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Developing System for Improving the Performance of the Private Hospital in Egypt

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Abstract

The purpose of this paper is to enhance the quality of private hospitals in Egypt. The health care field, especially in the private hospital in Egypt has acquired huge importance lately because of its great contribution to the fast handling of patients. Today, customers of the private hospitals complain from slow handling during registration process, which may lead to making the patient condition worse and may refers to bad performance of the hospital at all. In view of the importance of these complains, the researcher selected the (PATH) as a tool to improve the quality in emergency department at hospital. Using that tool structural and organizational changes such as: quality committees; multidisciplinary teams and technology investments. The study found that applying the (PATH) in the emergency department leads to decrease the patient waiting time and leads to improve the overall performance of the (Sina hospital).

Keywords: Developing, Private hospital, PATH.

1 | Introduction

Private Health Care simply cares for people and their lives. It is the art of delivering attention and hopes to an active process that requires collaboration, communication, and decision-making across care providers and care settings. Egypt has a long history in private health care and medical practice, which dates back to the Pharaonic times. In recent decades, Egypt has achieved several improvements both in health care provision and health indicators. The objective of this research is to develop a standard management model through which the private health care provider can work through applying the (PATH) for Quality Improvement in Sina hospital.

1.1 | Research Methodology

Determine the theoretical framework of the study based on books, articles, and other researches related to the subject of the study. After the study problems have been identified and variables and hypotheses, the researchers conducted a case study within the hospital. To stand on the causes of these problems and identify population and sample of the study through:

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- Studying activities of Sina hospital, which is one of the private hospitals in Tenth of Ramadan City, which was established in 2007.
- Studying the previous studies related to improving the performance by using DMAIC methodology.
- Studying the Sina customers reports which indicate the results of the hospital's performance in general.

The researchers have collected data about different hospital departments for 12 months starting from 1/1/2018 to 30/12/2018 for the case study and in order to analyze the root causes in order to analysing the problems. The researchers start to implement an improvement plan for 6 months starts from 1/1/2019 to 30/6/2019, and the result was good. The researchers monitoring of the different hospital departments for 6 months starts from 1/7/2019 to 30/12/2019 to follow up on the execution of the improvement plan.

1.2 | Research Hypothesis

The research hypothesis says applying PATH methodology will:

- Reduce the patient's waiting time.
- Improve the efficiency of the emergency unit in the hospital.

2 | Literature Review

In a study Bakhshi et al. [4], show how mathematical modeling can be used to create job rotation for improving workforce performance in semi-automatic systems. Abbasimehr and Khodizadeh Nahari [1] put into study the issue of improving the demand forecasting with using LSTM. The results revealed that the suggested method outperforms the regular method. Ali [2] proposed a Six Sigma DMAIC hierarchy based framework can be implemented in order to reduce food waste. Kristensen et al. [13], studied the need to obtain good practices grade in health technology assessment according to ISPOR HTA. Their study revealed that priority should be put in to develop good practices in HTA. Veillard et al. [22], study implementating of the WHO (PATH) as a tool to improve quality in hospitals in eight European Countries. The researchers suggest using PATH to improve performance of hospitals and to help hospitals in evaluating and assessing their own performance. In particular, PATH is a tool that can be used by hospital managers in order to evaluate and improve their services. The study identifies the dimensions of the PATH framework as follow: safety and patient-centeredness dimensions cut across with other dimensions of hospital performance (clinical effectiveness, staff orientation, efficiency, and responsive governance), that indicate the performance of these two dimensions can reflect aspects of performance across the other dimensions.

Shih [3], Measuring Hospital Performance, suggested that patients and Providers agree that high-quality care is a fundamental component of a high-performance health system. The results are summarized as follows: developing new process measures to reduce mortality and other poor outcomes, while improving performance on the current measures, can help move the nation toward achieving higher-quality health care and a high-performance health system. Klazinga [12] in a study entitled "A performance assessment framework for hospitals assert: the WHO regional office for Europe PATH project" aimed to achieve the hospital performance by using framework to assess the performance of hospitals. The researchers, have found that the framework of hospital need to update in order to achieve two aims: to reflect the developments in performance measurement of the health system and policy of health care, such as the more recent call placed by governments on value for money, patient centredness, and patient safety. To show the relationships between the different performance dimensions to support the achievement of ultimate goals of the health system, providing jurisdictions within Canada with an actionable framework and dynamic to enable discussion of relative performance and assessment.

Joynt et al. [23], compared using HQA process to measure the performance for heart failure, heart attack, and pneumonia with death rate. They also created a performance score for all conditions in

hospitals. Testing full performance range showed a harmonic relationship of higher performance with a low death rate. Tanya et al. [20] in a study entitled “hospital quality improvement: strategies and lessons from U.S.A hospitals” investigates the impacts of quality strategies on hospital improvement. The researchers come up with the following conclusions:

- *Improving the obligation to the improvement in quality and convert it to an ongoing cycle is the key of Successful.*
- *The whole process reflects the establishing, development and build-up of the quality culture.*

In a study entitled “Quality improvement in the Estonian health system—assessment of progress using an international tool”, aimed to evaluate the quality of the health systems in Estonia with the assessment tool given by the (WHO). By using Design for analysis health care quality situation, by using the self-assessment questionnaire provided by the Council of Europe and WHO Regional Office for Europe as a framework to evaluate national activities in quality improvement. The results of this study showed the shortages and strengths of the current institution of quality activities in Estonia and the methods for improvement. Sicotte et al. [18] in a study entitled “A conceptual framework for the analysis of health care organizations ‘performance’” studying the possibility of implementing a conceptual framework for the analysis of health care organizations ‘performance. He finds that there are six major categories for criteria to establish well health care, these categories are an important component in performance framework evaluation. These components include: effectiveness/Clinical outcomes; stakeholder/customer satisfaction; learning accessibility; coordination; quality; financial efficiency; innovation; and production/internal business.

3 | Method for Using PATH

As the first step before collecting data, a working group from the hospital must be formed to assess the feasibility of all indicators, spreads values such as change and adaptability, responsibility towards patients and teamworks. Data collection can be used as a by-product, procedures of the documentation will be reviewed and amended, after computed all indicators, areas need to additional scrutiny can be specified, weaknesses and strengths and the quality plan to improvement can figure out. Including targets and actions ([9] and [5]).

Hospitals Participating can compare their results with their own historical data or with results of their peers. Hospitals can compare their results with an international component in PATH or with points in the international references. These comparisons should be used as a starting point to further explanations and questions but not as a specified standard. When the hospitals join PATH they become members of the international network to share quality improvement strategies and suitable practices. ([6] and [7]).

4 | The Pilot Study

4.1 | Introduction

Sina hospital in the tenth of Ramadan city is one of a private hospitals in Egypt established in 1998. It has 50 beds and 22 departments. It implements QMS according to ISO 9001:2000 requirements in order to continually improve its performance and enhance customer satisfaction. The hospital QMS documents enable getting historical data that enables the hospital to decide about the needed improvement. The company QMS documentation consists of the following:

- *Policy statement.*
- *Objective statements.*
- *Quality manual.*
- *Job description manual.*
- *Procedure and work instructions cover the activates within the scope of the quality management system.*

- Records to provide evidence related to the implementation of the QMS.
- External documents such as standards, manual, and laws.

