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Measuring the Quality of Humanitarian Information Products: Insights from the 2015 Nepal Earthquake

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Abstract. Information plays a critical role in humanitarian assistance. It has become a product that is shared for multiple purposes such as situational awareness, decision-making, coordination, reporting, and attracting funding. In the aftermath of sudden onset disasters, humanitarians are constrained with huge workload, time pressure, and uncertainties and thus, information products are often criticized with respect to quality issues.

In this paper, we aim at developing an empirically grounded framework that can measure the quality of information products through accuracy, objectivity, completeness, and consistency. We validate the framework with the help of practitioners and apply it to the information products of UN WFP for the 2015 Nepal earthquake response. Our analysis shows that the quality of studied information products could be improved with respect to consistency, accuracy, and objectivity. We discuss the implications of our study and propose future research directions.

Keywords: Information quality · Humanitarian response
Framework · Case study · 2015 Nepal earthquake

1 Introduction

Humanitarian assistance is driven by information [1]. From early warnings to needs assessments to final evaluations, information determines priorities and resource allocation. It has become a product that is shared for multiple purposes such as situational awareness, decision-making, coordination, and reporting. Besides, humanitarian organizations (HOs) have interests in creating their own information products to show their impacts and attract funding.

However, the huge amount of information products has not yet been translated into a better response to disasters. One specific challenge is that humanitarian information products often suffer from quality issues [2]. Although relevant

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guidelines are in-place in theory, such as thirteen fundamental principles suggested by the United Nations Office for the Coordination of Humanitarian Affairs (UN OCHA), their implications for the practice have proved to be "extremely challenging" in disaster settings [3]. In this regard, measuring the state of information products' quality is the first step for further improvement.

In this paper, we propose a framework to measure the quality of information products through the "verifiability" principle that has been suggested by UN OCHA. Verifiability ensures "information is accurate, consistent and based on sound methodologies, validated by external sources, and analyzed within the proper contextual framework" [4]. Methodologically, we develop a theoretical framework to assess information quality, validate it by the help of practitioners, and apply it to the UN World Food Program (UN WFP)'s documents for the 2015 Nepal earthquake response.

The remainder of the paper is structured as follows. In Sect. 2, the background regarding information quality in disaster contexts is presented and our research contribution is explained. Our research design and the information quality measurement framework are provided in Sect. 3. In Sect. 4, the results of applying the proposed framework on the Nepal case are illustrated. Finally, discussion and conclusions are presented in Sect. 5 followed by implications and limitations of our research.

2 Background

UN OCHA plays a pivotal role in managing and analyzing information in humanitarian disasters response [3]. According to UN OCHA, a practical information system that supports relief operations in humanitarian disasters response requires processes that should comply with reliability, verifiability, interoperability, accessibility, sustainability, timeliness, relevance, inclusiveness, accountability, impartiality, humanity, reciprocity, and confidentiality. Van de Walle and Comes [3] categorize these principles into "check, share, and use" functions, where the checking function (reliability and verifiability) has a great impact because other functions rely on it. In this function, while reliability focuses on methods for collecting the data and information, verifiablity accounts for the accuracy, objectivity, completeness, and consistency of the information [3].

The last four features are commonly referred to as information quality requirements in information systems literature. Quality itself can be defined through value, conformance to specifications, conformance to requirements, fitness for use, loss avoidance or meeting and/or exceeding customer expectations [5]. According to Eppler [5], information quality (IQ) is "the characteristics of an information product (e.g., a set of information bundled for a specific purpose) to be of high value to its users and to meet or exceed the requirements of all its stakeholders".

There are several papers that provide sets of attributes for information quality in differenet domains. However, Bharosa et al. [6] discuss that not all of the attributes in other contexts are relevant for disasters settings. Seppänen

and Virrantaus [7] express that the key feature of information quality is taking into account the context, presentation, and need. They suggest that frameworks for information quality should fit into the perception of practitioners regarding what high quality is in the humanitarian contexts. Besides, Bharosa et al. [6] note that practitioners expressed difficulties with measuring information quality which particularly reduced incentives for dealing with IQ requirements.

Table 1 shows a non-exhaustive list of IQ attributes in the humanitarian literature within the last decade. As this table depicts, some attributes are frequently used to reflect on the IQ, such as accuracy, consistency, and completeness. Van de Walle et al. [8] distinguish differences between the IQ and information richness attributes. They argue that IQ contains context-independent attributes and objectivity should be considered with this respect [8].

