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Abstract. In this paper it is describe a SWOT analysis of an Electronic Heath Record (EHR) implemented in a Portuguese hospital. As the EHR is a core part of a hospital information system, it is extremely important to ensure that it offers the best functionalities and that users are satisfied. With this analysis it is intended to gather information about the system, in order to improve the EHR implemented in the hospital. In the end, and appending to the results of a usability evaluation done in previous works, the evaluation team had enough knowledge about are the strengths and weaknesses of the EHR, as well as what opportunities can be taken and the threats that have to be avoided.

Keywords: Electronic Health Record, SWOT analysis and TOWS analysis

1. Introduction

The sustained demand by healthcare organizations to improve the quality of patient care and patient safety boosted the adoption of information and communication technologies (ICT). Therefore, nowadays hundreds of ICT systems, such as the electronic health record (EHR), have been adopted in order to serve physicians as well as other professionals in their daily work with patients. An EHR can be defined as a longitudinal electronic record of patient heath information generated by one or more encounters in any care delivery setting, such as progress notes, medications, vital signs, past medical history, laboratory data or radiology reports. It has the ability to generate a complete record of a clinical patient encounter, which includes evidence-based decisions support, quality management and outcomes reporting. The EHR has proved to be an excellent tool for healthcare organizations. Once EHR systems play an important role in a hospital environment, it is vital to ensure that it presents the best conditions possible. In this context, this article highlights one manner to perform an evaluation to the state of this type of systems. The EHR implemented at Centro Hospitalar do Porto (CHP), in Portugal was sub-

jected to a SWOT analysis in order to ascertain what can be change to improve the system. This analysis can reveal what are the great strengths of the system as well as its major pitfalls. In addition to this, the opportunities than can be taken advantage of are highlighted and the key threats to the system are alerted. At the end of this analysis, a great amount of information about the EHR is gather, which can be used to improve the system, availing to become a better tool for the professionals of the hospital as well as for patients.

2. The Electronic Health Record

The EHR, assumed as a Hospital Information System (HIS) for excellence, is a core application which covers horizontally the virtual health care unit and makes possible a transverse analysis of medical records along the several services, units or treated pathologies, bringing to healthcare units new computation models, technologies and tools, based on data warehouses, agents, multi-agent systems and ambient intelligence [1]. It receives the information of patients, in particular exams, thru a platform which main goal is providing rye interoperability between heterogeneous information system and medical equipment [8]. Beyond the organizational, functional, technical and scientific requisites, one may have to attend ethical and legal needs, as well as data quality, information security, access control and privacy. Despite the fact that there is not one exact definition for EHR, it can be defined as the computerized records of patients' clinical data. This information, which can be clinical, administrative or financial, is inserted in an electronic system that enables the capture, maintenance, transmission and storage of clinical information which is essential, not only for the monitoring of the health status of each patient but also for proposes such as cost management [2][3]. Thus, the EHR is an assembly of standardized documents, ordered and concise, directed to the register of information that can be compiled either by physicians or other health professional; a register of compiled facts, containing all the information regarding patient health data; and a follow up of the risks values and clinical profile [1]. The main goal is to replace hard documents by electronic ones, increasing data processing and reducing time and costs. The patient assistance will be more effective, faster and quality will be improved. With the adoption of such a system like EHR, it is possible to facilitate and improve care in health establishments. It enables the possibility of acquiring the versatility of a device capable of storing a vast sum of information, which can become more accentuated with the development of computer science. The data legibility and duplication, the continuous data processing, the ability to detect errors, the reduce frequency of loss records, the support communication between external sources of medical information, management and resource planning or releasing alarms concerning eventual pathological anomalies are some of the great advantages acquired with this system. Analysing the advantages at a structural level, the EHR supports the customization of the user interface, allowing the use of different layouts of insertion and viewing in-

formation under the very useful aspect of the availability of specific modalities in the hospital. Along with this, the EHR enables the automated collection of clinical parameters from monitors, imaging equipment, chemical analysis, among others [2]. Furthermore, it allows that the entire information can be share among different users whom are directly involved in the healthcare of the patient.

