

Developing strategic health care key performance indicators for assessing and improving the information system of operating room theaters

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Abstract: Healthcare information system has always been a trending topic in public sector researches. The healthcare industry is a particular environment, characterized by high product and process complexity. The lack of resources is forcing the sector to be more and more efficient compared to the needs of customers.

In order to measure operating room performances, hospitals need scorecards or dashboards displaying and tracking core performance indicators. The major constraint of service providers is their inability to match their performance priorities with the customers' priorities, perception and expectations. In order to overcome these issues, it becomes important to adopt a suitable performance measuring system, based on Key Performance Indicators (KPIs), which is developed through the active participation of all relevant stakeholders. Indicators ideally should consist of data already available in Operating Room (OR) information systems, and qualitative measures, such as satisfaction surveys.

Given this scenario, the development of an adequate monitoring system allows to intercept in real time the alarm signals given by a drift on one or more aspects that are considered by this study: efficiency performance, level of service, quality and customer satisfaction.

The purpose of the study is explorative and explanatory, with the aim of determining which indicators are most important for inclusion in developing a scorecard for measuring and monitoring OR performance and also to fill the gap in the literature, due to the lack of specific industry contributions.

In order to create the dashboard of indicators, after a first part of literature review that provides an overview of all the KPIs adopted and monitored in the operative block, collected thanks to the experience of the experts directly involved in the study, the number of KPIs was reduced using the Delphi method in order to define the definitive dashboard.

Keywords: Second-stage DEA, KPIs, Hospital efficiency, Organization, Innovation, Performance Measurement System

1. Introduction

The lack of resources is forcing the healthcare sector to be more and more efficient compared to the needs of customers (both as patients but also as lenders, see the Regions) and, paraphrasing one of the main marketing dogmas, must offer the right product (intervention and subsequent checks), in the right place and at the right time (within decent time). Quality is also fundamental, as it allows to limit the cases of readmission and consequent waste of resources. Given this scenario, the development of an adequate monitoring system allows to intercept in real time the alarm signals given by a drift on one or more aspects that are considered by this study: efficiency performance, level of service, quality and customer satisfaction.

1.1 Operating Room efficiency challenges

The Operating Room (OR) is a convergence of resources uniting people, equipment, coordination, and time. The need to coordinate different professional skills in the management processes of an operating room brings with it inevitable management difficulties. Thus, nowadays hospitals not only compete for the number of patients but

also the type of patients in terms of case complexity. In addition, public hospitals also compete for private patients, not only with private hospitals but also among themselves (Hall & Savage, 2005).

The governance of management complexity requires not only the involvement of different professionals for the analysis of all the salient aspects, but also the need to use appropriate indicators for the continuous monitoring of activities to ensure, in case of need, the timeliness of the necessary corrective actions.

1.2 Italian healthcare system

Healthcare is provided to all citizens and residents by a mixed public-private system. The national level is responsible to allocate healthcare resources and ensuring a uniform level of service. The central government sets the general objectives and fundamental principles for the national healthcare system. Recent reforms have delegated administrative, financial and organizational responsibility to the 20 Italian Regions.

The Sistema Sanitario Nazionale (SSN) is controlled by regional governments and is administered by local health authorities (“Azienda Sanitaria Locale”/ASL - often

referred to by their former name “Unità Sanitaria Locale”/USL) (De Nicola and Gitto, 2013). Regional governments are responsible for legislative and administrative health functions, planning health care activities, organizing supply and monitoring quality, appropriateness and efficiency of the services provided (Lo Scalzo, 2009).

1.3 Hospital Performance Evaluation

Performance evaluation plays a strategic role in healthcare organizations, in order to address the best use of resources and rationing of demand. Lack of resources has obliged to analyses and monitor technical efficiency of existing hospitals in order to improve hospital performance, so as to employ medical resources effectively and make the healthcare system more efficient and sustainable. Hospitals can use different tools to measure the performance of the whole or part of operations in the effort to improve their effectiveness, efficiency and customer satisfaction. Analysis and management tools include Total Quality Management (TQM), Balance Scorecard (BSC), Key Performance Indicators (KPI) and benchmarking, used with varying degrees of success (Paranjape et al., 2006). In general, adopting any performance measurement tool brings advantages and disadvantages. Two factors are responsible for failure to implement an effective performance measurement system (PMS): the first is a wrong design of the measurement system; the other the difficulty in implementing such systems (Neely and Bourne, 2000). This left a wide gap between what to measure and how to measure it (Amaratunga and Baldry, 2003). In order to overcome these challenges, it is necessary to use performance measurement tools that can facilitate data collection, analysis and application; these and others can be achieved by adopting the KPIs tool.

