

## **Developing Goodson's model for rapid performance assessment of emergency department**

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### **Abstract**

Over the past years, raising costs of health care in most countries cause to attract more attention to different aspects in the field. One of the best improvement methodologies known in literature is based on lean principles. The main aim of this methodology is to create values in the system by eliminating losses and creating continuous efforts toward improvement. Therefore, by measuring the performance of hospitals based on lean principles, and by identification of critical factors that function as obstacles to the execution of this approach and also by rating them, health centers can be led toward application of the principles of lean thinking.

This study has aimed to develop Goodson's rapid performance assessment for health centers based on lean principles to measure their efficiency. Unlike other performance evaluation models, this model does not require abundant primary data and long time for survey. The proposed model helps managers to receive optimum feedback towards their performance in fastest possible time.

The performance of emergency department of a large hospital in Tehran is investigated by our model. After observation, scoring and analysis, the proposed results for the revision of supply chain systems and repair equipment Emergency Center are presented.

**Keywords:** Performance evaluation, emergency department, rapid performance assessment, lean principles.

### **1- Introduction**

In recent years' services have found special importance through people and organizations, so from 1980 services were considered as a specific concept. In all organizations, quality is a competitive tool. Since managing the quality has a significant role to improve effectiveness and efficiency of system, thus elaborating the quality will cause customer satisfaction, cost reduction and profitability increase. One of the most important performance improvement methods which were introduced by Toyota Company was lean production.

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This method caused significant success in production sector of this company. today lean system is one of the most advanced systems in planning and control which has attracted much attention in order to raise quality level in production systems. Lean System focuses on two principles: a) Create value b) Remove MUDA (removable and worthless activities). In following years due to the outcome of this procedure, Lean approach accounted a special position for itself in service sector ( Decker & Stead, 2008). One of the most important service sectors are health systems due to their high sensitivity and direct relation with needs of community.

Recently, costs of hospital services are increased in most countries, so that hospitals consume 60% of total health costs ( Graban, 2012). Quality problems caused by congestion and delays at the hospital and also rising costs of treatment, led to complaints and grievances of patients. The reason of these delays is existence of some problems in process design and materials flow ( Mazzocato, et al., 2012).

Lean System is a proper solution which is recommended to solve cost and quality issues in health systems (Staudacher, 2008).

Therefore, to ensure the proper implementation of Lean thinking and principles in hospitals, a performance evaluation system should be designed to examine lean indicator constantly. This paper investigates the emergency department as one of the critical parts of hospital that generally has many wastes in its function due to lack of time and resources. This study is an attempt to develop professor Goodson's evaluating model in health systems in order to obtain a model for measuring emergency department's performance. Then, to assess efficiency of model and determine system consistency with lean principles, a teaching hospital in Tehran was evaluated using this model.

## **2- Literature review**

The idea of lean production was created in 1960 based on preventing mass production due to lack of economic justification in Japan and avoiding wastes. Then MIT with the help of some manufacturing companies and institutions started an extensive studies and activities to enforce lean principles within the framework of a project called International Program motor vehicles in 1985 ( Womack, et al., 2007) , (Toni & Tonchia, 1996).

