

# Attention to Information Quality: The Case of Safety Telephone Services for Ageing People in Finland

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This article investigates information quality within multi-actor service networks offering safety telephone services for ageing people. A clear connection between the quality of information and success of business has been acknowledged, but tools for analysing information quality in network environments on the basis of qualitative data have been lacking. There is also a limited understanding of information processes of virtual networks of public and private service organizations in the literature. In the present article, a novel framework for information quality analysis is introduced and operationalized. The framework extends previously developed methods and provides a fundamentally different way to assess information quality, contrary to earlier quantitative studies. Operationalization of the newly developed framework is undertaken in the virtual network environment of safety telephone services for ageing people. These services utilize rapidly developing well-being technology. The analysis is based on data from interviews with professionals working in several service networks of different types and sizes in Finland. The results provide a detailed account of the state of information quality in the case networks. Such results can be utilized as guidelines when planning information-related matters in the case networks in the future.

**KEYWORDS:** information quality, information management, service network, safety telephone services

## Introduction

Studies of organizations usually mention information transfer as one of the key problem areas. If they do not, there is likely to be something wrong in the methodology or conclusions. Information transfer and management are areas characterized by many—and often conflicting—demands. Employees require more information and fast, but on the other hand, they are struggling with a wealth of information that is too large to digest.

A crucial issue concerning information transfer and management is the quality of information that is collected, stored and transferred. It has been stated that there is a clear connection between the quality of information and success of business. Poor information quality costs billions of dollars in social and economic impact (*cf.* Strong, Lee and Wang, 1997a). Still, very few companies or other organizations have started to improve the quality of information in a systematic manner. Poor quality information is typically inaccurate, overlapping or insufficiently defined. Mapping and management of information quality need to be continuous processes. (English, 1999.)

Discussions on information mostly concern information systems, information technology, data warehouses and data mining, to mention a few examples. The most relevant issue is, however, the information itself—the material that is essentially needed. Successful companies excel by exploiting information. They must define, measure, analyse and improve the quality of information (Huang, Lee and Wang, 1999).

The real goal of information quality is to increase customer and stakeholder satisfaction—better information quality leads to better customer service (English, 1999; Huang, Lee and Wang, 1999). If internal users of information within organizations are treated as consumers of information, their performance and productivity will improve. Delivering quality information may be seen as a self-reinforcing process leading to improved company performance. (Huang, Lee and Wang, 1999.)

Tools have been developed for measuring and analysing information quality (*e.g.*, Huang, Lee and Wang, 1999; English, 1999; Wang and Strong, 1996; Paradise and Fuerst, 1991; Wang, 1998; English, 1996; Wang, Lee, Pipino and Strong, 1998; English, 2001; Dvir and Evans, 1996; Allen, 1996; Strong, Lee and Wang, 1997a; 1997b). These have mainly been utilized in individual organizations, often companies. Information transfer processes and management of information quality are challenging enough within one organization with clearly defined boundaries. Yet, we are witnessing a rapid increase in networking and virtualization among companies. Although these translate into further challenges in all areas of operations, information-related issues require particularly urgent attention.

Networking and virtualization do not concern companies only. Public organizations, cooperatives and non-governmental organizations are also forming networks, or entering into networks of companies. This tendency is clearly seen, for instance, in the social and health care sector of the society, and in the utilization of new kinds of well-being technology. Challenges appear to be especially numerous there.

The present article investigates information quality in multi-actor networks that provide services based on the use of well-being technology. Tools for analysing information quality in such environments are lacking. In this article, a new

kind of framework for information quality analysis is introduced and operationalized. It will extend previously developed methods and provide a fundamentally different way to assess information quality on the basis of qualitative data—contrary to the earlier quantitative studies.

## Objectives

The research problem behind this article is the need to investigate and develop management of information quality. The objective of the article is to introduce a framework of analysis for investigating information quality within information processes of organizational networks on the basis of qualitative interview data—in order to contribute to development of tools for information quality management and analysis—and to operationalize this framework of analysis within networks providing safety telephone services to ageing people.

The quality of information cannot be improved independently of the processes that produced this information and of the contexts in which information consumers utilize it (Strong, Lee and Wang, 1997a; 1997b). A starting point in the present article is that the same applies *vice versa*. That is, contexts and processes of networks cannot be improved independently of the quality of information. Quality information is essential also because through the assessment of information, knowledge controls and guides decision-making and other processes in organizations (*cf.* Huang, Lee and Wang, 1999; English, 1999; Miller, Malloy, Masek and Wild, 2001).

The objective of the present article is solidly anchored on existing literature, but the approach is novel in that it results in a new type of qualitative methodology and its operationalization in emerging forms of organizational environments. The methodology widens the sphere of qualitative methods of analysis. The article also indicates possibilities for further development and operationalization of the methodology to be introduced.

Enterprise networks and information management systems are widely studied fields—and the focus of considerable attention also within the business community—but there is a very limited understanding of the information processes of networks of public and private service organizations in the literature. Virtual organizations, virtual enterprises and virtual teams within enterprises have been studied by many researchers in the last few years (*e.g.*, Rouse, 1999; Voss, 1996; Kotorov, 2001; Jarvenpaa, Knoll and Leidner, 1998; Putnam, 2001; van Hout and Bekkers, 2000; van der Smagt, 2000; Katzy and Dissel, 2001; Kayworth and Leidner, 2002; Miles and Snow, 1992; Duarte and Tennant Snyder, 2001; Handy, 1995; Holton, 2001; Lipnack and Stamps, 1997).

The kinds of multi-actor service networks that provide the field of operationalization in this article have, however, barely been investigated. Some work has been done to assess effectiveness of public-sector service networks (*cf.* Provan and Milward, 2001), but information-related matters were not included among the effectiveness criteria. Very little work has been devoted to the particular requirements placed by the utilization of well-being technology on information processes, information quality and networking among different types of organizations—despite the growing societal weight of such technology. The scarcity of reference literature may be due, in part, to the rapid development of the field in question.

## Scope

The amount of information transferred within safety telephone services is treated as background information only. The article does not contain an investigation of information systems as such, either. Firstly, the focus is on content and quality of information, and secondly, within the case networks, such an approach would not be meaningful due to the development state or even lack of information systems.

