Improving Performance in Surgical department through Communicating Information to Decision Makers: Intervention Study in a tertiary Hospital

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Operations Research, Managers, Policy Brief

ABSTRACT
Hospital performance evaluation is crucial for early detection of pitfalls, and problem-solving. Data shouldn't be passively collected. They must be measured and understood through an underlying conceptual framework. Purpose: The General Surgical Department in collaboration with the Public Health Department had the objective of developing a module for periodic monitoring and evaluation of the eight general surgical units based on calculated key performance indicators (KPIs), Composite Indices (CIs) and communication of growing out information through policy briefs directed to the heads of units for better resources allocation and evidence based decision making. Methodology: An operations research using pre-post intervention design. The exploratory component was completed in six months in the 8 units of the department. Pretest service statistical data analyzed KPIs derived from hospital bed and surgical room utilization. Data were utilized for the calculation of 5 CIs for each unit. Study intervention included the development of policy briefs (PB) that were submitted to the head of the department. Informed decisions were made guided by the info-graph data in the form of traffic color coded ranking matrix to promote various services and to improve performance in the department units particularly lower ranked units. The post-test included reanalyzing of the service statistical data. Findings: Comparing pre-posttest figures revealed improvement in the calculated KPIs and CIs. Originality and practical implications: Bringing up a novel, feasible monitoring and evaluation model using refitted tools would support surgical unit heads in evidence-based decision-making and eventually improve performance efficiency.

1. Introduction

An estimated two billion people worldwide are bereaved of appropriate access to high-quality surgical care. This crisis is deeply congregated in low- and middle-income countries (LMICs) Slowed or inadequate access to both general and sub-specialty surgical care is interpenetrated with considerable psychosocial morbidity and stigma. Surgery departments' role in the development of comprehensive healthcare systems is consequently more and more recognized. So regular monitoring and evaluation of surgical care services is increasingly required (Meara *et al.*, 2016). Hospital performance evaluation is decisive in payment systems, early detection of pitfalls, and problem-solving. Data and numbers should not be passively collected. They can only be measured and understood through an underlying conceptual framework (Scopetti *et al.*, 2021).

Building up a set of indicators that properly reflect the hospital's performance and secure information about the quality of care dimensions is a must to achieve sound performance measurement. A better assessment across all hospital departments will increase transparency and trust among patients. (Catuogno *et al.*, 2017) Hospital evaluation includes the development of key performance indicators (KPIs). They are specific and measurable metrics used within health care to measure performance by acting as 'flags' or 'alerts' to identify good practices, provide comparability, and identify areas for improvement within a service provision process (Safdari *et al.*, 2014). In 2015, the Lancet

Commission on Global Surgery proposed "Indicators" to evaluate progress toward timely access to

safe surgical care. They measured access to surgery, surgical workforce, surgical volume, perioperative mortality rate, and consequences of surgery. Despite being rapidly taken up by practitioners, data points from which to derive the indicators were not defined, limiting comparability across time or settings (Zadey *et al.*, 2023). Furthermore, to describe an entire set of KPIs, a composite index (CI) can be utilized. It represents a single number exhibited by the mathematical incorporation of ample indicators or measures (Landewé and van der Heijde, 2021). With one aggregated value, CI helps to measure inconsistent phenomena, compare between departments or across time, track at varying times to check for trends, and eventually give a straightforward message about the situation. (Refaat and Hadi, 2018; Mazziotta and Pareto, 2022) The Egyptian parastatal health sector is made up of quasi-governmental institutions such as the Teaching Hospitals. The largest and most advanced hospital in this group is Cairo University Hospitals (CUH), which is a brand contemporaneous organization (Fakhouri 2016; Fasseeh *et al.*, 2022).

The General Surgical Department plays a pivotal role in health service delivery to a wide spectrum of surgical cases. The department consists of eight surgical units in CUH is eight in-patient units. Those units receive and serve cases from outpatient clinics and other departments.(Kasr Al Ainy, Cairo University, 2024) Although the management information system is well established in CUH, due to the huge amount of data, the available server cannot respond to the dynamic need to develop periodic reports on the performance of each unit. Units were not successful in manipulating data due to the lack of a well-designed statistical system to develop KPIs that monitor performance. Consequently, there is no feedback of information about the performance of the 8 units to exchange data between service providers and decision-makers to improve performance. The study aims to improve the performance of the eight surgical units of CUH through developing a module for periodic monitoring and evaluation of these units. It assessed their calculated key performance indicators (KPIs), Composite Indices (CIs) followed by communication of the growing out information through policy briefs directed to the heads of units (decision-makers).Eventually, re-assessing the outcome of the feedback of information on KPIs of the units was done.

Methods:

Study design:

A health system - operations research, pre-posttest intervention study. It included quantitative and qualitative components.

Study setting and duration:

Over one year from November 2022 to November 2023, the study was conducted in eight units of the General surgical department at Cairo University (CU).

