

HSWAI: a health sector website assessment instrument

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ABSTRACT

Emerging technologies enable hospitals all over the world to improve their operation in order to become more efficient and effective. Despite all possible benefits of using those technologies, hospitals still struggle with problems of inefficiency of their websites' operation. Nowadays, the patients use the health-related websites as an important information source and interaction point, therefore the assessment of hospital websites becomes a critical issue. In this paper, we present the process to reach an instrument for health sector website assessment. To identify the set of dimensions, indicators and sub-indicators, a qualitative research has been carried out using the Design Science Research (DSR) approach. Analytic Hierarchy Process (AHP) has been used to derive the appropriate weights for dimensions and indicators. This methodology means an improvement on hospital websites assessments, by bringing website assessment closer to domain experts that are actual domain knowledge holders and to citizens who are the final users and service receivers.

CCS CONCEPTS

• **Applied computing** → **Computers in other domains** → Computing in government → *E-government*

KEYWORDS

Assessment, Evaluation, e-Health, e-Government.

ACM Reference format:

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1. INTRODUCTION

In the health care area, patients and their relatives are increasingly involved in both medical decision-making and actual care, so the web has become a significant tool and a useful interface among involved stakeholders. Health-related websites are listed among the most visited on the Internet, 7% of all Google searches are health-related [1]. In recent years, we have witnessed significant growth and popularity of websites that have taken a central role in health institutions operation. In the globalized world, patients have greatly increased their demand for information, and hospitals' websites are being used as an important health care information platform [2]. On the other hand, since health care provision institutions throughout the world invest time and money in order to develop and maintain user-perceived websites, evaluating their quality is necessary to understand whether websites comply with user needs and expectations. However, the debate about how and what elements to assess on health sector websites remains open and many different approaches and frameworks can be found. The different approaches on identifying the assessment characteristics show that it is a complex task of multidimensional nature. Emerging technologies and societal changes have created a growing, seemingly limitless demand for more access to medical information on which to base health decisions. The web has become an important source for patients to gain access to health information and on-line services [3]. This situation has arisen a general concern on the structure and operation of hospital websites.

We should point out that in the increasingly competitive world of health care provision, an efficient web presence is not a trivial matter. Hospitals are investing time and money in creating and maintaining sophisticated patient-oriented websites to attract and retain customers. Such organisations need to check the type of information and services they are providing, since users of their websites may exchange with them personal and sensitive information.

The main objective of this paper is to present the process of design and implementation of a user-oriented assessment instrument of hospital websites. The paper is organized as follows. In the next section, the research background is presented. Section three illustrates the main steps of instrument development. Section four, briefly presents the main elements of the proposed assessment instrument. Implementation issues are discussed in section five and finally, section six provides conclusions.

2. STUDY BACKGROUND

A number of evaluation approaches and methods for health sector websites have been suggested over the last years. However, the issue of proper information and services provision on the web is still under discussion, as is their impact on public health and the question of whether hospitals provide the user requested information in the proper way. A review of these studies reveals that the majority of suggested health sector evaluation approaches and methods focus on usability characteristics and take into account, in less degree, the specific needs of content elements. Also, most of them do not follow the front-end assessment perception, which means that the website evaluation methodology should include user's point of view in the evaluation process.

Most of the existing studies are either dealing with a limited number of website aspects or they are directed towards a specific health sector area. The previous researches and studies are accumulating different models and/or frameworks to evaluate the quality and performance of websites. These initiatives use different types of assessment schemes and could be categorized as follows, although some of them cover aspects of more than one category.

Some researches have been published describing, evaluating and analysing the quality of health-related websites, mainly focusing on content quality. These studies tend to take as objective the assessment of the quality of those websites which provide information about a specific health-related matter or about some specific clinical condition. Lewiecki et al. [4] develop and evaluate measurement tools to determine the quality of osteoporosis websites for patients. They use indicators in the categories of content, credibility, navigability, currency, and readability. Guardiola-Wanden-Berghe et al. [5] conducted an observational, descriptive and cross-sectional study carried out using systematic check techniques, on assessment of documentary and content quality assessment of eating disorder websites. Reznicek et al. [6] evaluate the quality of websites of Obstetrics and Gynecology departments in German-speaking countries using Google search rank, technical aspects, navigation and content as objective criteria. Norum [7] evaluates the quality of Norwegian cancer hospitals websites according to general information, hospital details and technical aspects.

