Trustworthiness Criteria for Supporting users to Assess the Credibility of Web Information

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ABSTRACT

Assessing the quality of information on the Web is a challenging issue for at least two reasons. First, as a decentralized data publishing platform in which anyone can share nearly anything, the Web has no inherent quality control mechanisms to ensure that content published is valid, legitimate, or even just interesting. Second, when assessing the trustworthiness of web pages, users tend to base their judgments upon descriptive criteria such as the visual presentation of the website rather than more robust normative criteria such as the author's reputation and the source's review process. As a result, Web users are liable to make incorrect assessments, particularly when making quick judgments on a large scale. Therefore, Web users need credibility criteria and tools to help them assess the trustworthiness of Web information in order to place trust in it. In this paper, we investigate the criteria that can be used to collect supportive data about a piece of information in order to improve a person's ability to quickly judge the trustworthiness of the information. We propose the normative trustworthiness criteria namely, authority, currency, accuracy and relevance which can be used to support users' assessments of the trustworthiness of Web information. In addition, we validate these criteria using an expert panel. The results show that the proposed criteria are helpful. Moreover, we obtain weighting scores for criteria which can be used to calculate the trustworthiness of information and suggest a piece of information that is more likely to be trustworthy to Web users.

Categories and Subject Descriptors

H.3.3 [**Information Storage and Retrieval**]: :Information Search and Retrieval- retrieval models, search process, information filtering

Keywords

Information quality; Web credibility; Trust; Trustworthiness

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1. INTRODUCTION

The Web is a huge and diverse source of information. However, it lacks quality control, allowing for incorrect or low quality information to be published. Moreover, studies have shown that the descriptive criteria for evaluating trustworthiness of information (i.e. those criteria that are actually used by naive Web users) tend to be based upon a range of heuristic factors such as the information's presentation and layout [6, 7]. These factors can be disguised by the pervasive availability of professionally designed templates which can make the Web information seem trustworthy regardless of its actual quality or source. As a result, web users are liable to arrive at false conclusions about the trustworthiness of information. Therefore, it is necessary to aid users in assessing the trustworthiness of Web information they consume. One promising approach is to collect and present available supportive information to the user in order to improve the accuracy of their assessments. Such supportive information should include important information regarding more robust *normative* criteria of trustworthiness. Examples may include the identity of the author (e.g. name, affiliation), the publication date of the information, and the number of times that the information has been referenced.

Against this, in this paper we analyse the relative importance of these normative criteria using a panel of experts. In addition, we calculate weights for the individual criteria, which represent each criterion's relative importance to the overall trustworthiness of the information. This will allow the criteria to be used in a tool that, when the user searches for information, automatically gathers supportive information for the user based on these criteria and uses that information to calculate the overall trustworthiness of the search results. Then, the supportive information will be displayed to the users in an easy to understand way. In this way, users will be able to more accurately and thoroughly assess the trustworthiness of the information they consume. Therefore, our main contributions are as follows:

- The evaluation and selection of the criteria used for supporting the evaluation of the trustworthiness of Web information.
- The calculation of the criteria's weights for use in calculating the total trustworthiness score of the informa-

tion. The calculation of such a score will allow search results to be ranked based on their relative trustworthiness.

The remainder of this paper continues as follows: Section 2 reviews related work on information quality and Web information credibility. Section 3 discusses the development of trustworthiness criteria. Section 4 presents the validation process of our proposed criteria. Finally, section 5 presents our conclusions and plans for future work.