Working Definitions:

Traffic colored coded ranking matrix Info-graph: A one-page summary for all DEPARTMENT units, ranked from best (Green zone), intermediate (Yellow zone), and critical (Red zone) for 21 KPIs (derived from service statistics), aggregated into five CIs. The infographic provides a guide for location, i.e., essential units, and service type, e.g. Bed utilization or Physician performance. (McCrorie *et al.*, 2016; Abdel-Razik *et al.*, 2023) *Policy brief (PB):* A document that summarizes research to inform policymakers. Briefly and simply, it explains a policy problem, gives a synthesis of pertinent evidence, suggests potential courses of action, and makes recommendations succinctly

and straightforwardly. (Felt *et al.*, 2018)

Study phases:

The study is composed of four phases:

1- Preparatory Phase:

- Approvals of the study protocol were attained by: the Public Health (PH) Department, the department, and the scientific and ethical committee Faculty of Medicine, (CU).

2- Pre-intervention: Situation Analysis Phase:

- It included the assessment of the quality of units' resources and management. During six months, an analysis of the collected service statistics data derived from the eight units **(**patients' files, units registry, and operating room (OR) registry was done.
- Working on the data and calculating different KPIs, CIs, and ranking of surgical units according to the calculated indices.

3- Intervention Phase:

- Designing nine policy briefs in English and Arabic languages, one for each unit head and one for the head of the department. They were developed from all analyzed data and included: an introduction, major findings, one info-graph/or figure, and surgical services policy recommendations.
- Conduction of in-depth interviews with the head of the department and four head professors, to communicate information derived from the module and display the PB.
- The raised issues guided by policy briefs were the module for monitoring and evaluation of surgical units, major findings, and suggested operational recommendations.

4- Monitoring and Evaluation Phase:

- Follow up on performance in hospital bed utilization and surgical operations pattern over one month.
- Re-collection of the service statistics data and calculation of KPIs and CIs for the 8 units within the department to assess the level of efficiency after the intervention.

Sample size and sampling technique

- All units (8 units) were included in the study. They were coded into letters A-H for confidentiality and easy manipulation of data **.**
- *Data collection tools:*

The study included Quantitative data and qualitative data.

Quantitative data: **(**Supplementary_material_appendix_1**)**

1-Service statistics indicators were derived from CUH records for the 8 surgical units.

First: Human Resources (4 indicators).

Second: The total developed composite indices were 5 indices as follows: Hospital stay (4 indicators).

1. Bed utilization (3 indicators).
2. Surgical volume (5 indicators).
3. Performance of physicians (3 indicators).
4. Professional specialty (2 indicators). **(**Supplementary_material_appendix_1**)** (Refaat and Hadi, 2018; Health Insurance Organization of Egypt, 2024)

Qualitative data:

In-depth interviews were held with the head of the department and 4 head professors of the surgical units. It was a sheer dialogue guided by the policy briefs that displayed the situation for each unit. The surgical professors explained the causes of strengths, weaknesses, opportunities, and challenges (SWOC) facing department.

Data management and analysis:

All collected data were revised for completeness and logical consistency. Pre–coded data were entered into the computer using Microsoft Office 2010, Excel program.

Descriptive statistics were calculated for quantitative data. Composite indices were developed based on ranking and using the rank numbers and centile methods to develop a matrix for groups of indices. Centiles were used to categorize ranked data into three categories: Best Situation, Prospective Situation, and Critical Situation, presented in a Priority/ranking info-graph matrix. (Abdel-Razik *et al.*, 2023)

Calculation of composite indices: From ranking scores:

1. Ranking 8 department units according to the values of the indicators from (8: best situation to – 1: worst situation for all indicators mentioned before.

2. Calculate the total score for each category= sum of the ranks of indicators for each unit.

3. Calculate the maximum score for each theme (category):

Maximum Score for the category= Number of the indicators included in the category *8.

Example: Maximum score for hospital bed utilization = (3 indicators of hospital bed utilization* 8 which is the highest rank for the department 8 units= 24)

4. Calculate composite index for each category= total score for each category÷ maximum Score for the category*100

5. Rank ordering of 8 units for each composite index (%) for each category from the best situation to the worst situation (from 8 to 1).

6. Develop a colored matrix (info-graph) with a green zone to present a favorable situation and yellow zone to moderate situation and a red zone to present an unfavorable situation for intervention.

7. Setting of the category composite index value for 8 units across the 3 zones depends on centiles estimation.

Centiles statistical use for scores in the performance matrix to develop colored zones of each indicator:

1. Minimum score
2. Maximum score
3. Maximum- minimum = range
4. Range ÷3
5. Green zone (all cells of the column of indicator matrix scores) 3rd centile = Maximum score – range ÷3 (cut off point)
6. Red zone (all cells of the column of indicator matrix scores)1st centile = Minimal score + range ÷3 (Cut off point)
7. The yellow zone is the vertical cells in the matrix located between the green and red zones.