The second group of studies is the one which bases website usability evaluation on a particular group of criteria. This group includes the biggest part of the studies published so far. They are based on the selection of a group of quality criteria, mainly referred to the way the information is presented, that is, to the reliability and accessibility of the websites as potential vehicles of

health messages rather than to the content of the messages themselves. The majority of these criteria have been elaborated aimed at being applicable to the evaluation of any health-related website, regardless of the type of information contained. Llinás et al. [8] evaluate and compare the user orientation of Spanish, American and British hospital websites. In their descriptive study, they evaluate websites according to readability, accessibility and the quality of information provided. Moreno et al. [9] present a qualitative and user-oriented methodology for assessing quality of health-related websites based on a 2-tuple fuzzy linguistic approach. To identify the quality criteria set, a qualitative research study was carried out using the focus groups technique. According to the qualitative research results, they defined five quality dimensions, credibility, content, usability, external links and interactivity services. Huerta et al. [10] assess the web presence of hospitals and their health systems based on five dimensions: accessibility, content, marketing, technology, and usability. Tsai and Chai [11] developed an evaluation questionnaire for nursing websites covering overall impression, download and switch speed, accessibility and convenience, web page content, and compatibility with common browsers. Randeree and Rao [12] consider the following factors for evaluating health sector websites: access/usability, audience, accuracy, timeliness, content, authority, and security. Calvo [13] assesses the quality and describe characteristics of websites of large Spanish hospitals evaluating the global quality, accessibility, usability, interactivity, updating, quality model, and information. Liu et al. [14] focus on the evaluation of quality of hospital websites in China using a pre-defined objective criterion based on content, function, design, and management and usage. The study conducted by Mira et al. [15] on the readability and accessibility of Spanish hospital websites concludes that they need to be more patient-oriented because the websites visited did not fulfil even half of the readability and accessibility attributes required by widely used standards. Mancini et al. [16] found that the enforcement of accessibility regulations has helped to significantly improve hospital website accessibility in Italy. Raj et al. [17] evaluated the usability and user experience of selected Nigerian university teaching hospital websites with the aim to provide better understanding of the design features and contents of the hospital websites that can offer positive experience and empower the users.

The third group of assessment studies deal with website evaluation through a detailed analysis of the information content provided by websites. This strategy to evaluate information quality is related to value the accuracy, exhaustiveness and completion of the provided content on the website. These studies normally carry out the content evaluation by means of considering specific pieces of expected information on hospital websites. For example, Maifredi et al. [18] explored the characteristics of the contents and the user-orientation of Italian hospital websites. The analysis considered Italian hospitals with a working website assessing technical characteristics, hospital information and facilities, medical services, interactive on-line services, and external activities. Bilsel et al. [19] present a quality evaluation model which consists of seven major e-service quality dimensions, including tangibles, reliability, responsiveness,

confidence, empathy, quality of information, and integration of communication issues of websites. Moslehifar et al. [20] study focus in four different categories such as general information, accessibility of websites, functionality of websites, and facilities information provided on websites. Patsioura et al. [21] proposed framework focuses on three main criteria: information, communication and electronic services. Garcia-Lacalle et al. [22] determine which factors have an influence on website adoption and level of development over time. The used checklist includes elements such as general information, contacting information, web linkage, quality of care, information for patients, information about resources and performance, site navigation and usability, health information, services provided to professionals and facilitating transactions. Gruca and Wakefield [23] evaluate the status of US hospital websites by examining the following features: electronic documents, providing decision aids, linkages to partners, building trust via external verification, facilitating transactions, multiparty targeting, self-service information, and discussion forums. Rafe and Monfaredzadeh [24] designed a hybrid qualitative framework to evaluate the quality of medical/hospital. The proposed framework consists of seven main categories, each having different metrics. The suggested categories are: content quality, design quality, organization quality, user-friendly quality, performance quality, service quality, and technical points.

Hospital website assessment can significantly contribute to developing websites that serve institutions' needs and meet the patients' expectations to the maximum possible extent. In order to achieve high-quality hospital websites, hospital management has to first understand the different dimensions that affect users' expectations and then relate these characteristics to specific website design aspects.

Although researchers have identified many essential evaluation elements, the users' perspective is necessary as they are the end recipients of the hospital websites' information and services. For this reason, one of the most important aspects considered in our suggested approach is the consideration of the users' point of view, both regarding the identification of the characteristics to be evaluated and also the possibility to let them judge directly the website quality.

Review of these methods yielded four criteria for determining hospital websites effectiveness and efficiency from both an internal functionality and user experience perspective. Authors led to developing the four-dimensional assessment instrument (HSWAI) [25] builds upon the assessment models outlined in the broad health sector website assessment literature, incorporating their most critical assessment elements into a simple but fairly comprehensive scheme.

3. HSWAI: DEVELOPMENT PROCESS

This section presents a detailed description of the overall process of HSWAI development.

Methodologically, this process followed a Design Science Research (DSR) approach. According to [26, 27], DSR aims at building new and innovative artifacts (e.g., method, model, theory, etc.) for a particular problem. DSR adoption is particularly

adequate for creating new artifacts based on already existent knowledge as well as on knowledge developed by the researchers over a sequence of construction-assessment steps performed during the overall research process. This generated knowledge, provides a better understanding of the area under study, and consequently leads to the creation of a better and more adequate version of the artifact that is expected to be produced.

Being the objective of this study to develop an instrument (artifact) for assessing the health sector institutions websites (HSWAI), the adoption of a DSR approach seemed to be convenient and appropriate.