Nowadays lean is one of the most advanced planning and control systems and because of its numerous accomplishments that achieved in production systems it's also used by services sector. In 1970 for the first time it was expressed that developments and experiences in lean manufacturing may also be used in services to improve the cost and quality (Bowen & Youngdahl, 1998). In 1989 Shouldice hospital, in addition to routine medical activities, put expected customer value and efficiency of the hospital as a priority and they achieved good results in their process (Bowen & Youngdahl, 1998). Laursen et al. (2003) introduced lean principles as a way to improve hospital performance; they also reviewed difficulties and obstacles in implementation of lean thinking in health centers. Yang and his colleagues examined the effects of lean in Hospitals waiting time improvement they introduced, separating patient pathway from flow of value as a challenge and they claimed that implementation of this in hospital is more difficult than manufacturing sector. They also declared that lean principles in healthcare systems can eliminates delays, rework, errors and improper methods (Young, et al., 2004). In 2005 Miller investigated on how to transfer lean principles from manufacturing sector to health systems(Miller, 2005). In 2008, Rajput through investigating England's medical centers about implementation of lean, considered its advantages and disadvantages, moreover he tried to solve these complications by expressing few recommendations (Rajput, 2008). In the same year Castro et al. (2008), published a comparative article in order to improve health system of England, in this comparison, higher efficiency of lean centers was shown. Bushel et al. (2002) stated that developing lean principles can help systems to reduce waste time and increase work flow and finally these changes will lead health system to progress. Staudacher (2008) with a case study expressed an experience of lean being in an Italian hospital. In this article he found that by implementing lean rules in a hospital there is less need to spend effort and cost, more over services will be done faster. Dickson et al. observed an emergency department as a case study before and after applying lean principles. They study few factors such as: Operation output, patient satisfaction, cost per patient and duration of treatment to measure performance and efficiency

improvement ( Dickson, et al., 2009). In 2012 Bhasin with regard to lean principles and also evaluation criteria in balanced scorecard method, examined the impact of lean methodology on quality management (Bhasin, 2012). Krogstie and Martinsen (2013) by choosing a health center as a case study and applying two methodologies of six sigma and lean at the same time, to improve the performance of the center, measured its performance. According to previous studies, the rate of failure of lean implementation at health system is between 50% and 95% (Thelen, 2016). Narayanamuthy, et al. (2016) considered three factors which are necessary to implement lean successfully in medical environment: preparation (pre-implementation stage), commit to lean principles (implementation phase) and performance evaluation of benchmarks (stage after implementation). In another study they referred to three factors as the main cause of failure lean implementation in health sector which are mismatch, lack of readiness and lack of system approach. They emphasize the necessity of performance measurement of lean criteria, while explaining the readiness step (Narayanamurthy, et al., 2018).

### **3- Methodology**

According to credible and useful results obtained from implementation of lean principles in previous studies, many organizations are trying to use this methodology to improve their own performance, while that situation of many organizations are significantly far from lean being. Rapid assessment model is one of lean measuring tools that managers can use it to assess their organization current performance quickly and according to that, they can adopt optimal strategy. For the first time, rapid assessment methodology raised by professor Goodson from university of Michigan to evaluate performance of production centers (Goodson, 2002). Makui et al. (2014) develop this model and by introducing TRA model, it was completed. Professor Goodson created his model based on strengths and weakness of many companies in which he had experience of working. He believed that for the discerning eye (trained eye) a short, 30-minute, rapid turnover in the factory can reveal a lot of hints. This method helps managers without requiring extensive basic information and by spending least possible time, diagnoses their organization rapidly and shallowly to Following its possible errors and take action for improving system. The information that this tool offers to managers can lead to identify strength and weaknesses of organization, so if they well managed, it can boost the performance of organization and promote its status. Undoubtedly rapid assessment process is not an alternative to other systematic performance measurement methods, but it is a parallel and complementally effort. However, most managers usually ignore visual information and they scarify it for quantitative information. As a result, favorable opportunities to identify strengths and weaknesses will be lost. Rapid Emergency assessment indicators are as below:

#### **3-1- patient satisfaction**

In an emergency department which meets criteria of lean thinking, all personnel are aware of treatment process that leads them to understand patient's needs and wishes carefully and consciously during treatment process. Paying attention to patient's requirements make it easy to identify factors like: No wasting time, hygiene and cleanliness of work place, early and effective diagnose low- cost treatment and appropriate behavior of staff as the main demands of patients.

#### **3-2- safety, discipline and cleanness of emergency department**

If emergency Center runs by lean patterns it is always clean and orderly, inventory of medicines and medical equipment such as injection and dressing tools etc. are countable and estimable and treatment process can be done by effective quality, safe and without wasting time. In such emergency center lighting is sufficient, air conditioning is appropriated and noises are controlled up to maximum possible amount.

Lean emergency centers are using label system in routes, equipment and medicines in order to avoid wasting time, flow process and reduce errors.

