ISSN: 03875547
Volume 45, Issue 02, April, 2022

Prioritizing Lean Six Sigma Initiatives Using the Modified Quality Function Deployment in the New Kasr Al-Ainy Hospital Intensive Care Unit

Hanaa Abou Zeina[1], Ahmed Taha[2], Hend Ibrahim[3], Yasmine Toman[4], Abdel-Karim Kamel[5]

Professor of Public Health and Community Medicine, Faculty of Medicine - Cairo University[1]
Ex General Director of the Cairo University Hospitals, Faculty of Medicine- Cairo University[2]
Lecturer of Public Health and Community Medicine, Faculty of Medicine- Cairo University[3]
Associate Lecturer of Public Health and Community Medicine, Faculty of Medicine, Cairo University[4]
Ex Vice-Director of the New Kasr Al Ainy Hospital, Faculty of Medicine- Cairo University[5]

Keywords:
Modified Quality Function Deployment, Priority lean Six Sigma initiatives, Intensive Care Unit, New Kasr Al-Ainy Hospital

ABSTRACT

Proper selection of quality improvement projects is critical. Improper selection results in wasted efforts, resources, and a frustrated staff. This study applied an innovative, well-structured, proven-to -be effective method; Modified Quality Function Deployment (MQFD), in prioritizing Lean Six Sigma (LSS) quality improvement initiatives, for the first time in a promising mega hospital (New Kasr Al-Ainy Hospital). The study aim was to improve the quality of services provided by the New Kasr Al-Ainy Hospital Intensive Care Unit (NKHICU) with the ultimate goal of increasing customer satisfaction, cost efficiency and staff morale. The study used a health system operations research, exploratory study design. External feedback was identified using satisfaction interview questionnaire with 30 NKHICU patients who matched selection criteria. Another satisfaction interview questionnaire was used for 30 NKHICU visitors. The average satisfaction score of the included participants was calculated. Structured observation was also used for the NKHICU. The research team provided training for some members of staff. Internal staff feedback was identified using in-depth interviews and small group discussions with the top managers and process-owners of the NKHICU. Average LSS initiative scores were calculated, ranked, compiled with the external customer voices in the 'House of Quality'. The final priority LSS initiatives were decided by management with the top one identified as sustainable adequate financial source generation, linked to many opportunities for improvements. We concluded that the MQFD method is effective in identifying priorities of LSS quality improvement initiatives in the NKHICU. It can be replicated in other settings in the Hospital.

1. INTRODUCTION

Healthcare facilities must undergo precise quality improvement efforts to ensure patient satisfaction while keeping a close eye on costs. Around the world, methodologies such Lean and Six Sigma are being utilized to improve quality [13].

Six Sigma uses statistical analysis to eliminate variations and improve quality, while Lean focuses on activities that add value for the patient [18]. Nowadays, many organizations are using a combination of both applications, which is called the LSS to achieve customer satisfaction with cost efficiency and quality performance [1].

These improvement projects may fail if not properly selected, resulting in wasted efforts, resources, and a frustrated staff. For this reason, the correct selection of an improvement project is considered the most critical step in Lean and Six Sigma [3]. An approach called quality function deployment (QFD) was used to translate patient-needs into priority improvement initiatives. Additional benefits of this methodology include improved teamwork, creativity and communication [17], [25]. In the modified version (MQFD), the patient feedback or “voice of the customer” is still used and is combined with the operational staff feedback to prioritize the subsequent selection of improvement projects. The combination of the feedback from the internal staff and patients when scoring improvement projects constitutes the main modification to the traditional QFD [4].

The “House of Quality” HoQ, is a diagram that looks like a house. It is the basic design tool of the QFD and is used to define the relationship between customer expectations and the organization/product capabilities. It utilizes a planning matrix to relate what the customer wants to how an organization (that produces the products or services) is going to meet those wants and a "correlation matrix" as its roof. Thus, it is a kind of theoretical map that provides the means for inter- functional planning and communications within organizations using it.

The New Kasr AlAiny Teaching Hospital (also known as the French Kasr AlAiny Hospital), is a hospital affiliated to Kasr AlAiny School of Medicine, and is run by its medical staff. However, it is not under the managerial supervision of Kasr AlAiny School of Medicine, but rather under that of Cairo University. It has a capacity of 1208 beds distributed over 10 floors. Of these, 78 are dedicated to providing intensive care.

It is often a challenge for organizations to select and prioritize improvement projects from the large pool of initiatives that exist. Not uncommonly, this results in the poor application and utilization of organizational resources. A MQFD is an approach that has already been proven to be not only useful in prioritizing LSS initiatives, but to also have additional benefits that reinforce team inspiration, morale and communication. We found a promising mega hospital such as the New Kasr AlAiny Hospital (NKH) and its intensive care unit (NKHICU) to be the ideal place to explore the applicability of this creation process.