2. RELATED WORK

The field of information quality research provides tools and methods that can be applied to analysing the quality of Web data and its data sources. In particular, it describes a number of quality criteria to help in assessing the quality of information [8]. For example, Taylor [14] defined five quality values for their value-model, namely: *Accuracy* (the data should be error-free), *comprehensiveness* (the completeness of the coverage of a particular subject or discipline), *currency* (how recent the data is), *reliability* (the consistency of the quality of the system and its output over time), and *validity* (the correctness of the information). Rieh, *et. al.* [11] identified the facets of the assessment of information quality based on the study of scholars. They presented seven criteria, namely: *source* (i.e. where the data came from), *content* (whether or not the information is useful for the users), *format* (the design and information structure), *presentation* (the writing style of the information), *currency* (how up-to-date the information is), *accuracy* (how accurate the information is and how reliable the links are), and *speed of loading* (the length of time required to retrieve the information). In addition, in 2000, Rieh and Belkin did more studies on the judgement of information quality and authority by scholars when they are interacting with information on the Web [12]. Their study collected data based on the scholars' actual searching behaviours and then concluded six major categories of criteria for evaluating information quality and authority. The six major criteria consist of *characteristics of information objects*, *characteristics of sources*, *users' own personal experiences*, *situation*, *ranking in search output*, and *general assumptions* (e.g. a salesman will always over-state the positive aspects of their product and omit any negatives, so do not trust everything they say).

Similarly, Tate [13] proposed information quality criteria for Web resources: *authority* is the degree to which a person or organisation is perceived as having the required knowledge to provide information on a given subject area, *accuracy* is the degree to which the information is accurate and free from errors, *objectivity* is the degree to which the material conveys neutral facts or information (i.e. the facts are not influenced by personal feelings or other biases), *currency* is the degree to which the material or information is up-to-date, and *coverage* is the scope of topics and the depth to which those topics are focused upon in the work.

Another area of research is that of Web credibility, which is the study of factors that lead people to believe or not to believe what they find online. Wathen and Burkell [15] reviewed selected literature focusing on the credibility of information on the Web. Their study included issues on general factors for identifying the credibility of information, the impact of the information media (which acts as a connector between users and information) on the assessment of credibility, and the assessment of credibility in the context of information presented on the Internet. The researchers proposed a model for evaluating the credibility of information on the Web. The model presented a process to evaluate credibility on three levels: surface credibility (such as presentation, interface design, and information structure), message credibility (i.e. relevance, accuracy, currency, and credentials of source), and content credibility (the information itself).

The evaluation process is iterative. That is, the assessment will check information on the Web based on the criteria in each level before moving to the next level of evaluation. If the information fails any of the criteria, the user is more likely to leave the site and find another. Fogg and his colleagues [7] studied the behaviour of users when they evaluate the credibility of Web information. They presented the factors that affect users' decisions regarding whether or not to trust information. The study used a variety of types of web site including e-commerce, entertainment, finance, health, news, non-profit, review, search engine, sports, and travel. Their overall analysis of credibility comments proposed eighteen factors namely: *the website's appearance*, *information design or structure*, *information focus*, *company motive*, *information usefulness*, *information accuracy*, *name recognition and reputation*, *advertising*, *information bias*, *writing tone*, *identity of the site operator*, *site functionality*, *customer service*, *past experience with the site*, *information clarity*, *performance on test by user*, *readability* and *affiliations*. Mainly, the results from this study suggested that the users judge the Web site based on its looks. Princeton Survey Research Associates [10] studied the factors that influence users when they evaluate the credibility of a Web site. From their study, it was seen that users have different credibility standards for different types of site. Nine key factors that affect users' decisions on whether to use a particular piece of Web information are: *ease of navigating to the site* on the Web, being able to *trust the information*, being able to easily *identify the sources of the information*, knowing that the Website is *updated frequently*, being able to *find out important facts about the Web site*, knowing *who owns the web site*, the businesses and organizations that *financially support* the site, whether the site displays *seals of approval from other groups*, and whether the site displays *awards and certificates* from other groups.

The criteria from these previous studies on information quality and Web credibility can be categorised into two main types: "*normative*" and "*descriptive*" criteria. *Normative* criteria are those which users are advised to use when evaluating information in order to get the best results. Such normative rules are discussed in the studies from Taylor [14], Rieh *et. al.* [11], Tate [13], and the message credibility level of Wathen and Burkell's study [15]. Alternatively, *descriptive* criteria are the criteria that users *actually* use when they are interacting with information. These are described in studies from Fogg, *et al.* [7], Princeton Survey Research Associates [10], and the surface credibility level of Wathen and Burkell's study [15]. Even though *descriptive* criteria are a reflection of the actual behaviours of users, the fact that they do not reflect the true trustworthiness of the information means that the decision a user makes regarding whether or not to trust the information is no better than arbitrary. For example, surface characteristic criteria [7, 10] are easy to disguise using professionally designed templates such as those from content management systems. There-

fore, surface characteristic criteria are not rigorous enough to support the user in making a critical judgement of the trustworthiness of Web information.