Safety telephone services are the field of case studies only. The whole of safety telephone services—not to mention the whole of well-being technology—cannot be discussed. Different types of safety telephone appliances and optional calling systems and their usability, for instance, are thus not described. The article touches briefly upon issues such as (i) customers'—ageing people's—opinions and requirements concerning safety telephone services and appliances, (ii) operations and work arrangements at call centres, (iii) service chains of customers as well as (iv) competence requirements of personnel working in these services. It would not make sense to totally exclude them in this type of an investigation, but a comprehensive analysis is beyond the scope of the article.

## Methodology

The article is based on (i) methodology development and (ii) operationalization of the methodology with the help of case studies. The data produced by applying qualitative methods were analysed with the help of an information quality framework. The new kind of framework of analysis is applicable also in other fields. The article presents the way in which the information quality analysis itself is undertaken, step-by-step, and specifies its results. Through this, insights are offered into practices and challenges of information quality management. Information quality analysis may be seen as a problem-solving method—either as an end in itself or one element in general quality assessments.

The data collection for this analysis was made following the general principles of conducting case studies (Yin, 1989). The data include: (i) written material ranging from memoranda to minutes of meetings to formal reports; (ii)

organization charts, personal records, maps, graphs, service statistics, etc.; (iii) open-ended and semi-structured interviews (the main data collection method), use of informants, and intraorganizational and interorganizational workshops, as well as (iv) absorbing and noting details and actions in the field environment.

Structured interviews and written questionnaires were seen as inappropriate for an analysis of this kind. It is not likely that they would unfold the participants' true views of the complicated phenomenon of information within the networks of organizations. Therefore, semi-structured and open-ended interviews were undertaken. The interviews assumed a conversational manner, but the interviewer followed a pre-prepared set of questions that concerned the networks' characteristics and work practices, information flows and management as well as problems in these (for further details on the methodology, see Melkas, forthcoming).

The interviews were audiotaped and transcribed for analysis. At workshops and seminars, field notes were made. After reading, coding and analysing the data, the results were sent to the interviewees for feedback and comments. The results were also discussed at several intraorganizational and interorganizational workshops, seminars or meetings.

The networks investigated represented several different types of safety telephone service networks in Finland, and one in Sweden. The branch is very fragmented. It is the duty of municipal authorities to give guidance on private safety telephone services, if the municipality in question does not have a system of its own. Many municipalities do have systems of their own, or they purchase the service from a private service provider. Within one municipality, there may even be several systems simultaneously. For instance, there may be internal systems in institutions offering sheltered accommodation, a municipal system and several private systems in operation at the same time.

The interviewees represented different types of safety telephone service systems of different sizes and operating in diverse locations. Most of the interviewees (24) represented a nation-wide network offering safety telephone services around Finland. Seven interviewees were from municipal systems (three networks, of which two Finnish and one Swedish). Four interviewees were from institutions offering sheltered accommodation (one system operated by a foundation and another by a cooperative). Three represented a system operated by a non-governmental organization, and four interviewees represented a pilot project testing mobile safety telephones.

The Finnish nation-wide network was by far the most interesting and challenging with regard to information-related issues and network collaboration. It received the most intensive attention in the study. Inclusion of the other types of networks for comparison increases the validity and reliability of the results. The bias in favour of the nation-wide system does have an impact on some of the emphases, but challenges and development needs were largely the same in all kinds of safety telephone service networks—apart from the very small ones in institutions offering sheltered accommodation.

The study was undertaken in the period from August 2001 to May 2003, which included the study visits, test interviews, actual interviews, seminars, workshops and observation. The municipal social and health care sector was well represented with 12 interviewees, but the interviews were directed in a balanced way also to companies (12 interviewees) and other organizations (16 interviewees from non-governmental organizations, foundations and cooperatives). The picture gained by the interviews around Finland was comprehensive, and the types of organizations and professional groups were representative of the branch. Half of the interviewees had a managerial occupation and the other half an employee occupation. There were 29 women and 11 men among the interviewees.

## Field of Case Studies and Definitions

A safety telephone is an apparatus with a big button and a pendant or chain around the neck, or a wristband with also a help button on it. One can give an alarm by pushing the button. Safety telephones have also been called 'safety alarm systems' and 'social alarm systems'. So-called well-being wristbands and mobile safety telephones are also being used these days. There are various types of accessories for safety telephones—dosers of medication, fire alarms, door alarms and so forth. In line with the diffusion of mobile safety telephones in particular, potential customers become more and more numerous—for instance, those working alone in occupations where there is a risk of encountering violence, or those who spend time in summer cottages or country houses in remote areas.

Safety telephone services consist, according to the definition of Lehto and Vuoksenranta (1999), of a safety telephone customer, a call centre and safety helpers who call on the customers to provide help or check up after an alarm has been given. The concept of customer thus refers in the present article to end customers—ageing persons utilizing safety telephones. Komminaho (1999) takes a slightly different perspective, arguing that safety telephone services contain alarm appliances, reception of alarm information, alarm and check-up visits and check-up calls. Both of these definitions are, however, somewhat too restricted. Telephone installers and medical institutions such as health centres and hospitals need to be included. They are essential parts of all types of safety telephone service systems.

As to ageing persons, different age limits are used—for instance, those aged 65 plus or 75 plus. In the context of the use of safety telephones, an age limit is not necessary. Although the use of these telephones is commonly associated with higher age, they may also be used by, for instance, younger disabled persons. A common aspect of elderly persons is their age, but otherwise they are a heterogeneous population with differing requirements and subgroups (Bouma, 1998).

The heterogeneous branch of safety telephone services in Finland provides a particularly interesting and challenging