However, since there is not yet a complete and certified list of KPIs for the OR used in the various organizations and functions, each organization develops its own set of KPIs leading to an innumerable number of measurement of performances and a consequent difficulty in carrying out benchmarking. However, the most effective KPIs are those developed through consensus creation with the active participation of core operators and support services or customers and service providers. Here comes the Delphi technique to generate consensus between the organization (Hinks and McNay, 1999; Grisham, 2009; Xia and Chan, 2012).

It should be noted that this is still a relatively unexplored topic in the literature. If much has been written on the themes of the associations of general practitioners and their budget system (Longo and Vendramini, 2001; Tozzi and Tedeschi, 2004; Vendramini and Corsalini, 2010), little has yet been published on the topics of performance measurement, especially in relation to the availability and use of indicators relating to both the assistance provided by general practitioners and to other services offered at the district level.

1.4 Research Objectives

The purpose of this study is to develop and define strategic Health Care KPIs for assessing and improving the

information system of OR Theaters and determine if it is possible to create a common KPI dashboard for OR at a national level.

2 Methodology

The information required to develop performance indicators can be obtained using systematic or nonsystematic methods. Nonsystematic approaches such as case studies are based on data availability and real-time monitoring of critical incidents (Pringle, 1998). Although these approaches play an important role, they fail to exploit much of the available scientific evidence. In systematic approaches, in contrast, indicator selection relies directly on the available evidence, complemented when necessary with expert opinion (Campbell, 2001; Hearnshaw, 2001). Experts examine the evidence and reach a consensus. Systematic methods enhance decision making (Hasson et al., 2000); facilitate the development of performance indicators (specially about outcomes and customer satisfaction) or review criteria for areas where the evidence alone is insufficient or controversy (Fink et al., 1984); and synthesize accumulated expert opinion. Among these methods, the Delphi technique has been widely used for indicator development in healthcare.

The empirical part is based on data provides from Estar (Ente di Supporto Tecnico Amministrativo Regionale) where a constructive research approach is used to create a performance measurement model in order to measure outcomes and customer satisfaction level. The findings from the empirical research are reflected against the theoretical background and a reviewed performance measurement framework is created based on the different forces affecting the measurement system. In order to identify the hospital's performance indicators, first related literature has been reviewed and then the experts' panel and Delphi method have been used.

A search of the literature for articles on PubMed, Scopus, Sciences direct, Google scholar, DOJA, SID, Research Gate, Taylor & Francis, and other databases has been conducted. Keywords used for searching was a combination of “performance”, “operating room”, “KPI”, “assessment”, “measurement”, “hospital”, “indicator”, “evaluation” and “criteria”. The Boolean AND / OR operators were placed between keywords in the searches. A total of 39 studies were identified for inclusion in the review. The search of database provided a total of 8.810 citations. Initially, the title of all the articles was checked out and 7.998 were excluded owing to contradiction with the study objectives. After adjusting for duplicates, 39 articles were remained.

At a methodological level, it is interesting to proceed to the evaluation and selection of the most significant KPIs, trying to identify them as a function of three families (Calzolaro 2012):

- KPIs that measure *efficiency performance*, i.e. the ability to use resources. The indicators measure the productivity and unit costs with which the process outputs are obtained;

- KPIs that measure the *level of service*. The indicators measure the response times to customer requests and the flexibility of the supplier;

- KPIs that measure the *quality*, that is the conformity of the outputs with respect to the client's expectations.

Among these 3 areas, *customer satisfaction* is not mentioned. It is difficult to evaluate in objective terms but becomes important in order to monitor the customer's perspective, not only in terms of survival and maintenance of a good state of health, but also in terms of effectiveness of care. - *Customer Satisfaction* becomes the fourth macro-category. It is important that the system is oriented towards a logic of continuous improvement of the quality of the performances.