In contrast, normative criteria are objective factors which consider the trustworthiness of Web information based on solid evidences that can reflect *true* trustworthiness of the information. For example, the authority criterion, source criterion, currency criterion and accuracy criterion [13, 11]. Therefore, we aim to develop normative criteria which are rational criteria for helping users to assess the trustworthiness of Web information. However, the proposed criteria from the previous studies are just guidelines for the users to use for assessing the credibility or quality of information. Thus, some of the suggested criteria might not be able to be used in practice or it might be difficult to retrieve the information required by certain criteria to support the user's judgement.

Our work proposes a set of practical criteria which are inspired by those of Tate, Taylor and Rieh. In doing so, we disregard some of the criteria which were proposed in these studies that depend upon subjective issues and which can again give users a false impression of the trustworthiness of a website. For example, we remove the objectivity criterion, which is assessed by evaluating the degree to which trust in the information is influenced by the user's personal feelings or other biases. This can be disguised through the use of professionally designed templates, which can affect the user's feelings towards the site by falsely making the site seem more professional. In addition, some criteria are difficult to gather the data for. One such criterion is the coverage criterion, which is the scope and the depth of topics. Furthermore, some criteria do not have a significant impact on trustworthiness, such as the reliability criterion (the consistency of quality of the system) and speed of loading (the time a document needs to be loaded). These functional criteria may indicate the performance of the system and may influence a user's trust, but they do not reflect upon the information on the Web itself and thus they should have less impact on the *actual* trustworthiness of the information. As a result, we exclude subjective criteria such as objectivity, coverage and functional criteria. Instead, we focus on objective criteria such as authority, currency and accuracy.

In conclusion, it would be more useful to have practical criteria that can be adopted to implement an assistance tool to aid users in evaluating the trustworthiness of Web information. Such a tool could automatically collect supportive data based on these rational criteria and present it to the user. We will discuss the process to develop our trustworthiness criteria in the next section.

3. DEVELOPMENT OF THE TRUSTWORTHINESS CRITERIA

We analysed and synthesised the criteria from the previously mentioned studies into information quality and the credibility of Web resources. In doing so we produced a set of two lists containing a summary of the criteria and components in each study. We then investigated those components in more detail in order to find out the criteria that can be adopted for implementation in practice. For example, we found that the currency criterion can assess the information based upon the information's last modification timestamps and the authority of the information can be evaluated based on the author or creator's details. However, some of the proposed criteria in previous studies require data that is difficult to gather such as the user's bias, which is subjective and abstract. Furthermore, some criteria do not have a significant impact on the trustworthiness of information. Given this, we generate a new list of the components from each study by excluding these criteria. The new list of components is used to generate the trustworthiness criteria by analysing the similarities in meanings between criteria from information quality and Web credibility. From this, we generated four criteria to be used for assessing the trustworthiness of Web information:

- An authority criterion, which relates to the author's identification and credentials.
- An accuracy criterion, which relates to the error-free expression of information.
- A currency criterion, which relates to how up-to-date the web information is.
- A relevance criterion, which relates to how well the content meets the user's needs.

We then examined and synthesised components in each criterion from the information quality and information credibility domains. An initial analysis identified that some components have a direct mapping between the two domain areas and that some components are unique insofar as they only appear in one domain. Furthermore, some components can be merged to best represent the meaning of the components. As a result, we produced a synthesised list of components for each criterion as shown in Table 1.

Criteria	Components
Authority	• Author/creator's qualifications • Author/creator's experience • Author/creator's contact details • Author/creator's affiliation • Web address (URL) • Author/creator's recognition and reputation
Accuracy	• Grammatically correct • No typos • Editorial process • Reliable links
Currency	• Date of publishing • Date of last modification
Relevance	• Title • Type of information • Literature • Number of citations • Content

Table 1: A potential set of trustworthiness criteria and components.