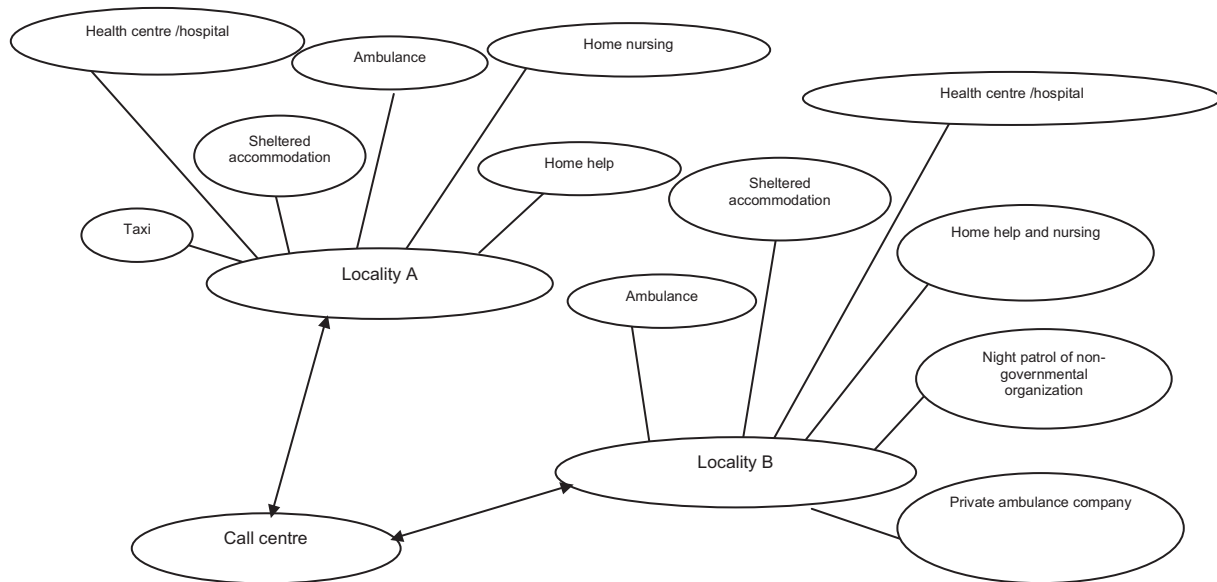


Fig. 1. Variety of actors involved in safety telephone services (examples).

environment for the operationalization of the new methodology for information quality analysis. The research sites were representative of the different types of safety telephone service networks. The investigation was done in local, regional and nation-wide networks of companies, public organizations and other organizations that offer safety telephone services in collaboration. Public organizations include various municipal social and health care institutions. Companies include call centre companies, care service providers, telephone operators and alike. Other organizations are non-governmental organizations, foundations and cooperatives as well as individual institutions offering sheltered accommodation. Particularly the large case networks are good examples of newly emerging virtual networks based on loose cooperation arrangements between organizations in different geographic locations (see Figure 1).

On the concept of 'network', Nohria and Eccles (1992) argue that it is a fluid, flexible and dense pattern of working relationships that cut across intra- and interorganizational boundaries. Networks and network organizations have been lively discussed in the research literature in recent years. Many have, for instance, argued that all organizations can be seen as networks. A thorough discussion on the concept is beyond the scope of this article.

Safety telephones increase the possibilities of an ageing person to continue to live at home even if she or he needs assistance. In fact, safety telephones are part of today's structure of elderly care in Finland, where it is no longer common that ageing people live together with their children's families. Safety telephones are used in homes as well as in sheltered accommodation and old-age homes. In all these environments, they increase the user's feeling of safety and security. In institutional settings, safety telephones facilitate the work of care personnel, who can provide help more quickly in emergencies or other cases of need.

Of the some 70,000 safety telephones in use in Finland today, more than half have been acquired by private citizens at their own expense, and the rest are owned or maintained by municipalities as part of public service provision. It is expected that the number of safety telephones and the need for related services will increase considerably within the next decade or so, in line with (i) the number of retired people and (ii) newly introduced mobile safety telephone services.

In addition to alarm calls, call centres also receive notifications concerning technical faults or service needs related to telephone appliances. Call centres may be tiny internal units in old-age homes that serve only the residents or large centres that serve thousands of customers from all over the country—or something from between, such as municipal call centres. Those providing the actual help to the ageing people may be employees from municipal home care services, private enterprises or NGOs offering care services, or even taxi drivers, depending on the place and hour of the day.

In safety telephone services that are built around a small call centre, the operations are relatively straightforward. For instance, in a call centre of an old-age home, the care personnel answers the phone, knows the persons who call, including their health status, and can provide help to the caller in just a few minutes. In a large call centre, challenges are numerous indeed. If there are thousands of customers, there is very likely a continuous information overload (for definitions, see Wilson, 2001). Persons receiving calls for help cannot know the customers or their background and health status. When services are provided in different cities and in the countryside all over the country, the situation is very demanding with regard to the collaboration network of the call centre. There have to be people who are ready to provide help at all hours of the day and who can be reached immediately without any problems. An alarm call may be the last call of the caller, so the network deals with matters of life and death.

Despite the growing societal importance of ageing people's safety services, the topic of safety telephone services has barely been investigated. Especially matters related to the necessary service structure around these services are poorly understood. This article sheds light on the complex information environment around safety telephone services, and most particularly, the quality of information that is transferred within these services. Attention to information quality in safety telephone services is a tool for improving service quality. It is also vital that the motivation of organizations to manage information well and institutionalise collaboration with others is increased. Otherwise, it is likely that the full potential offered by technology and appliances is not utilized.

## Information and Quality Information

Definitions of information have followed two patterns, either (i) focused on information (and knowledge) being fundamentally different from data (the hierarchical view) or (ii) emphasized that some knowledge is needed before data and information can be created. There are also studies in which data, information and knowledge are used interchangeably, or in which one or two of these concepts are used without any clear definitions. Huang, Lee and Wang (1999) note that in practice, managers tend to differentiate information from data intuitively, and in their book, they use 'information' and 'data' synonymously unless otherwise specified.

Lillrank (2003), a representative of the hierarchical view, defines data as the factual content of information. Devoid of context, a number, for instance, carries no meaning—it is thus data. Information transforms into a component of knowledge, when it is analysed critically and its underlying structure is understood in relation to other pieces of information and conceptions about how the world works (Lillrank, 1997; Roberts, 2000; Miller *et al.*, 2001). Within information theories, information is seen as a message's characteristic (Åberg, 2000) or as an act, a process (Wiio, 1989). The latter definition is appropriate for the present article. Information has also been discussed as a product, a production factor and—from a larger perspective—as a deliverable (a product, a service, information or a combination of these that is planned and implemented for a customer; Lillrank, 1997).

Information and information systems can be seen as separate but interdependent entities. The quality of an information system can be analysed as the quality of any production system, covering the generic elements of hardware, software and humanware. (Lillrank, 1997.) In this article, information systems are not investigated. The case environment of safety telephone services is such that an investigation of information systems would not lead very far. If information systems exist, they are not compatible. Moreover, all the relevant types of information are not transferred through the information systems.

The concept of information quality has gained increasing attention during the last few years. Information quality has been studied overwhelmingly by researchers interested in computing, management information systems, databases and their management, data security and data warehouse quality, to mention a few. The concept of data quality has been used to a greater extent earlier than the concept of information quality. Researchers have concentrated on company environments and business information (*e.g.*, English, 1999; Huang, Lee and Wang, 1999; Chengalur-Smith, Ballou and Pazer, 1999; Wang *et al.*, 1998; Wang, 1998). Studies of information quality in heterogeneous service networks consisting of organizations from different sectors—and with incompatible or missing information systems such as in the present article—have not been undertaken.