In this study, our aim was to improve the quality of services provided by the NKHICU with the ultimate objective of increasing customer satisfaction, cost efficiency and staff morale.

2. Methods

We employed an operational research, exploratory design for our study that took place from 27th March-12th April 2019. Initially, a facilitator (the champion) was assigned to communicate the project to the top managers and internal staff.

Determining the voice of the external customers: This was the first phase and it began with a structured observation checklist with sections related to the general characteristics of the NKHICU, the physical

environment around the beds, the interaction between the study patients/visitors and NKHICU staff, the characteristics of the visitor waiting area and services provided. Pilot testing of the observation checklist was carried out. It was concluded to be simple and functional with no modifications necessary. Training on observation was provided to two personnel of the NKH public relations office by two of the research team members, using a PowerPoint presentation and an interactive learning session. To ensure objectivity and avoid observational bias, the NKHICU (which was distributed over three floors) was observed by three independent observers, at different times of the day and on different days of the week over a period of two weeks. Observations were carried out by two of the researchers and the two individuals who had received training. Each unit was observed for at least 15 minutes at a time by each observer.

Separate structured interview satisfaction questionnaires were developed for patients and visitors. The questionnaires were adapted from previous research studies; [5], [22], [15], and translated to colloquial Arabic language to ensure full understanding by all participants.

The questionnaires included sections pertaining to some socio-demographic data, satisfaction with regard to some quality dimensions (a 5-point Likert scale was used ranging from 5, denoting very satisfied, to 1: very dissatisfied), and suggestions for improvement of services provided by NKHICU.

The study patients were questioned about their satisfaction with regard to nine quality dimensions, namely: the physical environment of the NKHICU, appearance of the staff, courtesy of the staff, respect of patients' rights, promptness of response to patients' needs, competency of the staff, privacy and security at the NKHICU, waiting time for investigations/consultations, and the quality of services for price.

The study visitors were questioned about their satisfaction with regard to ten quality dimensions, namely: the physical environment of the NKHICU, appearance of the staff, the waiting area, courtesy of the staff, respect of visitors' rights, promptness of response to patients' needs, competency of the staff, privacy and security at the NKHICU, waiting time for investigations/consultations, and the quality of services for price.

Training on data collection through interview questionnaire was provided by two of the research team members to two of the NKH public relations personnel using a PowerPoint presentation and an interactive learning session. The two structured interview questionnaires were pre-tested on five patients and five visitors respectively. The goal was to identify any ambiguous questions or any respondent difficulties in understanding the questionnaire. No modifications were needed.

Thirty NKHICU patients were included based on the time allocated for data collection in this phase of the research [21]. The inclusion criteria were a length of stay not less than two days in the NKHICU, a fair consciousness level, and willingness to participate in the research. Thirty next-of-kin NKHICU visitors were also included. An average of 2-4 interviews were conducted on two days each week.

The objectives of the study were explained to the patients and visitors prior to data collection and oral informed consent was obtained from all. Responses to the satisfaction questions were used to calculate the average satisfaction score of the patients and visitors.

Determining the voice of the internal staff: This was the second phase and it began with in-depth interviews with three NKHICU physicians and two nurses. The theme was current service attributes that might result in patient dissatisfaction. Responses were checked for clarity and duplication and the top seven responses were determined. These responses were then translated into the corresponding critical customer requirements

(CCRs) i.e. expected service attributes.

Root causes for unmet CCRs, were identified by a group discussion headed by the Ex-Vice Director of NKH, together with the research team. The theme was root causes for failure to achieve the top seven CCRs. For each CCR, the participants endeavored to determine the root cause for this failure. This was by repeatedly asking "Why" for each CCR that had not been achieved yet [18]. Root causes were sifted and organized using the Fishbone diagram. Group discussion was used to reach consensus.

The third phase included group discussion to reach a list of solutions (potential LSS initiatives) for the root causes obtained in the previous step. The leader was the Ex-Vice Director of NKH, with members of the research team. Group discussion was used to reach consensus about the top seven LSS initiatives.

The fourth phase was ranking the top seven LSS initiatives. The Vice Director of NKH, the Director of NKHICU, and three NKHICU physicians, were asked to score the LSS initiatives identified in the previous step from (1) least important to (5) most important. Average scores were calculated. The initiatives were ranked according to their average scores.

The next phase was demonstrating the House of Quality (HoQ), the tool of the MQFD. The rank and average scores of the feedback from patients and internal staff were placed in the HoQ. The HoQ had two principal components: horizontal and vertical.

