EVALUATION OF AN OPERATING THEATRE DESIGN BY A SOFTWARE PROGRAM (OTDA: OPERATING THEATRE DESIGN ANALYZER)

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ABSTRACT

The design and establishment of the operating theatre (OT) is not a simple architecture engineering work. This project needs a specialized planning and execution effort from all engineering specialists driven and coordinated by the needs, preferences and safety of the medical/surgical team. More than one reference in operating theatre design is available, but each reference is dedicated for the design of a special part of the project. This paper presents a complete comprehensive integrated paperless database application program called Operating Theatre Design Analyzer (OTDA). This application is used to ensure the optimal OT design referring to seven international standards and three accreditation programs integrated with each other throughout the recommendation report has been resulted. It helps the owners of healthcare facilities or those who are interested in this area to identify and solve the problems in the OT design. The program was introduced to many hospitals in different Arab countries for evaluation; the percentage of compliance with standard for each item in OTDA was recorded. The analysis of the results reflects a lack of infection control awareness and misunderstanding of the role of the clinical engineer in OT design and healthcare facilities design as whole

KEYWORDS

Evaluation of operating theater design, planning of operating theater, New trends in operating theater design

1. INTRODUCTION

Creating something from nothing is an awesome task; it requires forethought, creativity, commitment, and enthusiasm. If this "something" is as large as a new operating theater or a renovated old one, it also requires planning, resources, education, and communication. The planning, design, and construction processes can be daunting if healthcare organization do not have the appropriate tools, personnel, and commitment for the task. Multidisciplinary collaborations must occur throughout all stages of the process, patients, staff, and the community should play an integral role [1].

The work of clinical engineers has a direct effect on health, safety and the environment. These public health domains are heavily guided by standards and regulations. Standards are documented agreements containing technical specifications or other precise criteria to be used consistently as rules, guidelines, or definitions of characteristics, to ensure that materials, products, processes, and services are fit for their purpose [2]. Service delivery in the healthcare sector is profoundly affected by the built infrastructure provided to support it [3]. A reliable, systematic framework to evaluate the infrastructure is a must. Internationally, some design evaluation toolkits specifically for healthcare facilities have been developed in an attempt to do just this. Achieving Excellence Design Evaluation Toolkit (AEDET Evolution) [4], [5] evaluates

DOI: 10.5121/ijdms.2011.3306

a design by posing a series of clear, non-technical statements, encompassing the key areas of impact, build quality and functionality. AEDET Evolution Summary document is part of a benchmarking tool to assist trusts in measuring and managing the design quality of their healthcare facilities. Another toolkit, developed for use throughout Australasia, is the New South Wales (NSW) Health Facility Guidelines Post Occupancy Evaluation [6], [7]. This guideline sets out NSW Health's Post Occupancy Evaluation (POE) methodology that will objectively test generic and specific aspects of the planning and detailed design of health facility buildings. The underlying purpose of this testing is to ensure continuous improvement in facility performance as a result of the planning, design and procurement of health facilities.

Operating Theatre (OT) is the "heart" of any major surgical hospital. The patient is the centre point of a functioning OT complex. The flow of the patients, staff and materials within these operating and procedure rooms, affect the design layout. Because of the variety of specialized procedures and equipment, some of the operating rooms will vary in layout, size and equipment needs [8]. Planning, programming, and design are the major phases of construction. Many large health care organizations have facilities staff that can greatly assist in most projects. Simulation modeling can be used to map the flow of existing operations and to validate how the design will impact future operations. One key thing to remember is that; phases sometimes overlap, depending on the overall scope of the project. The phases move from the broad conceptual drawings in the planning phase to the very detailed design of every aspect in the construction documents [1], [9].