Conventionally, information quality has been described as how accurate information is. Huang, Lee and Wang (1999) claim in their comprehensive 'guidebook' that no standard definition for the concept exists. English (1999: 27), again, represents information by the formula:

$$\text{Information} = f(\text{Data} + \text{Definition} + \text{Presentation})$$

These three components make up the finished product of information. Each of them must have quality to have information quality. "If we do not know the meaning (definition) of a fact (data), any value will be meaningless and we have nonquality. If we know the meaning (definition) of a fact, but the value (data) is incorrect, we have nonquality. If we have a correct value (data) for a known (defined) fact, but its presentation (whether in a written report, on a computer screen, or in a computer-generated report) lacks quality, the knowledge worker may misinterpret the data, and again we have nonquality." (English, 1999: 27.)

English (1999: 24) lists also two general definitions: (i) information quality is consistently meeting knowledge worker and end-customer expectations through information and information services, enabling them to perform their jobs efficiently and effectively and (ii) information quality describes the attributes of the information that result in customer satisfaction. Wang and Strong (1996: 6) define 'data quality' briefly as "data that are fit for use by data consumers".

Approaches to study information quality have been divided into (i) an intuitive, (ii) a theoretical/system and (iii) an empirical approach (Wang and Strong, 1996; Huang, Lee and Wang, 1999). Here, the approaches to studying information quality are more appropriately divided into (i) a customer requirements based approach (*e.g.*, Lane Keller and Staelin, 1987), (ii) a quality dimensions based approach and (iii) a technical quality versus negotiated quality approach (Lillrank, 2003). The quality dimensions based approach is the most central in this article.

Lists of information quality dimensions have been produced by, *inter alia*, Strong, Lee and Wang (1997a; 1997b),

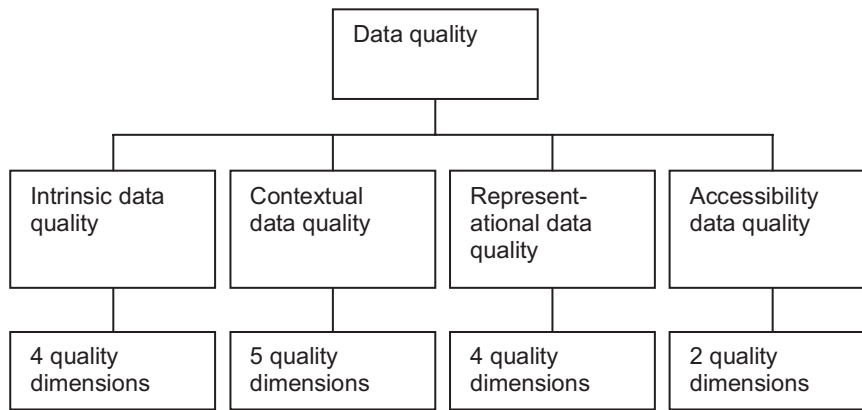


Fig. 2. Hierarchical representation of data quality.

Wang and Strong (1996), Wang *et al.* (1998), Wang (1998), Wolstenholme, Henderson and Gavine (1993), Lillrank (1997), Huang, Lee and Wang (1999), Dvir and Evans (1996) and English (1999). Wang and Strong (1996) report the results of a study that identified the attributes of data quality that were important to data consumers. The concept of data is used here in accordance with the original article and with the understanding that it is not in contradiction with the concept of information. Wang and Strong took an empirical approach and followed the methods developed in marketing research for determining the quality characteristics of products. They first collected data quality attributes from data consumers, then collected importance ratings for these attributes and structured them into a hierarchical representation of data consumers' data quality needs.

From initial 179 data quality attributes Wang and Strong (1996) developed a hierarchical framework with four data quality categories and fifteen dimensions (Figure 2): (i) intrinsic data quality consisting of accuracy, objectivity, believability and reputation; (ii) contextual data quality consisting of value-added, relevancy, timeliness, completeness and appropriate amount of data; (iii) representational data quality consisting of interpretability, ease of understanding, representational consistency and concise representation and (iv) accessibility data quality consisting of accessibility and access security.

A data quality framework had not existed before. Wang and Strong's (1996) framework provides a basis for deciding which aspects of data quality to use in any research study (see Wang and Strong, 1996, for the definitions of the dimensions). Their framework has more dimensions than works of some other researchers. Earlier, most studies were based on a small set of quality attributes that were commonly selected (for instance, accuracy only). Wang and Strong's framework has been utilized and advocated later by, for instance, Wang *et al.* (1998), Wang (1998) and Huang, Lee and Wang (1999).

According to Lillrank (2003), the quality dimensions based approach makes no distinction between information itself and context dependent elements (timing and reputation). It also leaves the question about information as an output and a process vague. There are several ways in which Lillrank's legitimate criticism can be taken into account (see, for instance, Harmaakorpi, Melkas and Kivelä, 2003). When choosing the appropriate approach, type of network and phase of network's development need to be considered. The present article introduces a framework of analysis that is designed—on the basis of Wang and Strong's (1996) work—for established service networks, where an assessment of existing practices is essential.

## Framework of Analysis for Information Quality

The information quality analysis framework is proposed in this article as a tool to investigate the quality of the different types of information that are transferred in the case networks. Information quality is one slice of the whole of information management, a topic too wide to cover here. It is, however, a very important slice that often seems to be forgotten due to, for instance, extensive attention to information systems—or, on the contrary, various knowledge management initiatives concentrating overwhelmingly on utilization of tacit knowledge. Methodologies for studying information quality have been developed, but qualitative methodologies that take into account the processual characteristic of information have been lacking. Moreover, networking and virtualization are trends that call for new ways of looking into information quality.

The information quality analysis framework helps in identifying information quality dimensions that are weak in a network (or in an individual organization). The analysis may be usefully combined with an investigation of network collaboration that helps in identifying weaknesses and strengths in network collaboration affecting management of information quality. The latter investigation is beyond the scope of this article; readers are referred to Melkas (forthcoming).