4.2 | Main Objectives

The main objectives of introducing PATH in Sina hospital is to develop a commonly accepted and suitable performance self-assessment instrument for the hospital. The main characteristics of the monitoring tool are described as following:

- Indicators are understood for Hospital staff.
- Monitoring and data gathering means no surcharge for hospitals as those data could be used routinely in hospital management.
- Data should be comparable to other hospitals in the country and abroad.
- Information from data analysis should should help in management decisions.
- Indicators are evidence-based.

The main expected result of the project will be a performance-monitoring tool (set of indicators) that is usable for routine self-assessment of hospital activities. In the long run, this can provide the basis for benchmarking and quality improvement at the hospital level. However, most important is the development of a performance monitoring culture in a private hospital in Egypt.

- Methods and approach.
- The development of PATH is split into three stages.
- Set of performance indicators.
- Descriptive sheets for indicators.

4.3 | Ensuring the Serious of the Customer Complaints

The researchers realized from QMS records and meeting with different staff the following:

- The patient's satisfaction with the handling time is not good.
- The documentation system becomes more sophisticated, so the hospital staff becomes loaded applying the QMS forms.

Therefore the researchers collected required data in table 3.9 from QMS records during the study period related to the different quality control divisions in the hospital. The main used records to collect the data are as follow:

- Customer complaints form (Fig. 1).
- Non-Conformance form (Fig. 2).
- Corrective and preventive action request (Fig. 3).

Figs. 4 and 5 show the Pareto chart for hospital departments versus the patient number in the year 2018. It was found that General Surgery and Urology departments received 2811 patients represent, 30% of total patients and General Surgery and Pediatric departments received 2664 patients in these years represent, 29% of total patients.

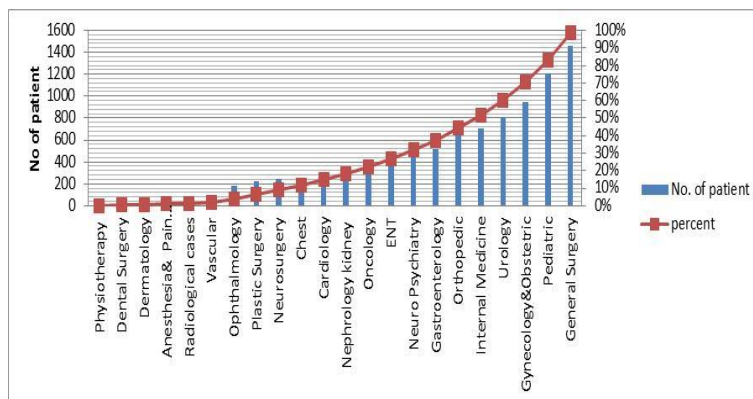


Fig. 4. Pareto chart for hospital departments versus the patient number in year 2010.

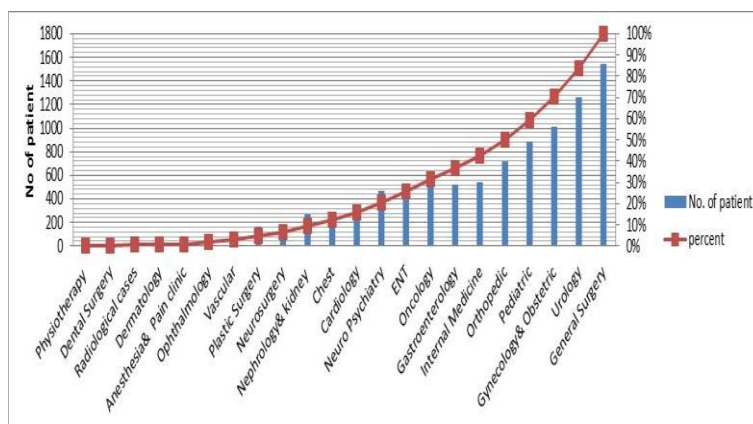


Fig. 5. Pareto chart for hospital departments versus the patient number in year 2011.

Table 1. Types of patient complaints from the hospital departments in year 2018.

Ser.	Complaint Subject	Number of Complaints
1	Waiting time	221
2	Answering time in the reception	160
3	Nursing staff	67
4	Check out time	60
5	Doctors	34
Total		542

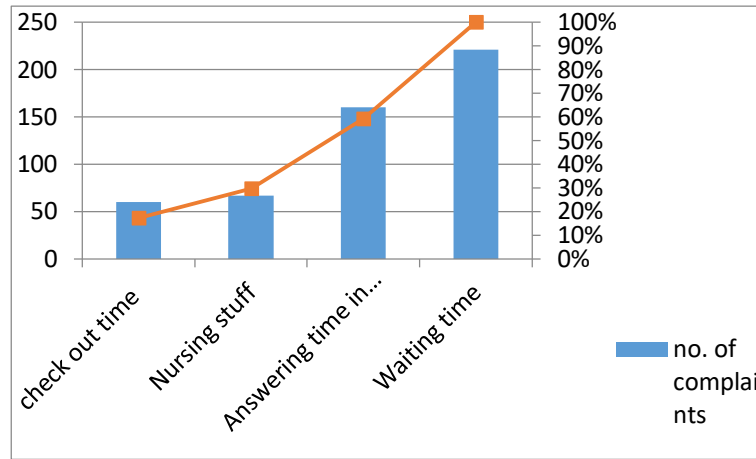


Fig. 6. Pareto chart of the complaint types.

The researchers analyzed the complaints reports and the result of the analysis is in the *Table 1*. From *Fig. 6*, it was found that 381 complaints presented, 70% of the received patient complaints are related to the Waiting time and Answering time in the reception. Therefore, the researchers started to study the relationship between the received 542 complaints.

4.4 | Selecting Case Study

The researchers collect the data from the hospital records in order to study the hospital department, they found that the most patient complaints during the interval 1/1/2018 to 30/12/2018. After collected and interpreted, as shown in *Table 1*. Pareto charts in *Figs. 4, 5, and 6* were charted and researchers found the following:

- The total number of patients in General Surgery and Urology departments is 2811 patients represent, 30% of total patients and General Surgery and Pediatric departments received 2664 patients in the year 2018 represent, 29% of total patients.
- 87 complaints from 221 of General Surgery represent, 39.37% are related to waiting time.
- 62 complaints from 221 of General Surgery represent, 28.05% are related to answering time in the reception.

Therefore, the researchers selected the General Surgery department as a case study and investigated in these 221 complaints. After that they found the main complaint was about “the patients are not satisfied because the waiting time in the general surgery department was long”.

4.5 | The Methodology Selection

The researchers assessed the following improvement methodologies to reduce the waiting time in the General Surgery department and improve the hospital management system.

- Total quality management (TQM).
- Performance assessment tool for quality improvement in hospitals (PATH).