The establishment and design of the operating theatre is not a simple architecture engineering work. It needs a specialized planning and execution efforts involving all engineering specialists driven and coordinated by the needs, preferences and safety of the medical/surgical team. The planning, design, and construction processes can be daunting if healthcare organization do not have the appropriate tools, personnel, and commitment for the task. Participation in future technologies should be phased as operating Theaters become old and must modernize in order to improve the quality of patient care. Regardless of the age of a facility, healthcare facilities must continually change in order to meet patient demands, support new procedures and technologies, and remain competitive [8]. Design specifications set out the specific design characteristics of the operating theatre.

This paper presents a software program that is intended to evaluate the existing OT design and provide design considerations in case of new OT design according to healthcare facilities design international standards. The program also guidelines its user, through a user-friendly menu, to apply and receive known accreditation programs. The implementation and evaluation of the program is described in the next sections.

2. MATERIALS AND METHODS

The design process of OTDA consists of three main phases: standards integration, OTDA questionnaire, and OTDA software. The details of each phase are presented as follows.

2.1. Standards Integration

More than one reference in OT design is available, but each reference is dedicated for the design of a special part of the project [10], [11], [12]. To form a complete comprehensive integrated program, we collected the international standards in healthcare facilities design. These standards are:

1. AIA (American Institution of Architecture), Guidelines for Design and Construction of Health Care Facilities [13].
2. FGI (Facility guideline institution), Guidelines for Design and Construction of Health Care Facilities [14].

3. JCAHO (Joint Commission on Accreditation of Healthcare Organizations) Planning, Design, Construction of healthcare facilities [15].
4. ICRA (Infection Control Risk Assessment), Matrix of Precautions for Construction & Renovation [16].
5. ASHRAE (American Society of Heating, Refrigerating, and Air-Conditioning Engineering), ventilation standard for healthcare facility [17].
6. HTM 2022 (Health Technical Memorandum), guideline for Design, installation, validation and verification Medical gas pipeline systems [18].
7. NFPA 99, 101, 72 National Fire Protection Associations [19], [20], [21].

All of the previous standards were concerned with healthcare facilities design requirements, so we extracted all the parts that belong to operating theaters design or requirements. Second we divided the international standards according to specialty, as we integrated AIA, FGI and JCAHO to produce a questionnaire for construction of operating theater, we used ASHRAE to produce a questionnaire about ventilation system of operating theaters. The HTM2022 was used to produce a questionnaire about a medical gas system piping in the operating theater. While NFPA99 was used to produce the safety requirements in operating theater and finally, ICRA was used to produce the precautions must be taken in mind for conserving infection control through the constructing or renovation process of operating theater.

2.2. OTDA Questionnaire

The previous phase resulted in an outline of a questionnaire that is constituted a complete comprehensive integrated approach. The result of its use will lead to a near optimal design.

The questionnaire is divided to nine parts, including the basic information about operating theaters, these parts are:

1. Surgery suite layout.
2. Operating and procedure rooms.
3. Pre- and post operative holding areas.
4. Diagnostic and treatment locations.
5. Support areas.
6. HVAC system.
7. Medical gas pipeline systems.
8. Details and finishes.
9. Building systems (plumbing, electrical, telecommunication, and safety & security systems).

Each part of this questionnaire consists of several question that can be answered with (yes, no and skip or next), skipping of the question means that this item is not present in the hospital. The answer will be “Yes” if this item is already done, while it will be “No” if this item was not done.

We distributed the questionnaire after making a professional development activity. The distribution methods were: by mail, by personal communication (hand to hand), and by the investigator filling. This issue is called a Pilot testing [22]; pilot testing may prevent costly mistakes. It is typically used if an instrument or method of data collection is being used for the first time or for the first time with a particular group.

