ENTITIES, ATTRIBUTES AND METRICS

Assignment 2-Part II
Software Metrics (PA 1407)

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I. ABSTRACT

The measurement process is often affected by poorly stated attributes of entities, in spite of owning a good measurement goal. This paper attempts to give a mapping from the entities to the metrics and scale types, by following scientific rules of measurement. The primary aim of this paper is to improve maintainability of a children's website by analysing its usability. Apart from solely analysing, the website's usability is also predicted for future use based on the selected metrics. Therefore the work presented here is targeted towards practitioners and managers to take informed decisions related to web usability.

Keywords: entities, attributes, scale types, metrics and measurement theory.

II. PILOT STUDY OF THE PROJECT

INTRODUCTION

In this section, we present a brief recap of the measurement goal proposed as a part of the previous assignment. By doing so, we intend to map the attributes of entities that are identified in this paper, to the metrics proposed in the earlier assignment. This mapping process is conducted in alignment with the measurement goal. Hence, the following sub section provides a recap of the goal. Later, a graphical flow diagram that demonstrates the procedure followed during the course of the project is detailed.

RECAP OF THE MEASUREMENT GOAL

The initial motivation to carry out this study was to analyse and measure web usability of a children's website http://pbskids.org, with special emphasis on maintainability, from the users' viewpoint. This is done to reduce the maintenance costs incurred by an organisation during deployment phase of a product. In the present context, the website under inspection, too, has completed the development phase and is available to the users. Therefore, by observing the users' behaviour during interaction with the website, we intend to draw key conclusions regarding several factors such as navigability, user acceptance and response time that form guidelines for practitioners and managers to analyse and predict the trends of usability.

THE PILOT STUDY

Figure 1 describes the various stages of the pilot study that we conducted. This diagram was chosen with a motivation to preserve repeatability of our study. Therefore the concept of a flow chart is accredited to the works of Fenton et al. as stated in [1].

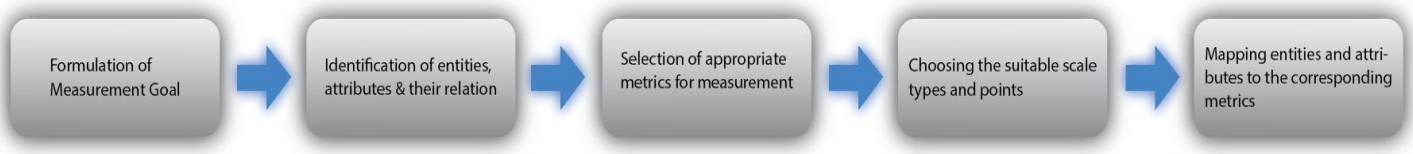

Figure 1 Flow chart of Pilot Study

The five stages depicted in the figure above give an outline of activities starting with the formulation of measurement goal (that was conducted as a part of previous assignment) to the mapping of entities and attributes to metrics, which is presented in this paper. Intermediary steps include listing the attributes of entities identified along with proper classification of their type. Next, the suitable scale types are decided based on the selected metrics. Further, a mapping rule is also elicited in order to preserve accuracy in the results obtained. Based on these results related to the possible metrics, measures and scale types identified, we present a model for predicting future usability trends. This model is estimated to foster the preparation of a questionnaire and selection of appropriate empirical study, for the work to be presented in next assignment.

The remainder of this document is organized in the following way: section III gives a list of entities and their attributes that were identified during the course of the project followed by mapping of these entities to the metrics proposed in section IV. Section V is about a brief discussion about the scale types chosen. To the end, the document is concluded by summarizing our work in section VI.

III. Attributes Identified and Their Types

In order to assess the usability of the website, it is important that key attributes pertaining to the users' viewpoint are properly identified along with a clear distinction about their type i.e. internal or external. As attributes are characteristic properties of entities, we first distinguish two of them, which are: i. Website and ii. Web page, and then relate them to the questions elicited in the earlier assignment. The context in which the previously mentioned entities were chosen is illustrated in Table 1 and is further elaborated in the discussion that follows.

Questions	Entity	Attribute	Type
Q1. Can the user visit all pages of the website?	Website	Navigability	External
Q2. How effective are the error and prompt messages?	Webpage	Readability	External
Q3. How long does it take to load a video or game after it is selected?	Webpage	Loading time	Internal
Q4. How long it takes to respond to a query submitted by the user?	Website	Response time	External
Q5. How frequently is the website subjected to revisions?	Website	Version	Internal
Q6. How well are the changes made in a website accepted by users?	Website	User acceptance	External

Q7. Is the website available at any given point of time during a day?	Website	Availability	Internal
Q8. Can users search the website for specific topic or content?	Website	Ease of use	External
Q9. How effectively are the users redirected to the site from search engines?	Website	Web page index	Internal
Q10. Are the buttons used in the website conveying appropriate message?	Webpage	Users' intuition	External

Table 1 Classification of entities and attributes

It can be observed from the table above that the majority attributes are pertaining to the website entity and a few of them are related to webpages of the website. Although a webpage can be considered as a part of the website, we explicitly mention webpage as an entity under certain contexts. For example, following the principles of Nielsen's heuristics, it is stated in [2] that attributes such as navigability, learnability and ease of use are attributes of websites that enhance web usability. However, it can be noted that aspects such as colour scheme and appearance of content in a website is specific to webpages as the various sections of a website have different style of rendering [3]. Hence, although a web page itself can qualify as an attribute of a website, based on context and studies that considered a similar approach in measuring the entities, we additionally opt for the webpage as an entity.