Analysis of the Qualitative data (derived from the in-depth interviews):

- The interview was transcribed, and coded and the data were analyzed.
- Copies of indicators and PB were presented to the Head of the department who submitted the PB to each surgical unit.
- Transcript data and field notes were organized in the form of SWOC analysis to cover simple questions which were the reasons behind having a special category of services and health impact to be in good or unfavorable situation in the displayed colored matrix.
- Analysis of qualitative data fell into three stages: data reduction (open coding), data display (axial coding), and conclusion drawing (selective coding). (Abdel-Razik *et al.,* 2023)
- The qualitative data extracted were summarized and organized to represent the perspective of the professional surgeons.

Ethical considerations

Ethical clearance for the study protocol was obtained from the Research Ethics Committee of the Faculty of Medicine, CU. (Reference number: MD-18-2022). Informed consent from each participant was obtained after proper orientation regarding the objectives of the study.

Results:

The total number of surgical procedure increased from 418 procedures /month in the preintervention to 467 procedures/month during the post intervention phase. Additionally, laparoscopic interventions were increased from 52.5% to 55.7%.

Table (I) portrays info-graph matrix elucidating pre-intervention and similarly table (II) for post-intervention. Both summarizes hospital bed utilization CIs (n=5) (across 8 units with colored cells according to traffic signals). The location of each unit in the matrix is dynamic and changeable from time to time because the matrix is composed of multiple CIs that differ in their value from time to time. Units (E, B) maintained excellence pre and post-intervention. Meanwhile, units (H, B, A) transcended post-intervention to become in the green zone (improved performance).

There were variations in the number of human resources per hospital bed in the eight surgical units. Four units have more nurses per 10 beds than other units (C, D, E, H). This information could guide

decision-makers to assign nurses to units F, G, A, and B. Generally there was a severe deficiency in the number of residents in all surgical units (except unit G). Lecturers who play a major role in capacity building of residents were less than 2 per unit except only in 3 units (C, E, G). Consequently, there is an urgent need to increase the number of professional surgeons and redistribute them among surgical units (table III).

Table (I): Info-graph matrix displaying "pre-intervention" ranking across the 8 surgical units according to score percent of "composite indices" General Surgical department - CUH November 2022- March 2023.

Rank order	Hospital stay index (4 KPI* indicators)	Bed utilization index (3 KPI* indicators)	Surgical volume index (5 KPI* indicators)	Physicians performance index (3 KPI* indicators)	Professional Specialty index (2 KPI* indicators)	Total
1st	E 97%	B 71%	E 73%	C 75%	D 88%	E 71%
2nd	C 69%	A 67%	G 63%	H 75%	G 81%	G 65%
3rd	G 63%	G 63%	H 63%	D 71%	F 69%	H 60%
4th	D 59%	E58%	B 55%	G 67%	E 56%	D 59%
5th	H 59%	H 54%	C 53%	E 54%	A 50%	C 56%
6th	A 53%	D 50%	F 53%	F 50%	H 44%	A 49%
7th	B 28%	C 46%	A 48%	A 29%	B 38%	B 45%
8th	F 22%	F 42%	D 45%	B 29%	C 25%	F 45%
Maximum score for each index	32	24	40	24	16	136

**KPI i.e. Key Performance Indicators*

Table (II): Info-graph matrix displaying "post -intervention ranking" across the 8 surgical units according to score percent of "composite indices" General Surgical department - CUH October 2023.

Rank order	Hospital stay index (4 KPI* indicators)	Bed utilization index (3 KPI* indicators)	Surgical volume index (5 KPI* indicators)	Physicians performance index (3 KPI* indicators)	Professional Specialty index (2 KPI* indicators)	Total
1st	G 88%	G 71%	E 75%	B 88%	B 88%	H 71%
2nd	E 81%	E 67%	B 65%	H 88%	H 88%	E 67%

3rd	**A 75%**	**D 63%**	**H 63%**	**A 67%**	**A 63%**	**G 64%**
4th	**H 72%**	**H 58%**	**A 55%**	**D 63%**	**G 56%**	**B 62%**
5th	**C 53%**	**F 54%**	**D 55%**	**F 58%**	**E 50%**	**A 61%**
6th	**B 41%**	**C 50%**	**G 55%**	**E 46%**	**F 50%**	**D 46%**
7th	**D 22%**	**A 46%**	**C50%**	**G 46%**	**C 31%**	**C 46%**
8th	**F 19%**	**B 42%**	**F 33%**	**C 38%**	**D 25%**	**F 40%**
Maximum score for each index	**32**	**24**	**40**	**24**	**16**	**136**

**KPI i.e. Key Performance Indicators*

Table (III): Info-graph matrix displaying distribution of Surgical Hunan Resources ratios by surgical units, CUH hospitals, March2022-September 2022.