The specific steps conducted for HSWAI development followed the *six-steps process model* presented in Figure 1. This model has been proposed by [26] as a systematized way of carrying out design science research.

Briefly, the first step of this model aims at defining the research problem to be addressed and the motivation to develop a solution for it (the final artefact). It also seeks to justify the usefulness of the artifact for the identified problem. The second step is focused on eliciting the objectives for the expected solution/artifact. Based on the objectives set out in step two, on the third step the attention is put on specifying how the artifact will be and should be obtained, as well as on its creation. The fourth and fifth steps concern the analysis and evaluation/validation of the artifact. At the end of these steps, researchers decide whether the artifact reached a final status or if there is a need to iterate to step 2 or 3 to improve the effectiveness of the artifact. The sixth step aims at disseminating the study and its results: the problem and its importance; and the artifact, its utility, novelty and effectiveness, to the different audiences.

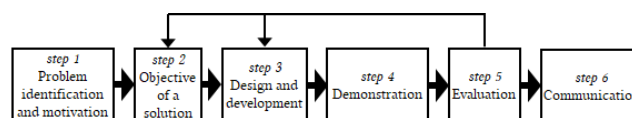


Figure 1: Design science research process model (adapted from [26])

The overall HSWAI development process took over one year and comprehended four cycles of refinement, corresponding to successive iterations of construction-validation (steps 2 to 5 in Figure 1). In each of these cycles, different sources of input, multiple kind of stakeholders, and diverse data collection techniques were used for validating the set of dimensions, indicators and sub-indicators that composed the HSWAI. As a result, in each cycle new elements were added, some elements were removed, and some elements suffered some name and description changes. This iterative process of construction-validation, involving multiple stakeholders and sources of information, led to a more appropriate, rich, and comprehensive final version of the instrument.

The sequence of construction-assessment cycles (4 in total) stopped when the dimensions, indicators and sub-indicators reached stability, with no relevant changes suggested on the validation conducted.

Figure 2 depicts the overall process of HSWAI development. Details on each of the cycles are provided in the following subsections.

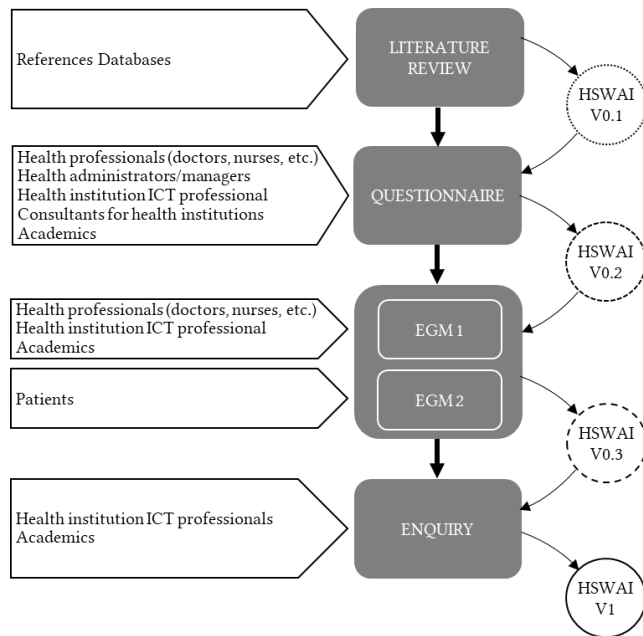


Figure 2: HSWAI development process

3.1.1. Literature Review

The development process started with an exploratory literature review that tried to systematize the conceptual content of the field, and contribute to theory development towards formulating a conceptual framework encompassing the relevant dimensions and indicators relevant to consider for the assessment of health sector websites.

Documents were searched in six academic online databases: Science Direct, EBSCOHost, Google Scholar, Web of Science, Scopus and Wiley Online Library. The search covered the years 2000 to 2017 and used the following keywords and operators: *hospital OR health sector AND web site OR website AND quality OR evaluation OR assessment*.

A total of 45 articles were found and the final selection was carried out taking into account the compliance with a set of inclusion and exclusion criteria. Inclusion criteria comprised documents that were original articles published in peer-reviewed journals or conferences. Only articles where the complete text was available for retrieval were included. Exclusion criteria consisted of studies which did not contain at least one health sector website evaluation aspect. Also excluded were those which did not make specific references to website characteristics. After considering the inclusion and exclusion criteria, 20 papers were determined as suitable and selected for further analysis.

Additionally, a secondary search was carried out in article abstracts to locate possible relative resources which do not contain some of the keywords in their titles. Four articles were found and included in the review process.

Content analysis of the selected articles was carried out using systematic check techniques on existing health sector web presence assessment studies. The different assessment approaches were analysed and the significant elements identified.

As a result, a framework, presented in a previous study [25], comprising 4 dimensions, 18 indicators, and 169 sub-indicators (Table 1), corresponding to version 0.1 of the instrument, was proposed.