### Basis and development of the information quality analysis framework

The information quality analysis framework was elaborated primarily on the basis of the works of Wang and Strong (1996), Strong, Lee and Wang (1997a; 1997b), and Wang *et al.* (1998). Their quantitative studies were part of the Total Data Quality Management Research Program of Massachusetts Institute of Technology. These studies gave a sound empirical and theoretical foundation for this article. Their data quality framework has been used effectively in industry and government (Wang and Strong, 1996). However, these researchers have also called for further research to apply their framework in specific work contexts.

Wang and Strong's (1996) work provided most of the dimensions of information quality that were investigated. The new framework of analysis was structured so that six stages of analysis were discerned from the following summary of challenges of information management:

*If the right piece of information from the right source, in the right format is at the right place at the right time and handled in the right way, action is relatively easy and predictable* (adapted by the author on the basis of Lillrank, 1998: 7).

Combining the dimensions of information quality with the six stages of analysis provides an essentially novel way to assess information quality in complex network processes on the basis of qualitative data.

For each stage of analysis, appropriate dimensions of information quality were assigned from those listed in Wang and Strong (1996). For another branch of business, dimensions to be assigned for the six stages could be different, depending on the operations. Choice of dimensions for the six stages was an iterative, cyclical process affected by gathering of background information on the branch of safety telephone services, study visits and test interviews. The starting point was that all the dimensions from Wang and Strong (1996) are included at each stage. However, that would have made the analysis quite heavy. Therefore, on the basis of the data collected, the author started to exclude dimensions from consideration. The data showed the necessary exclusions relatively clearly. In this phase, also a few 'service-specific' dimensions were added (see a separate description below). The result was the framework that is shown in Table 1.

The word 'right' in Table 1 means the opposite of wrong. It cannot be given a universal definition, as situations and contexts vary. The information quality analysis framework was designed with the aim of taking into account the context dependent variables, and information as an output and a process. Within safety telephone services, for instance the information that is given by a customer in an alarm call transforms as the service process advances. This is the reason for not testing Wang and Strong's seminal framework of information quality as such. Their information quality dimensions have here been placed in an innovative way under the different stages of analysis. This approach brings with it the advantage of utilizing a framework that suits the particular characteristics of the case environment of this article—but that is, on the other hand, flexible to be used in other branches or organizations.

The 'service-specific' dimensions that were added to the framework of analysis on the basis of the information on

Table 1. The framework of analysis for information quality.

Stages of analysis	Information quality dimensions
Basis: the right source of information	Relevancy, timeliness, completeness Accuracy, objectivity, believability Accessibility, security
Component: the right piece of information	Relevancy, value added, timeliness, completeness, appropriate amount of information
Content and instrument /means: in the right form	Accuracy (including accurate coding of message), objectivity, believability, reputation Interpretability, ease of understanding, concise representation, consistent representation Ease of operation, traceability, flexibility
Timing: at the right moment	Timeliness, relevancy Appropriate velocity
Routing: in the right place	Accessibility, security Relevancy, value added Traceability
Processing procedures: handled in the right way	Accessibility (intellectual and physical), security Interpretability, ease of understanding, concise representation, consistent representation Traceability, cost-effectiveness, ease of operation Authority of person handling, appropriate velocity, sustainability (costs, ethical aspects)

safety telephone services are the following:

- Under the stage of analysis ‘content and instrument/means’: for accuracy, an explanatory addition: accurate coding of message; ease of operation, traceability, flexibility;
- Under ‘timing’: appropriate velocity;
- Under ‘routing’: traceability;
- Under ‘processing procedures’: for accessibility, an explanatory addition: intellectual and physical; traceability, cost-effectiveness, ease of operation, authority of person handling, appropriate velocity, sustainability (costs, ethical aspects).

Traceability, cost-effectiveness, ease of operation and flexibility are dimensions that were originally included in Wang and Strong’s framework but which the authors later eliminated, because these dimensions could not be readily assigned to any category (intrinsic, contextual, representational and accessibility information quality). They were re-introduced in the present analysis because of the author’s assessment—made on the basis of the data collected—of their importance in safety telephone services.

Accurate coding of message is included as an explanatory remark for accuracy under the stage of analysis ‘content and instrument/means’. This is intended to reflect the occasional difficulty in interpreting customers’ needs when an alarm call is received at a call centre. How the person on duty interprets the customer’s message and transfers the information forward to the collaboration network may have a major impact on overall service quality. Interpretation is likely to depend largely on the call centre personnel’s tacit knowledge and experience, but it is an issue that needs to be brought up in an information quality analysis.

Appropriate velocity is a concept that is related to both accessibility and timeliness, but is insufficiently covered under them. Yet, it needs careful attention particularly in the context of safety telephone services. Appropriate velocity has to do with how quickly incoming calls are answered at a call centre, how quickly relevant service providers are called out to provide help, how quickly help is finally provided to the customer, how quickly changes in customer information are inserted into the customer database, and so forth. There may be definitions or guidelines as to how quickly help is provided—for instance, within half an hour—but the velocity dimension seems to require increasingly systematic attention with regard to all types of information.

The explanatory remark concerning accessibility—intellectual and physical—is intended to highlight the importance of handling information in a way that ensures intellectual accessibility within the often very heterogeneous collaboration networks of safety telephone services. As the networks may consist of representatives of many different professions in many different locations and work environments, intellectual accessibility of customer or other types of information is not self-evident, even if physical accessibility (the extent to which information is available, or easily and quickly retrievable) would not cause any problems (*cf.* Miles and Huberman, 1985). Intellectual accessibility is closely related to ease of understanding and interpretability but more wide-ranging, requiring a comprehensive consideration of collaborators’ point of view.

Authority of person handling has to do with confidentiality of health related information. This matter is at a level different from the other dimensions. It is intended to highlight the importance of the security dimension and to widen its sphere. As to sustainability, costs and ethical aspects require our consideration. Sustainability with regard to costs is connected to cost-effectiveness (the extent to which the cost of collecting appropriate information is reasonable), but concerns the whole of safety telephone services. In addition to the cost of collecting information, also the costs of storing and transferring information, the costs related to information systems, and the quality costs of missing, incomplete and incorrect information, inappropriate or inefficient services, and of missing follow-up and assessment of customers’ services should be taken into account.

Sustainability with regard to ethical aspects has to do with overall practices and management of information processing in a way that ensures consideration of the customer’s point of view. The precise ethical aspects have to be defined at the level of an individual organization and, where relevant, the collaboration network, depending on the exact type and combination of services. No list of what the ethical aspects include is therefore given here.

Figure 3 summarizes the first three steps in applying the information quality analysis.