Nurses /10 beds	Residents /10 beds	Lecturers /10 beds	Doctors/ nurses
Unit C 4.6	**Unit G 1.7**	**Unit C 2.5**	**Unit G 1.5**
Unit D 3.8	**Unit C 1.3**	**Unit E 2**	**Unit A 1.2**
Unit E 3.8	**Unit D 1.3**	**Unit G 2**	**Unit C 1.2**
Unit H 3.8	**Unit H 1.3**	**Unit F 1.7**	**Unit D 1.2**
Unit F 3	**Unit A 1.2**	**Unit H 1.7**	**Unit E 1**
Unit G 3	**Unit E 0.8**	**Unit D 1.3**	**Unit F 1**
Unit A 2.6	**Unit F 0.8**	**Unit A 0.9**	**Unit H 0.9**
Unit B 2.6	**Unit B 0.6**	**Unit B 0.9**	**Unit B 0.8**

Regarding the Average Hospital length of stay (ALOS) per patient for the pre and post intervention across the 8 units. There was a decrease in ALOS during post intervention compared to pre-intervention across all units. The average pre-intervention hospital stay 8.4 days per patient had reduced to be 6.7 days per patient. The differences between pre and post intervention ALOS per patient were 1.7 days that represents average wasted hospital bed days per patient before intervention (Figure 1).

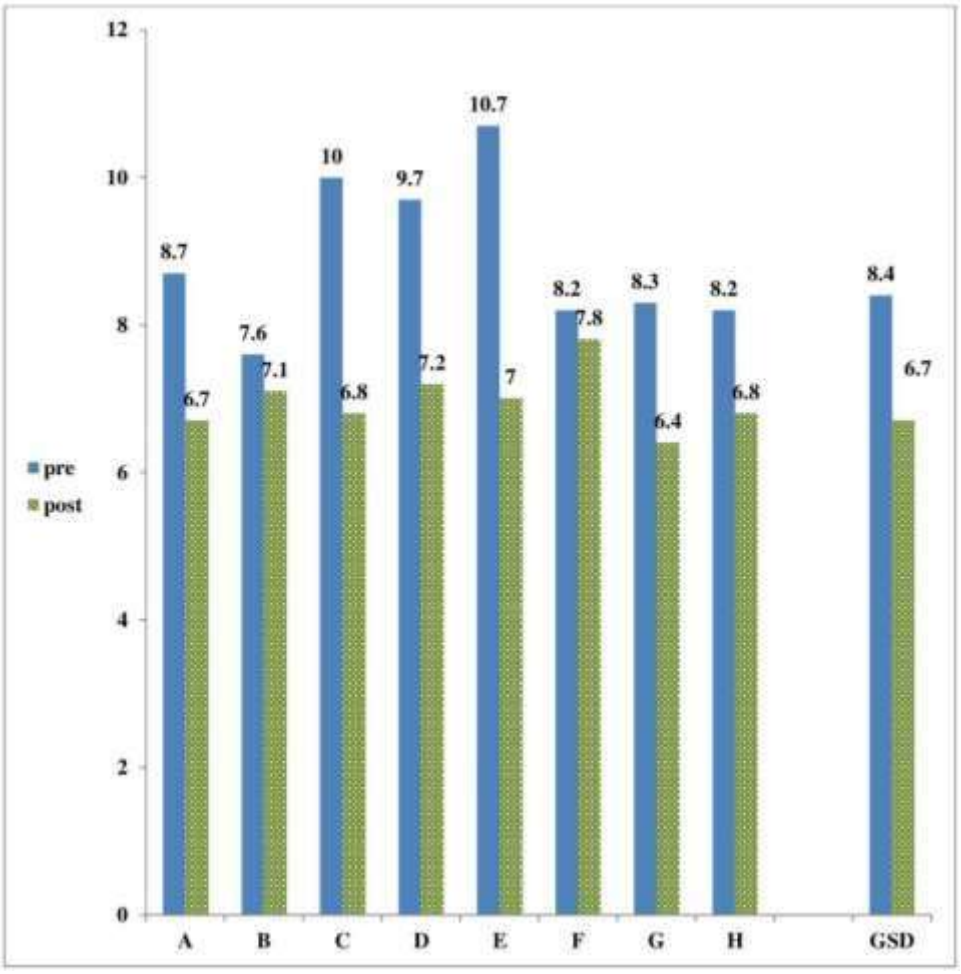

Figure (1): Pre- post intervention Average hospital length of stay- days per patient across the 8 General Surgery –CUH.

Pre- post intervention Bed occupancy Rate (BOR) across the 8 units. There was marked increase in the in BOR during post intervention compared to pre-intervention across all units. It was in pre-intervention was 56% had increased to be 76%. This a great success in efficacy in using hospital bed days (Figure 2).