Table 1: HSWAI V0.1: dimensions and indicators

DIMENSION	INDICATOR	NUMBER OF SUB-INDICATORS
Content	Hospital Information	18
	Quality Metrics	13
	Organizational Structure and Medical Information	15
	Patient Information	15
	Research and Teaching	9
Services	Administration Procedures	5
	Appointments	7
	Patient Care	7
	Inter-Hospital Communication	3
	Communication with Others	2
Participation	Community Interaction	11
	Media	9
	Marketing/Advertising	8
Technology	Navigability	7
	Accessibility	12
	Usability/Readability	13
	Credibility	8
	Privacy/Security	7

3.1.2. Questionnaire

The next cycle in the development process included the validation of HSWAI V0.1, produced in the first cycle, through the application of a questionnaire to health sector professionals.

The main goal of this survey was to understand if health sector professionals and academics, researchers, IT professionals and consultants working on the sector, found the framework adequate, if the proposed dimensions, indicators and sub-indicators made sense within the health context, and if they were applicable to their health institutions. The latter is relevant since some elements may not be applicable in all the types of hospitals, namely in private and public hospitals; in non-teaching and teaching hospitals; etc.

The survey was organized into four groups of questions, corresponding to the four instrument's dimensions (Content, Services, Participation and Technology), each group containing questions about the indicators and sub-indicators identified for the respective dimension.

For each sub-indicator, respondents were asked to indicate:

- The relevance of the sub-indicator (if the item was relevant to be included in HSWAI). The possible replies were *Maintain*, *Remove* or *Alter*. If *Remove* or *Alter* were chosen, the respondent would be asked to provide a justification of why it should be removed/altered.
- The applicability of the sub-indicator (if the item applies to the type of health institution of the respondent). The possible replies were *Applicable* or *Not Applicable*.

The group of indicators and sub-indicators referring to the *Technology* dimension was only available for reply for IS professionals, academics and IS consultants due to its specificity and level of detail.

The survey was sent to 69 participants from five professional groups associated with the health sector: (i) Health professionals (doctors, nurses, etc.); (ii) Health institutions administrators and managers; (iii) Health institution information systems and technology (IST) professionals; (iv) Academics researching in the area; (v) Consultants working directly with health institutions.

The questionnaire was kept open for 45 days. During this period of time, two email reminders were sent.

A total of 8 complete answers and 45 incomplete answers were received. From the incomplete answers, 4 were also considered for analysis because they had advanced greatly in the survey and contributed with their opinion for some of the items. Table 2 presents the segmentation of responses per type of professional group. The category *Other* refers to participants that did not fall into any of the defined professional groups.

Table 2: Profile of respondents

PROFESSION	NUMBER OF RESPONDENTS
Health professionals (Doctor, Nurse or Health Technician)	4
Health Institutions IST Professionals	3
Health institutions administrators and managers	3
Other	2

Respondents' answers were carefully analyzed. In one case, a meeting was scheduled with the respondent (a hospital administrator) in order to clarify some doubts in his responses.

After analyzing and debating over the suggestions received, some changes were done to the sub-indicators. Most of the changes corresponded to merging sub-indicators for a simplified understanding. This was the case for five sub-indicators which resulted from the merging of at least two sub-indicators. Two sub-indicators suffered text adjustments and one was removed.

3.1.3. Expert Group Meetings

The third refinement cycle in the development process was grounded on information collected through two Expert Group Meetings (EGM). The purpose of the Expert Group Meetings (EGMs) was to collect contributions from participants to reformulate, add and remove indicators and sub-indicators, as

well as to validate and attribute relative significance (weights) to the dimensions and indicators that compose the HSWAI.

Two EGMs were conducted, one with professionals from the health sector (six participants: two doctors, one academic with professional and research experience in the health sector, one health IT consultant, and two researchers from an institute responsible of measuring and evaluating ICT adoption in Latin America), and another with users (11 participants).

Both meetings followed the same structure. The agenda began with welcome and self-introductions, followed by the presentation of the EGM's purpose and objectives, the description of the instrument structure, and the discussion of the following five main points:

- 1) Dimensions relevance - Which are the important dimensions (categories, areas) to consider when assessing a hospital website?
- 2) Indicators relevance - Which are the important indicators to consider for each dimension?
- 3) Sub-indicators relevance - Which are the sub-indicators that should be taking into account when evaluating a health institution websites?
- 4) Dimensions weighting - Which is the relative weight of each dimension?
- 5) Indicators weighting - Which is the relative weight of each indicator for each dimension?

The input from the several stakeholders participating in the EGMs was valuable to foment the reflection and to incite discussion that led to the revision of dimensions, indicators and sub-indicators. The main conclusion taken from these discussions led to the following decisions:

- A Methodological Guide should be created to describe the scope of instrument application, as well as each dimension, indicator and sub-indicator. Regarding each sub-indicator, a detailed explanation of how the evaluation should be conducted should also be provided;
- At least in this stage of development, the instrument should only be applicable to hospitals and "hospital-like" institutions;
- The instrument can be applicable to both public and private hospitals but it must have in consideration the differences between the two types of institutions.