Although IQ attributes in disaster settings are discussed in the literature, to the best of our knowledge, no metric is offered for measuring the state of IQ accordingly. Without a measurement tool, effective incentives for dealing with the IQ requirements cannot be developed. Therefore, no insights can be offered to practitioners regarding where to invest more efforts for improvements and how.

In this paper, we aim at addressing this gap. We propose theoretical metrics for accuracy, objectivity, completeness, and consistency and validate them by the help of practitioners. We apply our measurement framework to the information products of the UN WFP for the Nepal response case. This enables us to show the usability of our framework within real world operations which should help to suggest insights for improving humanitarian information products.

3 Research Design and the Proposed Framework

Our research design is illustrated in Fig. 1. Reviewing literature enabled us to identify four attributes for information quality (cf. Sect. 2). The other requirement is to define some metrics which can measure each attribute consistently. We follow the 5-scale scoring system (very poor, poor, medium, good, and very good) and propose measurable thresholds for each attribute with the help of practitioners.

We conducted remote Skype interviews with two practitioners given the list of attributes and asked them how they relate each attribute to the scoring scale. The selection of interviewees was based on the expertise, experience, and availability of contacts that we had in our network. Due to ongoing relief operations around the world, only two practitioners accepted to participate in our research with short notice. These interviewees worked in UN OCHA and Medair when we carried out our research and were responsible for developing information products. They had more than five years of experience and were deployed to at least four relief operations in different countries. To handle the differences between responses from interviewees, we calculated the mean value to reach the thresholds for each attribute.

Having assumed that attributes do not have the same impact on the information quality, we acquired the relative importance of each attribute. We used the

Table 1. Information quality requirements in the humanitarian literature

Author(s)	Information quality aspect	Description	Attributes
Bharosa et al. [6]	Quality requirement	Quality dimensions that information should meet	Relevance; Quantity; Accuracy; Timeliness; Completeness; Format; Consistency; Availability
Friberg et al. [9]	Quality criteria	Quality dimensions that information should meet	Relevance; Accuracy; Conciseness; Believability; Completeness; Clarity; Validity; Timeliness; Objectivity
Seppänen and Virrantaus [7]	Product internal quality	Objective product-related quality aspects from a producer point of view	Conciseness; Consistency; Accuracy; Currency
	Product external quality	Subjective product-related quality aspects from a user point of view	Comprehensiveness; Clarity; Applicability; Value-added; Reputation
	Service internal quality	Content management aspects from a producer point of view	Convenience; Timeliness; Traceability; Interactivity
	Service external quality	Aspects of the infrastructure on which the content management process runs and through which the information is provided	Accessibility; Security; Speed
Van de Walle et al. [8]	Context dependent	Aspects that shape the information richness (the ability of information to change understanding within a time interval)	Credibility; Reputation; Value-added; Timeliness; Relevancy; Appropriateness; Interpretability; Ease of understanding
	Context independent	Aspects that construct information quality	Accuracy; Objectivity; Completeness; Consistent and concise representation

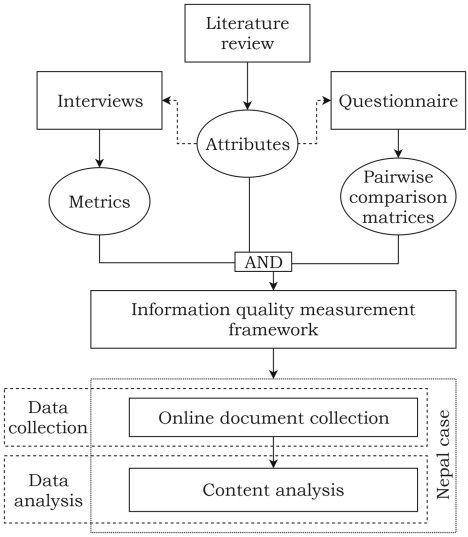

Fig. 1. Schematic representation of our research design

Saaty [10]'s analytical hierarchy process (AHP), which is a popular method for multiple attributes analysis. Several scholars in various fields have used AHP because of its simplicity and strength for eliciting preferences. In the AHP, decision-makers' preferences are elicited as values for pairwise comparisons. With a pairwise comparison matrix for n items, the decision maker indicates how much more important item i is than item j using the scales and corresponding values. When there is more than one decision maker, it is recommended to use weighted geometric means to synthesize judgments. However, the consistency ratio of responses must remain ≤ 0.1. For a detailed explanation of AHP steps and formulas, readers are referred to Saaty [10].

