ANALYZING INFORMATION QUALITY IN VIRTUAL SERVICE NETWORKS WITH QUALITATIVE INTERVIEW DATA

(Research Paper)

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Abstract: In this paper, a novel framework is introduced for analyzing information quality within information processes of complex organizational networks on the basis of qualitative data. Networking and virtualization are trends that call for new ways of looking into information quality. Also public organizations, cooperatives and non-governmental organizations are forming networks, or entering into networks of companies. Tools for analyzing information quality in such environments have been lacking. The newly developed framework is operationalized within multi-actor service networks offering safety telephone services for ageing people. These services utilize 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 information quality analysis framework helps in identifying information quality dimensions that are weak in a network. This analysis is usefully combined with an investigation of network collaboration that identifies weaknesses and strengths in network collaboration affecting management of information quality.

Key Words: Information Quality, Qualitative Methodology, Service Network, Safety Telephone Services

INTRODUCTION AND BACKGROUND

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. A crucial issue concerning information transfer and management is the quality of information that is collected, stored and transferred. Mapping and management of information quality need to be continuous processes [3]. Discussions on information often focus on information systems, information technology, data warehouses and data mining, to mention a few examples. Information itself is the material that is essentially needed. The real goal of information quality is to increase customer and stakeholder satisfaction [3] [8]. 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 [8].

Tools that have been developed for measuring and analyzing information quality (e.g., [2–4] [8] [24–25] [27–29]) 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, however, concern companies only. Public organizations, cooperatives and non-governmental organizations are also

forming networks, or entering into networks of companies. This tendency is 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. Tools for analyzing information quality in such environments and on the basis of qualitative data have been lacking.

RATIONALE AND PURPOSE

The objective of the paper is to introduce a new kind of framework for information quality analysis within information processes of organizational networks on the basis of qualitative interview data – and to describe how this framework was operationalized within multi-actor networks that provide 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 [24–25]. One starting point in this paper is that the same applies vice versa; 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. [3] [8] [18]).

Enterprise networks and information management systems are widely studied fields – and the focus of considerable attention also within companies – 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 recent years (e.g., [1] [5–7] [9–12] [14] [17] [21–23] [26]). The kinds of multi-actor service networks that provide the field of operationalization in this paper have barely been investigated. Some work has been done to assess effectiveness of public-sector service networks (cf. [20]), but information-related matters were not included among the effectiveness criteria. Very little work has been devoted to the 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 paper does not contain an investigation of information systems as such. The focus is on content and quality of information, and within the case networks, such an approach would not be meaningful due to the poor development state or even lack of information systems. The amount of information transferred within safety telephone services is treated as background information only. Due to the objective of methodology development for network environments, the quality of the service provided to customers – ageing people – is not systematically investigated.

METHODS

New framework for analyzing information quality

The paper is based on a doctoral dissertation [15] that contains (i) methodology development and (ii) operationalization of the methodology with the help of case studies. The data produced by applying qualitative methods were analyzed with the help of the information quality framework. The paper presents the way in which this operationalization was undertaken. Details of the data collection for the operationalization are described in the Appendix. The comprehensive results cannot be specified in a brief paper of this kind (see [15] for further details). The information quality analysis framework is proposed as a tool to investigate the quality of the different types of information that are transferred in the case

networks. Information quality is an essential slice of the whole of information management, but it may be overlooked due to, for instance, extensive attention to information systems – or various knowledge management initiatives concentrating overwhelmingly on utilization of tacit knowledge. The information quality analysis framework helps in identifying information quality dimensions that are weak in a network (or in an individual organization). The use of the framework is combined with an investigation of network collaboration that helps in identifying weaknesses and strengths in network collaboration affecting management of information quality. A description of the latter investigation is, however, beyond the scope of this paper (for details, see [15]).