The assessment result was as follow: TQM will not be suitable in this case since the hospital already implements a quality management system according to ISO 9001:2000 requirements and still has the mentioned complaints, and the TQM will not improve the specific process. The hospital needs to computerize all registration process for the patients. In order to achieve the patient's requirements related to the waiting time to be less than 30 minutes, the variation in the control chart must be reduced considering the cost savings, so the researchers thought that (PATH) methodology will be suitable for this state.

Implementation of the PATH Methodology includes measuring the efficiency of the general surgery department, and DAMIC Methodology to improve the performance of the General Surgery department in Sina hospital.

4.6 | Identify PATH Indicators

There were only two dimensions from PATH [8] that can be applied in the general surgery department because the remaining dimensions apply to the whole hospital. These 2 dimensions are shown in *Table 2* are related to patients' complaints from the general surgery department.

Table 2. PATH indicators.

Dimensions	Indictors
	Number of Emergency surgery
Clinical effectiveness	Readmission time
	Admission after day surgery
	Training expenditure
Staff orientation	Absenteeism

4.7 | Data Collection Procedures

The collecting procedures for data were organized as follows:

- *Collecting data for the indicators of PATH in the data collection sheets.*
- *Analysis of PATH indicators.*
- *Comparing the analysis results with the acceptable limit for each indicator.*
- *Mading PATH database for analysis.*

4.7.1 | Presentation of hospital performance

In the way of analysis, the performance of the general surgery department was compared with the result of each PATH indicators and reach to the requirement of the acceptable limits according to hospital capacity over a 12-month period (from 1/1/2018 to 30/12/2018). *Fig. 7* shows the Number of Emergency surgery: the figure shows that the acceptable level for general surgery in Sina hospital is more than the patient's number in the year 2018, and that means there is a bad investment for capital.

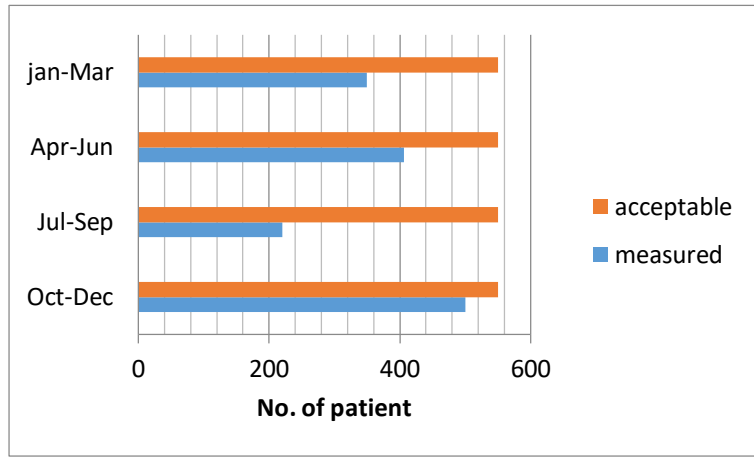


Fig. 7. The number of emergency surgery in year 2011.

Fig. 8 shows the admission time in the general surgery department: the figure reveals that the admission time consumes a long time especially in the months of January, February, and March; mean that the waiting time for patients is too long in the case of a large number of patients.

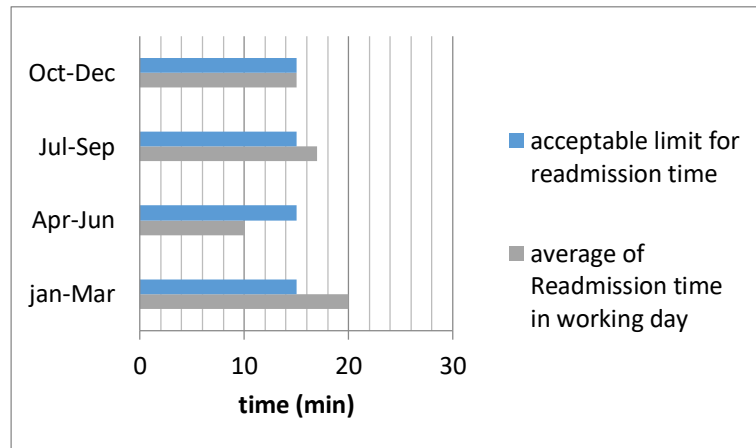


Fig. 8. The Re-admission time in general surgery department.

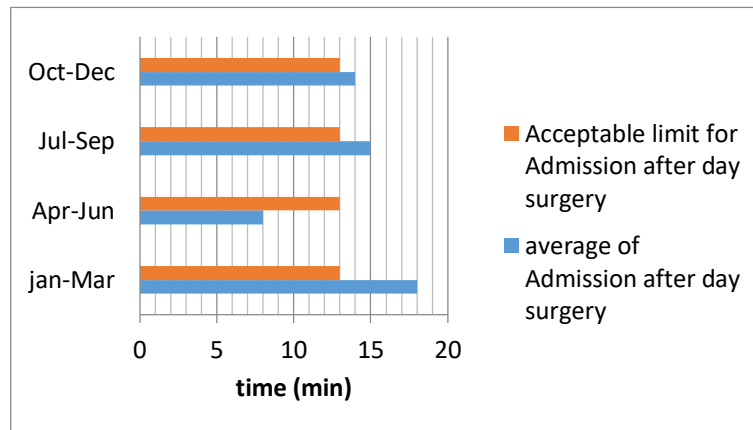


Fig. 9. The admission after day surgery in general surgery department.

Fig. 9 shows the time of admission after one-day surgery in the general surgery department. The figure shows that the time of admission after one-day surgery consumes a long time especially in months January, February, and March, or this meaning that waiting time for patients is too long in the case of a large number of patients. Fig. 10 shows the hospital expenditure in the year 2018. It was found that the total

expenditure for training the hospital staff was 5%. The Absenteeism percentage in the year 2018 is represented in Fig. 11.

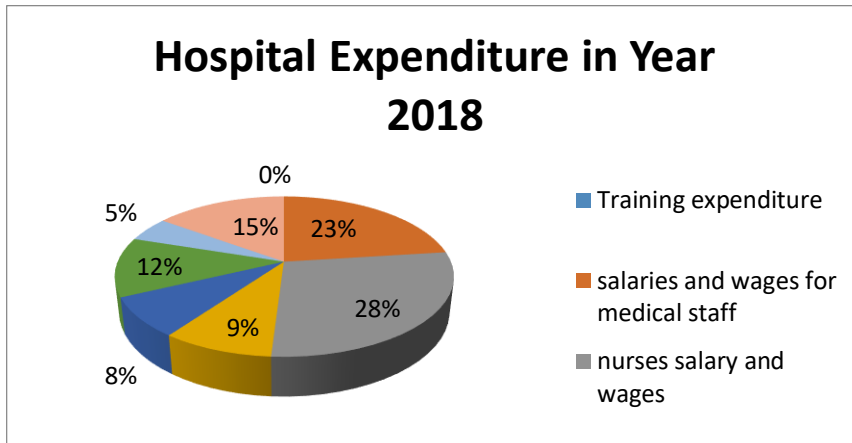


Fig. 10. Hospital expenditure in year 2018.