We completed the information quality framework using the validated attributes and related experts-driven metrics after eliciting the weights. We elicited attribute weights from the two practitioners that previously participated in our interviews. The consistency ratio was 0.09 which shows the responses were acceptable. Our framework is depicted in Table 2. The final information quality score for each product can be calculated by multiplying the assessment score of each attribute to its corresponding weight. For a set of documents, it is assumed that the final information quality equals to the geometric mean of individual values.

As Table 2 shows, practitioners that participated in our study prioritized the attributes as consistency, accuracy, objectivity, and completeness (from the most important to the least). This finding supports Friberg et al. [9] as they also indicate that conciseness and clarity are the most important attributes followed by accuracy. We elaborate more on this finding in Sect. 5. In the next section, we apply our framework to the 2015 Nepal earthquake case.

Table 2. Proposed information quality measurement framework

Attributes	Definition	Metrics	Assessment	Weights
Consistency	Information is free of contradictions with other sources	More than 30% contradicts with other sources	Very poor (0)	0.442
		Between 20% and 30% contradicts with other sources	Poor (1)	
		Between 10% and 20% contradicts with other sources	Medium (2)	
		Less than 10% contradicts with other sources	Good (3)	
		No contradicts	Very good (4)	
Accuracy	Information is free of error, precise and close to reality	More than 35% of provided information has errors	Very poor (0)	0.278
		Between 15% and 35% of provided information has errors	Poor (1)	
		Between 5% and 15% of provided information has errors	Medium (2)	
		Less than 5% of provided information has errors	Good (3)	
		No error in provided information	Very good (4)	
Objectivity	Information is unbiased	Less than 50% of unowned information is sourced to reliable external sources	Very poor (0)	0.170
		Between 50% and 70% of unowned information is sourced to reliable external sources	Poor (1)	
		Between 70% and 90% of unowned information is sourced to reliable external sources	Medium (2)	
		More than 90% of unowned information is sourced to reliable external sources	Good (3)	
		Unowned Information is sourced to reliable external resources	Very good (4)	
Completeness	Information covers the scope	Less than 70% of promising topics are addressed	Very poor (0)	0.110
		Between 70% and 80% of promising topics are addressed	Poor (1)	
		Between 80% and 90% of promising topics are addressed	Medium (2)	
		More than 90% of promising topics are addressed	Good (3)	
		All promising topics are addressed	Very good (4)	

4 Case Study and Results

4.1 The 2015 Nepal Earthquake Case

The twin earthquakes that struck Nepal on April 26 and May 12, 2015 caused around 9,000 deaths, and around half a million families in the central region of the country lost their homes [11]. UN WFP activated the Logistics Cluster on April 27, 2015 to assist the humanitarian relief operations with assets and customs clearance [11]. We apply our framework to the logistics-related information products that UN WFP published during the Nepal response.

By selecting "Nepal" as the operations country and focusing on logistics between April 26 and July 15, 2015, we found in total 253 documents from the following online sources: wfp.org, logcluster.org, unocha.org, reliefweb.int, humdata.org, and humanitarianresponse.info. Overall, 77 documents were collected (26 UN WFP and 51 Logistics Cluster) and then categorized based on their titles.

We used summative content analysis [12] to analyze the collected documents with respect to our metrics. Two researchers carried out the categorization and analysis separately and discrepancies were solved under supervision of a senior researcher. We started our analysis by identifying and quantifying the paragraphs in "situation reports" that addressed operations' statistics, covered demands, logistics hubs, and transportation status. These topics are derived from the interview with our interviewees regarding the promising topics. Then, we compared paragraphs with respect to metrics and scored each document. We used other sources (concept of operations, info-graphics, and meeting minutes) to complement our analysis.

4.2 Results

Figure 2 shows the results of analyzing the quality of studied information products. This figure depicts that UN WFP's situation reports and Logistics Cluster documents effectively covered promising topics. Both categories also had "good" level of accuracy in their products. However, the results were not the same for the evaluation of consistency and objectivity. According to our analysis, UN WFP's situation reports showed more consistency compared to Logistics Cluster's documents while the results for objectivity were vice-versa.