Basis and development of the information quality analysis framework

The information quality analysis framework was elaborated primarily on the basis of the quantitative studies of Wang and Strong [29], Strong, Lee and Wang [24–25] and Wang et al. [28]. Their data quality framework has been used effectively in industry and government, but they have also called for further research to apply the framework in specific work contexts [29]. Wang and Strong's work [29] 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 and 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 [13, p. 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. Each stage of analysis represents a criterion for information quality that is key to the successful operation of a network. Each criterion is then further broken down by information quality dimensions that are most relevant to that stage of analysis.

For each stage of analysis, appropriate dimensions of information quality were assigned from those listed by Wang and Strong [29]. For another branch of business, dimensions to be assigned for the six stages could be different, depending on the operations. The starting point was that all the dimensions from [29] are included at each stage. However, that would have made the analysis quite heavy. On the basis of the data collected, the author started to exclude dimensions from consideration. The data showed the necessary exclusions relatively clearly. Where there was unclarity, the dimensions were kept. The assignments were based on an assessment of the definitions of dimensions of information quality, aims of the six stages of analysis as well as the data collected (knowledge of the branch). In this phase, also a few 'service-specific' dimensions were added (as described below). The result was the framework that is shown in Table 1, and subjected to testing and operationalization.

In the interviews, it became quite clear that collecting data from the interviewees for making the assignments would have led to meagre and unreliable results. The interviewees from safety telephone services are not used to thinking about information at a conceptual level. Even at the practical level, these things are felt to be somewhat difficult to grasp. The case environment thus caused quite many special challenges. Developing a list of criteria for the assignments could even be counterproductive in environments, where the topic of information and information quality first need to be made visible. It seems that criteria could be developed in future research at the level of an individual organization – or rather, a couple of organizations, where people would agree on the assignments in joint discussions, and the researcher would then document their reasons for the assignments and develop a list with the help of those. The persons would need to be knowledgeable about the topic of information quality. However, also 'difficult' network environments need to be studied.

The word 'right' in Table 1 means the opposite of wrong. It cannot be given a universal definition, as situations and contexts vary. The new framework was designed with the aim of taking into account context dependent variables as well as information as an output and a process. Within safety telephone

services, the information that is given by a customer in an alarm call, for instance, transforms as the service process advances. This is the reason for not testing Wang and Strong's [29] seminal framework of information quality as such. Their information quality dimensions have here been assigned in an innovative way to the different stages of analysis. This approach suits the particular characteristics of the case environment – but it is also flexible for use in other branches or organizations.

Stage 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 and ethical aspects)

Table 1. The information quality analysis framework.

Adding service-specific information quality dimensions

The 'service-specific' dimensions that were added to the framework of analysis on the basis of the information on safety telephone services are the following:

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

Traceability, cost-effectiveness, ease of operation and flexibility are dimensions that were originally included in Wang and Strong's framework [29] 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 reintroduced here because of the author's assessment – based on the data collected – of their importance in safety telephone services.

Accurate coding of message was added to the stage of analysis 'content and instrument /means' as an explanatory remark for accuracy. 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 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 it is felt to be insufficiently covered by 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 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. [16]). Intellectual accessibility is closely related to ease of understanding and interpretability but more wide-ranging, requiring a comprehensive consideration of collaborators' point of view and needs.

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 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 as well as 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.

The 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 subscribed. This is usually done by filling in a form that contains details on who subscribes (if different from the customer) and her/his contact information, customer's contact information, address for invoicing, some space for additional notes, information on customer's health condition, medication, technological aids (such as hearing aid), other related services (typically municipal home care) as well as near relatives and their contact information. These types of information are given by the customer only or by the person subscribing 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) (for their definitions, see [29]). The quality dimensions utilized in the different stages of analysis overlap in many cases, but it is argued that an artificial separation would lead to an incomplete and

misleading picture.

Stage 2:
Analysis of *component* aims at finding out whether the right pieces of information are stored and transferred. This has to do with information quality dimensions such as relevancy, value added, timeliness, completeness and appropriate amount of information (dimensions of contextual information quality). If, again, the example of customer information is used, 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 subscribes to 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 of 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.