Criterion	List of components
Authority	• Item 1: The name of the content creator (e.g. author's name or a name of organization) • Item 2: The creator or author's affiliation • Item 3: The creator or author's position • Item 4: The creator or author's title (e.g. Dr or Professor) • Item 5: The physical address of the organization • Item 6: The brief detail of the content creator's experience
Currency	• Item 7: The publication date of the content • Item 8: The last modification date of the content
Accuracy	• Item 9: Information of the editorial process (e.g. has the content passed peer-review or has it been reviewed by others)
Relevance	• Item 10: Number of times that the information has been referenced in other documents • Item 11: Publication medium (e.g. book, journal, article, blog, etc.) • Item 12: An overview of the content (e.g. title, abstract, etc.) • Item 13: A list of references

Table 2: A list of components to be evaluated in the experts' validation.

While these criteria and their components are practical, it is not clear how useful each of the components is to evaluate the trustworthiness of information. Consequently, in the next section we discuss the validation of these criteria by way of a survey of experts.

4. VALIDATION PROCESS OF TRUSTWORTHINESS CRITERIA

Validation is the process of evaluating how well an instrument works or fulfills its function [2, 9]. In order to validate the trustworthiness criteria to ensure that the criteria will actually help Web users to evaluate the trustworthiness of Web information, we elicited the opinions of experts using a questionnaire and then we analyzed their responses. In our questionnaire, we asked the experts to imagine that they were the supervisor of new undergraduate students who are looking for information to use in their work. The experts were asked to give opinions about how useful each of the criteria is in order to support the evaluation of the trustworthiness of Web information. Some of the components in the criteria were edited to make them suit the scenario. For example, within the accuracy criterion the components are "*grammatically correct*", "*no typos*", "*editorial process*", and "*reliable links*".

According to the scenario, academic publications are normally expected to be grammatically correct and to contain no typos (academic content needs to pass the process of peer review). Therefore, we can indicate the accuracy of information based on the editorial process, which will cover all of the aspects of being grammatically correct, containing no typos and having a reliable link. Therefore, we constructed a total of thirteen components for trustworthiness criteria to be validated against, as shown in Table 2. We used the generated items from Table 2 to create a questionnaire.

The purpose of this questionnaire is to allow an expert to rate the effect of the items on the evaluation of the trustworthiness of Web information. There are four sections in this questionnaire:

- Section 1: The effect of the presence of each element on the person's confidence in their ability to evaluate the trustworthiness of Web information
- Section 2: The effect of the absence of each element in the perceived trustworthiness of Web information
- Section 3: The importance of the elements in assessing the trustworthiness of Web information
- Section 4: Additional elements which should be considered

We used the priori power analysis function in the G*Power program [4]. This provides an efficient method of controlling statistical power before a study is conducted, to compute a sample size, N, in our study. The total sample size that is estimated from G*Power is 10 participants, with an α-level of 0.05 and a power of 1.0. The purpose of this questionnaire was to evaluate the criteria that help users to assess the trustworthiness of Web information. Therefore, participants should be familiar with the process of the evaluation of information, in particular, within the Web environment. Moreover, they should have experience in assessing the quality or credibility of Web information.

We recruited five experts who were librarians and five experts who were academic researchers from the University of Southampton. Those experts were recruited based on their experience in assessing the credibility or the quality of information on the Web. The profile of each category of expert is described as follows:

- Academic researcher: Experts in this category are research fellows who have had experience in searching for information and selecting the publications to reference in their research.
- Liaison staff in the library: All five experts have experience in evaluating the credibility of information on the Web. Moreover, they are involved in the subscription or unsubscription of journals in various areas. In addition, one of the participants in this category has been specifically trained in evaluating the credibility of information. Furthermore, two experts within this category have created a tutorial session for evaluating the credibility of information on the Web for students and staff in the university.