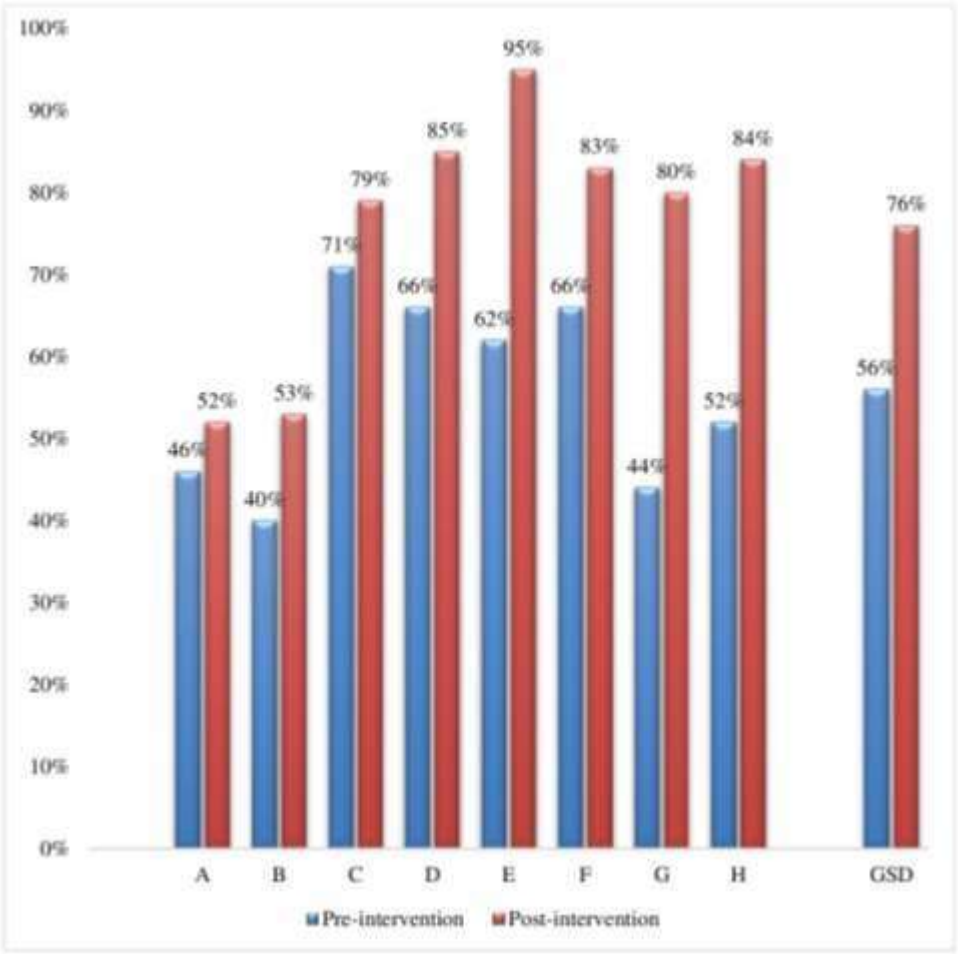

Figure (2): Pre- post intervention Bed Occupancy Rate across the 8 General Surgery Units–CUH.

Pre- post intervention in Bed turnover rate (BTOR) showed marked increase across all units from 6.6 patients/ bed to be 11.6 patients/bed (Figure 3).