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 investigated.

RESULTS

Mapping of information flows

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

- types of information that are transferred and stored;
- events (or types of information) that trigger an action or a process;
- which piece of information justifies which action;
- how an activity triggered by an event proceeds in the network (organization);
- bottlenecks of information flows; and
- logic of the network (organization) in organizing information processes.

Such a mapping including a graphical presentation of its results is necessary for translating the interview and other case data into the set of stages of analysis and relevant information quality dimensions (see figure 1 for a summary of the whole research methodology).

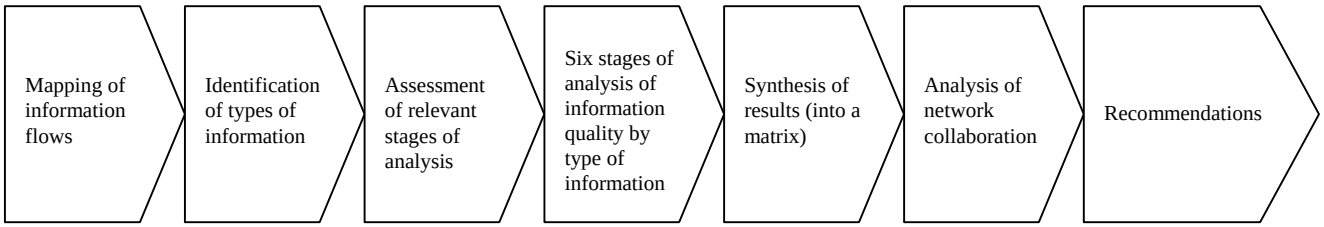

Figure 1. The information quality analysis step by step.

Types of information within safety telephone services

In this brief paper, only the types of information that are transferred within safety telephone services can be discussed; for comprehensive results of the mapping, see [15]. Discussions on information processes within safety telephone services centre round alarm information. The reason seems obvious – those information processes form the foundation for that service type. However, even safety telephone service professionals appear to concentrate overwhelmingly on alarm information, without giving the necessary attention to the other types of information (especially network 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 the different types of networks – depending on their environment and operations.

The four types 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. Comprehensive frequency data on the transfer of the different types of information are not available for any of the case networks. It can be estimated that there are differences in the transfer of (i) customer information and (ii) network information. 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, the personnel knows the customers and deals with alarm calls, so there is no need to transfer network and customer information.

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 can be considered fairly representative for safety telephone services in general. In the survey, 80 per cent 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 per cent of the calls, the call centre personnel called for urgent ambulance transportation. Other kinds of helpers were called for in 14.3 per cent of the cases (such as visiting nurse or near relative) [19].

Type of information	**Examples**
Customer	Customer's contact information

information	Condition of customer's health Customer's medication, technological aids (such as hearing aid), other related services Near relatives and their contact information Changes in the information mentioned Expressions of consent regarding information transfer
Alarm information	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
Technical information	Broken appliance Need to change battery of appliance Disconnection and connection of appliance Service needs related to, e.g., thunderstorms
Network information	Organization of operations Changes in organization of operations Contact information of collaborators and changes in it Feedback from customers Feedback from collaborators

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

Identification of relevant stages of analysis

Taking into account many different types of networks and types of information might lead to chaos in the application of the information quality analysis framework, unless the investigation is further systematized beforehand. This systematization is an iterative and cyclical process based on an understanding of the service branch, study visits and interviews. Weighting is based on the interview data, but it is not a mechanical process for which numerical criteria could be shown. The systematization 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 systematization shows which analyses are meaningful. For instance, an analysis of basis 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 care professional). There does not seem to be anything 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 systematization was vital before the detailed analysis. When applied in an individual organization, irrelevant parts of the information quality analysis framework could be identified in joint discussions without anyone filling in a table first. Even there, however, a similar matrix to that in Table 3 could be developed by unit or department – particularly in bigger organizations. This can also help in giving the appropriate weight to the different types of information. 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.