4.1 Identifying a Statistical Analysis Method for the Collected Data

We designed our questionnaire to have four sections composed of two types of questions. One of these types is rating scale questions, which ask the participants to rate the usefulness, effect, and importance of items. Another type is open-ended questions which ask for the participants' suggestions. Therefore, we obtained two types of data from our study: quantitative data from rating scale questions and qualitative data from open-ended questions. As a result, we use a quantitative analysis approach for quantitative data. Moreover, we use a qualitative analysis method for qualitative data. We will discuss the analysis approach adopted for each data in more detail in the section 4.2 and section 4.3 respectively.

4.2 Analysis of the Quantitative Data

We used quantitative analysis methods for the quantitative data from questions 1 in section 1 and question 1 in section 2. According to the normality test (which determines whether data is normally distributed), the responses to some of the questions are normally distributed but others are not. Therefore, for the consistency of analysis, we decided to choose a non-parametric test in order to analyze our collected data. We selected a non-parametric test because this test requires no assumption about the distribution of the underlying population. Therefore, it can be used on both items that are normally- and non-normally distributed. We selected the Wilcoxon signed rank test for analysis. This test is equivalent to the t-test but it is better suited for use on non-parametric data. An important point to note regarding non-normally distributed data is that it is asymmetric. Therefore, the mean is a poor estimator of the central tendency of the data because it is highly influenced by asymmetric outlying values. Consequently, the median is a more robust estimator rather than mean inasmuch as it is not influenced by extreme values. As a result, we will compare the median of the usefulness rating of each item in the questionnaire with a constant value which we set up based on the mid-value of rating scale in each section to show whether or not an item has significant importance in evaluating the trustworthiness of Web information. We used SPSS to analyse the data and the default test statistic is a two-tailed test.

4.2.1 Wilcoxon Signed Rank Test Analysis Results for Section 1 of the Questionnaire

This section investigates the effect of the appearance of items in the user's confidence their ability to evaluate the trustworthiness of Web information. We are interested in the experts' opinions on the items in both directions (they think items are even more helpful or they think items are less helpful). Therefore, we are interested in whether the median rating of each item is significantly different from 3 (very helpful) out of 4. We set the null hypothesis that the median response is equal to 3. The significance level is 5% (α-level: 0.05). The results in Table 3 show that, at the 5% significance level for a two-tailed test, the medians of ten items (those above the line) are equal to 3. Therefore, we retain the null hypothesis. This indicates that these items are particularly very helpful in assessing the trustworthiness of Web information. Conversely, the medians of the three items below the line in Table 3 are significantly less than 3. This indicates that these three items are not very helpful for assessing the trustworthiness of Web information. As a result, we exclude these three items from our proposed trustworthiness criteria.

Criterion	Median	Z
Author's name	3.00	1.000
Publication date	3.00	0.705
Editorial process	3.00	0.705
Author's affiliation	3.00	0.655
List of references	3.00	0.655
Number of citations	3.00	0.317
Content of the tile or abstract	2.50	0.194
Publication medium	3.00	0.180
Last modification date	2.50	0.160
Author's position (e.g. research staff, senior lecturer, etc.)	3.00	0.083
Physical address of organization	2.00	0.015
Author's title (e.g. Dr, Professor, etc.)	2.00	0.010
Detail about the author's experience	2.00	0.003

Table 3: Wilcoxon signed rank two-tailed test for a single sample group in question 1 of section 1 for the hypothesis that the importance of the specified criteria is 3. This hypothesis was accepted for criteria above the line, and rejected for those below it.

An interesting point from the results in Table 3 is that the "*author's name*" and "*publication date*" criteria are scored higher than what are seemingly more informative criteria such as "*editorial process*" and "*number of citations*." One possible explanation for this is that the author's name can be used as a gateway to other information e.g. from the author's name, you can tell the author's experience (either because you recognise the name, or you can look them up). In addition, publication date might be considered to be important because more modern papers have more background knowledge to build upon and therefore are more likely to be trustworthy or, at the very least, they are more likely to accurately represent the current state of the art.