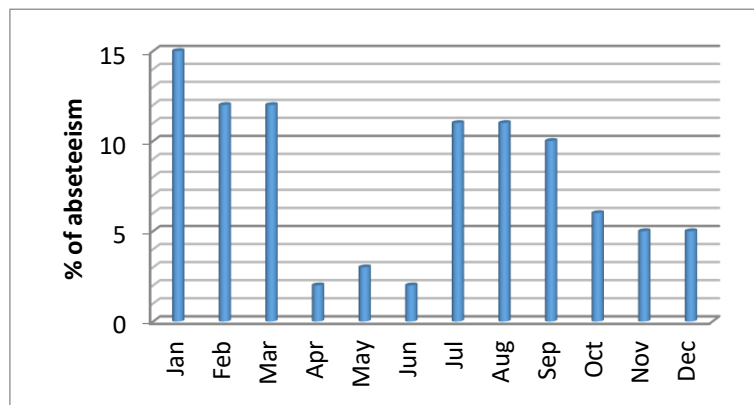


Fig. 11. The Absenteeism percentage in general surgery department.

4.7.2 | Cause and effect diagram

A brainstorming session held to discuss the root causes of the reasons for delaying the admission time in the general surgery department. The data collected from PATH indicators were reviewed; and the researcher found that the root causes of the problem were focused on the following factors (see Fig. 12):

- Human factor.
- Lack of trained staff.
- Lack of surgeons.
- Absenteeism percentage.
- Material factor (no delays were detected due to this factor).
- Method factor.
- Bad quality control check.
- Paperwork.
- Machine factor (no delays were detected due to this factor).
- Measurement factor (no delays were detected due to this factor).
- Environment factor (no delays were detected due to this factor).

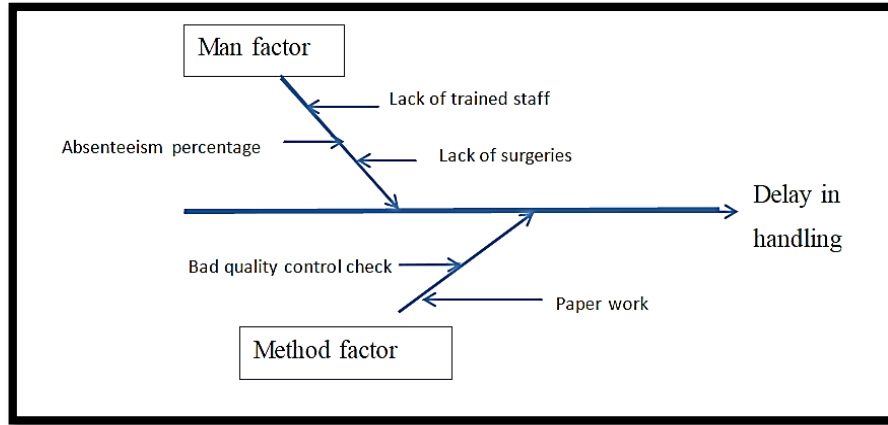


Fig. 12. Cause and effect diagram.

4.7.3 | Rating the effected causes

Based on the causes of the delay, the researcher juggled the different causes and decided to rate the choices as follows:

- I. 1= not recommend.
- II. 3= recommend.
- III. 5= highly recommend.

The remedy selection matrix in Table 3 and Fig. 13 show the stated results and their Pareto chart.

Table 3. Rating the causes of the handling delay.

Cause	Lack of Trained Staff	Lack of Surgeons	Absenteeism Percentage	Bad Quality Control Checks	Paper Work
Jan-Mar	5	5	3	3	3
Apr-Jun	3	5	1	3	3
Jul-Sep	3	1	1	3	3
Oct-Dec	3	3	1	3	3
total	14	14	6	12	12

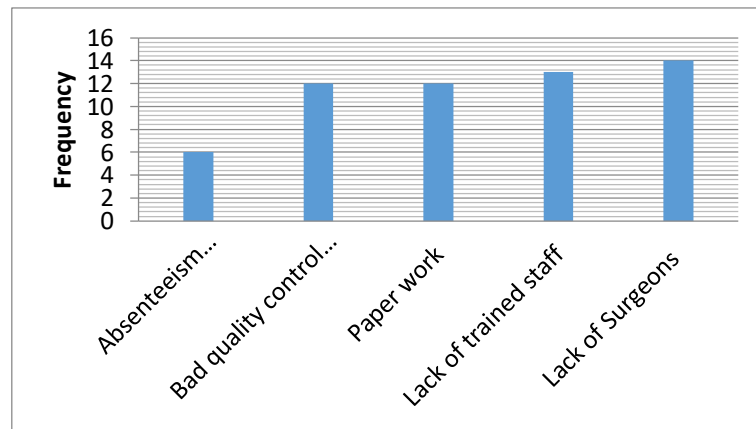


Fig. 13. Chart for the causes frequency.

4.7.4 | Identifying actions for improvement

Assessment of Performance is the first step to improve the quality. It should be used as a source for inspiration and source for improving the procedures of data collection and determining the improvement

actions [17], [12], [15], [19], [16] and [10]. It should be handled as a part of a strategy to improve the quality, as accepted by the Institute of Health Care Improvement (*Fig. 14*).

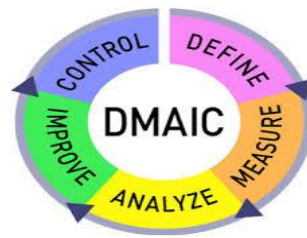


Fig. 14. Model for improvement.

4.7.5 | Screen potential causes

Fig. 12 shows fishbone diagram of the discussed factors that cause delay in patients handling in general surgery department. The identified root causes associated with the delay are represented in *Fig. 13*. The researcher realized that in order to achieve the best solution the following factors need to be taken into consideration:

Decreasing the patient waiting time.

Creating quality control check point to improve the department performance.

Improving the QMS documentation to reduce the amount of data entry, lost files and improve retrieval.

5 | Remedy Selection

5.1 | Remedies Evaluation Criteria

The research has evaluated these suggestions and agreed with the following criteria of the evaluation:

- *Impact on the problem.*
- *Ease of implementation.*
- *Time of implementation.*
- *Cost of implementation.*
- *Total cost reduction.*

5.2 | Remedies Selection Matrix

Based on the remedies evaluation criteria, the researcher decided to rate the choices as follow:

- I. 1= do not recommend.
- II. 3= little recommend.
- III. 5= recommend.
- IV. 7= highly recommend.

The remedy selection matrix in *Table 4* shows the stated results, which are the decisions of the researcher on each remedy.

Table 4. Remedy table.

Criteria	Remedy 1	Remedy 2	Remedy 3	Remedy 4
Impact on the problem.	7	1	7	5
Ease of implementation.	7	3	3	5
Time of implementation.	7	3	3	5
Cost of implementation.	7	1	3	5
Total cost reduction.	3	1	5	3
Total	31	9	20	23

According to Fig. 15 the researcher decided to pick up the highest-rated remedy (Advanced training for reception staff) in order to achieve the highest chance for improvement.