3. SWOT Analysis

The assignment of providing a well-functioning health service demands continual adjustments and sometimes also the introduction of new financing and organizational methods. We must be careful, however, that in enterprise such modifications we do not obliterate aspects that are function well. Hence, it is essential to comprehend the assets and drawbacks of the EHR, as well as the prospects available to the system and the vulnerabilities that threaten it. In another words: Which features of the EHR should be safeguarded from any modification? Which characteristics can be improved? With these deliberations in mind, the idea of enterprise a so-called SWOT analysis of the EHR implemented at the CHP was developed. SWOT is an acronym that stands for: Strengths, Weaknesses, Opportunities and Threats. The origin of this technique still remains a little dubious, with the vast majority assigns the development of this strategic planning tool to Albert Humphrey, between the years 1960 and 1970. SWOT analysis (Table 1) aims to identify the strengths and weaknesses of the case of study (normally an organization) and, at the same time, the opportunities and threats presents in the environment. Strengths represent the internal power that an organization possesses to compete against its rivals [4]. Weaknesses represent aspects that negatively impact product and/or service value with regards to customers or competitive environment [5]. Opportunities are defined as a set of conditions suitable for achieving certain goals at the right time, and threats are any improper event or force in the external environment that causes harm to the organization's strategy [6]. Afterwards the identification of these factors, strategies are developed which may build on the strengths, eliminate the weaknesses, exploit the opportunities and counter the threats. The first two variables (strengths and weaknesses) can be identified by an internal appraisal and the remaining aspects (opportunities and threats) by an external assessment [7]. Hereupon, it is possible to say that SWOT analysis considers the organizational environment, which is composed by many elements that organizations deal with and form complex cause-and-effect type of relationships with. Environment can be divided into two categories: internal and external environment. The internal environment is one that can be controlled by the organization/institutional and therefore is directly sensitive to the strategies formulated. It deals with internal factors within an organization in various areas such as management, culture, finance, research and development, staff, operational efficiency and capacity, technical frameworks and organizational structure. The external environment is not in control of the organization. It acts homogeneously on the

whole of organizations engaging in the same market and the same area. This way, opportunities and threats influence equally the entire organizations, whose probability of impact should be handled by each company separately. Hence, the external appraisal scans the entire factors that take place outside the organization's boundary such as political, economic, cultural, social, technological and competitive environment with a view to identifying opportunities and threats [7]. A variation of SWOT analysis is the TOWS analysis, projected by Heinz Weihrich. In the TOWS analysis the various factors are identified and these are then paired e.g. an opportunity is matched with a strength, with the intention of stimulating a new strategic initiative. With the TOWS analysis, the information gathered with the SWOT analysis is exploited in order to assemble different strategies (Table 2). The S-O strategy uses the strengths to capitalize on opportunities and the S-T strategy uses the strengths to prevent the threats. The W-O strategy aims to improve the weaknesses through opportunities. The W-T strategy is the most defensive strategy of the TOWS analysis. All the strategies that can be created, are proposed to avoid threats and, at the same time, minimizing the weaknesses.

Table 1. The SWOT Matrix

	Internal	External
Positive	Strengths	Opportunities
Negative	Weaknesses	Threats

Table 2. The TOWS Matrix

	Opportunities	Threats
Strengths	S-O Strategy	S-T Strategy
Weaknesses	W-O Strategy	W-T Strategy

4. SWOT analysis of the EHR

In order to gather information to perform the SWOT analysis, the EHR implemented at CHP was object of an intense study. This study undertook the perception of the various aspects present in the SWOT analysis. The results of this study were consolidated and subsequently the items of SWOT analysis emerged which are mentioned hereinafter.