2.3. OTDA Software

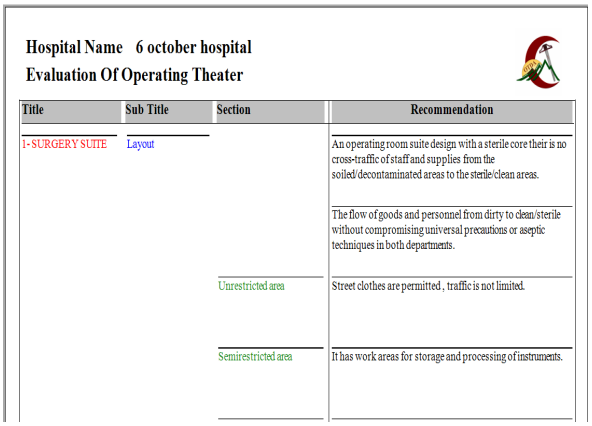
A user-friendly software program was designed to collect the answers of the previous questionnaire. The program is called OTDA as an abbreviation for Operating Theatre Design Analyzer. Figure 1 shows the main window of the program.

Figure 1: OTDA main window

This program has many ideas as it makes an evaluation of an existing OT design, presents recommendations to comply with standards, and guides its user to follow the steps of a user choice of accreditation program. The evaluation of an existing OT design consists of all the questionnaire items but in a software program, Figure 2 shows the evaluation window.

Figure 2: The evaluation of OT design

Answering any question in the questionnaire makes a feedback recommendation that appears in the final report (Figure 3) to reach the optimum OT design.



Hospital Name 6 october hospital

Evaluation Of Operating Theater

Title	Sub Title	Section	Recommendation
1- SURGERY SUITE	Layout		An operating room suite design with a sterile core their is no cross-traffic of staff and supplies from the soiled/decontaminated areas to the sterile/clean areas.
			The flow of goods and personnel from dirty to clean/sterile without compromising universal precautions or aseptic techniques in both departments.
		Unrestricted area	Street clothes are permitted , traffic is not limited.
		Semirestricted area	It has work areas for storage and processing of instruments.

Figure 3: OTDA evaluation report

OTDA contains a special window for an OT new design. This window presents many of the latest trends in OT design [23], [24], [25], and the application of ISO [26], LEED [27], and JCI [28] accreditation programs. Figure 5 shows the OT new design window.

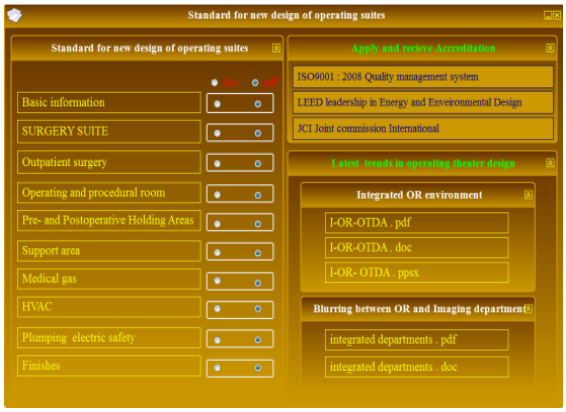


Figure 4: OT new design window

3. RESULTS AND DISCUSSION

We used the convenience sampling or accidental sampling [29], at our data collection; it is a type of non-probability sampling which involves the sample being drawn from that part of the population which is close to hand. That is, a sample population selected because it is readily available and convenient. This type of sampling is most useful for pilot testing. We used such a sample and couldn't scientifically make generalizations about the total population from this sample because it would not be representative enough. This data does not represent all the levels of healthcare facilities in deferent societies in operating theater design area and we are not aiming to determine the level of care provided to the patient in such hospitals.

The Response rate [30] (also known as completion rate or return rate) in survey research refers to the number of people who answered the survey divided by the number of people in the sample. It is usually expressed in the form of a percentage. The OTDA questionnaire was introduced to fifty healthcare facilities; only twelve of them answered it. The response rate of OTDA questionnaire = 12/50 = 24%.