Changes in the instrument were extensive and include: adding new sub-indicators, namely related to the availability of health sector institutions' quality metrics; merging some sub-indicators, improving the description of some sub-indicators, moving some sub-indicators to other more suitable indicators, and removing indicators and sub-indicators from the instrument, mainly due to the associated difficulty or ambiguity of assessment.

The name of two dimensions was also adjusted: dimension *Participation* was renamed to *Community interaction* and dimension *Technology* to *Technology features*.

After the third construction-validation cycle, the assessment framework of HSWAI (version 0.3) included four dimensions, 16 indicators and 168 sub-indicators, as depicted in Table 3.

Table 3: HSWAI V0.3: dimensions and indicators

DIMENSION	INDICATOR	NUMBER OF SUB-INDICATORS
Content	Health institution information available on the website	21
	Quality Metrics	14
	Organizational Structure and Medical Information	16
	Patient Information	15
	Research and Teaching	11
Services	Administration Procedures	4
	Appointments	3
	Patient Care	9
Community Interaction	Participation	11
	Media	9
	Marketing/Advertising	10
Technology Features	Navigability	7
	Accessibility	10
	Usability/Readability	14
	Credibility	7
	Privacy/Security	7

Two other points discussed during the EGMs (point 4 and 5 enumerated before) were related to the definition of weights for each dimension and indicator. One of the EGM's objectives was, in fact, to seize the opportunity of having a professionals group and a group of citizens available to perform the dimensions and indicators weight attribution. The aim was to understand which of the dimensions and indicators would represent aspects considered more relevant in health institutions websites.

Weight attribution was done using the Analytical Hierarchical Processing (AHP) method. AHP was chosen since it represents an accurate approach for quantifying the weights of criteria. It has particular application in group decision making, where individual experts use it to estimate the relative magnitudes of factors through pair-wise comparisons.

Each EGM participant was given a questionnaire in which he/she had to compare each dimension with every other dimension, using the scale presented in Table 4. The same had to be done to every indicator within each dimension.

Table 4: Scale adopted for dimensions/indicators comparisons

EXPLANATION	NUMERIC VALUE
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If Option A and Option B are equally important : Mark/Insert ->	1
If Option A is moderately more important than Option B : Mark/Insert ->	3
If Option A is strongly more important than Option B : Mark/Insert ->	5
If Option A is very strongly more important than Option B : Mark/Insert ->	7
If Option A is extremely more important than Option B : Mark/Insert ->	9
Use even numbers for intermediate judgments ->	2, 4, 6, 8

Scorings given by EGMs participants were averaged and a rough estimation was attributed to each dimension and indicator following three simple rules:

- 1) The weight value is a multiple of 10;
- 2) The weight value is the result of truncation resulting from the average;
- 3) If, after applying rules 1 and 2 the sum of weights does not result in 100, we add 10 to the element (dimension or indicator) which scores closer to the next multiple of 10. This process was repeated until the sum of weight results in 100.

Table 5 summarizes the scores obtained.

Table 5: Dimensions and indicators scores

DIMENSIONS/INDICATORS	PARTICIPANTS AVERAGE	ROUGH ESTIMATION	ALGORITHM ESTIMATION
Content	23,7	20	20
Health institution information available on the website	18,4	20	20
Quality metrics	20,75	20	20
Organizational structure and medical information	16,35	20	10
Patient information	37,15	30	40
Research and teaching	7,35	10	10
Services	47,15	40	50
Administration procedures	13,05	20	10
Appointments	41,35	40	40
Patient care	33,65	30	30
Community Interaction	12,65	20	10
Participation	70,55	70	70
Media	18,8	20	20
Advertising/Marketing	10,65	10	10
Technology	16,5	20	20
Navigability	14,3	20	20
Accessibility	22,75	20	20
Usability/Readability	21,2	20	20

Credibility	17,55	20	20
Privacy/Security	24,2	20	20

3.1.4. Enquiry

The fourth and last refinement cycle of HSWAI development process involved experts that had a large experience working with the health sector and understand both informational and technical components.

The aim of this validation was to get feedback on the weights attributed to the dimensions and indicators. An email was sent to two experts. One of them replied positively, providing feedback on HSWAI version 0.3. No further main changes were suggested neither to the set of dimensions, indicators and sub-indicators nor to the weights. The expert left just minor remarks on two sub-indicators and slight changes were introduced on their descriptions.

Considering the stability achieved in the list of elements and weights, the iterative process of construction-validation cycles was stopped and the final version of HSWAI (Version 1.0) was produced.

Table 6 systematises the different versions of HSWAI produced through the overall development process.