These macro-indicators measure all aspects of an intervention or health system in terms of patient perspective and of staff perspective.

2.1 Performance measurement system characteristics

The goals of the business organizations are usually referred to as the strategic goals and objectives. The important feature but usually not explicitly expressed in the PMSs literature are the support structures, which can include data acquisition, collation, sorting, analysis, interpretation, and dissemination (Neely, 1998; Franco-Santos et al., 2007). Kaplan and Norton identified four perspectives of measures that have to be balanced: finance, internal process, customer, and learning and growth (Kaplan and Norton, 1992). In addition, in a further work, they suggested that the number of measures can be from 4 to 7 in each heading (Kaplan, 2012)

For healthcare firms, PMS is a relatively new branch of research, playing an important role in operations and in business strategy implementation. A PMS can help in giving the requisite information for the monitor, control, evaluation, and feedback functions for operations management. In terms of effectiveness, achieving a higher level on product reliability might lead to greater customer satisfaction. Explaining this statement in health terms it could say that having under control operating room processes increase a positive satisfaction level of the patient. In terms of efficiency, it might reduce the costs incurred by the business through decreased field failure and warranty claims. Once again, this means that hospitals can decrease their re-admission rate after an operation.

Franco-Santos et al. (2007) suggest that three processes of PM construction can be highlighted: namely "provision of information", "planning and selection of measures" and "acquisition of data". In the current PM literature, there is not only a single interpretation on maintenance of performance. In conclusion, the accuracy of the PMS is something that must be tailor-made built.

2.2 Identification of operating room efficiency indicators using Delphi Technique

To measure OR performance and their efficiency, hospitals need scorecards or dashboards displaying and tracking core performance indicators. The main challenge in developing

a scorecard for measuring and monitoring OR performance is determining which indicators are most important for inclusion. The major constraint of service providers is their inability to marry their performance priorities with the customers' priorities, perception and expectations (Hinks and McNay, 1999). In order to bridge this divide, there is need to adopt suitable performance measuring system, such as KPIs, which are developed through the active participation of all relevant stakeholders (Beatham et al., 2004). Indicators ideally should consist of data already available in OR information systems, and qualitative measures, such as satisfaction surveys. However, variations between hospitals are possible in terms of which data elements and indicators are collected and analyzed, making external benchmarking difficult. Only with uniform data and indicator definitions hospitals proceed with benchmarking and maybe share knowledge, and best practices. In order to reach consensus, the Delphi technique is used. This method is useful where information gathering and feedback from interested parties (experts) are difficult due to external commitments, geographical limitations and the need to ensure anonymity (Geist, 2010; Xia and Chan, 2012). The basic principles underlying the Delphi technique include the identification and use of participants similar to the hospital environment that can respond to the research question (Franklin and Hart, 2007). The group interacts with the same problem through a series of iteration processes, in which the information of the previous iterations are communicated to all the participants. All requests are processed through a coordinator or a central facilitator, who reports feedback to participants after each iteration (Green and Price, 2000; Franklin and Hart, 2007).

The contribution of each participant is treated anonymously and no participant can be traceable to its contribution and vice versa. Consensus is reached by adopting the stipulated benchmark agreed upon at the beginning of the exercise. In the classic method in the first round the participants generate perspective solutions to the research question. The iteration process then starts from the second round. In the modified method, a list of generic solutions is given to the participants in response to the research question from the first round (Franklin and Hart, 2007). Then, the iteration process starts already in the first round.

Through the ARS Toscana (Agenzia Regionale Sanitaria Toscana) the potential stakeholders of the activity were contacted. To ensure effective participation, potential participants were involved in one-on-one interaction where possible (Day and Bobeva, 2005; Donohoe and Needham, 2009). The present study started in November 2017 and ended in April 2018, involving 9 experts, whose job descriptions are summarized in Table 1. The coordinator collects the answers and recirculates anonymous feedback to all group members. The process continues until the unanimous consent is reached, through iteration. There are no a priori rules defined regarding the number of rounds in the Delphi method. What matters is that the level of consensus or convergence of opinions is reached or the participants are no longer modifying their previous decisions (Franklin and Hart, 2007, Adnan and Daud,

2010). To compete in any case with scientific research, in some papers it is possible to find a consensus percentage between 51 and 80% agreement among the participants (Hasson et al., 2000).