- The horizontal component represented the information gathered and selected from the results of the patient and visitor feedbacks.
- The vertical component represented the priority LSS initiatives list based on the results from internal staff feedback.

A matrix was used to determine the relationship between both feedbacks and to provide an appropriate prioritization sequence for the LSS initiatives to be utilized in subsequent steps.

The matrix was created with rankings of High, Medium and Low and translated to the final MQFD with the following notations:

● = strong relationship = score of 5.

○ = moderate relationship = score of 3.

△ = weak relationship = score of 1.

This step was conducted by the Ex-Vice Director of NKH, with members of the research team.

The second step in this phase was calculating the absolute score and the relative score using simple mathematical calculations (shown in the results section). Then, the co-relationship between the LSS initiatives in the ‘roof’ of the QFD was determined using the same scale as in the relationship matrix. This step was conducted by the Ex-Vice Director of NKH, with members of the research team.

The final prioritization of the LSS initiatives was done taking into consideration the relative score. The prioritization of the projects does not necessarily need to follow the relative score. However, the final decision of which project should be selected, may be defined by the top-level management based on insight. This step was conducted by the Director of the NKH.

Lastly, a meeting was conducted with the top management to get their insight into the replicability of MQFD in other areas in the hospital.

2.1 Data management and analysis

Quantitative data: Data was coded, entered using Microsoft Office Excel Program (2010). Data was then transferred into the Statistical Package for Social Sciences Software program, version 21 (International Business Machines, Chicago). For categorical variables, the number and percentage were calculated.

The average satisfaction score of both feedbacks was calculated by calculating the arithmetic mean for all scores which is the sum of the scores divided by the number of responses. Priority was given to LSS initiatives with the least average scores.

Qualitative data: Results of qualitative data were presented in the form of narration. Root cause analysis template was used.

Quantitative and qualitative data were displayed together since they are complementary and explanatory for each other.

Strengths of the study included having two supervisors with in-depth knowledge and authority in the NKH, in addition to the use of more than one simple and effective tool for determination of the voice of the external customers. Also, among the data collectors were workers in the NKH who received training by the research team on the related data collection tools. This facilitated timely data collection and provided a chance to develop and involve workers from the NKH.

Limitations of the study included the conversion of the NKH into a Covid-19 isolation hospital during the pandemic. This sometimes limited the communication with the NKHICU staff & the NKH decision-makers. Consequently, the research team was obliged to switch from large group discussions to smaller ones. Another limitation was the difficulties in arranging a suitable time for all participants in the study.

Administrative and ethical considerations included ensuring the privacy of the participants in the study, ensuring the data security, obtaining approval for our research protocol from the Research Ethics Committee, Faculty of Medicine, Cairo University.

3. Results

3.1 Results of the structured observation of the NKHICU

NKHICU beds were distributed along three floors for various specialties. The physical environment around the beds in the NKHICU and the appearance of the physicians and nurses (neat and clean) generally received excellent results.

The interaction between the study patients & visitors and NKHICU staff in all the study NKHICUs generally received excellent results

Characteristics of the waiting area for NKHICU visitors and services provided for them generally received a description of ‘inconvenient conditions’.

3.2 Results of the structured interview satisfaction questionnaires of the study patients

Almost three quarters (70%) of the thirty study patients were male, almost half (46.7%) were aged 60 years and above, about one third of (33.4%) were either illiterate (questionnaires filled in by relatives) or could read & write only at primary school level and 70% had a 2-4 day stay in the NKHICU. More than half of the payments (56.7%) were through a job health insurance scheme. A total of 83% described themselves as generally satisfied or very satisfied with regard to some of the NKHICU quality dimensions.

The calculated average satisfaction score of the study patients revealed that high out-of-pocket expenses for medications/supplies, unexplained high bills, inadequate cleansing & disinfection of the surroundings and delayed conduction of investigations resulted in the lowest values of 2.6, 3.1, 4 and 4.3 respectively. Regarding suggested improvements raised by some of the study patients, increased availability of medications/supplies was the most common (30.0%).

3.3 Results of the structured interview satisfaction questionnaire of the study visitors

An equal number of male and female study visitors participated in the interview questionnaire of the study with 30% being in the age group 50-59 years and 87% frequently visiting their relatives in NKHICU. Only 11% were dissatisfied or very dissatisfied with the services provided by NKHICU while 43% neither satisfied nor dissatisfied (neutral). The top suggestions raised by visitors were related to availability of medications/supplies (20.3%), inconvenience of waiting area (17.6%) and high prices (9.5%).