Table 6: HSWAI versions

HSWAI VERSION	DESCRIPTION
HSWAI v0.1	Initial set of dimensions (4), indicators (18) and sub-indicators (177)
HSWAI v0.2	First refinement of dimensions (4), indicators (16) and sub-indicators (166)
HSWAI v0.3	Second refinement of dimensions (4), indicators (16) and sub-indicators (168), and weights identification
HSWAI v1.0	Freezing of dimensions (4), indicators (16), sub-indicators (168), and weights

4. HSWAI: INSTRUMENT DESCRIPTION

This section presents a detailed description of the HSWAI final version.

This final version assesses the website according to four main dimensions: *Content*, *Services*, *Community interaction*, and *Technology features*. Each dimension has a set of indicators which are further subdivided into sub-indicators. The set of dimensions, indicators and sub-indicators is summarized in Table 7.

Table 7: HSWAI

C1: CONTENT
C1.i1: Health institution information available on the website Institution name on the page header; Institution logo on the page header; Welcome message; Institution postal address; Institution telephone and/or fax number; Institution e-mail address; Institution VAT number; Map of the hospital area (including parking lots); Ways of reaching the hospital: private and public transportation; Complementary services: press, cafeteria, television, telephone, parking, religious service; Phone directory; Institution history; Statement of purpose (Mission, Vision, Values); Area covered by the hospital

(population served); Quality Management Certification (e.g. ISO, EFQM); Management Reports (This item may include Activities Plan, Budgets, Activities Reports, Account Reports, etc.); Public procurement: announcement information on the website; Public procurement: connection to national portal; Emergency information; Home hospitalization information; Applied legislation to the health institutions context

C1.i2: Quality Metric

Number of institution beds disclosed; Waiting list disclosed; Waiting time consultation; Waiting time surgery; Waiting time to be seen in the emergency room; Date of last monitoring of the waiting list disclosed; Institution report of the number of admissions in the previous year; Institution quality indicator: nosocomial infection rate disclosed; Institution quality indicator: inpatient mortality rate disclosed; Institution quality indicator: surgical mortality rate disclosed; Institution quality indicator: others; Information on births per year; The website provides open data regarding patients and hospital practices; Results of surveys regarding patient satisfaction are provided

C1.i3: Organisational Structure and Medical Information

Organization chart (medical management, nursing management, institution management); Services charter; Listing of services available at the institution; Detailed list of outpatient institution services available (consultation, diagnostic services); Departments or units providing user services: complete list; Departments or units providing user services: location; Departments or units providing user services: telephone and/or fax number and/or e-mail address; Departments or units providing user services: working hours; Personnel map; List of employed doctors; Doctors' curricula/information; Photos of the medical team (physicians, nurses) available; Head of service; Possibility to read online or to download health-care booklets; Medical glossary available; Conditions and Treatments

C1.i4: Patient Information

Information regarding patient privacy; Patient's rights and obligations; Admission guide: different types of admissions are disclosed; Admission guide: information and rules to be followed on admission; Admission guide: information and rules to be followed during the stay at the institution; Admission guide: information and rules to be followed on discharge; Admission guide: information and rules to be followed by visitors; Information and procedure for obtaining a copy of the medical documentation; Patient care service or unit: location; Patient care service or unit: business hours; Patient care service or unit: telephone and/or fax; Details of how to pay charges or fees; List of consultations/services with fees available; Information for foreigners; Affiliated insurance companies and other entities

C1.i5: Research and Teaching

Scientific studies that the institution promotes or is involved in; Publications of the institution; Undergraduate or postgraduate courses that are held at the institution; Schedule of activities that take place at the institution: courses, congresses and conferences; Number of internships accepted by the hospital each year; Presence of a library; Library: address; Library: business hours; Library: publications catalogue; Library: services available, such as reading, loans, copies; The website provides clinical open data

C2: SERVICES

C2.i1: Administration Procedures

Provision of online forms; Possibility of forms downloading; Possibility of filled forms uploading; Electronic payment

C2.i2: Appointments

Manage medical examination via web; Manage Admission via web; Manage visits to outpatient consulting rooms via web

C2.i3: Patient Care

Asynchronous communication with the doctor via message exchange system; Asynchronous communication with the doctor via e-mail; Synchronous communication with interactive communication tool (chat with a doctor); Electronic directory with patient's records; Provision of telemedicine (video-conference system) services; Patient telemonitoring (e.g. specific vital signs, blood glucose, peak flow rate, blood/urine chemistry); Private area access: with login and password; Private area access: with Digital ID card or Mobile Digital Key; Possibility to require and/or obtain medical prescription