4.2.2 Wilcoxon Signed Rank Test Analysis Results for Question 1 of Section 2 of the Questionnaire

This section investigates the effect of the absence of items in the perceived trustworthiness of Web information. We set the null hypothesis that the median response is equal to 3, which means an item will largely decrease the confidence of the trustworthiness of Web information if it is not present. The significance level is 5% (α-level: 0.05). The results in Table 4 show at the 5% significance level for a two-tailed test, that the medians of the three items above the line are equal to 3. This indicates that the effect of the *absence* of these three items will largely decrease the experts' confidence of the trustworthiness of the information on the Web. Conversely, the medians of the eight items below the line are different from 3, specifically they are all less than 3. This indicates that the absence of these eight items does *not* significantly decrease the trustworthiness of Web information

Criterion	Median	Z
Author's name	3.00	0.6555
Author's affiliation	3.00	0.414
Publication date	3.00	0.059
Content of the tile or abstract	2.00	0.026
Last modification date	2.00	0.024
Editorial process	2.00	0.023
Publication medium	2.00	0.014
Detail about the author's experience	2.00	0.006
Number of citations	2.00	0.006
Physical address of organization	1.50	0.006
Author's title	1.00	0.004

Table 4: Wilcoxon signed rank two-tailed test for a single sample group in question 1 of section 2 for the hypothesis that the importance of the specified criteria is 3. This hypothesis was accepted for criteria above the line, and rejected for those below it.

(i.e. the Web information can still be trustworthy without it). The results support the usefulness of the ten items which were discussed in section 4.2.1.

4.2.3 Analysis results for section 3 of the Questionnaire

This section investigates the importance ranking of each of the proposed trustworthiness criteria in assessing the trustworthiness of Web information. Given the same situation as before in that the experts are an advisor to new undergraduate students who are starting their studies at university, we asked the experts to rank the importance of each of the given criteria for supporting the assessment of the trustworthiness of Web information. We then calculated an importance score of each of the criteria. The importance score is calculated by assigning points to the rank given by the expert for each item, with the highest ranking item receiving the highest number of points. For example, the first place rank is assigned the maximum number of points, M, the second place is assigned $(M-1)$, and the third place is assigned $(M-2)$ and so on. In this study, we asked the experts to rank the *three most important* elements. Given this, we assign a first place rank 3 points, a second place 2 points, and a third place 1 point. From this, we calculate the importance score of each element as the fraction of its number of importance points given by the experts to the maximum number of importance points it is possible to achieve (i.e. the number of points it would have received had each expert ranked the criterion as being the most important). More formally, it is said that the importance score of a criterion c, I_c is:

$$I_c = \frac{3x_{c,1} + 2x_{c,2} + 1x_{c,3}}{3N} \quad (1)$$

where $x_{c,i}$ is the number of votes for the criterion, c, to be in the i^{th} position. Thus, I_c represents criterion c's relative importance as a fraction of the maximum importance. From this, the relative weight of each criterion, W_c, can be calculated as follows:

$$W_c = I_c \left(\sum_{k \in criteria} I_k \right)^{-1} \quad (2)$$

Criterion	Importance Score	Weighting factor
Author's affiliation	0.50	0.25
Author's name	0.30	0.15
Editorial process	0.30	0.15
Publication date	0.23	0.12
Publication medium	0.23	0.12
The resource locator (URL)	0.10	0.05
Content of the title or abstract	0.10	0.05
Author's title	0.07	0.03
Number of citations	0.07	0.03
Last modification date	0.07	0.03
Detail about the author's experience	0.03	0.02
Author's contact detail	0.00	0.00

Table 5: The importance score and weighting factor of each criterion

This weighting equation simply normalises the criteria's scores such that they sum to one. This is beneficial as, assuming the individual criterion scores are of the range $[0, 1]$, it allows for a trustworthiness score to be bounded to the range $[0, 1]$. Thus, "perfectly" trustworthy piece of information would score 1 where as a completely untrustworthy piece would score 0.