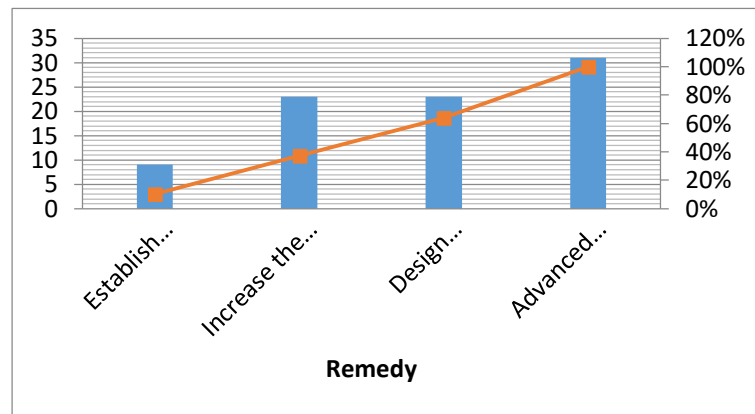


Fig. 15. Pareto chart of remedy.

5.3 | Improvement Methodology

The improvement would take two different simultaneous tracks as shown in Fig. 16.

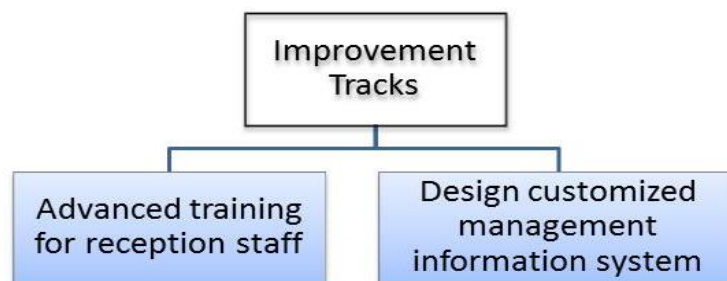


Fig. 16. Improvement tracks.

The first track included organizing advanced training for reception staff (first remedy) while the second track was to design a customized management information system that manages the reception process in the hospital (second remedy).

5.3.1 | Organize advanced training for reception staff

Manager of Sina hospital asks the human resource manager to establish a plan to train the reception staff to improve the performance of the reception staff. The cost for organizing training courses inside the hospital is 500\$, which is considered to be low and important to reduce the admission time.

5.3.2 | Design customized management information system

In a hospital, an information system consists of data, hardware, software, telecommunication, people, and procedures, as shown in Fig. 17; the meaning of each component is explained in Table 5.

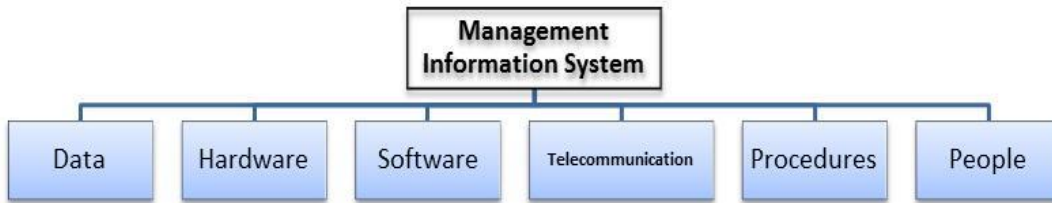


Fig. 17. Management information system.

Table 5. Management information system in each component.

Serial	MIS Components	Meaning
1	Data	All input used by the system to produce information.
2	Hardware	PCs and external components for input/output, hardware and storage devices ...etc.
3	Software	Group of instructions that explain how computer handled data and how computer store information and data.
4	Telecommunication	Software and hardware that send and receive pictures, text animation, and sound as electronic data.
5	People	Professionals who organize and analyze the information required to create an information system, and to write computer codes to operate the hardware.
6	Procedures	The required data to achieve optimal data operations, it included security measures, dispensing applications or software.

Management information system developing barriers and aids. The researcher with the help of I.T teams brainstormed to discover all barriers that might be facing improvement and developing of management information system. The researcher summarized all the barriers in Fig. 18 and illustrated how the management information system can develop in aid as hierarchical chart as shown in Fig. 19.

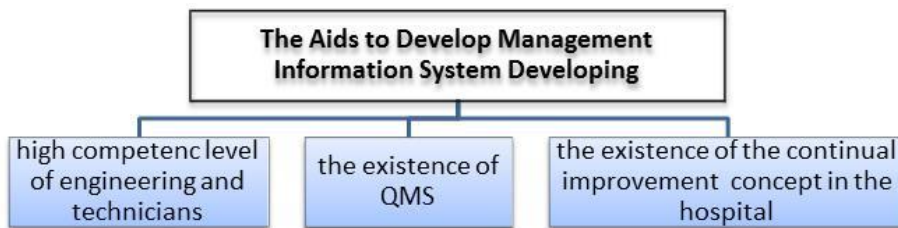


Fig. 18. Management information system developing barriers.

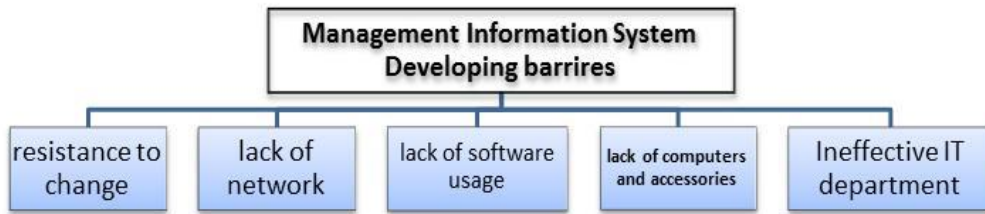


Fig. 19. Management information system developing aids.

Since the hospital does not have competent employees to design the company management information system, so the company's top management signed an agreement with a software designer and database analyzer to do that. The software designers and the database analyzer decided to start analyzing the inputs and the required outputs from the management information system software by deeply understanding and analyzing the admission processes to find out all the needed steps to provide the service and prevent the repeated for unneeded steps. The researchers decided to use the DMS. The hospital was supplied with the needed hardwares, which consists of computers and equipments used to perform input, processing, and output activities. This includes the following:

- *Input devices such as keyboards, mouse, scanners, and bar code.*
- *Output devices such as secondary storage devices, printers, computer screens, and monitors.*
- *Networking devices such as routers, switches, and cables. All the network components are connected to Uninterrupted Power Supply (UPS) units to protect them from any sudden interrupted power.*

Data and information security. In order to control and manage the company information security risks, the following security controls have been considered: Using firewall server to:

- *Prevent network penetration.*
- *Block unwanted sites.*
- *Prevent file infiltration.*
- *Applying daily, weekly, and monthly network backup system.*
- *Utilizing anti-virus software.*

Disconnecting the USB, CD ROM, etc. to prevent the data transfer from the hospital network and prevent loading any unrequited data (songs, films, etc.).