C3: COMMUNITY INTERACTION

C3.i1: Participation

Suggestions via web; Complaints via web; Information request via web; Communication with the institution via Chat; Discussion forum; If the website has a forum it is possible to identify the administrator; Opinion polls available; FAQ; Associations that work at the institution: voluntary associations (social responsibility); Associations that work at the institution: patient associations; Associations that work at the institution: associations for the defense of patients' rights
C3.i2: Media The institution in the media: features news that appeared in press, radio, TV, social networks; Website provides an up-to-date news/events schedule/newsletter; Virtual visit to the institution; Links to other websites of interest: hospitals, scientific societies, institutions; Public relations office: work hours; Public relations office: location; Public relations office: telephone and/or fax number; Public relations office: e-mail address; Institution news: new techniques used by the center specialists, infrastructure improvement
C3.i3: Advertising/Marketing Website sponsors and investors are disclosed; Advertising and contents are differentiated; Advertising is not contradictory with respect of the website contents; Information on how to make a donation to the hospital; Facebook link; Twitter link; LinkedIn link; Youtube link; Other social networks link (e.g. Flickr, Instagram); Information about job opportunities at the hospital
C4: TECHNOLOGY FEATURES
C4.i1: Navigability Website name appears on browser title bar; Active part of the site appears on browser title bar; Best browser version for the website is indicated; Inter-website links are distinguished from intra-website links; Inter-website links show a full description of the linked website; Functioning intra-website links; Functioning inter-website links
C4.i2: Accessibility Compliance with level A WCAG 2.0 W3C; Compliance with level AA WCAG 2.0 W3C; Compliance with level AAA WCAG 2.0 W3C; Accessibility symbol present on the main page; Website is validated through W3C CSS 3.0 Validation Service; Website is validated through W3C Markup Validation Service (html5); Website listed on the first page of results after performing a Google search; For individual sub-pages, there is a specific and meaningful description provided via the META/description tag; Website is compatible with the 3 most used browsers in the country; Website is compatible with the 3 most used mobile browsers in the country
C4.i3: Usability/Readability Website map available; Website search engine; Access to the website in foreign languages; Website load time; Illustrations/pictures/photos accompany text to assist description; Graphics open conveniently (images/graphics are quick to load); Website pages can be printed; Individual sub-pages have specific and meaningful titles; The layout of the website is responsive (i.e. does it adapt to varying screen sizes), or there is a separate version for mobile devices; The website offers means to adjust (increase) the text size without compromising the functionality of the website; The website offers means to adjust (increase) the contrast of textual information for visitors with visual impairments; The website provides a (consistently accessible) menu structure for navigating the department's sub-pages; Website does not include pop-up advertising; Website Technological Sophistication (universal services use via web services, APIs, widgets)
C4.i4: Credibility The text is grammatically correct; The text does not have spelling errors; Interest Conflict declaration or Declaration of non-conflict is shown; Date of last website update; Pages have dates associated with them (There are indications of updates to materials); Website has HON (Health On the Net) foundation code certification; Webmaster characteristics
C4.i5: Privacy/Security General disclaimers provided; Copyright notice; Ownership of the site; Responsible of the website content; The site is secure (encrypted); There is a website privacy policy; Cookie Policy

Some sub-indicators are not applicable to every type of hospital institution as is the case of private hospitals or hospitals without research and teaching capacity.

Each sub-indicator has a dichotomic scale, scoring the value 0 or 1, depending on its presence/observance or not on the website.

Each HSWAI dimension and indicator has a specific weight, which illustrates its relative relevance to the overall evaluation of the website. The weights are presented in Table 8.

Table 8: HSWAI weights

C1: CONTENT	20%
C1.i1. Health institution information available on the website	20%
C1.i2. Quality Metrics	20%
C1.i3. Organisational Structure and Medical Information	10%
C1.i4. Patient Information	40%
C1.i5. Research and Teaching	10%
Total weight of C1 indicators	100%
C2: SERVICES	20%
C2.i1. Administration Procedures	20%
C2.i2. Appointments	40%
C2.i3. Patient Care	40%
Total weight of C2 indicators	100%
C3: COMMUNITY INTERACTION	20%
C3.i1. Participation	70%
C3.i2. Media	20%
C3.i3. Advertising/Marketing	10%
Total weight of C3 indicators	100%
C4: TECHNOLOGY FEATURES	20%
C4.i1. Navigability	20%
C4.i2. Accessibility	20%
C4.i3. Usability/Readability	20%
C4.i4. Credibility	20%
C4.i5. Privacy/Security	20%
Total weight of C4 indicators	100%
TOTAL	100%

Sub-indicators of an indicator weight equally, being their weight obtained by the formula $(1/\text{number_of_applicable_sub_indicators}) * 100\%$.

Considering these weights, an index that shows the level of maturity of the health institution website can be calculated.