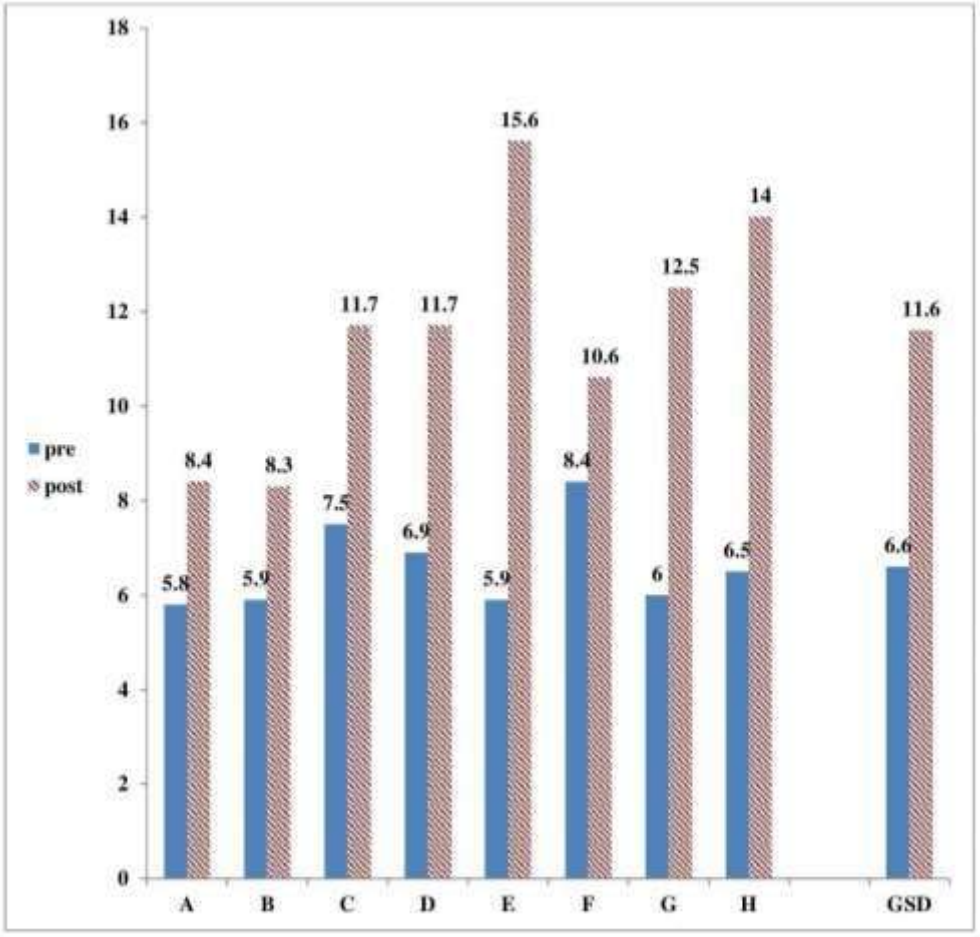

Figure (3): Pre- post intervention Bed turnover rate across the 8 General Surgery Units–CUH.

Qualitative data*:* Five days after the distribution of the PB to the heads of surgical, the researchers conducted in-depth interviews with the head of the department and two heads of the units who accepted/or had time to participate in the in-depth interviews.

- Major themes were derived from the interviewed professors and explained the variation of performance between various units.
- Data was summarized and organized utilizing Strengths, Weakness, Opportunities, Challenges (SWOC) analysis approach (Figure 4).