Using different servers for many purposes such as the applications, share, database, domain controller to manage the network, e-Mail, web, and file transfer protocol. Assign user account for each user (user name and password). Prevent some users from using the internet.

The software development process. The software designer and the database analyzer used the waterfall methodology for the software development process. This methodology is known as the waterfall model or software life cycle ([14], [11] and [21]). In the waterfall model, the database software projects are generally broken down into five stages as in Fig. 20. The relationship between all stages can be described as a waterfall, which is due to stage outputs used as inputs for the next stage. Through each stage, extra information is collected or developed, with a combination of inputs to be used in the next stage.

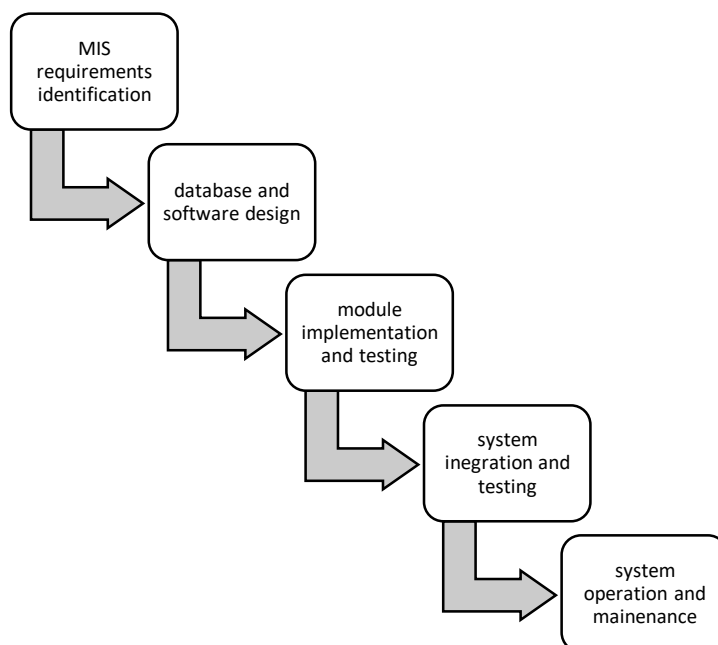


Fig. 20. Waterfall model for management information system.

5.4 | Newly Developed System

After completing the management information system, it was implemented on the reception office of the general surgery department. Fig. 21 show the data flow in the reception office.

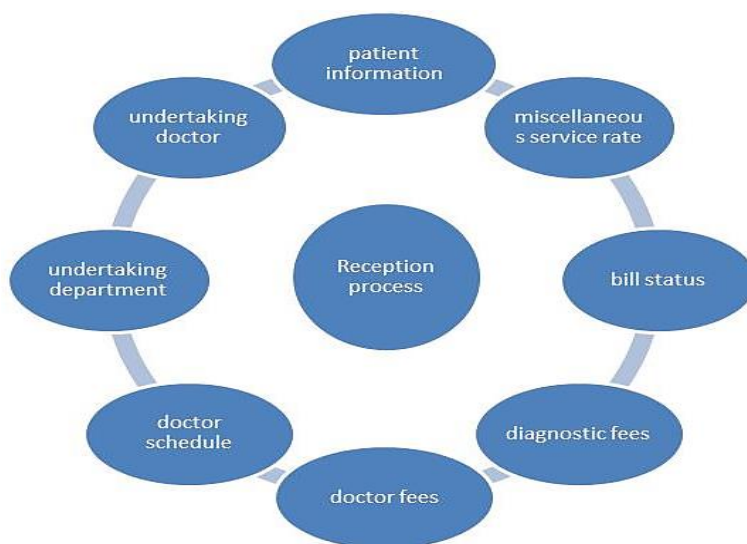


Fig. 21. Data flow of the reception office.

5.5 | Control Phase

It is the fifth step of DMAIC methodology, and this phase consists of:

- I. Collecting the measurements after improvement.
- II. Determining process capability.
- III. Implementing a process control system.

5.5.1 | Collect the measurement after improvement

Patient information in the general surgery department from 1/6/2019 to 30/12/2019 has been measured after applying the developed system, sample for measured data in *Table 6*.

Table 6. Sample for measured data during study period.

Patient ID	Admission Time (min)	Patient ID	Admission Time (min)	Patient ID	Admission Time (min)
232	11	56	8	121	9
343	8	39	9	654	8
564	7	100	9	878	10
136	13	239	10	456	11
109	7	764	11	680	15
354	6	888	15	796	13
239	12	374	7	438	12
224	14	567	7	421	12
209	10	234	8	912	12
194	15	342	9	340	7
179	12	127	10	329	8
165	10	198	10	242	9
150	9	230	6	187	14
135	9	212	7	329	15
121	8	195	9	454	11
106	7	178	9	561	12
91	11	160	8	282	7
765	14	143	8	265	7
230	13	126	9	247	7
222	12	108	10	899	10
598	10	91	12	543	12
522	11	73	11	765	13
570	8	404	10	317	8
617	9	386	14	299	8
664	8	369	11	805	6
711	8	351	10	852	8
758	7	334	9		
St. Dev	2.406446	Mean	9.8625		
		Range	9		

5.5.2 | Determine process capability

The QI macros 2014 was used to analyze the data collected in *Table 6* after improvement and the chart of capability is shown in *Fig. 22*. The mean time for the reception time is 9.86 minutes, standard deviation is 2.4 and Cpk is 1.26.

Upper Spec Limit	74.0568						
Lower Spec Limit	73.9527						
Cp	1.26	Upper	Lower	n	4	Cr	0.79
Cpk	1.26	1.262	1.262	Mean	74.00475	ΔZ	0.00
Pp	1.00			Median	73.9985		
Ppk	1.00	1.000	1.000	Mode			

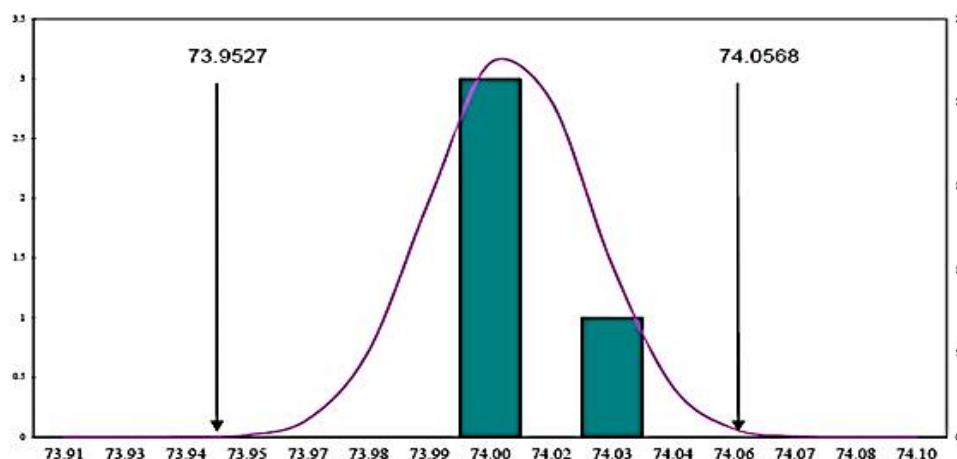


Fig. 22. Chart of capability for the reception time.