Focusing on quality levels for each producer, we found some tradeoffs in our results between completeness and other attributes or between objectivity and consistency. This implies the requirement for checking the content when producer wants to cover a complete list of promising topics. This also explains the low level of consistency for the information products of Logistics cluster: they had to keep track of several aspects with very few resources that they had in the Nepal response. It also shows that the consistency of shared information in one of the most important relief coordination clusters (logistics) can be improved considerably.

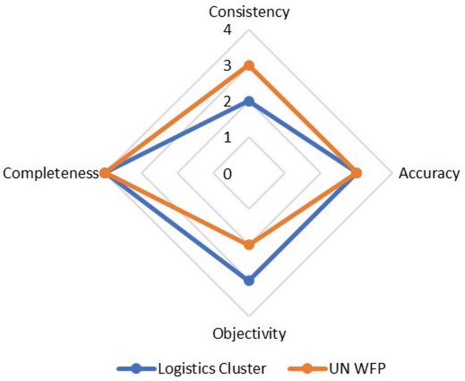

Fig. 2. Results for analyzing the information quality of UN WFP's documents

Another result of our analysis is the overall quality score of studied information products. UN WFP's situation reports had a better information quality (2.94 out of 4) than Logistics Cluster's documents (2.668 out of 4). Although the studied documents showed "very good" level of completeness and "good" level of accuracy, the overall score of information quality did not reach the "good" level. This is due to the low scores of the consistency attribute while it has the most impact on the overall quality. In the next section, we discuss our results in more details.

5 Discussion and Conclusions

Interviews with humanitarians show that assuring high information quality is difficult, if not impossible because of the complexity, dynamics, and uncertainty of disasters contexts [6]. Our study proposes a tool for measuring the quality of information products to increase the incentives for dealing with requirements.

Our research supports literature on what constitutes quality for information products in sudden onset disasters response [6,8]. Participants in our research confirmed the dominance of consistency and accuracy for the quality of information products. This can be partly explained by our focus on the checking function while for different functions, other attributes may require more concentration. Another reason can be the very few number of participants in our research, which is the main limitation of our research.

As our results show, the quality of our studied information products could be improved with respect to consistency, accuracy, and objectivity. Problems with quality in information products during the response are noted in the literature before [13,14]. For instance, Cook and Shrestha [15] observe that during the Nepal response "news and reports from government, media, and other organizations often conflicted and made it difficult to coordinate and carry out relief operations". Altay and Labonte [13] note that inaccuracy of information was a significant challenge during the 2010 Haiti earthquake response.

Our research depicts that consistency demands more attention than accuracy. The studied documents of the Logistics Cluster, the main humanitarian logistics coordination body, had good-level of information accuracy while their consistency level was moderate. This implies that some information of Logistics Cluster's documents contradicts with UN WFP's resources between 10% and 20%. Due to the high impact of consistency on the overall score of information quality, it demands more attention. One challenge is to deal with tradeoffs between objectivity, completeness, and consistency in information products. The more information included in the documents, the more time required for checking the consistency which is hardly available in the immediate aftermath of sudden onset disasters.

We also have to discuss how HOs can use our framework. Humanitarian information managers often work under stressed conditions in sudden onset disaster response where they face huge workload [16]. To compensate for this constraint, we suggest dedicating more resources on the highly-weighted attributes. Although the list of attributes in our framework is not exhaustive, it can give insights regarding where improvements can start. For instance, if HOs find low levels of consistency and accuracy in their information products, they can expect low overall quality level.

Proposing improving strategies requires more investigation. Our Nepal field study showed that one way to improve information quality can be to equip practitioners with adaptable information systems [16]. Information systems that are designed for developed contexts may not necessarily work for other developing countries. Technological and infrastructure requirements may hinder effective implementations [16]. The other approach is to improve the skills of humanitarian information managers by offering frequent disaster exercises or enriching preparedness efforts with gamification approaches, as discussed by Meesters and Van de Walle [17]. Another suggestion can be to design advanced templates or checklists for meeting the quality criteria.

Our research has implications for research and practice. Scholars can use our validated work as an starting point for proposing a comprehensive framework for ensuring the quality of humanitarian information products. They can also use our study to suggest solutions regarding improving strategies. Practitioners can use our framework to assess the quality of their information products. Given our explanations regarding how to use the insights, HOs can target improvement plans based on final scores of attributes.

Our study's main limitation is the small number of practitioners that participated in our study. Also, we only applied our framework to one case and more investigation regarding its ability to capture information quality is required. Future research can be to analyze the tradeoffs between different attributes and integrating improvement plans into our framework.

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