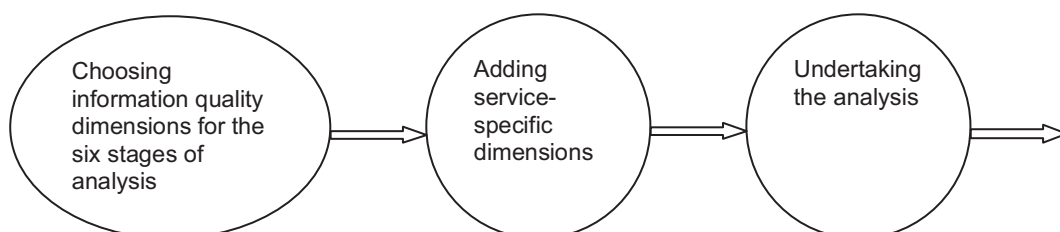


Fig. 3. The first steps in applying the information quality analysis.



## Six stages of analysis

### Stage 1:

Analysis of *basis* contains an investigation of the sources of different types of information. In the case of, for instance, customer information, a certain amount of basic information is given for the call centre's database when a safety telephone is first ordered. This is usually done by filling in a form that contains details on who is placing the order (if different from the customer) and her/his contact information, the customer's contact information, the address for invoicing (if applicable, depends on the service environment), some space for additional notes, information on the condition of the customer's health, medication, technological aids (such as hearing aid), other related services (typically municipal home care), and near relatives and their contact information. These types of information are given by the customer only, or by the person placing the order together with/on behalf of the customer. Depending on the service system, the information may be supplemented by, for instance, municipal home care employees, or telephone installers.

The quality dimensions utilized in the analysis of basis are relevancy, timeliness, completeness (dimensions of contextual information quality); accuracy, objectivity, believability (intrinsic information quality); and accessibility and security (accessibility information quality). The quality dimensions utilized in the different stages of analysis overlap in many cases, but an artificial separation would lead to an incomplete and misleading picture. (For definitions of the dimensions, see Wang and Strong, 1996).

### Stage 2:

Analysis of *component* aims at finding out whether the right pieces of information are transferred. This has to do with dimensions such as relevancy, value added, timeliness, completeness, and appropriate amount of information (dimensions of contextual information quality). If we, again, take the example of customer information, we can distinguish two different situations that place different demands. When an alarm call from a customer is received at a call centre, the right pieces of customer information to be transferred differ from those pieces that should/could be transferred when a new customer orders the service, as background information to service providers—depending on demands for confidentiality and possible related expressions of consent by the customer.

### Stage 3:

Analysis of *content and instrument* implies an investigation on whether the information in question is transferred in the right forms. Dimensions of information quality to be investigated in this context include accuracy, objectivity, believability, reputation (intrinsic information quality); interpretability, ease of understanding, concise representation, consistent representation (representational information quality); and ease of operation, traceability and flexibility.

### Stage 4:

Analysis of *timing* focuses on whether the necessary information is available at the right moment. Timeliness and relevancy (contextual information quality) as well as appropriate velocity are the quality dimensions investigated.

### Stage 5:

Analysis of *routing*, again, focuses on checking whether the necessary information is in the right places. Dimensions such as accessibility, security (accessibility information quality); relevancy, value added (contextual information quality) and traceability are utilized in this context.

### Finally, stage 6:

Analysis of *processing procedures* is directed at investigating whether the information in question is handled in the right way. Accessibility (intellectual and physical); security (accessibility information quality); interpretability, ease of understanding, concise representation, consistent representation (representational information quality); traceability, cost-effectiveness, ease of operation, authority of person handling, appropriate velocity and sustainability (costs and ethical aspects) are the dimensions utilized.

## Undertaking the Information Quality Analysis

### Mapping of information flows

Before the developed framework can be applied, a mapping of information flows needed to be undertaken to find out about:

- Types of information that are transferred;
- Events (or types of information) that trigger action or process;
- Which piece of information justifies which action;
- How an activity triggered by an event proceeds in the network (organization);

Table 2. Types of information transferred within safety telephone services.

Type of information	Examples					
<b>Customer information</b>	Customer's contact information	Condition of customer's health	Customer's medication, technological aids (such as hearing aid), other related services (typically municipal home care)	Near relatives and their contact information	Changes in the information mentioned	Expressions of consent regarding information transfer
<b>Alarm information</b>	Customer's name and address	Reason for alarm call	Basic information on customer's health	Special remarks (e.g., especially poor hearing)	Information on near relatives if they should be informed in case the customer is hospitalized	Information on visits and actions by safety helpers
<b>Technical information</b>	Broken appliance	Need to change battery of appliance	Disconnection and connection of appliance	Service needs related to, e.g., thunderstorms		
<b>Network information</b>	Organization of operations	Changes in organization of operations	Contact information of collaborators and changes in it	Feedback from customers	Feedback from collaborators	

- Bottlenecks of information flows; and
- Logic of the network (organization) in organizing information processes.

### Types of information within safety telephone services

Discussions on information processes within safety telephone services centre round alarm information. The reason is obvious—those information processes form the foundation for that service type. However, even safety telephone service professionals concentrate overwhelmingly on alarm information, without giving the necessary attention to the other types of information.

Information being transferred within the safety telephone service networks can be divided into four types: customer information, information related to alarm calls, technical information, and information related to collaboration network (see Table 2). Table 2 reports examples from interviews, not a general, ideal state of affairs. The requirements for the precise contents of the different types of information vary somewhat across different types of networks—depending on their operations.

It needs to be emphasized that these were identified as the distinct types of information that are transferred in the networks. For instance, information that is given to the customer and near relatives at the time of installation of the safety telephone is of essential importance, but it is not transferred in the networks. Therefore, it is not included as such in the information quality analysis.

Frequency data on the transfer of all the different types of information within safety telephone services do not exist for the case networks. It can be estimated that there are differences in the transfer of (i) customer information and (ii) information related to collaboration network. The importance of transferring the latter kind of information namely depends on the type of network. For instance, in an internal system of an institution offering sheltered accommodation, personnel knows the customers and deals with alarm calls, so there is no need to transfer network information—nor customer information, for that matter.

Detailed survey data are available on the reasons for incoming alarm calls for one of the case networks. Those are cited here to give an idea of the percentages of typical reasons. The figures are considered representative for safety telephone services in general. In a survey at a company-owned call centre, it was found out that as many as 80% of all the alarm calls were related to technical faults, needs to change batteries, test alarms, needs to have social contact, causeless alarms and false alarms. These usually do not lead to sending help to the customer. In only 0.4% of the calls did the person in charge at the call centre call for urgent ambulance transportation. Other kinds of helpers were called for in 14.3% of the cases (such as non-urgent ambulance transportation, visiting nurse, home help, personnel of sheltered accommodation, night patrol or near relative). (Molander, 2003.)