Based on the nature of the attributes chosen, we broadly divide them into two categories, namely, internal and external. The discussion that follows presents the rationale for classification of the identified attributes. However, following the fundamentals of web attributes as given in [1], it can be stated that attributes that could be measured independently were made the internal attributes, whereas those attributes whose behaviour had to be taken into account were grouped into external attributes.

INTERNAL ATTRIBUTES

Attributes such as webpage index, availability and version number are internal to the website and can stand alone during measurement. This means that, these attributes can be measured independently without the interference of human interaction. Such attributes, for example, the loading time can be measured on a time scale [3]; given the network traffic is assumed to be constant. Similarly, the website availability is measured by analysing the number of users online at a given instance. The ease of redirection to a webpage from a search engine is measured by the number of index pages contained in a website [6].

EXTERNAL ATTRIBUTES

These are the attributes that are highly user centric, in a way that the measurement is based on the manner in which a user rates these attributes. For instance, attributes such as ease of use of a website, intuition of web content, navigability, readability and acceptance of a user can only be measured by taking into account the behaviour of the users interacting with the entities. In the present context, the entities are the website and specific web pages. Further, the behaviour of the users is translated to the feedback and the perception of either the parents or children who interact with the website. Additionally, it is justified from the relevant literature, as pointed out in [4] and [5], that user acceptance and ease of use are two of the many quality attributes that are dependent on the age of the users interacting with the website.

IV. MAPPING OF ENTITIES AND ATTRIBUTES TO METRICS

In this section, we present the mapping of attributes to the measures identified (as shown in Figure 2). Further, the rules for measurement are described in Table 2. Starting with the domain and range of the measures, it is obvious that the domain is the webpage or the website and the range is its attributes like the navigability, usability etc. Further, we emphasise on the rules governing the mapping in the following discussion.

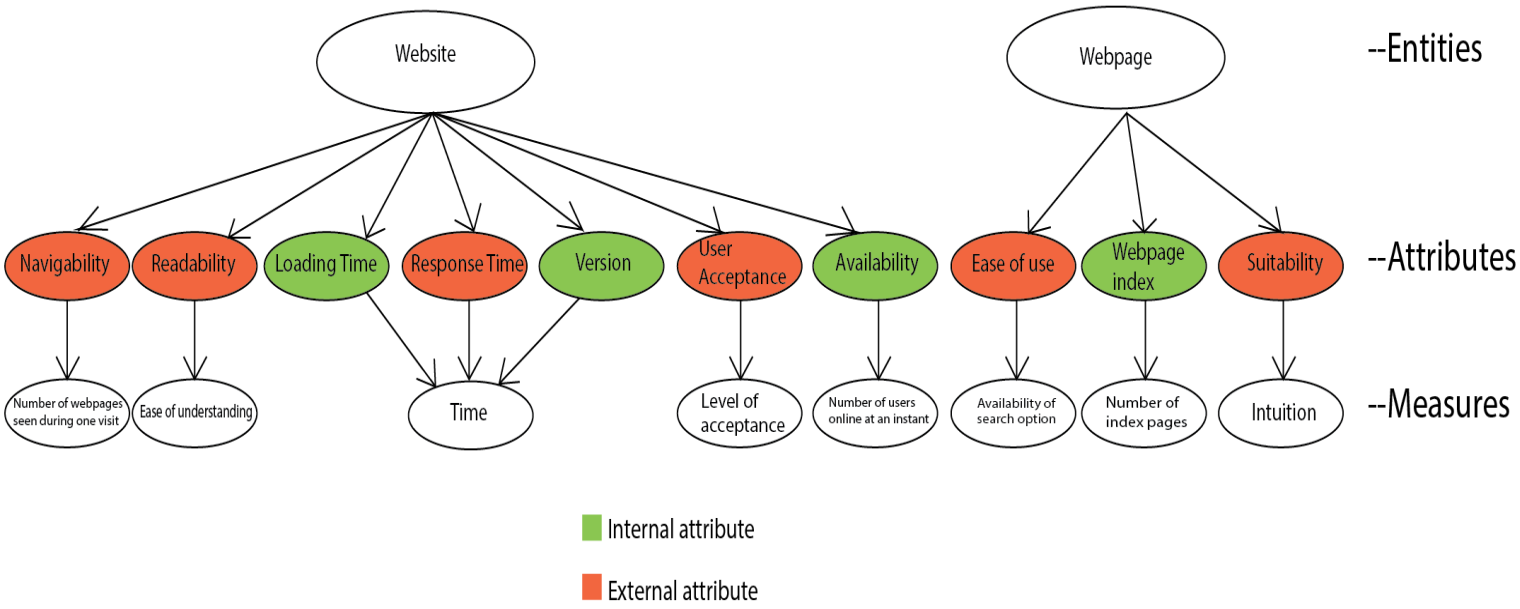

Figure 2 Mapping of attributes to measures

Given below is a set of rules to be followed to preserve repeatability of the measurement process.