Table 1 shows the final result of OTDA questionnaire, the data collected from twelve hospitals in Egypt, KSA, Jordan and Sudan. These results refer to the percentage compliance of each item with a standard. After analyzing the OTDA questionnaire results we noticed that:

1. The compliance percentage of surgery suite layout and separated O/P surgery is very high reaching 100% in most of the hospitals, because those items are the main items in OT design.
2. The integrated O/P surgery item is found in one hospital as this hospital is very small one day private hospital (20 beds).
3. The operating and procedure room general considerations compliance ranges around 65% on average, we consider it a low value for this item may be resulting from limitations in area or lack of knowledge of the standard limits.
4. The compliance percentage of pre-post areas item is very low with min. of 23% and max. of 85%. This may be resulting from areas limitations or lack of OT design standards and infection control knowledge.
5. A moderate compliance percentage of the support area.

6. HVAC system is an unknown item, as there wasn't a good archived data for hospital design information and absence of contact between the clinical and mechanical engineers in the healthcare facility.
7. Although the medical gas item is very important in healthcare facilities; its compliance percentage is considered very low. Excluding hospital no.7, this item compliance ranges around 42%. Hospital no.7 applied the JCI accreditation program while most of the others do not have Anesthetic Gas Scavenging System (AGSS) which is a recent technology in this field.
8. The details and finishes item have a good compliance percentage as it deals with infection control considerations in OT design.
9. The compliance percentage of the building system item reached a min. value of 15% and ranged around 46%, it is considered a low value for this item, may be due to funds limitations.

4. CONCLUSIONS

An evaluation of operating theatre design software program called OTDA was described in this paper. The program is comprehensive integrated paperless database application that can be used to ensure the operating theatre design compliance with seven international standards and three accreditation programs.

After a pilot testing of the program in twelve hospitals in different Arab countries we noticed a lack of compliance in most of the OT design items. Some countries do not have a national reference standard for OT design and the ministry of health approves the OT design without applying the international standards.

The Analysis of the results reflects a lack of infection control awareness, and a misunderstanding or un-realization of the role of the clinical engineer in OT design and healthcare facilities design as whole.

This study confirms that; clinical engineers are the best ones who can coordinate the planning and design of an operating theatre hence the whole healthcare facility, especially in developing countries.

As future work, we intend to expand our test to cover all Arab countries. A broad study will reflect the level of care provided to patients and encourages the establishment of an Arab nation international OT design standard.

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Table 1: Percentage of compliance

No	Country	Hospital	Surgery suite layout	Separated O/P surgery	Integrated O/P surgery	Operating & procedure room-general considerations	Pre-post areas	Support area	HVAC	Medical gas	Details & finishes	Building system
1	Egypt	Bani Souif teaching hospital	85%	---	---	64%	23%	43%	N	40%	72%	35%
2		6 October (old building)	80%	100%	---	43%	---	48%	N	33%	74%	35%
3		6 October (new building)	80%	100%	---	67%	54%	68%	N	50%	92%	73%
4		Said Glal teaching hospital	70%	100%	---	64%	54%	78%	N	33%	76%	42%
5		Shebien Elkom teaching hospital	50%	100%	---	60%	31%	55%	N	40%	46%	15%
6		Nasr City health insurance hospital	50%	50%	---	69%	43%	63%	N	40%	71%	38%
7	KSA	Alghad- teaching hospital	90%	100%	---	86%	77%	100%	Y	100%	92%	79%
8		Jenat private hospital	90%	---	79%	50%	46%	69%	N	50%	68%	36%
9	Jordan	Prince Hamza hospital	90%	100%	---	80%	54%	93%	N	67%	80%	65%
10		King Abdallah hospital	90%	100%	---	80%	85%	88%	N	40%	76%	88%
11	Sudan	Wad Maddani hospital	80%	100%	---	64%	46%	66%	N	33%	76%	23%
12		Senar teaching hospital	75%	100%	---	60%	46%	70%	N	40%	68%	31%

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