3.4 Internal staff feedback

In-depth interviews with three physicians and two nurses working in NKHICU including the question, "What do you think about the current service attributes that might make an attendant patient dissatisfied?' resulted in the following answers and corresponding critical customer requirements (CCRs):

1- Deficient medications and supplies. → Available medications and supplies

2- Unmaintained devices. → Well-functioning maintained devices

3- Bad communication. → Good communication.

4- Deficient number of nurses. → Supply suitable number of nurses

5- Poor sanitation/cleanliness. → Good sanitation/cleanliness

6- Patient doesn't know management plan → Involving patient in the management plan

7- Late response to consultations. → Timely response to consultations

The root causes of the unmet CCRs are presented in the fishbone diagram (Figure 1). Inadequate financing was the root cause behind poor supplies, insufficient number & quality manpower, and inconvenient waiting areas for NKHICU visitors. Other identified root causes included:

- Lack of soft skills and supportive supervision for the providers,
- Inadequate performance of the medical engineering department,
- Ineffective health information system,
- Lack of or poorly communicated clinical standards.

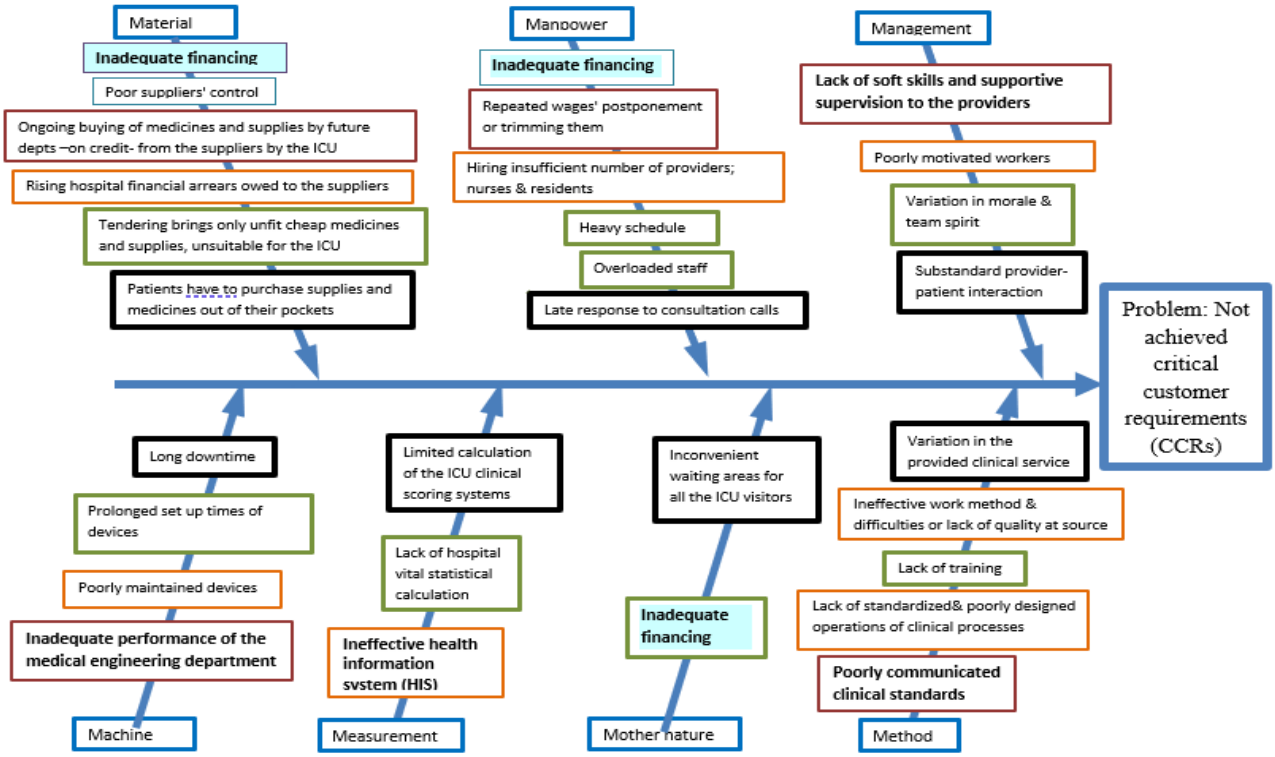


Figure (1): The Fishbone diagram for the root cause analysis of the unmet CCRs

The list of created improvement initiatives and their rankings are shown in the Matrix 1:

Matrix (1): The L-shaped matrix of the ranked average score LSS initiatives of the NKHICU