5.5.3 | Effect of management system software on the reception time

As illustrated in Figs. 23 and 24, the mean value for reception time has been reduced from 8.9 minutes before the improvement to become 5.2. The improvement in the reception time is summarized in Table 7.

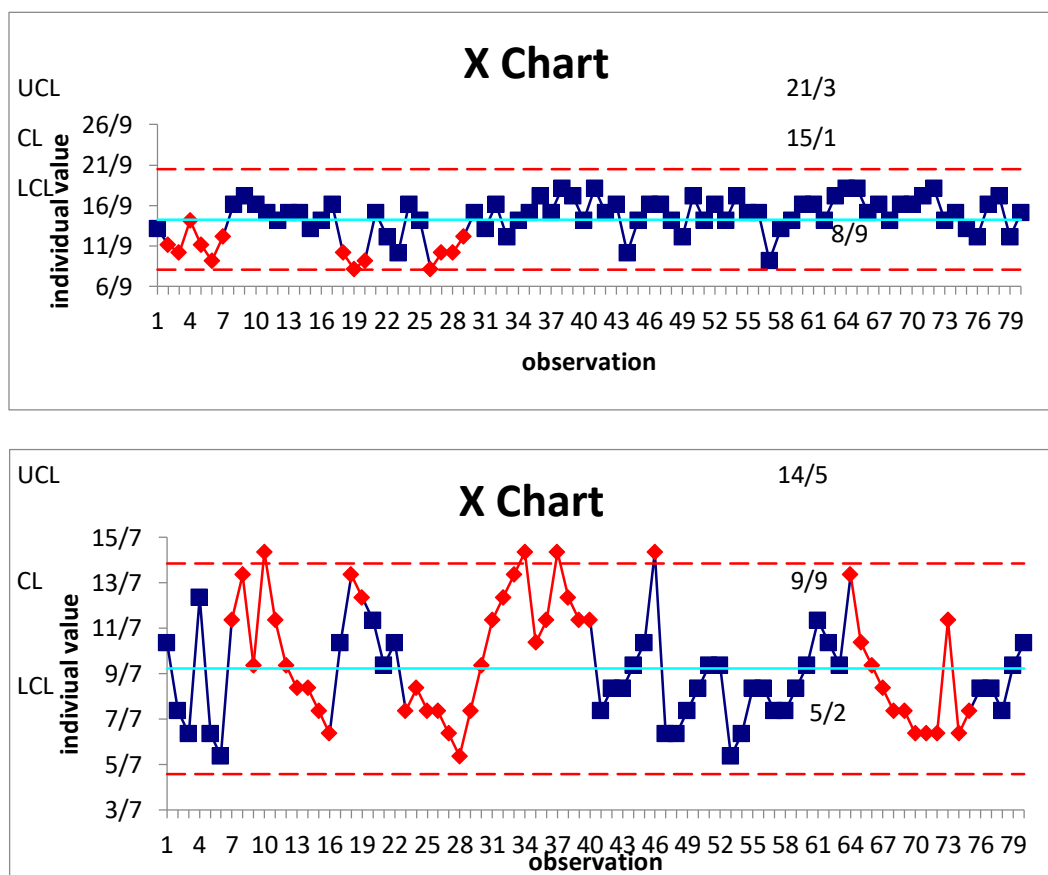


Fig. 23. X-Chart for the receiving data before improvement and after improvement.

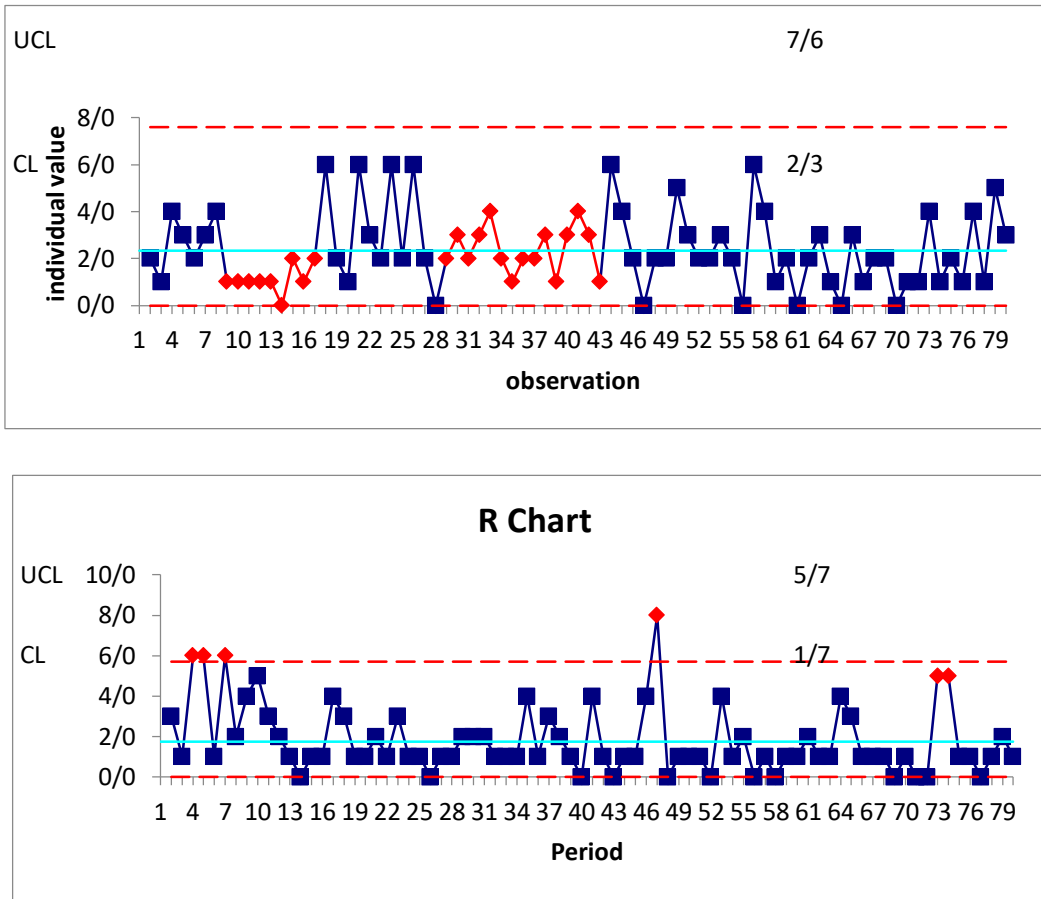


Fig. 24. R-Chart for the receiving data before improvement and after improvement.

Table 7. The improvement of reception time.