Attribute	Metric	Rule
Navigability	Number of web pages seen during one visit.	- We should have a checkpoint from where we start measuring. Ex: The home page. - The number of clicks that takes to navigate to a webpage from the checkpoint shouldn't exceed three. [7]
Readability	Ease of understanding	- There should be uniformity in the messages being displayed.
Loading time	Time	- The time being measured is calculated from the moment the user is connected to the server. - The time passed during the loss of connection with the server is not considered.
Response time	Time	- The time being measured would include only the number of working hours.
Version	Time	- The versioning methods followed by the

		website developers must be considered.
User acceptance	Level of acceptance	- The user must be notified of the changes made to the website.
Availability	Number of users online at an instant	- A user is said to be online only if he is active for a certain amount of time on the website.
Ease of use	Availability of a search option	- The sample considered for measuring the availability of a search option is restricted to parents alone and not the children.
Web page index	Number of index pages	- The web pages must be indexed in most of the popular search engines like Google, Bing and Yahoo search etc.
Suitability	Intuition	- There should be uniformity in the symbols that are used all through the website.

Table 2 Rules of Measurement

V. DISCUSSION OF SCALE TYPES AND POINTS

In this section the scale types and scale points selected for the metrics are described in Table 3.

Attribute	Metric	Scale Type	Scale Point
Navigability	Number of web pages visited during one visit.	Absolute	Webpage count.
Readability	Ease of understanding the displayed messages.	Ordinal	Likert scale with points 1 to 5.
Loading time	Time.	Interval	Time in seconds
Response time	Time.	Interval	Time in hours
Version	Time.	Interval	Time in days
User acceptance	Acceptance by a user.	Ordinal	Likert scale with points 1 to 5.
Availability	Number of users online at an instant.	Absolute	Count of users.
Ease of use	Search options in a website.	Nominal	Yes or No.

Web page index	Indexed pages by search engines.	Absolute	Webpage count.
Users' intuition	Intuition of buttons.	Ordinal	Likert scale with points 1 to 5.

Table 3 Scale Types and Scale Points

In the above table, it must be noted that all likert scales selected have the same scale points from 1 to 5, with 1 being lowest rating and 5 being highest. All scale types chosen based on the fundamental rules of measurement theory as stated in [1].

MODEL FOR PREDICTIONS

As stated in [1], measurement is not done solely to assess the present situation, but also predict trends that are bound to take place in the future. Considering this aspect of measurement, we identify those attributes and their probable scale types that might serve as guidelines to expect the effects of revisions of a website as a part of its maintenance activities. We enlist the top three measurements as a set of probable guidelines:

- *Webpage index:* Users who intend to visit the site for the first time often use a search engine to find out relevant content [6]. Therefore, the number of indexed webpages of a website would decide how well users are redirected to the website which indicates improvement in web usability.
- *Availability:* The websites uptime is another important attribute that fosters the use of website by the end users. If it can be checked that a website is available for most parts of the day, chances are that the number of users visiting the website would increase [3].
- *Response time:* The time it takes to respond to a query submitted by the user is measured in terms of response time. This is one of the essential attributes from the users' perspective that would affect the web usability. It is thought that websites that are quick in responding are rated as more usable as compared to sites that take longer.

The aforementioned attributes coupled with the rules for conducting the measurement serve as the model that we propose for predicting the usability of the website.

THREATS TO VALIDITY

The possible threats associated with the present paper are elicited as follows:

- Although the references chosen are peer reviewed and taken from scientific databases such as Compendex and Inspec, there still exists a threat of relevance to the topic being dealt in the present context. By this we mean that most of the papers chosen were related to websites in the context of e-commerce, health care system etc.
- The model presented in an effort to provide as an input to practitioners and managers, is yet to be tested, evaluated and analysed.
- There might be a more suitable scale for few specific measures that are more appropriate.

VI. SUMMARY AND CONCLUSIONS

As an extension to our previous report where we discussed about the Goal Question Metric (GQM) framework to measure the usability of a website, in this part we have identified and

presented the entities and attributes of the website in accordance with the metrics. We have classified the attributes into internal and external attributes based on their nature. We then mapped the metrics to the entities and attributes. We have tabulated all this data and schematically represented it for a better understanding. The scale types that would best suit the metrics in measuring the attributes and entities have been elucidated. Further, along with the scale types we have also discussed about the scale points with proper motivation.

We hope to give few predictions of some scientific significance regarding the web project that would help the practitioner or manager take informed decisions to improve the usability of the website. The questionnaire to be used for this purpose along with the research method would be discussed as a part of the next assignment's subject.

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