N.	Initiative	Score (1)	Score (2)	Score (3)	Score (4)	Score (5)	Total score	Average score	Rank after scores
1	Generating sustainable adequate financial sources.	5	5	2	5	5	22	4.4	**1**
2	Improving clinical process	3	4	3	1	3	14	2.8	**4**
3	Maintaining needed medical supplies and medications.	1	1	2	4	4	12	2.4	**6**
4	Ensuring convenient waiting areas for all ICUs' visitors.	3	2	2	3	2	12	2.4	**7**
5	Deploying an objective system for quality indicators monitoring related to: • bed occupancy • clinical outcome • readmission rate	2	2	4	4	3	15	3	**3**
6	Providing a proper system for admission and discharge of ICUs.	4	4	3	1	2	14	2.8	**5**
7	Deploying optimal number of workforces: residents, nurses and house keepers.	5	1	2	5	4	17	3.4	**2**
8	Ensuring effective maintenance for medical equipment.	1	2	1	1	1	6	1.2	**9**
9	Enhancing the soft managerial skills of the front-line managers.	2	3	2	2	2	11	2.2	**8**

3.5 Building up the house of quality

Generating a sustainable financial source had a strong relationship with the out-of-pocket purchasing of medications/supplies, high bills, and improper cleansing of surroundings. It had a weak relationship with the delayed investigations and inconvenient conditions for the visitors.

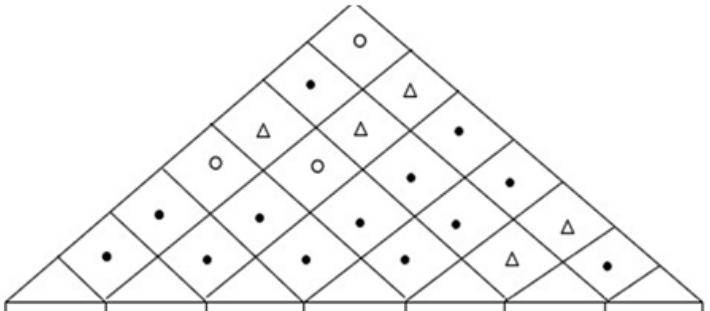
The external feedbacks 1, 3 and 4 had an average score of 2.6, 3.1 and 4 respectively with a high relationship (value of 5) denoted by a filled-in circle for initiative Area 1. The external feedbacks 2 and 5 had an average ranking of 4.3 and 1.9 respectively with a medium relationship denoted by a non-filled circle (value of 3) for initiative Area 1. In addition, the internal staff feedback had a ranking of 4.4 for initiative Area 1. Considering both sets of feedback, the absolute score for initiative Area 1 was calculated as:

Absolute Score = $[(2.6 + 4.4) \cdot 5] + [(4.3 + 4.4) \cdot 3] + \cdots + [(1.9 + 4.4) \cdot 3] = 159.5$

The relative score is an automatic ordering from high absolute score to low absolute score.

The top relatively ranked LSS initiative was generating sustainable adequate financial sources, with an absolute score of 159.5, the second one was deploying the optimal number of workforce, with an absolute

score of 106.3, the third was ensuring convenient waiting areas for all ICU visitors, with an absolute score of 91.7, the fourth was maintaining essential medical supplies and medications, with an absolute score of 89.5, the fifth was improving clinical processes with an absolute score of 79.3, the sixth was improving clinical processes, with an absolute score of 75.7 and the seventh was providing a proper system for admission to and discharge from ICU, with an absolute score of 39.3.



● High - Score of 5

○ Medium - Score of 3

△ Low – Score of 1

External Feedback		Aver. score	Generating sustainable adequate financial source (4.4)	Deploying optimal number of workforce (3.4)	Deploying objective system for quality (3)	Improving clinical process (2.8)	Providing a proper system for admission and discharge of ICUs (2.8)	Maintaining needed medications/supplies (2.4)	Ensuring convenient conditions for visitors (2.4)
Out of pocket buying of medications/supplies	1	2.6	●	△	○	●	△	●	○
Delayed conduction of investigations	2	4.3	○	●	△	○	△	○	△
Unexplained high bills	3	3.1	●	○	△	△	△	○	○
Improper cleansing and disinfection of the surroundings	4	4	●	●	○	○	△	△	●
Inconvenient conditions for the visitors	5	1.9	○	△	●	△	○	●	●
Absolute Score			159.5	106.3	75.7	79.3	39.3	89.5	91.7
Relative Score			1	2	6	5	7	4	3
Finally prioritized LSS initiatives			1	7	4	3	6	2	5

Figure 2: The house of quality with the finally prioritized LSS initiatives of the NKHICU at the time of data collection

3.6 Final prioritization of LSS initiatives

The top relatively ranked LSS initiative as generated from the house of quality included; generating sustainable adequate financial sources, with an absolute score of 159.5, the second was deploying optimal number of workforce, with an absolute score of 106.3, the third was ensuring convenient waiting areas for all ICU visitors, with an absolute score of 91.7, the fourth was maintaining essential medical supplies and medications, with an absolute score of 89.5, the fifth was improving clinical processes with an absolute score of 79.3, the sixth was improving clinical processes, with an absolute score of 75.7 and the seventh was providing a proper system for admission to and discharge from ICU, with an absolute score of 39.3.