The participants for the research were selected from the strategic level of the healthcare units. To qualify, each participant was expected to have served in their current position for not less than one year or not less than five years as staff of the respective department (Ogbeifun et al., 2016).

Table 1: Delphi participants

Professional Category	Participants during all phases	Round	Round II	Round III
Health management	5	6	5	5
Surgeons	4	7	6	4
Nurses	3	4	3	3
ICT delegates	4	4	4	4
TOTAL	16	21	18	16

In total 21 people were recruited assuming a 25% drop-out rate during the sessions and a target number between 15 and 18. Respectively 21, 18 and 16 experts participated in each of the three rounds of the Delphi activity, meeting the minimum conditions of the sample size for Delphi participants (Hallowell and Gambatese, 2010). The list of KPIs were given to the participants in order to be evaluated in a Likert scale between 1 and 5, where 1 is the minimum score and 5 the highest score. It was agreed that only articles with a score greater than 2.0 would pass to the next round with the obligation to maintain 7 for efficiency category, 4 for quality and 2 for each other category of indicator. Before reaching unanimity of opinions, the method went through three cycles of successive iterations of information. The statistical average was used to obtain the level of consent (Day and Bobeva, 2005; Adnan and Daud, 2010). After analyzing each iteration, the elements that did not measure up to 3.0 benchmarks did not exceed the next round.

3 Main results

The participants for the research were selected from the strategic level of the healthcare units. To qualify, each participant was expected to have served in their current position for not less than one year or not less than five years as staff of the respective department (Ogbeifun et al., 2016). The participants were asked to choose, from a set of indicators proposed, for each single Dimension, those preferable to represent the Dimension itself in the process of defining the Performance. One simplification has been adopted: the predetermination of the set of indicators is chosen by consulting ARS Toscana, which selected them according to various criteria, i.e.: Availability at Regional level; replicability; specificity (compared for the project); standardizability; robustness.

Finally, throughout the help of internal expert panel, 71 indicators were selected. It has been asked to them to rank the most important indicators. The generic list of KPIs was circulated in the first round. The indicators that did not pass the score of 2 were rediscussed and then eliminated.

The experts rated the importance of the indicators, on a five-point Likert scale (“Not important,” “Somewhat important,” “Relative important,” “Very important,” and “Extremely important,” respectively). The required level of consensus was defined. Two necessary conditions had to be fulfilled:

1. a minimum value of at least 3 (Relative important, very important and Extremely important);
2. a consensus percentage of at least 80%. In the consensus calculation, the consensus percentage was calculated by classifying the values 1-2 as not important (0) and 3-4-5 to (1) as important.

The following Table 2 shows the Delphi scores of all the three rounds. Due to space constraints only the indicators that have passed the second round have been included.

Table 2: Delphi Scores

KPI	Round I	Round II	Round III
Occupancy Rate	3.6	4.44	4.29
Starting on time	3.47	3.78	4.36
Surgeries / Scheduled Number of Surgeries	4.0	4.56	4.64
Turnover Time	3.27	4.11	4.79
Discharge Process Time	3.47	4.67	4.50
Average delay	3.13	3.89	4.57
Operating Room Turnaround Time	3.8	4.56	4.57
Mortality rate	3.27	4.33	4.07
Readmission rate	3.27	4.22	4.64
Perception of waiting times from taking charge to discharge	3.27	4.11	4.64
Patient Wait Times by Process Step	3.33	3.89	4.93
Employee absenteeism rate	4.22	4.29	
Waiting time for admission operation room	3.20	2.82	
Rate of Patient complaints	4.20	4.22	4.93
Staff turnover	4.56	2.64	
Quality of Nursing Care	3.4	3.78	4.88
% Repeated surgeries	3.27	4.22	4.29
Number of Mistake Events	3.6	4.22	4.21
Social satisfaction	3.93	3.73	
Perception of waiting times from taking charge to discharge	3.27	4.11	4.64
Patient Wait Times by Process Step	3.33	3.89	4.93