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
Sheltered accommodation (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.

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

Table 3 implies that differences in relevance mainly depend on the type 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 natural restrictions, the actual analysis on the basis of the framework could start. The six stages of analysis were undertaken by analyzing the interview data with the help of the information quality dimensions assigned for the different stages. Going through the comprehensive analysis with the six stages is beyond the scope of this paper. Only one brief example, discussion of timeliness of the sources of customer information is included here. Each type of information was assessed by the relevant stages of analysis and all the information quality dimensions assigned to them.

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 was poorly organized. 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 safety telephone subscription, 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 for 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 read in [15]. Table 4 shows the 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. The quality dimensions 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 are 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. Although there was some overlap in the information quality dimensions investigated during the different stages of analysis, the importance of the various dimensions was discerned in a meaningful way (see, for instance, the results for customer information by stage of analysis).

There were altogether 48 dimensions assigned to the six stages of analysis. Six of those 48 were – according to the detailed analysis – not important for any type of information (analysis of basis: relevancy, objectivity, believability; analysis of content and instrument: reputation, traceability; analysis of routing: traceability) (Table 4). Table 1, the starting point, was thus reasonably correct, and the differences between the types of information were made visible. As to the dimensions that were excluded from the six stages of analysis, it is claimed that if something important had been omitted, it would have come up. Table 1 was both a 'hypothesis' and based on an early assessment of the data collected. The dimensions that were not meaningful were excluded at an early stage already. The results were also discussed with the practitioners in many meetings, and these discussions support the conclusions made on the basis of the analysis.

Stage of analysis	**Type of information analyzed**	**Information quality dimensions investigated**
Basis: the right source of information	Customer	(Relevancy), **timeliness**, **completeness**, **accuracy**, (objectivity), (believability), **accessibility**, **security**
	Network	(Relevancy), **timeliness**, **completeness**, **accuracy**, (objectivity), (believability), **accessibility**, (security)
Component: the right piece of information	Customer	**Relevancy**, value added, **timeliness**, **completeness**, appropriate amount of information
	Alarm	**Relevancy**, value added, timeliness, **completeness**, **appropriate amount of information**
	Network	**Relevancy**, **value added**, **timeliness**, **completeness**, appropriate amount of information
Content and instrument /means: in the right form	Customer	**Accuracy** – (including accurate coding of message), objectivity, believability, (reputation), **interpretability**, **ease of understanding**, **concise representation**, **consistent representation**, **ease of operation**, (traceability), flexibility
	Alarm	Accuracy – including accurate coding of message, (objectivity), (believability), (reputation), **interpretability, ease of understanding, concise representation, consistent representation,** (ease of operation), (traceability), (flexibility)
	Network	**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	Customer	**Timeliness**, **relevancy**, appropriate velocity
	Alarm	(Timeliness), (relevancy), **appropriate velocity**
	Technical	(Timeliness), (relevancy), **appropriate velocity**
	Network	**Timeliness**, **relevancy**, **appropriate velocity**
Routing: in the right place	Customer	**Accessibility**, **security**, **relevancy**, **value added**, (traceability)
	Alarm	(Accessibility), (security), (relevancy), (value added), (traceability)
	Technical	(Accessibility), (security), (relevancy), (value added), (traceability)
	Network	**Accessibility,** (security), (relevancy), (value added), (traceability)
Processing procedures: handled in the right way	Customer	**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
	Alarm	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)
	Network	**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**

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.

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

It was thus possible to undertake a successful operationalization of the framework of analysis even in the complicated network environment. For utilization in practice for planning purposes, the summary table naturally needs to be read together with the full descriptions of the results. The comprehensive analysis continued after the operationalization of the framework to include the investigation of network collaboration as well as formulation of recommendations for practical development work in the case

networks with regard to (i) information quality and (ii) related general network collaboration (see [15] for the full description). Network collaboration is a prerequisite for many of the improvements that could be done to information quality, and information quality considerations may contribute to the creation of network identity and to socialization and institutionalization processes at network level.