The most prioritized LSS initiatives were generating sustainable adequate financial sources, maintaining essential medical supplies & medications and improving clinical processes.

4. Discussion

Health-care facilities, especially top-level ones such as ICUs, must ensure quality performance and competitiveness. Additionally, ICU admission is stressful for both the patient and their families [22] and is very costly [24]. Therefore, the ICU was chosen as the ideal place for conducting this prioritization tool with

the aim of improving the quality of services provided.

Like any organization, healthcare facilities cannot survive if they cannot attract patients. This explains our strong reliance on identifying the voice of the patients and their visitors early in this study [19], [3]. We used several robust data collection tools derived from previous research studies especially those conducted in ICUs [10], [22], [15] to obtain feedback and suggestions of the external customers; patients and visitors.

The selection of an improvement project may be the most difficult step in LSS and can determine the early success and long-term tolerance within any organization. Many projects confront the problem of no linkage with business objectives or customer needs, too large or high-level project scope along with uncertain problem and goal statement. Not uncommonly, this results in bad application and utilization of organizational resources, sub-optimal behavior and can lead away from the organization's goal instead of towards it [19], [3]. In addition, good project prioritization helps an organization remain focused on its most important strategic objectives, as it allocates scarce organizational resources [20].

According to [7], the MQFD model can be used to prioritize improvement initiatives in various health care settings as it can be easily applied and uses rigorous methods. Priority LSS improvement initiatives, can be the beginning of an improvement journey that can fit NKH policy and match the preferences and skills of the staff. These can be replicated in the future in other healthcare settings in NKH.

While QFD incorporates external customer expectations to prioritize the improvement initiatives, the modified QFD uses the patient feedback or ‘voice of the external customer’ combined with the operational staff feedback i.e., internal feedback. Feedback is one of the greatest tools one has for improving the quality of an organization or product. Customer complaints can have a significant impact on improving a product or process. For healthcare organizations, one should always listen to feedback from patients and staff members and be prepared to improve services based on this feedback [4].

With this aim in mind, the initial phase in this study was obtaining external feedback from patients/visitors (sources of dissatisfaction with the service) through analysis of observation results, patient and visitor questionnaires, and interviews with patients and visitors. The external feedback is input into the ‘what’ area of the MQFD. This process concurred with the studies of [4], [6], [2].

Observations were carried out by three individuals at different times of the day to ensure objectivity and avoid bias [14]. To ensure technical sustainability and replicability, the research team provided the necessary training on observation and on how to fill in the questionnaires to allow members of NKH to assist with data collection. The results of the observation phase provided the necessary findings that were the gate to the subsequent phases of the study.

The second phase of the study was obtaining the internal staff feedback (identifying the voice of the patients, from the internal staff’s perspectives) and translating this feedback into the corresponding critical customer requirements “CCR” (refer to the Results section). This goes in accordance with results of others [4], [8] that express the need clearly in terms of “what” the need is, not ‘how’ the need can be satisfied. This will limit misunderstanding of what is meant.

[4] justified involving the internal feedback in the prioritization process pointing out that patients may be reluctant to voice complaints or to answer frankly especially in face-to-face questionnaires. They may also believe it possible to track their response on a computerized questionnaire. They may fear that they are

jeopardizing their treatment if they provide a negative opinion to the department.

The root cause analysis was a fundamental step in internal staff feedback. The root cause is the basic reason for the occurrence of a problem. There is usually one root cause behind chronic problems that consequently require a package of solutions [16]. Figure (1) shows that there are multiple root causes behind the unmet critical customer requirements (CCRs). The list of solutions which represents the LSS initiatives are presented in Matrix (1).

The top causes for patient and visitor dissatisfaction were out-of-pocket purchasing of medications/supplies, delayed conduction of investigations, unexplained high bills, improper cleansing and disinfection of the surroundings, and inconvenient conditions for the visitors (Figure 1). Similarly, in a study by [11] the most common healthcare complaints related to ICUs were; improper handling of patients, improper facility and equipment function, uncomfortable physical surroundings, delay in medical procedures, and lack of communication of medical decisions or plans.