Employee absenteeism rate	4.22	4.29	
Waiting time for admission operation room	3.20	2.82	
Rate of Patient complaints	4.20	4.22	4.93
Staff turnover	4.56	2.64	
Employee Satisfaction	3.73	3.99	
Patient Retention Rate	3.81	4.14	
amount of the electronic medical record	3.46	3.95	
Vacancy Rate	3.72	4.21	
Makespan	3.82	4.23	
Waiting time of surgeons	3.1	3.37	
bed turnover	3.54	3.65	
Patient falls rate	3.77	3.93	
Hospital accidents prevalence rate	3.98	3.21	
Sentinel event rate	3.44	3.67	
Employee Satisfaction	3.73	3.99	
Patient Retention Rate	3.81	4.14	
amount of the electronic medical record	3.46	3.95	
Vacancy Rate	3.72	4.21	
Makespan	3.82	4.23	

Confirming what is written in Hasson et al. (2000) and Mullen (2003) papers, in round two more indicators were eliminated. This is an indication that the participants changed their opinion from the rating they provided in the first round. Continuing to quote Hasson and Keeney (2011), experts changing their opinion should be seen as strength and not weakness, because the fact that opinions can be compared in the same research is seen as an added value to the Delphi method. The controlled feedbacks allow participants to view their individual submissions in the light of the whole group, tailoring the opinion of the participants towards group consensus (Hasson and Keeney, 2011; Ogbeifun et al., 2016). The scores on each item improved in the subsequent rounds. In the second round the minimum for the qualification was moved to 4 on the Likert scale. The KPIs who reached the minimum in the second round were re-proposed in the third round to allow the participants to interact again. After analysis, the number of items were retained until a consensus of at least 80% was reached. The developed KPIs are shown in the Table 3.

Table 3: Developed KPIs

PMS perspectives	Indicators	Indicators
Efficiency performances	Starting on time Surgeries / Scheduled Number of Surgeries Turnover Time	Occupancy Rate Discharge Process Time Average delay

	Operating Room Turnaround Time	
Quality / appropriateness / Outcome	Mortality rate Number of Mistake Events	% Repeated surgeries Readmission rate
Level of Service	Patient Wait Times by Process Step	Perception of waiting times from taking charge to discharge
Customer satisfact	Rate of Patient complaints	Quality of Nursing Care

The quality of KPIs in the medium and high priority categories are adequate performance indicators that can guarantee better performance, verifying that the Delphi technique is a reliable tool for building consensus.

According to the results, 15 indicators were selected for KPI of hospitals using the opinion of the experts' panel. 7 indicators were selected in efficiency/operations perspective, 4 for Quality/Care and 2 for each for the other categories. Through this study, operating room theatre hospital indicators were classified based on a sort of balance scorecard under four categories as efficiency, customer satisfaction, level of service and quality.

4 Conclusions and future work

Once a performance measurement system has been developed it has to be implemented. This means that the performance measurement system will have to interact to two different dimensions of the environment (Neely, 2005). The first is the organization itself - the internal one. The second is the external one – that is the market within which the organization competes. We assumed to consist of two distinct elements – customers and competitors. In healthcare terms, it means that a Hospital competes, for instance, with national excellence (Interregional Mobility) or with proximity hospitals around the same Regions (this event impacts differently on a financial level).

As written above, the external environment is assumed to consist of two distinct elements, customers and competitors. The technique that has been chosen to measure this perspective is Benchmarking. There is a wide literature on the benefits deriving from the adoption of specific departmental information systems for the operative room block management (Van Essen, 2012; De Deyne, 2004; Dexter, 2003), appropriately integrated in the hospital information fabric.

However, it is important to note that these systems are effective in creating and dynamically managing the management procedures already identified as being optimal for the reference operating sector; guaranteeing, in other words, an excellent tool for the realization of previously designed optimization and control strategies. In particular, in addition to offering the operating calendar scheduling tools, they support operators in rapid rescheduling of activities in case of unforeseen events, delays or cancellations.

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