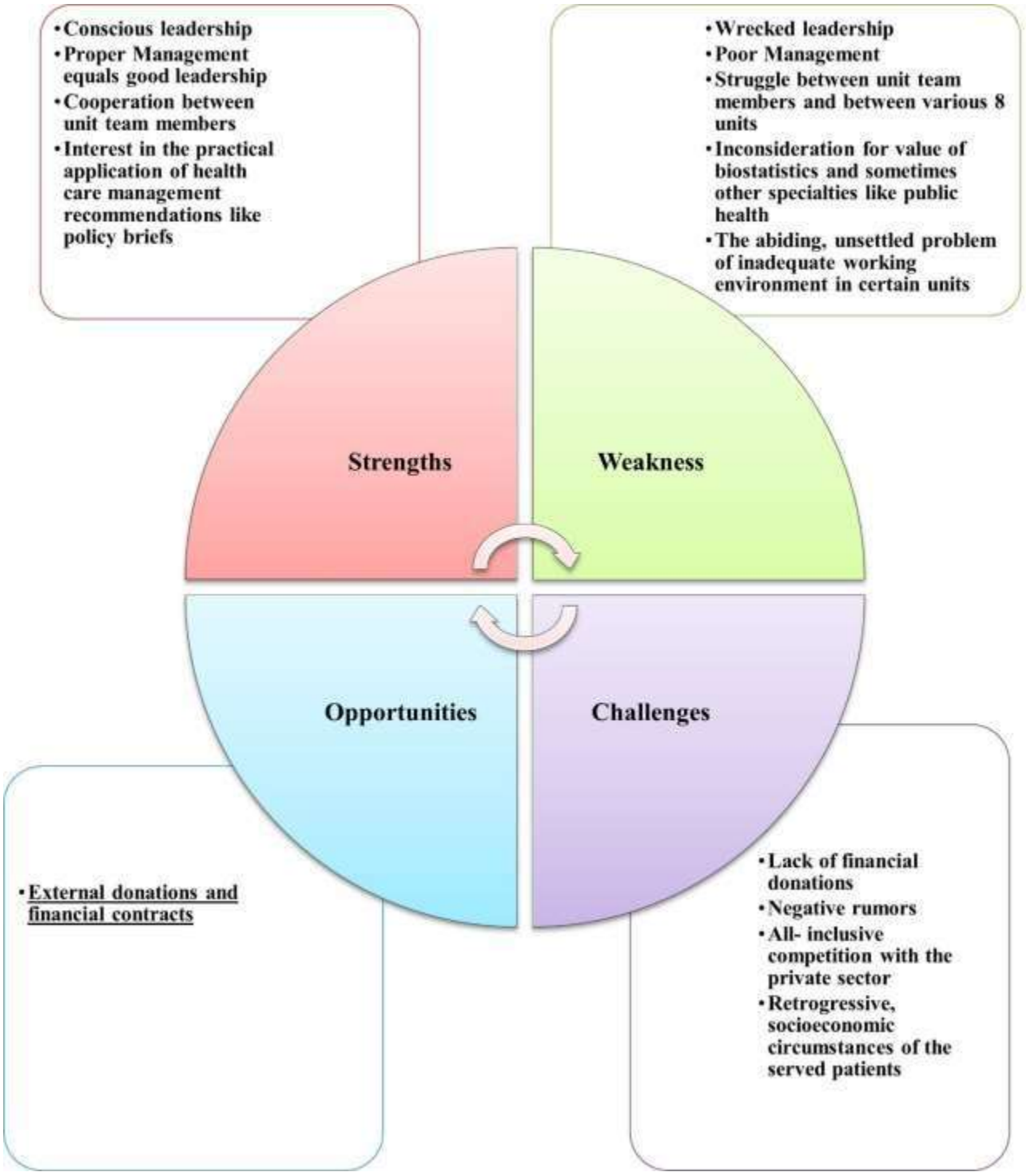

Figure (4): Summarizing Strengths, Weakness, Opportunities, Challenges (SWOC) analysis approach.

Discussion:

The current study has a holistic approach to the operational performance of the eight surgical units of Cairo university surgical department. The collected data could answer the major question which is: what are the items that distinguish each of the eight surgical units? Consequently, capitalization on such items could improve the whole performance of the department. Specific groups of data were collected from the eight units: resources such as the organizational structure of the staff, hospital beds

in each unit, hospital bed utilization/patients' cycle, and professional surgical operations. The data were transformed into information (KPI, CIs, and info-graphs). This facilitates the communication of evidence-based information designed as policy briefs to the head of the department, and individual heads of the 8 units. This approach was adopted by many other studies. This means that making changes to enhance performance was through human resources after being empowered by information (indicators) and knowledge (transforming information into required interventions). (Gil and Brammli-Greenberg *2018*; Reyes *et al.,* 2017) Both quantitative and qualitative data were employed to get more comprehensive information. The combination of quantitative and qualitative data collection methods is valuable for evaluating organizations.**(** Badila *et al.,* 2020)

Abildgaard *et al.*,(2016) highlighted that both quantitative (questionnaire data) and qualitative (in-depth interviews and focus group discussions) methods provide distinct knowledge about intervention processes in organizational evaluations. The study used approaches of mathematical maneuvers (not biomedical statistics) to facilitate the vitalization of data and indicators: (CIs) formulation, use of simple ranking to develop performance scores, splitting information into favorable and unfavorable situations by using centiles to aggregate indices into three zones as traffic signals. (McCrorie *et al.,* 2016) There are many sources for how to develop indices from different groups of data and indicators. For example, Human Development Reports are published at national and international Levels. Those reports aim to rank countries after calculating a composite index for each country to raise the interest of policymakers to work on human development issues related to health, education, economic, environmental, and social parameters. **(**Nardo *et al.*, 2008), Similarly, previous papers provided insights into the use and construction of CIs in the context of KPIs. (Refaat and Hadi, 2018; Mazziotta and Pareto, 2022; Abdel-Razik *et al.*, 2023). Chorfi *et al.*, (2020) proposed a mathematical programming approach for constructing CIs from a set of sub-indicators, specifically applied to the healthcare supply chain. Mazziotta and Pareto (2022) introduced a new approach to CIs construction, focusing on computing performance intervals for statistical units. CIs were developed for different groups of indicators. Several publications discussed the application of color coding in healthcare and highlighted its use for classification and identification purposes. Previous papers used color coding for ranking KPIs in different contexts including quality assessment, healthcare classification, and performance evaluation systems. (Shrivastava *et al.,*2014; Hey, 2017). Shrivastava *et al.*, (2014) evaluated various color quality metrics and found that the feeling of contrast is a good subjective preference indicator. Hey (2017) provided guidelines for selecting effective KPIs and emphasized the importance of specific, realistic, and benchmarked indicators. In the current study, we calculated 5 CIs (n=5), developed by raking scores, which considered replacing the value of each indicator for each unit (n=8) by ranking the score from good situation (8) to unfavorable situation (1). Consequently, working on rank scores to be percent of the maximum score allows aggregation of groups of indicators to form a composite index. Such procedure contemplates that the best situation of each indicator is the standard reference for the ranking process. Application of centile estimation to allocate the department units across three zones in the colored matrix as the traffic signals (Red, Yellow, and Green) according to ranking score percent was done before in a similar Egyptian study. (Abdel-Razik *et al.,* 2023)

The current study approach was to assess the performance in hospital units by focusing on the administrative registry and OR registry. Costa *et al.,* (2015) made a similar approach and measured the quality indicators in the OR, particularly turnover time and performance levels, in a public university hospital.