A variety of internal staff categories were involved in different phases of the improvement project prioritization. Involving the staff maintains their sense of ownership and dedication. Moreover, better communication and transparent processes ensure effective system thinking throughout the organization. These benefits are in line with what was already identified in the literature [4], [23], [8], [7].

Top management and process owners were involved in the prioritization process from the start. This included five talented persons; the Vice Director of NKH, the director of NKHICU (at the time of data collection) and three NKHICU physicians who were able to objectively score the list of previously generated LSS initiatives, and rank them (Matrix 1). Involvement of management is cornerstone and key to the success of any improvement process [9].

Hospital management based the final prioritization on their experience. They now have a clear-cut direction as to where resources should be directed for improvement implementation. The result is ongoing projects that will have the greatest impact on patient and staff satisfaction, with best allocation of efforts and resources [4].

The first initiative selected, which also had the highest relative score, was to generate adequate sustainable financial resources. This is because adequate financing is necessary for fulfilling critical customer requirements. Funds are needed for the provision of medications and supplies, deployment of the necessary work-force numbers, ensuring convenient amenities for visitors and improvement of the clinical process. Moreover, the hospital will continue to receive the new International Organization for Standardization 9001 certification for quality management system with its new specifications [12].

The second initiative selected (which received a relative score of four) was maintaining supplies of essential medications. It has a strong relationship with adequate financing. Out-of-pocket purchasing of medications and supplies was reported as a great concern by both the external and internal feedbacks. The highest percentage of suggestions raised by patients and visitors was the provision of sufficient drugs and supplies [12].

The last step entailed an official meeting with the director of the NKH and the director of NKHICU to enlighten them about the final applicable results of the research and to get their opinions and recommendations about the replicability of MQFD in other areas in the hospital (refer to the Methods section). It is important to highlight the role of the champion in this study. According to Management and Strategy

Institute, 2017, champions guide the team through organizational support and resources, removing roadblocks. Champions do not need to be "experts" in Six Sigma or lean tools and techniques, but they do require competent skills in facilitation, collaboration and conflict resolution. We consider the Vice-Director of NKH at that time (and he is also one of the supervisors in this study) as the champion. His continued support for this study through ongoing communication with the staff throughout the Covid- 19 pandemic allowed the successful completion of the internal feedback.

5. Conclusion

The study concluded that the MQFD method used in this research was effective in identifying and presenting the priorities of quality improvement initiatives in the NKHICU. This provides a wide scope to be replicated in other departments in Kasr AlAiny Hospitals.

List of abbreviations

CRs	Critical Customer Requirements
HoQ	House of Quality
ICU	Intensive Care Unit
LSS	Lean Six Sigma
MQFD	Modified Quality Function Deployment
NKH	New Kasr Al-Ainy Hospital
NKHICU	New Kasr Al-Ainy Hospital - Intensive Care Unit
QFD	Quality Function Deployment

6. Acknowledgements

I would like to thank the authors of this research for their cooperation, the NKH directors and NKHICU staff for their active participation in data collection and a special thanks to the trainees, study patients and visitors who took the time to participate in this study.

7. References

[1] Ahmed, S., Manaf, N. H. A., & Islam, R. (2013). Effects of Lean Six Sigma application in healthcare services : a literature review History of the Lean and Six Sigma, 28(4), 189–194. https://doi.org/10.1515/reveh-2013-0015

[2] Ali Akram, M., Iqbal Mahmud, M., Riad Bin Ashraf, S., Awal, S., & Talapatra, S. (2018). Enhancing the Healthcare Service Using Quality Function Deployment and Database Management System in the Outpatient Department of a Government Hospital of Bangladesh. International Research Journal of Engineering and Technology, 5(4), 2022–2029. Retrieved from www.irjet.net

[3] Bazrkar, A., & Iranzadeh, S. (2017). Prioritization of Lean Six Sigma improvement projects using data envelopment analysis cross efficiency model. Quality - Access to Success, 18(157), 72–76.