The results of the importance score and weighting factor for each criterion are shown in Table 5. It is interesting to note the relative importance attributed to some of the criteria. For example, it can be seen from Table 5 that the number of citations ranks fairly lowly in terms of importance from the top three most important factors. The citation number might help to indicate other authors' trust in the information. However, it does not guarantee the actual quality of the information as the paper may have been cited for negative reasons (for example, it may have been cited by papers providing corrections to it). Moreover, it can be seen that the criterion regarding the author's contact details is completely disregarded, having never been ranked among the top three most important criteria by the experts. Instead, the experts suggested to focus on the information's author's details, which can provide more concrete confidence in that information's trustworthiness.

After finishing the analysis of quantitative data, we analyse the qualitative data which we obtained from open-ended questions in section 2 (handling missing useful supportive information on the Web) and section 4 (the process of evaluating the relevance of information and the user's needs) from the questionnaire. We will discuss the details of this analysis in the next section.

4.3 Analysis of the Qualitative Data

The qualitative data consists of non-numerical results from the study. It aims to build a subjective understanding of a situation. We used a qualitative analysis method in order to analyse the results from the questionnaire. As part of the qualitative analysis, we employed thematic analysis, which is a method for analysing classifications and presenting themes (patterns) that relate to the data. Thematic analysis is considered as an appropriate approach to discover the relationships between concepts. It can detect and identify factors

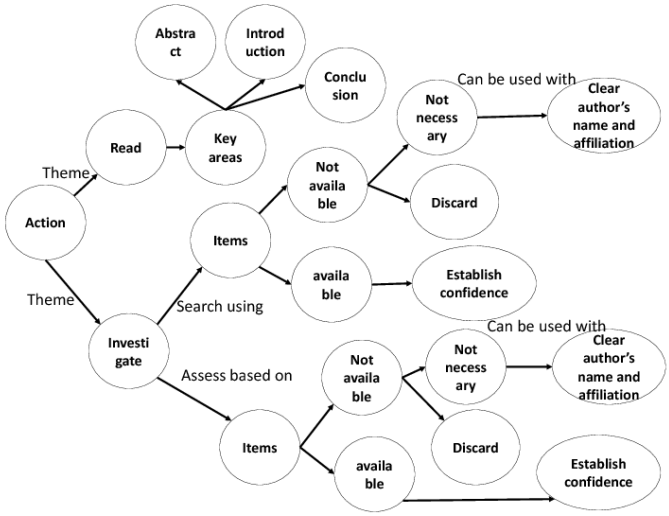

Figure 1: The themes of the evaluation process when some supportive data are missing.

or variables that influence any ideas or suggestions generated by participants' opinions [1, 3]. Therefore, thematic analysis can help to elicit an appropriate explanation for the participants' responses. We will discuss the analysis approach adopted for each open-ended question in more detail in section 4.3.1 and section 4.3.2 respectively.

4.3.1 Analysis of the Results from Question 2 in section 2 of the Questionnaire

The second question of section 2 is an open-ended question which allows experts to freely respond. We asked the experts to give a suggestion regarding how to increase their confidence in a piece of Web information if certain supportive information is not presented alongside it on the web. The results from the analysis show that the process for assessing the trustworthiness of Web information when some supportive information are missing can be divided into two themes: the "investigation" and "read" themes as shown in Figure 1.

The pattern of the "investigation" theme can be categorised into two main methods, one of which is finding the missing information using other supportive information provided. The most key item used to find additional supportive information is the author's name (except for the case in which the author's name is itself missing). The other method is to use the provided supportive information itself to assess the trustworthiness of Web information. The main supportive information from the experts' recommendations is the author's homepage, which might provide links to their organisation or research group's web page. In addition, the publisher, the type of information, the references in the information, and page information can be used to help to evaluate the trustworthiness of Web information when some supportive information is missing. The outcome of the investigation into the trustworthiness of the information can be one of three cases. The first is to accept the information which is being considered. The second is to discard the information because it lacks trustworthy supportive information. In particular, if the author's name or the title of information are missing, the outcome of the process is more likely to be to discard the information. The third outcome is to ignore the missing information because it does not affect the trustworthiness of the information. Thus, the information can be used so long as the author's name and affiliation are stated clearly. The pattern of the "read" theme assesses the trustworthiness of Web information based on the supportive information. However, it focuses on reading through the supportive information itself in order to estimate the trustworthiness of Web information.