Table 3. Relevance of analyses by type of network and type of information.

Type of network	Type of information	Analysis of basis	Analysis of component	Analysis of content and instrument	Analysis of timing	Analysis of routing	Analysis of processing procedures
Nation-wide network (company operated) (1)	Customer	3	3	2	2	3	3
	Alarm	0	3	3	3	3	3
	Technical	0	0	0	3	2	0
	Network	2	3	3	3	3	2
Municipal network (3)	Customer	2	3	2	2	2	3
	Alarm	0	3	3	3	3	3
	Technical	0	0	0	3	2	0
	Network	2	3	3	3	3	2
Block of service flats (cooperative or foundation operated) (2)	Customer	1	2	2	2	2	2
	Alarm	0	2	2	2	2	2
	Technical	0	0	0	2	2	0
	Network	1	1	1	1	1	1
Private customers (non-governmental organization or foundation operated) (1)	Customer	3	3	2	2	2	2
	Alarm	0	2	3	2	2	2
	Technical	0	0	0	3	2	0
	Network	1	2	2	2	2	2
Pilot project (1)	Customer	3	3	2	2	3	3
	Alarm	0	3	3	3	3	3
	Technical	0	1	1	3	2	1
	Network	2	3	3	3	3	2

Weighting:

0 = Not applicable. This stage of analysis is not applicable to this type of information.

1 = Applicable but of lesser relevance.

2 = Applicable.

3 = Applicable and of particular relevance.

### Identification of relevant stages of analysis

In a network environment, taking into account different types of networks and different types of information may lead to chaotic application of the information quality analysis framework, unless the investigation is further systematised. This systematisation is, again, an iterative and cyclical process based on an understanding of the service branch in question, gained by making interviews. Weighting is thus based on the interview data. The systematisation was done by assessing the relevance of each of the six stages of analysis by network and by type of information (Table 3).

The starting point was that all six stages are undertaken. Excluding some stages in the case of, for instance, technical information is not contradictory to the intention to investigate information processes. The systematisation simply shows which analyses are meaningful to undertake. For instance, an analysis of basis (the sources) is not meaningful with regard to technical information. Information on a broken appliance is relayed automatically (or sometimes by the customer, a near relative or a municipal care professional visiting the customer). There is nothing problematic in the sources of such information, in any kind of a network.

In this investigation, the amount of data was so large that a prior systematisation was vital before the detailed analysis. When applied in an individual organization, irrelevant parts of the information quality analysis framework can be identified in joint discussions without anyone filling in a table first. Even there, however, a table similar to Table 3 could be developed by unit or department—particularly in bigger organizations. Development of a table may also help in giving the appropriate weight to the different types of information that are transferred. Certain types may be seen as self-evident and omitted in planning, although they contribute to the transfer of other types of information. Particularly in heterogeneous multi-actor service networks such as those investigated here, employees are not very knowledgeable about the different types of information.

Table 3 implies that differences in relevance mainly depend on the types of information; there are not many differences between the types of network within safety telephone services. The only environment with clear differences was institutions offering sheltered accommodation.

After thus identifying the necessary and meaningful restrictions, the actual analysis on the basis of the framework could start with the six stages. They were undertaken by analysing the interview data on the basis of the information quality dimensions assigned for the different stages. Going through the comprehensive analysis of the six stages in this article is impossible for reasons of limited space. Only one brief example, discussion of timeliness of the sources of customer information is included here. Each type of information was assessed by each stage of analysis and all the information quality dimensions assigned to it.

### An example of detailed results: Timeliness of the sources of customer information

Timeliness—the extent to which the age of information is appropriate for the task at hand—of the basis of customer

information was found to require particular attention in safety telephone services. The basis of customer information is here understood as databases at call centres or corresponding units that answer alarm calls. The results showed that in large service systems, where each individual customer cannot be known, updating and supplementing customer information would be important. Ageing people's health condition may change quickly, and certain changes—for instance, if dementia comes out—even make the use of safety telephones difficult, if not impossible. Other types of information also change, such as telephone numbers of near relatives. The results indicated that these are not kept systematically up-to-date.

*When the subscription is placed, the customer information is given on the form that is filled in. Changes have not, indeed, been communicated to the call centre. [...] We could have improved our practices there. There may be customers who do not get any type of service other than this safety telephone service . . . if [the safety helper] does not know [the customer] and [the customer] has, for instance, a low blood sugar level—that the helper knows how to act . . . (Employee of municipal home care service, nation-wide network.)*

The age of customer information may be from the time of subscription to the safety telephone, which may have taken place years ago. The results showed that procedures for updating and supplementing customer information have usually not been defined or are not sufficiently clear to the personnel. In one of the bigger networks investigated here, there is a system where the customers' files are regularly checked and subscriptions renewed once a year. In another, smaller network, updates of information on customers' medication are systematically and regularly asked for, but the customers rarely return the form.

Timeliness of the basis of customer information was shown to have a different weight in different kinds of networks. In internal safety telephone systems of institutions offering sheltered accommodation, timeliness of the basis of customer information was found to have a relatively small weight, as the personnel who helps the customers knows them. The results indicated that in a municipal system, again, collaboration partners sometimes benefit from access to other databases with up-to-date health-related information on the customers (for instance, databases of hospitals or health centres).

### Summary results

The rest of the results of the operationalization of the framework of information quality analysis are presented in the form of a summary table (Table 4). The full analysis including further illustrative quotations from the interviews may be seen in Melkas (forthcoming). Table 4 shows the whole structure of the analysis that was undertaken. For each stage of analysis, the relevant types of information are listed. For each type of information, the quality dimensions that were found to be particularly central in the analysis are written in bold. Those quality dimensions that are of lesser importance are written in normal letters, and those of no importance are in brackets.

The results are not summarized by type of network here. Although the type of network was found to affect many things, it also became evident that—apart from internal safety telephone systems of institutions offering sheltered accommodation—the problems and challenges in the operations are very similar. Differences between the networks investigated lie in the scale of problems and challenges.