Another symptom of these criteria is warning and guidance signs for patients and staffs. This information will make the treatment process safer.

### **3-3- Visual management system**

In lean emergency center navigation, direct and warning signs, guide patients and staffs, so apparently caused a safer treatment procedure with higher efficiency. In such a lean system, quality standard indicator and risk prevention factors are visible at boards. Moreover, resume information, record and attending schedule of doctors and other personnel are accessible.

At lean emergency centers a controller system monitors current workflow process constantly.

### **3-4- Programming system**

In emergency centers that have been established on the basis of lean thinking principles, a monitoring process continuously supervises all tasks. This process causes the right division of labor in center in order to avoid long waiting queues, staff's unemployment and reducing human errors so the center can use all of its capacities. Emergency permanent process includes continuous control system for treatment levels, medicines and equipment inventory and work allotment.

### **3-5- Using the space, patient and equipment movement during treatment**

Lean emergency centers use their available space quite efficient. Also, they use effective facilities for movement of their patient and equipment without wasting time. In such centers, departments that work in parallel and related to emergency department, and patient and staffs regularly communicate with them like radiology, pharmacy, laboratory and other related units have been built in a suitable distance to the center. Using empty spaces in bed and equipment layout and also taking advantage from all parts of emergency department are two more factors that help these centers to have lean performance. Observers with paying attention to visual signs which are provided in table 5 will be able to realize efficient usage of space in emergency department.

### **3-6- Levels of inventory**

In contrast to industrial production units that store of raw materials doesn't have any economic justification; in hospitals it is really important to maintain an effective level of inventory because lack of medicine and equipment sometimes can cause loss of life. To meet patient's needs certain level of medicine and medical equipment should be stored so, hospitals must be aware of their demand by an information system. Inventory management in hospitals is important, in the sense that there should be a system to outdate expired drugs immediately from the system meanwhile delivery of medicine and medical equipment to emergency room must be managed. Existence of large amount of inventory without managing can cause waste.

### **3-7- Teamwork and motivation system**

In emergency centers that run by lean principles, interest in doing tasks and responsibilities and continuous effort to improve performance of system can be seen in all personnel. In such a center staffs are permanently trying to provide better services with more quality and they tend to share their successful experiences with others. Moreover, interaction between all personnel, including nurses and doctors and etc. in all shifts is clearly can be seen because they believe that such a broad engagement between them is quite necessary to prepare effective and efficient services. Motivated employees can be identified easily with a rapid turnover in the emergency room otherwise; they are erratic, impatient and trivial staffs.

### **3-8- Repair and maintenance of medical equipment**

A sign of lean managing in emergency department is attention to condition and maintenance of equipment and medical tools in order to avoid treatment stop. In such an emergency centers medical equipment and tools are kept fine and equipped and each of them have a specs sheets that their date of purchase, price and other technical specification have been recorded there. In addition, next to each equipment a sticker or board have been hanged that in which all equipment records, date of replacement parts, date of repairs and etc. are accurately inserted. To avoid possible failure mode of devices, method of proper use and necessary measures in case of contingent problems have mentioned on a board nearby

devices. Preventive maintenance programs for medical tools and equipment are also another factors that helping to prevent sudden failures in devices.

Presence of a team of specialists at the center or training staff to solve possible problems that may happen for devices are also other approaches that are considered by lean emergency centers.

### **3-9- Management the complexity and variability**

Another factor for lean Administration is managing complexity and variability of the system. First of all, in this step emergency crises should be identified in order to understand the complexities of system. One of crises in emergency centers is patient's congestion in specific periods of time. In such cases due to the high volume of work and difficulty of decision-making in emergency situations, possibility of human error is higher.

Another problem is lack of adequate capacity and disability of sector various hospitals' sectors in acceptance of patients who need to stay in specialized departments. In addition, in some time periods staff work less, and this is what the hospital may occur at certain hours of the day. Actions that hospitals predict against such accidents will be able to have a significant impact on complexity and variability to control these factors.