Reception Time		
Mean	After	9.8625
	Before	15.1375
Range	After	9
	Before	10
St. Dev.	After	2.55939
	Before	2.40645

6 | Conclusions

The researchers realized the following problems within Sina hospital:

- I. Admission after one-day surgery in general surgery takes a long time.
- II. Regestation process takes a long time.
- III. Low performance for the reception staff.
- IV. Existence of a management program in the reception office is important.
- V. Organizing a training program for the reception staff is very important and has a great priority.
- VI. The general surgery department in the Sina hospital was selected to verify the hypothesis after a pilot study.
- VII. PATH was selected to analyze the performance of the general surgery department.
- VIII. The DMAIC methodology was chosen to solve the problem by designing a management information system that results in reducing the admission time.

- IX. The admission time reduced after applying the hospital management information system and paperwork reduced. That leads to reduce admission time and increasing patient satisfaction.
- X. Reducing the reception time: to be 9.8625 minutes instead of 15.1375 minutes.

The researcher proves the research hypotheses which are:

- I. Applying DMAIC methodology will
- II. Reducing the registration time for patients.
- III. Improving the hospital management system.

Finally, the new contributions of the research are:

The developed a system for the admission process in general surgery has the following advantages:

- I. Monitoring admission process from the beginning to the end.
- II. Reducing the registration time for the new patients.
- III. Reducing the readmission time for the patients after one-day surgery.
- IV. Reducing the checkout time.
- V. Improving the performance of the general surgery department.

Potential Conflict

No potential conflict of interest in the research.

References

- [1] Abbasimehr, H., & Khodizadeh Nahari, M. (2020). Improving demand forecasting with LSTM by taking into account the seasonality of data. *Journal of applied research on industrial engineering*, 7(2), 177-189. DOI: [10.22105/jarie.2020.232594.1168](https://doi.org/10.22105/jarie.2020.232594.1168)
- [2] Ali, A. Y. (2020). Six Sigma-DMAIC and food waste hierarchy-based framework for reducing food waste in University canteens in Ethiopia. *International journal of research in industrial engineering*, 9(1), 77-83. DOI: [10.22105/rirej.2020.209160.1105](https://doi.org/10.22105/rirej.2020.209160.1105)
- [3] Shih, A. (2007). *Measuring hospital performance: the importance of process measures*. Commonwealth Fund.
- [4] Bakhshi, M., Hashemi, S. E., & Dezhdar, H. (2020). Applying mathematical modeling to create job rotation for improve workforce performance in semi-automatic systems. *International journal of research in industrial engineering*, 9(4), 318-327. DOI: [10.22105/rirej.2020.243223.1140](https://doi.org/10.22105/rirej.2020.243223.1140)
- [5] Barry, T. J. (1991). *Management excellence through quality*. Asq Press.
- [6] Crosby, P. B. (1984). Quality without tears: the art of hassle free management, new customer satisfaction and job satisfaction in a service environment. *Hum relat*, 46(3), 725-727.
- [7] Deming, W. E., & Edwards, D. W. (1982). *Quality, productivity, and competitive position* (Vol. 183). Cambridge, MA: Massachusetts Institute of Technology, Center for advanced engineering study.
- [8] World Health Organization. (2007). *Performance assessment tool for quality improvement in hospitals*. Retrieved from https://www.cmj.org.pl/who/path_brochure.pdf
- [9] Hoyle, D., & Thompson, J. (2000). *Converting a quality management system using the process approach*. Transition Support.
- [10] Jackson, S., & Bircher, R. (2002). Transforming a run down general practice into a leading edge primary care organisation with the help of the EFQM excellence model. *International journal of health care quality assurance*, 15(6), 255-267. <https://doi.org/10.1108/09526860210442029>
- [11] Womack, J. P., & Jones, D. T. (2003). *Lean thinking: banish waste and create wealth in your corporation, revised and updated*. Free Press
- [12] Klazinga, N. (2000). Re-engineering trust: the adoption and adaption of four models for external quality assurance of health care services in western European health care systems. *International journal for quality in health care*, 12(3), 183-189. <https://doi.org/10.1093/intqhc/12.3.183>

- [13] Kristensen, F. B., Husereau, D., Huić, M., Drummond, M., Berger, M. L., Bond, K., ... & Wailoo, A. (2019). Identifying the need for good practices in health technology assessment: summary of the ISPOR HTA council working group report on good practices in HTA. *Value in health*, 22(1), 13-20. <https://doi.org/10.1016/j.jval.2018.08.010>
- [14] Arcelay, A., Sánchez, E., Hernández, L., Inclán, G., Bacigalupe, M., Letona, J., ... & Martínez-Conde, A. E. (1999). Self-assessment of all the health centres of a public health service through the European model of total quality management. *International journal of health care quality assurance*, 12(2), 54-59.
- [15] Nabitz, U., Klazinga, N., & Walburg, J. A. N. (2000). The EFQM excellence model: European and Dutch experiences with the EFQM approach in health care. *International journal for quality in health care*, 12(3), 191-202.
- [16] Nabitz, U. W., & Walburg, J. A. (2000). Addicted to quality—winning the dutch quality award based on the EFQM Model. *International journal of health care quality assurance*. 13(6), 259-265. <https://doi.org/10.1108/09526860010373235>
- [17] Vallejo, P., Saura, R. M., Sunol, R., Kazandjian, V., Ureña, V., & Mauri, J. (2006). A proposed adaptation of the EFQM fundamental concepts of excellence to health care based on the PATH framework. *International journal for quality in health care*, 18(5), 327-335. <https://doi.org/10.1093/intqhc/mzl037>
- [18] Sicotte, C., Champagne, F., Contandriopoulos, A. P., Barnsley, J., Béland, F., Leggat, S. G., ... & Baker, G. R. (1998). A conceptual framework for the analysis of health care organizations' performance. *Health services management research*, 11(1), 24-41. DOI: [10.1177/095148489801100106](https://doi.org/10.1177/095148489801100106)
- [19] Simón, R., Guix, J., Nualart, L., Surroca, R. M., & Carbonell, J. M. (2001). Use of several models as diagnostic and quality improvement tool: EFQM and joint commission. *Rev calidad asistencial*, 16(5). (In Spanish). DOI: [10.1016/S1134-282X\(01\)77427-1](https://doi.org/10.1016/S1134-282X(01)77427-1)
- [20] Alteras, T., Meyer, J., & Silow-Carroll, Sh. (2007). *Hospital quality improvement: strategies and lessons from u.s. hospitals*. Retrieved from <https://www.commonwealthfund.org/publications/fund-reports/2007/apr/hospital-quality-improvement-strategies-and-lessons-us-hospitals>
- [21] Tennant, G. (2017). *Six Sigma: SPC and TQM in manufacturing and services*. Routledge.
- [22] Veillard, J., Champagne, F., Klazinga, N., Kazandjian, V., Arah, O. A., & Guisset, A. L. (2005). A performance assessment framework for hospitals: the WHO regional office for Europe PATH project. *International journal for quality in health care*, 17(6), 487-496.
- [23] Joynt, K. E., Harris, Y., Orav, E. J., & Jha, A. K. (2011). Quality of care and patient outcomes in critical access rural hospitals. *Jama*, 306(1), 45-52.