The operationalization led to useful results that can be utilized as guidelines when planning information-related matters in the case networks in the future. Particularly the dimensions written in bold deserve to be focused on. The summarized results also show that the utilization of this novel framework of analysis—in combination with the other steps of the comprehensive information quality analysis—results in a multi-faceted picture of the state of information quality. The importance of the various information quality dimensions by type of information and stage of analysis was discerned (see, for instance, the results for customer information by stage of analysis). Even in the complicated network environment, it was thus possible to undertake a successful operationalization of the framework of analysis. For utilization in practice for planning purposes within the branch in question, the summary table naturally needs to be read together with the full description of the results.

### Discussion

The emphasis in this discussion is on the framework of information quality analysis and its usability. This research opened up new insights into three directions: (i) analysis and management of information quality, (ii) service networks based on virtualization and (iii) the branch of safety telephone services. Literature studies had shown that new tools to analyse information quality are needed, and that such analyses have not been undertaken in network environments and on the basis of qualitative interview data. The framework introduced in the present article is, on the one hand, general in that it is argued to be well applicable in different organizational environments, and on the other hand, it was adapted here to the branch in which it was operationalized. The framework is thus flexible, and it may well have good future potential in organizational research.

The environment of safety telephone services and their virtual networks was felt to be particularly challenging, as there were many completely different types of information transferred in multi-actor, multi-professional, multi-organizational, even multi-locality networks. Moreover, information flows form the basis for the operations in an especially clear way. In fact, the importance of information-related matters is claimed to be beyond comparison with

Table 4. Summary results of the operationalization of the framework of information quality analysis.

Stage of analysis	Type of information analysed	Information quality dimensions investigated
Basis: the right source of information	Customer	(Relevancy), <b>timeliness, completeness, accuracy</b> , (objectivity), (believability), <b>accessibility, security</b>
	Network	(Relevancy), <b>timeliness, completeness, accuracy</b> , (objectivity), (believability), <b>accessibility, (security)</b>
Component: the right piece of information	Customer	<b>Relevancy</b> , value added, <b>timeliness, completeness</b> , appropriate amount of information
	Alarm	<b>Relevancy</b> , value added, <b>timeliness, completeness, appropriate amount of information</b>
	Network	<b>Relevancy, value added, timeliness, completeness</b> , appropriate amount of information
Content and instrument /means: in the right form	Customer	<b>Accuracy</b> – (including accurate coding of message), objectivity, believability, (reputation), <b>interpretability, ease of understanding, concise representation, consistent representation, ease of operation</b> , (traceability), flexibility
	Alarm	Accuracy – including accurate coding of message, (objectivity), (believability), (reputation), <b>interpretability, ease of understanding, concise representation, consistent representation</b> , (ease of operation), (traceability), (flexibility)
	Network	<b>Accuracy</b> – (including accurate coding of message), (objectivity), (believability), (reputation), <b>interpretability, ease of understanding, concise representation, consistent representation, ease of operation</b> , (traceability), (flexibility)
Timing: at the right moment	Customer	<b>Timeliness, relevancy</b> , appropriate velocity
	Alarm	(Timeliness), (relevancy), <b>appropriate velocity</b>
	Technical	(Timeliness), (relevancy), <b>appropriate velocity</b>
	Network	<b>Timeliness, relevancy, appropriate velocity</b>
Routing: in the right place	Customer	<b>Accessibility, security, relevancy, value added</b> , (traceability)
	Alarm	(Accessibility), (security), (relevancy), (value added), (traceability)
	Technical	(Accessibility), (security), (relevancy), (value added), (traceability)
	Network	<b>Accessibility, (security), (relevancy), (value added), (traceability)</b>
Processing procedures: handled in the right way	Customer	<b>Accessibility – intellectual and physical, security, interpretability, ease of understanding, concise representation, consistent representation</b> , traceability, <b>cost-effectiveness, ease of operation, authority of person handling</b> , appropriate velocity, sustainability – costs, ethical aspects
	Alarm	Accessibility – <b>intellectual and physical, security, interpretability, ease of understanding, concise representation, consistent representation</b> , (traceability), (cost-effectiveness), (ease of operation), (authority of person handling), <b>appropriate velocity</b> , sustainability – <b>costs</b> , (ethical aspects)
	Network	<b>Accessibility – intellectual and physical, (security), interpretability, ease of understanding, concise representation, consistent representation</b> , (traceability), <b>cost-effectiveness, ease of operation</b> , (authority of person handling), <b>appropriate velocity, sustainability – costs, ethical aspects</b>

Notes: The summary results concern the nation-wide network.

**Bold letters:** The quality dimensions that were found to be particularly central in the analysis.

Normal letters: The quality dimensions that are of lesser importance.

(Normal letters in brackets): The quality dimensions that are of no importance.

many other branches.

The demanding operationalization of the framework of information quality analysis in this particular environment succeeded quite well. The field of operationalization is important also because different kinds of distance care and distance service arrangements are being developed and tested—for ageing people as well as others. The results of the present analysis are potentially useful for such new types of social and health care services (for instance, telemedicine).

Throughout the analysis as well as during the documentation of its results, the framework of analysis was continuously assessed. Several weaknesses were detected. It was often difficult to code the interview data so that different matters could be placed unambiguously under the relevant information quality dimensions. However, a careful consideration of the usability of the framework led to the conclusion that certain weaknesses detected seem inevitable in an investigation of the present kind to get a comprehensive picture of a complicated phenomenon and things related to it. The framework of analysis can be streamlined in several ways for future research. Again, the flexibility of the framework needs to be emphasized. For instance, it could be utilized in a study of a few service chains of customers of one virtual network (for instance, subscription chain, installation chain, communication chain, alarm chain and repair chain) and/or of a few collaboration partners ('chains' of negotiations, closing of contracts, initiation of operations, alarms, communication and so forth).

The information quality analysis as undertaken enabled a versatile investigation, and it is regarded as a key to practical development work in organizations. Even the certain degree of repetition across the stages of analysis and

information quality dimensions seemed meaningful, because at each stage, new insights were gained, and the area of information quality was well gone through. The wealth of interview data and other materials on a very complicated environment were systematized to an extent where information quality planning by organization or network has become possible. The value of the analysis is also supported by the fact that it is grounded on a solid theoretical basis. The present analysis was the first attempt to study information quality in the branch of safety telephone services in Finland, or elsewhere, to the author's knowledge. Results of the information quality analysis could be utilized also in individual organizations' quality management systems. An information quality analysis could form one element of a general quality assessment at organizational or network level. However, the analysis is applicable immediately even without quality management systems—there seem to be many uses for the valuable results.

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