The value of i_{HSWAI} is obtained with the following formula:

$$i_{HSWAI} = 20\% \times C1 + 50\% \times C2 + 20\% \times C3 + 10\% \times C4$$

where,

$$C1 = 20\% \times C1i1 + 20\% \times C1i2 + 10\% \times C1i3 + 40\% \times C1i4 + 10\% \times C1i5$$

$$C2 = 20\% \times C2i1 + 40\% \times C2i2 + 40\% \times C2i3$$

$$C3 = 70\% \times C3i1 + 20\% \times C3i2 + 10\% \times C3i3$$

$$C4 = 20\% \times C4i1 + 20\% \times C4i2 + 20\% \times C4i3 + 20\% \times C4i4 + 20\% \times C4i5$$

and that the calculation of the value of each indicator is obtained by the formula:

$$\frac{\sum \text{values of all the sub_indicators}}{\text{number of sub_indicators} \neq \text{"not applicable"} / \text{total number of sub_indicators}}$$

In the case where hospitals do not have "Research and Teaching" (C1i5) resources, calculation of criteria C1 follows the rule:

$$C1 = 22\% \times C1i1 + 22\% \times C1i2 + 11\% \times C1i3 + 45\% \times C1i4$$

In this case the weight of $C1i5$ (10%) is distributed in the right proportion by $C1i1$, $C1i2$, $C1i3$, and $C1i4$.

The final value of i_{HSWAI} will be a value between 0 and 1.

5. HSWAI: INSTRUMENT APPLICATION

The previous section described the main elements (dimensions, indicators and sub-indicators) that compose the proposed health sector website assessment instrument. It also indicates the weight that each of these elements should assume in the computation of the value of the index that shows the level of maturity of the health institution website (i_{HSWAI}).

This section presents some guidelines on how to apply the HSWAI to a concrete set of health institutions.

The application of HSWAI is done through the direct observation of the hospitals' websites. For this reason, the first step on the application process is to identify the URL of the hospital main website. Also extremely relevant is to identify the type of hospital that is being assessed. As mentioned in the previous section, some elements of HSWAI and some weights and weights distributions vary slightly depending the type of hospital: some sub-indicators are not applicable for private hospitals; some indicators are just applicable to university teaching hospitals. For this reason, the type of hospital must be identified right at the beginning of the assessment process.

The observation of the hospital website should be conducted by two assessors, under the supervision of a third one (supervisor) who should be an expert on the assessment process. This means that for each hospital website there are two observations (one from each assessor).

Assessors should access each hospital website and score each of the 168 HSWAI sub-indicators with "0" or "1" depending on the presence or not of the sub-indicator.

The assessors should be instructed to assume the logic and attitude that would typically be of an average user/patient when navigating the website. This means that the effort put in the search for the assessment sub-indicators should be similar to the one performed, on average, by a citizen while using the website, and not an exaggerated and extensive effort.

Finished the assessment, the supervisor should compare the values registered by both the assessors. In cases when the two assessors assign different values to a specific sub-indicator, they should be requested to reassess it more thoroughly. In case the assessment discrepancy remains, the supervisor should decide which value will be assigned to the sub-indicator.

After data collection and validation, the health institution website index (i_{HSWAI}) can be computed, taking into consideration the value registered for each sub-indicator as well as the weights defined for each dimension and indicator.

Data obtained can be analysed in different perspectives. Besides the presentation of a global ranking of hospitals' website level of maturity, other rankings for each of the four dimensions considered can be generated giving more specific perspectives and allowing more detailed and fine-grained analysis.

Further segmented analysis by region and by private/public hospitals, can also be performed, providing interesting

information. This type of information will be useful not just at a hospital level (used by each hospital to improve its management and performance) but at a global level (used by policymakers to define policies for the health sector).

6. CONCLUSIONS

This paper presented the development process of a comprehensive hospital website assessment instrument and discussed its implementation issues.

From the methodological point of view, development of assessment instruments is a complex task and a lot of experts input and validation experiences were used in order to produce a well-established output.

Some particular challenges were faced and had to be resolved during HSWAI development process namely: (i) the determination of instrument's assessment scope, which has been decided to be limited to hospitals; (ii) the uniqueness of each hospital and more specifically how to deal with differences between private and public hospitals that led to different weight calculations; and (iii) the fact that not all hospitals are associated with teaching activities imposed differences in the final calculations.

The final version of the proposed assessment instrument comprises a component-based model that addresses users' information needs and service requirements underpinning hospital website strategy planning. The components have been derived from existing health sector website assessment studies and frameworks and . Four main assessment dimensions have been identified and analysed in specific measurable indicators (16) and sub-indicators (177): Content, Services, Community Interaction and Technology Features.

The main goal of the current methodology is to make hospital website assessment process more systematic and efficient, for domain experts and practitioners, by providing specific process and guidelines that they could use. Such assessment instrument creates certain requirements to hospital website design process and facilitates its development and its evolution.

HSWAI offers to hospital management aggregated and at the same time scientifically sound information to improve their provided services, it offers to citizens the possibility to compare and select health service provider, and finally it assists health sector policy-makers to monitor and further develop eHealth policy.

The instrument allows its systematic adaptation to the local needs and its application to different types of health institutions. The proposed instrument is currently applied in Portugal and will be revised and updated in view of this experience. Ideally this can be done in continuous collaboration with health sector institute managers, personnel, websites designers and developers, as well as agency administrators and public stakeholders. Finally, comparison of the proposed instrument with similar initiatives would be a future research perspective.

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