4.1 - Strengths of the HER

- Power management of change in the system;
- Ability to personalize objects like interface;
- High availability and support full-time;

- High accessibility;
- Security;
- Technologically modern system;
- Ease of maintenance;
- Ease of use (usability);
- Credibility of the management team;
- Immediate access to detailed clinical information;
- Reports customized to meet the needs required;
- High computing power;
- Interoperability;
- Ability to remotely access the system.

4.2 - Weaknesses of the EHR

- System documentation nonexistent;
- Graphical interface somewhat confusing;
- Necessity of paper documentation in some services of the CHP;
- Insufficient education and training of health professionals;
- Computers are old and therefore slow.

4.3 - Opportunities to the EHR

- Ability to integrate with other applications;
- Ability to provide information via Internet;
- Ability to expand and sustain new services;
- Increasing importance of digital files;
- Government incentives;
- Extinction of paper use in the CHP;
- Modernization and organizational development;
- Projection of more efficient and usable interfaces;
- Developing better and more effective security protocols;
- Increasing expectation of citizens to obtain answers of clinical services faster and, at the same time, reliable;
- Use of mobile devices to access the system;
- Use of new technologies in order to enrich the system.

4.4 - Threats to the EHR

- High degree of competition from other systems;
- Expansion of software companies for the health market;
- Competition / market pressure;
- Competition for scarce talented IT resources;
- Economic-financial crisis and subsequent financial constraints;
- Readiness to recover from disasters;
- Cyber attacks (hackers);
- System is based on Internet Explorer.

5. TOWS Analysis of the EHR

Once the SWOT analysis is concluded, it is possible to combine the outcomes from this analysis, promoting the TOWS analysis. Through this analysis it is possible to scrutinize the combinations between the different aspects of the system.

5.1 - Strengths to maximize opportunities

- The possibility of modifying the system and customizing objects allows the projection of a more efficient and usable interface;
- The safety that the system grants coupled with the technical support that exists at full-time enables the development of better and more effective security protocols;
- Once the platform is at the forefront in terms of technology, numerous opportunities are glimpsed. First, the possibility of implementing the system in other hospitals, both nationally and at international level. However, organization modernization and the possibility of acquiring technologies at attractive prices may reinforce this status of the system, making it a viable alternative to similar systems from reputable companies;
- The remarkable interoperability that exists in the system permits the integration of new applications and the expansion and support of new services;
- The fact that the system can be accessed remotely facilitates the availability of information on the Internet (e.g., patients access their own information comfortably at home) and healthcare professionals access the system via mobile devices;
- The excellent specifications on the handling of the system (immediate access to detailed information, high-capacity computing, among others) based on the growing expectation that citizens have in obtaining responses of clinical services faster and at the same time reliable.

5.2 - Strengths to minimize opportunities

- All the strengths verified in the system devaluate the competition, whatever it may be. However, it is essential to continue the improvement of the system, because the competition is expected to do the same;
- The security of the system restricts the exposure to computerized attacks and, consequently, violation of patient privacy;
- Since the system is updated, as the technology is concerned, the huge competition for talented and lacking IT resources does not have great influence on the system.

5.3 - Opportunities to minimize weaknesses

- The projection of more efficient and usable interfaces guides for improving the current system interface;
- Government incentives, organizational modernization and new technologies with attractive prices are conditions that provide the upgrade of computers in the CHP, which are already a little outdated.

5.4 - Minimization of weaknesses and avoid threats

- There is not any system documentation, but is compensated by the presence of full-time technicians in the CHP;
- Modification of the system interface to not be overtaken by competition.