Multistage examination from time of admission until diagnosis especially in congestion time can prevent human errors and mistakes favorably. Staff monitoring system in each working shift can help hospitals not to face absence of specialists and loss of patient in any time of the day.

Adequate equipment and direct communication of emergency staff with other parts of hospital will cause treatment in a proper time.

There are lots of data in any emergency center that importing and analyzing them for professional use not only reduces the complexity but also will obtain information that can upgrade productivity and improve performance.

### **3-10 -Supply chain integration**

Supply chain in health system is very discrete and constituent factors are acting independently, coordinating them is extremely a difficult task.

In hospitals, one of the main contractors is physicians. They have a high penetration and particular prioritize to select their suppliers. Entrust power of choice and change the suppliers to physicians not only improves the efficiency but also increases patient safety because they are dealing with patients and treatment processes alternatively (Toba, et al., 2008).

One more thing that lean emergency centers committed to it is buying in bulk. It is better that these centers instead of using several suppliers for the purchasing similar medicines and medical equipment, use fewer. This can make the purchase process and conventional paper works less and also won't let suppliers to be aware of growth and development procedure. Close monitoring of services to patient from login to the center until end of treatment process (discharging or admitting to one part of the hospital) helps medical centers in lean being procedure. In addition, not using out dated information system also indicates the proper functioning of the supply chain. Information system which is used must be proportional to the current changes and capacity of system in order to transfer valuable data seamlessly without disruption.

### **3-11- Commitment to quality**

A lean emergency center always tries to get a higher level of quality in its services and show this commitment to its consumers. In a lean emergency center, providing high quality services and commitment to enhance the quality are defined as the main mission of the center and personnel and signs of that can be easily seen. Holding some meetings to diagnosing the roots of errors after any accident or conducting mortality report sessions in order to find patient's cause of death can help staff to increase their knowledge and improve their experiences. Moreover, these proceedings will help center to act stronger toward disasters and crises, reduce monetary damages and casualties, prevent system from risk of unintentional human errors and increase quality of services.

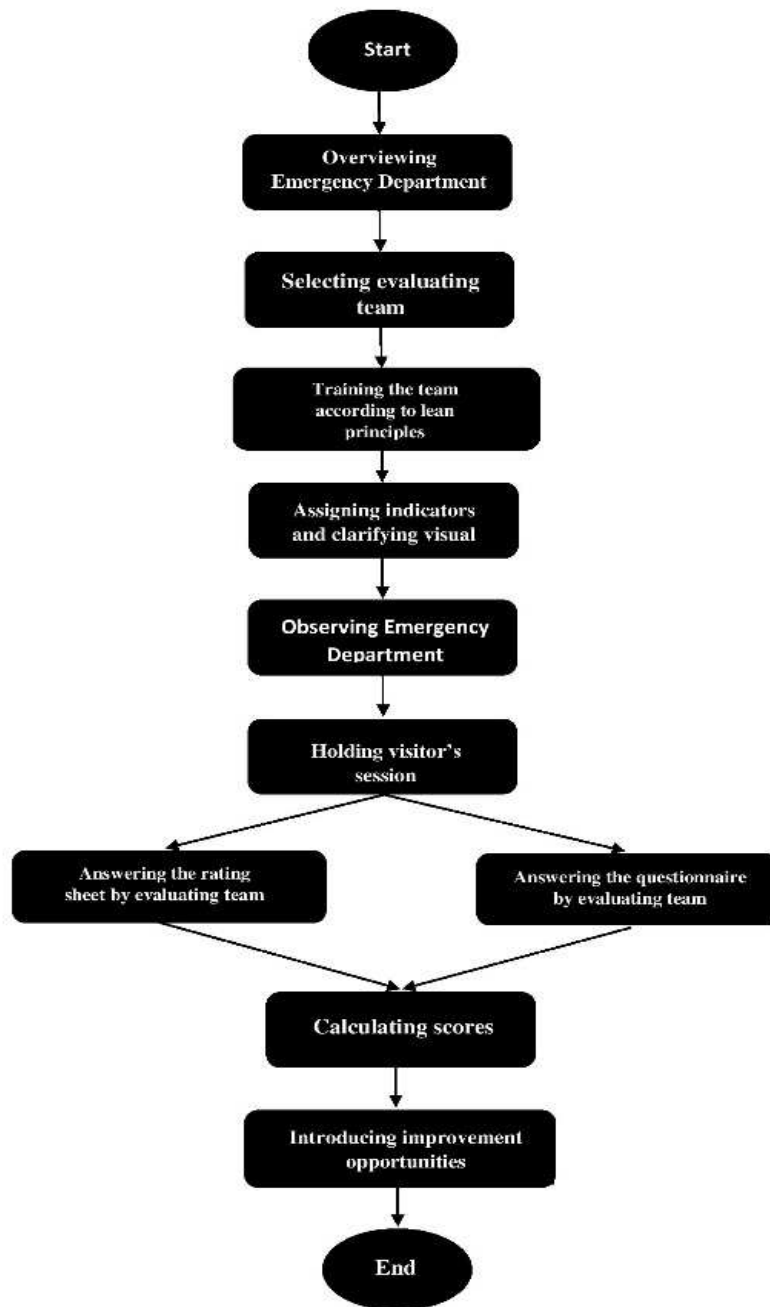
In implementation of this method after formation of team and introducing the method observation must be done. During observation team members should refrain from taking notes in order not to lose visual cues and if required they can have short conversation with patients and staff.