In the current study, using CIs simple ranking identified priority for improving efficiency and effectiveness by improving bed utilization indicators in E, G, and H Units and other units as C, H, and D units the priority was improving physicians' performance and decreasing the surgical cancellation rates. In hospital care milieu, a hospital bed is a costly, sparse piece of merchandise. Average length of stay (ALOS) and Average preoperative length of stay are indicators used as measures of efficacy. ALOS refers to the number of days each admitted patient stayed in the hospital. It is often better to compare homogenous group of hospitals that have a similar case-mix. (Aloh *et al.*, 2020) The units studied here all belong to general surgical department and are known for treating almost the same kind of patients (homogenous). A shorter stay would decrease the cost per case. However, too short a period of stay may also have negative effects on health outcomes or decrease patient satisfaction and recovery. This leads to higher rate of readmission; costs may even increase.(Shahu *et al.*, 2021)

BOR is a measure of utilization of the available bed capacity in the hospital, and it indicates the percentage of beds occupied by patients in a given period of time. It reflects efficiency in the use of hospital beds. HIO set 75% as the standard BOR. (Health Insurance Organization of Egypt, 2024)

In contrast, Borkar and Thorat (2017).considered that BOR above 85% have a negative impact on the safe and efficient operation of a hospital and leads to increased risk of hospital acquired infection, serious errors, staff consumption of antidepressants and higher mortality. BTOR measures productivity of hospital beds, and it represent the number of patients treated per bed in a defined period of time. BTOR of chronic care hospitals such as orthopedic or teaching hospitals are expected to be lower than those of acute care hospitals (Aloh *et al.*, 2020)

Efficient bed management is crucial for better utilization of hospitals. Hospital utilization indices are sensitive indicators to find pressure areas and thus help in the proper allocation of hospital resources and forming better healthcare policies for hospitals. Calculating hospital bed indicators is important for efficient bed management and gave insights into utilization patterns and trends in different hospital settings.**(** Alatawi *et al.*, 2020)

Regarding human resources, our study calculated the number of nurses, residents, and lecturers per 10 beds and the doctors to the nurses ratio. This goes in accordance with similar studies that calculated the percentage and distribution of human resources. Such papers highlighted the challenges and deficiencies in managing human resources in healthcare organizations. For example; Zhu *et al.*, (2021) found that hospitals faced shortages and improper distribution of manpower, particularly in nursing units. More studies emphasized the complexity of managing personnel in healthcare organizations, requiring activities such as attracting, training, and developing employees, as well as flexible policies to adapt to changing environments to achieve productivity, service quality, and patient outcomes. **(**Simon, 2020)

Classification of each surgical procedure was skill, major, intermediate, and minor. National Institute for Health and Care Excellence (NICE) guidelines classified the surgeries into major/ complex, minor, and intermediate. Classification of each surgical procedure as open and laparoscopic, aimed at measuring the utilization pattern of each surgical unit. These classifications help to demonstrate the surgical skills gained by each physician according to the surgical pattern of each unit and to map the standard requirements of each unit for simpler resource allocation.**(** O'Neill *et al.*, 2016)

In-depth interviews with action takers guided by an info-graph colored matrix for KPI (study

intervention) was the qualitative method utilized by the researcher. In these dialogues, the participants were the decision makers [the head of the department and the representative professors] The advantage of such dialogues is that in the pre-test, the units' decision-makers set their plans to solve common problems. Previous papers supported that feedback of information to decision makers is an important intervention in healthcare organizations. **(**Korshever and Pomoshnikov 2022).

PB given to the decision makers of the units included a brief introduction, methods, the major findings, and the recommendations. Several papers discussed the use of PB as an intervention for healthcare organizations. O'Brien et al. proposed a shared decision-making model and a decision-making platform to improve the quality of strategic decisions in healthcare management, he emphasized that PB, along with evidence-based informed priority setting, can support decision-makers in making better healthcare decisions . (O'Brien et al., 2019)

Limitation:

The study design is a pre-test-posttest intervention study, with no control group. However, working in 8 units allowed capitalizing on this situation and making all the units test and control facilities between each other. Additionally, service statistics could be affected by defective patient files and poor documentation. However, working in all units and with all patients at specific times reduces such bias.

Conclusion:

The introduction of a monitoring and evaluation model using operation research tools supports surgical units heads in evidence-based decision-making and improves the efficiency of the performance of surgical units. Effective communication between the clinical departments and the health information system unit improved the department performance through transparency and accountability.

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Declarations:

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Author Contributions:

Each author has made a substantial contribution to the following.

- **Dr. Madiha Said Mohamed Abdel-Razek**: the conception and design of the study, drafting the article, and final approval of the version to be submitted.
- **Dr. Ahmed Abdel-Hamid Taha**: interpretation of data, revising the article critically for important intellectual content, and final approval of the version to be submitted.
- **Dr. Shaimaa A.M. Abd El Fatah**: analysis and interpretation of data, drafting the article, and final approval of the version to be submitted.
- **Dr. Yomna Mohamed Ali Bayoumi**: acquisition of data, drafting the article, and final approval of the version to be submitted.

Dr. Asmaa Abdelnaby: acquisition of data, drafting the article, and final approval of the version to be submitted.

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