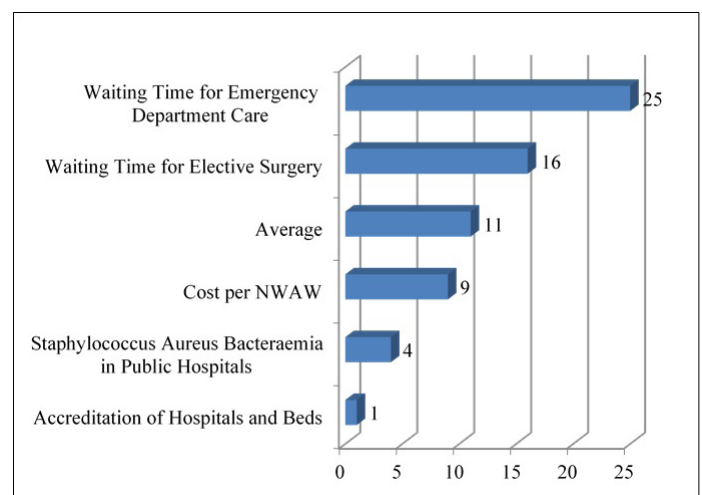

Figure 4: HCRFs by level of consequence.

As Figure 4 shows, there are significant differences between HCRFs, waiting time for emergency department care (PR1) is considered the biggest risk factor and waiting time for elective surgery (PR2) is the most likely risk factor. Whilst cost per NWAW (OSR1), staphylococcus aureus bacteraemia in public hospitals (OSR2), accreditation of hospitals and beds (OSR3) are seen as having the least probability and impact risk. Clearly, these results are matched with our previous analyses of HCRF probability – impact matrix. A discussion will be conducted to address these remarks in the forthcoming section.

Discussion

As previously stated, it is a very difficult paradigm to measure quantitatively the quality of healthcare delivery. Moreover, it was thought that to measure it was an impossible task. Based on the proposal of Donabedian [7], the three available types of measurement for quality of healthcare delivery are qualitative measures and include a namely structure of the healthcare organization, caring process and outcome of the patient. However, the quality measures based on organization structure and process are doubly not be able to reflect the patient satisfaction which consider as a meaningful and essential tool to address limitations

and also to develop an efficient action plan to improve quality of healthcare organization [8]. In this research, because of its ability to appropriately address quality of healthcare delivery, different risk factors may influence quality of healthcare are evaluated. The proposed matrix identified all the risks and opportunities that may affect operational performance of the healthcare organisation. Higher probability and severity have high numerical values cause high-risk index. Thus, a high detection levels should be scaled in terms of reducing the risk index and consequently highlights the need to implement a mitigation procedure.

The results indicate that despite an adequate delivery of healthcare, high risk situations can still occur at these selected Australian hospitals. Undoubtedly, these risks can have potentially harmful effects on patients. Actually, the amount of time which the patient spends in waiting is an important index for assessing patient satisfaction and consequently the quality of healthcare delivery. Here, in this research, waiting time for both; emergency department care and elective surgery are seen as high-risk factors affecting the utilisation of healthcare services as well as causing patient stress. This barrier can be overcome when obtaining the required care and resolved by increasing the number of the healthcare providers' staff. The healthcare risks matrix reveals that the risk of waiting times for emergency department care and for elective surgery causes the maximum fear. Whilst the risk related to cost per national weighted activity unit (NWAU) is considered a medium risk.

Risk factors refer to infection from staphylococcus aureus bacteraemia, and accreditation of hospitals and beds may result in significant illnesses and can necessitate additional diagnostic and therapeutic interventions and consequently generate added costs and are found within the lowest of important risks, based on the questionnaires conducted in this research. This is attributed to the low death rate of hospitalised patients at Australian hospitals.

Conclusion

Nowadays, there is no doubt that the healthcare delivery process is considered as one of the key factors when measuring the quality of life. Rather, it is considered as the "weakest link" in the index of hospital quality. There is not a single measure that can define and analyse the overall different risk factors related to healthcare quality and delivery that can exist in hospitals. Therefore, defining and analysing several risk factors are advised in order to avoid or to manage potentially risky situations. The common method to this end is completely subjective and based on physician or patient questionnaires. The aim of the empirical investigation into HCRF's presented in this research was to contribute to the explosive growth of research now focused on quality performance of healthcare organisations. It prioritises several risk factors associated with patient care and the organisation and staff involved. Based on two parts of the questionnaire the risk matrix was developed to analyse selected risk factors. The probability-impact risk matrix which

was used to calculate and determine the consequence in the case of an event was considered to be a risk. The matrix was pursued and highlighted for the ease of position on a certain level of risk considered. The main conclusion which can be drawn from this research is that the population of South Australia might enjoy all the benefits of affluence and a modern healthcare system but they also run a significant risk as patients.

This presented research can be valuable for managers as well as researchers that are engaged in the investigation of healthcare system risk and analysis tools. In addition, this paper pointed out critical risk factors that should be kept in mind, within the healthcare industry. The proposed risk assessment tool is intended as a guide to assist in priority settings within the establishment of a comprehensive emergency plan. Finally, a remark has to be made on the objectivity of responses given by the respondents. Therefore, a larger sample could be interesting to lessen the subjective perception effect of values assigned to risk dimensions on the analysis output of the research.

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