### **3-12- methodology**

Rapid emergency department assessment should be run with a team, consisting 4 or 5 people and a supervisor who is completely familiar with the methodology.

After initial meeting and sharing basic information of center, expressing its unique features, explaining rapid performance assessment method comprehensively and dividing evaluation benchmarks between team members they can start observing the emergency department. Immediately after visiting the center, team members in a meeting should discuss about all benchmarks individually and answer the questionnaire with yes or no responses. In this procedure a questioner (refer to appendix 1) and rating sheet (refer to appendix2) will be used as evaluating tools.

Figure 1 is the roadmap of rapid emergency department assessment that illustrates the implementation steps of the model to achieve the result in sequence. This shape helps the viewer to have a general understanding of the model.



**Fig1.** Rapid performance assessment of emergency department roadmap

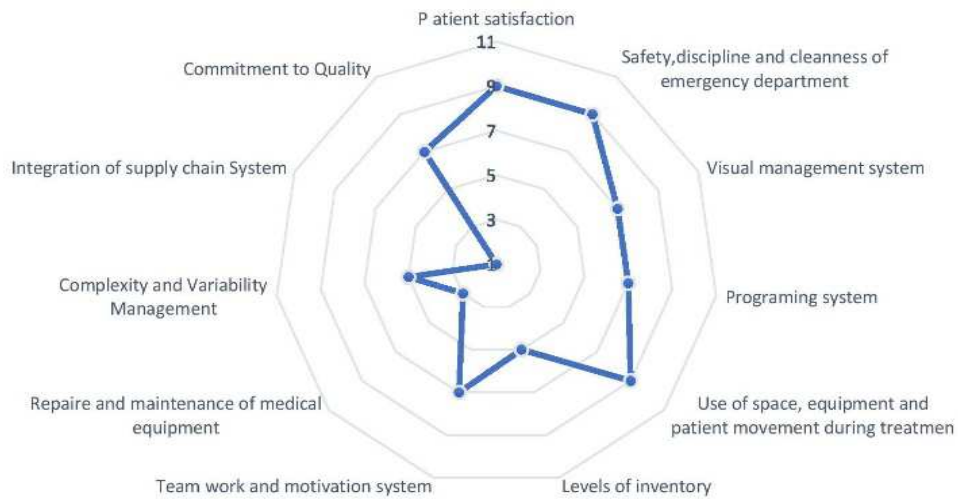
#### 4- Case study

To review the function of the proposed model, an emergency department in one of the major and educational hospitals in Tehran is evaluated by an evaluating team.