[4] Bonilla, C., Pawlicki, T., Perry, L., & Wesselink, B. (2008). Radiation oncology Lean Six Sigma project selection based on patient and staff input into a modified quality function deployment. International Journal of Six Sigma and Competitive Advantage, 4(3), 196–208. https://doi.org/10.1504/IJSSCA.2008.021836

[5] Brown, A., & Hijazi, M. (2008). Arabic translation and adaptation of Critical Care Family Satisfaction Survey. International Journal for Quality in Health Care, 20(4), 291–296. https://doi.org/10.1093/intqhc/mzn013

[6] Buttigieg, S. C., Dey, P. K., & Cassar, M. R. (2016). Combined quality function deployment and logical framework analysis to improve quality of emergency care in Malta. International Journal of Health Care Quality Assurance. https://doi.org/10.1108/IJHCQA-04-2014-0040

[7] Dehe, B., & Bamford, D. (2017). Quality Function Deployment and operational design decisions–a healthcare infrastructure development case study. Production Planning and Control, 28(14), 1177–1192. https://doi.org/10.1080/09537287.2017.1350767

[8] Gremyr, I., & Raharjo, H. (2013). Quality function deployment in healthcare: A literature review and case study. International Journal of Health Care Quality Assurance, 26(2), 135–146. https://doi.org/10.1108/09526861311297343

[9] Hermano, V., & Martín-Cruz, N. (2016). The role of top management involvement in firms performing projects: A dynamic capabilities approach. Journal of Business Research, 69(9), 3447–3458. https://doi.org/10.1016/J.JBUSRES.2016.01.041

[10] Heyland, D. K., & Tranmer, J. E. (2001). The Development of a Questionnaire and Preliminary Results, 16(4), 142–149. https://doi.org/10.1053/jcrc.2001.30163

[11] Jerng, J., Huang, S., Yu, H., Chan, Y., Liang, H., & Liang, H. (2018). Comparison of complaints to the intensive care units and those to the general wards : an analysis using the Healthcare Complaint Analysis Tool in an academic medical center in Taiwan, 1–12.

[12] Kamel, A.-K. (2020). The executive Director of the New Kasr Al Ainy Hospital,. Personal Communication.

[13] Kovach, J. V., & Ingle, D. (2018). An approach for identifying and selecting improvement projects. Https://Doi.Org/10.1080/14783363.2017.1419055, 31(1–2), 149–160. https://doi.org/10.1080/14783363.2017.1419055

[14] McLeod, S. (2005). Observation Methods - Naturalistic, Participant and Controlled | Simply Psychology. Retrieved January 29, 2022, from https://www.simplypsychology.org/observation.html

[15] Min, J., Kim, Y., Lee, J. K., Lee, H., Lee, J., Kim, K. S., … Lee, Y. J. (2018). Survey of family satisfaction with intensive care units A prospective multicenter study. Medicine (United States), 97(32). https://doi.org/10.1097/MD.0000000000011809

[16] Omarli, S. (2017). Which Factors have an Impact on Managerial Decision-Making Process ? An Integrated Framework. Essays in Economics and Business Studies, 42(5). https://doi.org/10.18427/iri-2017-0068

[17] Özgener, Ş. (2003). Quality function deployment: A teamwork approach. Total Quality Management and Business Excellence, 14(9), 969–979. https://doi.org/10.1080/1478336032000090897

[18] Pelletier, L.R. and Beaudin, C. L. (2005). Q solutions: essential resources for the healthcare quality professional. National association for healthcare quality.

[19] Ray, S., & Das, P. (2010). Six Sigma project selection methodology. International Journal of Lean Six Sigma. https://doi.org/10.1108/20401461011096078

[20] Robert S. Kaplan, D. P. N. (2004). Strategy Maps: Converting Intangible Assets into Tangible Outcomes | Harvard Business Publishing Education. Retrieved February 1, 2022, from https://hbsp.harvard.edu/product/1342-PDF-ENG

[21] Ross, R. (2016). Determine provider-level sample sizes for patient satisfaction surveys. Retrieved January 19, 2022, from https://www.mgma.com/resources/quality-patient-experience/determine-provider-level-sample-sizes-for-patient

[22] Schwarzkopf, D., Behrend, S., Skupin, H., Westermann, I., Riedemann, N. C., Pfeifer, R., … Hartog, C. S. (2013). Family satisfaction in the intensive care unit: A quantitative and qualitative analysis. Intensive Care Medicine, 39(6), 1071–1079. https://doi.org/10.1007/s00134-013-2862-7

[23] Simons, L. P. A., & Verhagen, W. P. (2008). Applying value-sensitive design and quality function deployment to healthcare ICT: the case of Dutch primary care unit dossiers. Journal of Design Research, 7(2), 155–176. https://doi.org/10.1504/JDR.2008.020853

[24] Thompson, K., Taylor, C., Forde, K., & Hammond, N. (2018). The evolution of Australian intensive care and its related costs: A narrative review. Australian Critical Care. https://doi.org/10.1016/j.aucc.2017.08.004

[25] Xie, M. (Min), Goh, T. N. (Thong N., & Tan, K. C. (2003). Advanced QFD applications, 204. Retrieved from https://www.goodreads.com/work/best_book/6487623-advanced-qfd-applications