In this study, we are also interested in other features apart from the proposed criteria that might affect the users' decision whether to trust information. In addition, we are interested in the process of evaluation the relevance of the information and the users need. Therefore, we asked the experts to give the suggestion towards this issues. We will discuss the detail of analysis the answers from the experts in the next section.

4.3.2 Analysis of the results from question 1 and 2 in section 4 of the questionnaire

Section 4 of the questionnaire aims to explore any additional elements that should be considered in order to help users to improve their process of determining the trustworthiness of Web information. In addition, we are interested in the process of assessing the relevance of information to the experts' needs. The other feature that was most recommended by experts for helping to assess the trustworthiness of Web information is quality, which includes quality of references, methodology and results. The second feature is evidence that can support the content provided such as mathematical proofs. The third is recommendations from colleagues and people you trust. Interestingly, the experts also mentioned that the publisher and their website can indicate the trustworthiness of Web information. The remaining features relate to the style and tone of the content. As a result, we consider adding information about the publisher in terms of providing the URL of the publisher into our proposed criteria. This allows the user to trace to the source who distributed the information. In addition, we consider providing links to the content of the supportive information (e.g. to the supportive information's PDF file) for users such that they can use the information to support their assessment.

The second question of section 4 aims to discover the patterns that experts use to evaluate the relevance of information with their needs. This can help to refine the relevance criterion of our trustworthiness criteria to evaluate the trustworthiness of information on the Web for naive users. Analysis of the results shows that the experts suggested to assess the relevance by reading the data from the key areas of article; namely the title, abstract, introduction (first paragraph), keywords and conclusion. These key areas are the main sections that can give an overview of the concepts discussed by the Web information. Therefore, the key areas in the information such as title or the first paragraph of information are important not only for assessing the trustworthiness but they are useful for supporting users to evaluate the relevance of information with their needs.

The results from the qualitative analysis confirm that providing useful supportive information can help to assess the trustworthiness of Web information. In particular, it can be seen that the criteria suggested by the experts correspond to our proposed trustworthiness criteria.

5. CONCLUSIONS AND FUTURE WORK

The quantitative analysis results suggest that 10 elements (namely, the author's name, the author's affiliation, the author's position, the publication medium, the title or abstract, the publication date of the content, the last modification date of the content, information of the editorial process, a list of references, and the number of times that information has been cited) were deemed useful for helping to evaluate the trustworthiness of information. Therefore, we selected these 10 elements to include in our proposed trustworthiness criteria. Conversely, 3 elements (namely, physical address, author's title, and detail of author's experience) were rejected as the expert validation showed them not to be significant factors in the evaluation of trustworthiness. Accordingly, we exclude these 3 elements from our proposed trustworthiness criteria.

The qualitative analysis results suggest that, when some of the required pieces of supportive information are missing, users need to search for other pieces of supportive information to assess the trustworthiness of Web information. This suggestion supports the concept of identifying and providing the supportive information to support the decision whether to trust information. In addition, key areas such as the title, abstract and conclusion are important to help in assessing the relevance of the information to the user. Moreover, analysis of the important criteria for assessing the trustworthiness of Web information provided a weighting factor that can be used to support this assessment.

Future work will be to investigate the proposed trustworthiness criteria and weighting factors with a real case study. We will develop a framework for helping a user to evaluate the trustworthiness of Web information using the criteria proposed in this paper and we will develop a prototype which is implemented based upon said framework. The prototype will be implemented as a chrome extension which collects metadata based on the proposed trustworthiness criteria using Semantic Web technologies and builds the supportive information to present it in the context of the users' search. In such a tool, when presenting the search results, items will be displayed as a combination of plain text and visual data, which provides an easy and effective way to convey the supportive information for helping the user to make a critical decision about whether to trust Web information. Then, we will validate the feasibility of providing supportive information to users in order to help them to evaluate the trustworthiness of Web information using this framework.

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