**Table1.** Evaluating team profile

Title	Specialty	Experience
Administrator	Industrial Engineer ( performance measurement)	4 years
Resident	Emergency medicine and critical care	3 years
Head nurse	Emergency medicine	24 years
Intern	Medical doctor	16 months
Technician	Hospital equipment	8 years

This center with allocating 50 beds to emergency room and due to its specific geographic location is considered as one of the most important and active emergency centers in Tehran. Obtained results are shown in figure 2.



**Fig2.** Result of rapid performance assessment of an emergency department in Tehran

In this center maintenance system and supply chain management were declared as priorities of improvement.



## 5-Results and discussion

At emergency departments patient dissatisfaction and waste of resources are likely to occur due to special circumstances and high workload. Therefore, use of lean methodology and continuous monitoring of its factors can have a significant impact on lean performance of system. Using rapid emergency model instead of time-consuming mathematical models that often need large amount of data, gives administrators the ability to recognize major problems of applying lean methodology in their system without waste of time. It should be noted that this model is a parallel approach with other performance evaluating methods.

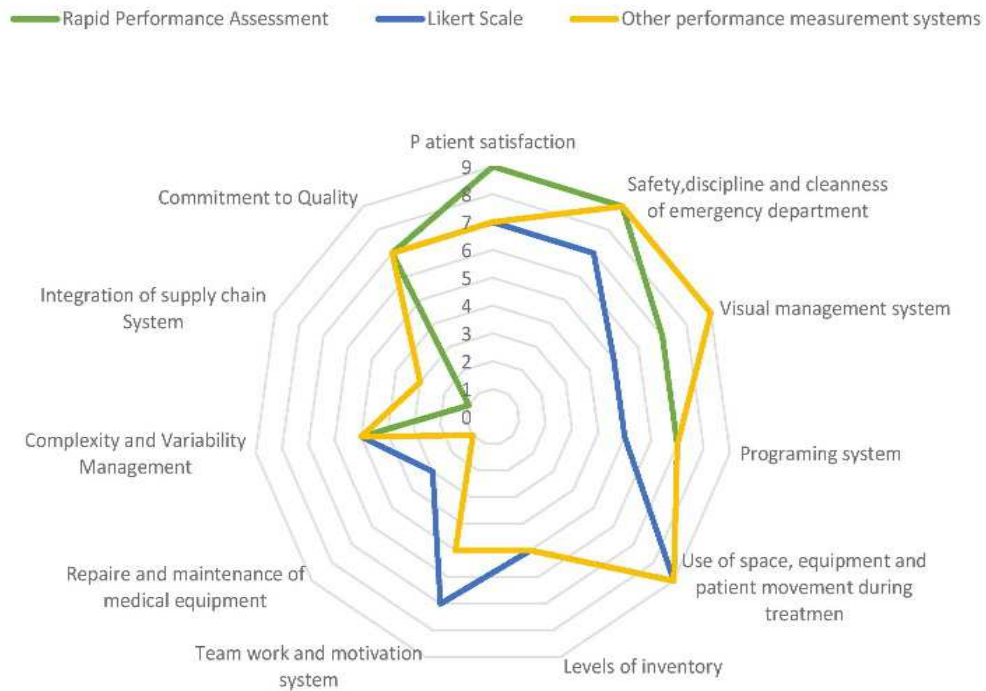
In previous studies, the emphasis has been always on positive impact of lean methodology in health centers, but in none of these studies, performance measurement has been used as a tool for controlling and monitoring lean factors. Meanwhile, in this research Professor Goodson's rapid performance assessment model has been developed for the first time in health care sector.

Goodson's Model is qualitative, therefore to validate the model and insure about the outcomes, we used Likert method with Fuzzy attitude. To quantify expert's opinion, we used Likert scale for questionnaire instead of Yes/ No questions with scores from 3 to 33 with ahead classification (very weak, weak, average, good, very good and best in case). This time expert must have spent more time to give accurate answers to questions based on some document. According to Likert scale defined in equation (1), results obtained (Figure3). It illustrates that results are consistent with result of our model.