6. Discussion

Through the SWOT analysis, it was possible to find out that the existing EHR in CHP is a system of high relevance, owning innumerable positive characteristics. Aspects such as interoperability, good usability and high availability of the system, foster the EHR implemented in CHP within such systems. However, it also has some weaknesses, though outnumbered when compared with its strengths. With this analysis, those weaknesses were identified and can be, now, overcome.
The absence of some kind of system documentation is addressed by the presence of full-time technicians, who are continuously available to assist any healthcare professional that encounters some sort of obstacle in the handling of the system. The interface is a tricky question. As the Portuguese legislation forces the healthcare professional to document in detail the entire information relatively to

the patient, which can spawn a huge amount of information. Therefore, when a professional access the clinical process of a patient, every part of the patient's information has to be displayed in the screen, which can make the reading of the process a bit confusing. This aspect can be partially resolved by using screens of larger dimensions (widescreens).

The computerization of the entire clinical process in the wholly services of the CHP is not an easy task. However, it is one of the main goals and steps are being taken to achieve that desired ambition. It is not an easy task and it may take some time, but all the efforts will be compensated.

The question of the old computers is complicated since technology is constantly progress and follow that improvement throughout the entire hospitals is an expensive task indeed. Added to this, the Portuguese financial situation does not benefit the constant modernization. It is a question that will take its time to be overcome.

This analysis showed that there are some opportunities that can be exploited. For instance, the importance that digital files have obtained in recent years coupled with organizational modernization can boost the existing propose to turn the hospital paperless. New services, features or even newly developed systems can be integrating into the EHR, increasing the relevance of the current system. These and others opportunities that came up cannot be overlooked, once is vital to improve the current system in order to be up with the competition.

It is important to take into account possible threats to the EHR. This analysis shows up a few threats that we need to be aware. The faced competition is one of the largest threats, if not the greatest, that this system has to face. There are a lot of EHR's solutions, some of them from reputable companies, like Siemens. However, not only existing solutions is important to take into account, as more and more software companies want to engage into the hospital market.

The economic and financial crisis is another key threat. High financial constraints and fear to hold large investments may constrain the bet in new IT resources, which are scarce. IT resources that proved to be talented will raise the dispute for them, which can be another threat.

Security is one issue that is widely considered as a main threat. However, we totally trust in the security of the EHR implemented in the CHP. Nevertheless, it is important to ensure the security and confidentiality of its information, avoid potential cyber attacks and have alternatives to disaster situations such as, for example, the situation of the system crashing. If this happens, the CHP cannot paralyze the activities, and therefore CHP should have alternatives to flank the situation.

If the SWOT analysis provided the identification of the strengths, weaknesses, opportunities and threats of the system, the TOWS analysis unveiled strategies to improve the EHR system. The strengths of the system can maximize the existing opportunities. For example, as the systems grants interoperability, new services can be integrated into the EHR. The strengths can also be used to minimize the threats. One example of this strategy is the following. The high security stated in the system enables the restricted exposure to computerized attacks. Once the system presents a great amount of strengths, a lot of opportunities can be harnessed and threats avoided, as stated earlier.

This analysis can built on other two strategies. The opportunities can minimize the weaknesses of the systems. For example, the interface of the system was one of the weaknesses and there was one opportunity identified related to that aspect, the projection of more efficient and usable interfaces. Taking advantage of this opportunity, the system can be improved, and the flaw is overcome. The last approach seeks the minimization of the weaknesses of the system as well as avoiding the threats.
At the end of those analyses, the CHP acquired extremely valued information regarding the EHR system. At this point, they know what are their best practices, what has to be enhanced, what prospects have to be exploited and the dangers to circumvent. In addition to this, significant strategies were developed and the CHP can use them to improve the existing EHR.

7. Conclusions

In this paper it is presented a possible strategic planning to an EHR system, appending to the results of a usability evaluation done in previous works [9]. Considering that strategic planning has not been done to the EHR implemented in the CHP so far, such kind of plan was essential for the hospital. The results show that the system has a lot of strong points as well as fewer weak ones. With the identification of the system's weaknesses, it is possible to circumvent them. This evaluation proved to be an excellent tool, which has provided useful information to improve the quality of the EHR, relevant to offer better conditions not only to the healthcare providers but also to the patients.

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