DISCUSSION AND LIMITATIONS

The emphasis in this discussion is on the framework for 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 qualitative tools to analyze information quality are needed, and that such analyses have not been undertaken in network environments. The framework introduced in the present paper 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 might 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 many other branches. The demanding operationalization of the framework for information quality analysis in this environment succeeded. Having a combined framework with both the six stages of analysis and the information quality dimensions enabled a well-structured investigation of the complex information flows in the case networks. Undertaking the analysis implied that if the information quality dimensions had been used without the six stages, some issues might have remained unnoticed in the information processes.

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. It was also felt to be difficult to document the results for this reason. Sometimes, it was even problematic to place matters under the six stages of analysis. The overlap in the stages of analysis, dimensions of information quality and presentation of the results was disturbing. However, coding checks were made, and after careful considerations of the usability of the framework, the conclusion was made that this was inevitable in an investigation of the present kind to get a comprehensive picture of a complicated phenomenon and things related to it.

In future studies, the number of information quality dimensions for the six stages of analysis could possibly be somewhat lower. The whole entity of information quality analysis as introduced – from the categorization of types of information to an investigation of bottlenecks of information flows – and from an assessment of the relevance of the different stages of analysis to undertaking the six stages of analysis – and finally, an investigation of network collaboration (and formulation of recommendations), is quite profound. Or, in its present multi-faceted scope, the information quality analysis may be better suited to an assessment of information quality in a smaller organizational context. Alternatively, the information quality analysis could be utilized in a study of a few service chains of customers of one virtual network (for example, subscription, installation, communication, alarm and repair chains) and/or of a few collaboration partners (‘chains’ of negotiations, closing of contracts, initiation of operations, alarms, communication and so forth).

CONCLUSIONS

It is argued that the above-mentioned shortcomings do not devalue the methodology developed. Numerous strengths were detected. The information quality analysis as introduced enables 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 of the operationalization, new insights were gained, and the area of information quality was thoroughly investigated. 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. This research 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. For suggestions on other avenues for future research and validation, readers are referred to [15].

Although its results could not be presented here, the investigation of network collaboration formed an important part of the information quality analysis. It highlighted issues that had not come up or had been merely touched upon in the earlier analysis. Yet, they affect information flows and quality. The network collaboration perspective also led to fuller use of all the valuable interview data and contributed to the basis for action scientific recommendations. It is thus argued that the linking of previously distinct research areas – information quality, network collaboration and information flows – was useful. The results of the operationalization of the methodology were branch-specific, so their wider applicability and significance remain to be seen. Their potential impact on the development of the branch in question is considerable. Interest towards information management was observed to increase in the case networks during the investigation. Training materials on information quality are being developed, and the results of this investigation are incorporated into general quality recommendations that are being formulated for the whole branch of safety telephone services in Finland. Closely related branches developing distance care arrangements may also benefit from those.

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APPENDIX: DATA COLLECTION FOR THE OPERATIONALIZATION

The data collection for the operationalization of the methodology was made following the general principles of conducting case studies [30]. The data included (i) written material ranging from memoranda 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 this research. It is not likely that they would unfold the care professionals' true views of the complicated phenomenon of information within the networks. The semi-structured and open-ended 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, see [15]). The interviews were audiotaped and transcribed for analysis. At workshops and seminars, field notes were made. After reading, coding and analyzing 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 be several systems in operation at the same time; for instance, internal systems in institutions offering sheltered accommodation, a municipal system and several private systems.

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 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 increased the validity and reliability of the results. The bias in favour of the nation-wide system had 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 internal ones in very small 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 picture gained by the interviews around Finland was comprehensive, and the types of organizations and professional groups were representative of the branch. Municipalities (the social and health care sector) and companies were both represented by 12 interviewees. Altogether 16 interviewees represented non-governmental organizations, foundations and cooperatives. 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.