(1)

- $3 \leq X < 8$  : Very weak
- $8 \leq X < 13$  : Weak
- $13 \leq X < 18$  : Average
- $18 \leq X < 23$  : Good
- $23 \leq X < 28$  : Very good
- $28 \leq X \leq 33$  : Best in case

Based on results obtained by other performance evaluation models, and by adjusting the responses according to lean principles, experts scored the indicators. Result of goodness of fit test (figure3) is clarifying that our rapid model has a high correlation.



**Fig 3.**Comparison of results

## 5- Conclusion

Figure 2 shows that in the studied emergency center two indicators of supply chain management and maintenance system don't have favorable conditions and system requires changes in the way that they are managed. To continue process of improvement it is necessary to rectify two more indicators which are levels of inventory and management of complexity and variability as next priorities. Methodology of rapid performance assessment with its unique features answers to any criteria and by its high flexibility, without spending large amount of time, gives managers of health centers wide range of information to diagnosis their units.

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## Appendix 1

Numb	Questionnaire	Yes	No
1	Are the staff of emergency center dealing with patients and their entourage with pleasure?		
2	Is queuing length short? Is there a commitment between staff to reduce patient's waiting time?		
3	Are rating of quality and customer satisfaction exposed publicly?		
4	Does the center meet cleanliness? Is the temperature and light adequate? Is the noise level low?		
5	Do safety patterns and hazard warning boards available to prevent accidents?		
6	Does the system have visual classification for medical devices and equipment?		
7	Does anything have its own place?		
8	Are infectious and non-infectious waste separated? Do they have any special system to dispose infectious waste?		
9	Are patient patients with special problems taken care of under isolated conditions? Are patients classified according to the type of illness and their deterioration?		
10	Do the work instructions appear in the entire Emergency Center? Are treatment checklist used?		
11	Are guide boards and directions available in all parts ?		
12	Can all the staff see center's development criteria signs, current operation condition, operational objectives and efficiency levels?		
13	Do all the tools and equipment have technical specifications sheet, repair and maintenance history, preventive maintenance plans and instructions?		
14	Is the current status of center from aspect of personnel empty beds and equipment monitoring through a central system?		
15	Do the initial actions for the patient occur once and in the shortest time? Do they use appropriate equipment to move the patients?		
16	Does the Emergency Center use all available spaces well?		
17	Is medicine preparation and initial treatment done immediately and continuously?		
18	Is there any system to estimate minimum amount of required equipment and medicine up to order? Is this system informing center the inventory level, time to dispose expired medicines?		
19	Are the medications and equipment delivered to different departments in a managed manner?		
20	Are the personnel committed to continuous service improvement?		
21	Are they holding training sessions and exchange workshops to improve quality services?		
22	Is any system located in the center to prevent critical devices from being interrupted? In case of interrupting can this system restart them as soon as possible?		
23	Are the strategies for confronting the crisis and its orders readable? Is there a specific system to prevent human errors?		
24	Is there an interaction between emergency staff and other parts of the hospital?		
25	Does the Emergency Center have the obligation to make a rooting session after any mistake or incident? Do they hold mortality report meetings to check out cause of deaths in their center?		
26	Are process of ordering, delivering, costs and quality certification of suppliers visible?		
27	Does the emergency room use an up-to-date information system?		
28	would you willing to use this emergency center?		
The total number of yes answers			

## Appendix2

Numb	Measure	Related questions	Weak 1	Less than AVG 3	Average 5	More than AVG 7	Perfect 9	Best in Case 11	Score
1	patient satisfaction	1,2,3,28							
2	safety, discipline and cleanness of emergency department	4,5,6,7,8,9,10,28							
3	Visual management system	3,5,6,9,10,11,12,13,23,28							
4	programing system	2,9,14,17,23,28							
5	use of space, patient and equipment movement during treatment	7,15,16,17,28							
6	levels of inventory	18,10,28							
7	Teamwork and motivation system	3,12,20,21,24,25,28							
8	Repair and maintenance of medical equipment	13,22,28							
9	Management the complexity and variability	14,22,23,24,25,28							
10	supply chain integration	14,18,19,26,27,28							
11	commitment to quality	8,12,20,21,23,25,28							
Total									