
The combined conceptual life-cycle model of information quality: part 1, an investigative framework

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Abstract: Systems information quality (IQ) investigative frameworks, thus far, lack a widely accepted model with which researchers can conceptualise the context of their study, and identify the important IQ characteristics to be examined and empirically tested. The result is a widely varied body of literature lacking a coherent and consistent approach to identifying and measuring systems IQ.

Presented is the combined conceptual life cycle (CC/LC) model of IQ, a framework which enables researchers to develop a more accurate research lens through which to examine user/information interaction and perceptions of IQ.

Importantly, the CC/LC is the first framework of its kind which can be used to address user IQ perceptions from either an information production and/or information retrieval perspective.

Keywords: information quality; IQ; information quality framework; combined conceptual life-cycle model; CC/LC.

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1 Introduction

Information quality (IQ) is a complex, multi-dimensional construct (Ballou et al., 1998; Klein, 2001; Aladwani and Palvia, 2002; Lee et al., 2003; Gendron et al., 2004; Knight and Burn, 2005), the investigation of which is made all the more challenging when

examined within the context of systems-based human information retrieval (IR) behaviours, also recognised as involving multi-dimensional constructs (Schamber et al., 1990; Wilson, 1999; Chang and Lee, 2001).

The following paper presents and discusses the proposed combined conceptual life-cycle (CC/LC) model of IQ, which was developed to conceptualise commonly accepted dimensions, or information characteristics, engaged by users in their ongoing value-judgements of the information they encounter. The specific context of the research investigation was user information seeking behaviour and information retrieval on the World Wide Web, an information environment devoid of enforceable IQ standards (Hawkins, 1999; Brooks, 2003), where users are required to determine quality for themselves.

Discussed first is the broad concept of IQ. This is followed by a literature review which explores the previous decade of research into systems-driven IQ to establish the common elements of user perceptions of IQ. It then proposes a conceptual framework by which researchers can develop context specific investigations into IQ as a user-perception driven phenomenon.

2 What is ‘information quality (IQ)’?

2.1 Information quality: the ‘fit-for-use/purpose’ paradigm

IQ is considered to be a multi-dimensional concept, in that multiple factors determine its state, existence and application. A somewhat general consensus has been reached in relation to a definition for IQ as being information/data that is ‘fit-for-use’ (also ‘fit-for purpose’) (Wang and Strong, 1996).

The ‘fit-for-use/purpose’ paradigm is useful in that it implies IQ is *context* driven (Lee et al., 2002; Neus, 2003; Gendron et al., 2004; Even and Shankaranarayan, 2005; Neely, 2005; Song and Zahedi, 2006). The great value in assigning a context to IQ is that:

- 1 it enables researchers to conceptualise the processes involved in any user/information interaction processes (Wang and Strong, 1996; Shanks and Corbitt, 1999; Dedeker, 2000; Eppler and Wittig, 2000; Kahn et al., 2002; Eppler and Muenzenmayer, 2002; Moraga et al., 2006)
- 2 it facilitates the process of associating characteristics (called ‘dimensions’) with the information, which can be used as value-judgment criteria (Kahn et al., 2002; Pernici and Scannapieco, 2002; Chang et al., 2005)
- 3 it helps researchers to better understand what criteria users may employ in their value-judgements of information (Chung et al., 2002; Li and Lin, 2006; Knight, 2008).

The ‘fit-for-use’ paradigm has been embraced by researchers for a number of reasons. Firstly, it facilitates the concept that IQ is *relative*, as information considered appropriate for one use, and therefore be perceived of high quality, may not possess sufficient attributes for another use (Tayi and Ballou, 1998). Secondly, it conceptualises the user *action* of user/information interaction and value-judgment into the information production or information retrieval process, while still remaining enigmatic and relative like the concept it is used to define. Thirdly, it gives IQ an investigative *context* (Strong

et al., 1997a, 1997b) in that it implies IQ cannot be defined and assessed outside of the reason for which it exists.

Shanks and Corbitt (1999) contend that IQ should be assessed within the context of its generation, while Katerattanakul and Siau (1999) advocate that it needs to be assessed according to its intended use. The reason for this contextual approach is both simple and logical, because it recognises the attributes and dimensions used to assess IQ can vary depending on the context in which the data is created or to be used (Shankar and Watts, 2003).

The problem with defining IQ in such non-specific terms is that researchers are still no closer to actually defining what a 'quality' piece of information is, or what criteria can be used to quantify or measure it. Instead, it recognises in the context of information retrieval (IR), that which is considered a 'quality' piece of information is highly reliant on the perceptions of the retriever of that information (Rieh, 2000; Kopcsó et al., 2001; Klein, 2002a, 2002b; Croft and Peterson, 2002; Toms et al., 2005; Forslund, 2007; Knight, 2008; Varlander, 2007).

So 'fit-for-purpose' recognises the certainty that users of information are constantly making choices regarding its quality as they interact with both the information and the information system. This *value-judgement during interaction* process only serves to further complicate any investigation into user-driven perceptions of IQ, because the cognitions engaged by users during information interaction can, and do, relate to both IQ and system quality perceptions. Thus, embracing the fit-for-purpose paradigm involves recognising the multi-dimensional nature of user IQ perceptions, not the least of which understands IQ from the users' point of view (Strong et al., 1997a). In other words, the quality of information cannot be assessed independent of the people who will use that information. And this just may be its saving grace, in that it implies users' perceptions of IQ will be manifest in their information behaviours. It follows then, that examining user information behaviour is an effective means for researchers to investigate what is IQ.

3 Frameworks and models of IQ: literature review

The IQ frameworks examined for the current paper cover systems IQ research from 1996 through 2007, and are presented (in point form) in Appendix. While varied in their approach and application, all 21 frameworks share a number of definitive characteristics regarding their classifications and descriptions of the dimensions of IQ. For example, the dimension *reliability* is present in 17 of the 21 frameworks, *accuracy* appears 14 times, as does *currency*. *Scope*, *relevancy* and *accessibility* also feature in over half the frameworks examined. The common dimensions of IQ identified from the literature examined will be discussed in detail later in the paper. What follows first, is a discussion of the conceptual aspects of some of the land-mark frameworks, with the objective of understanding how researchers arrived at their lists of dimensions.

The frameworks cited in Appendix can be classified into four types of IQ models:

1 Conceptual IQ identification models:

- CIQF – categorical IQ framework (Wang and Strong, 1996)
- SDQF – semiotic data quality framework (Shanks and Corbitt, 1999)
- conceptual framework for measuring IS quality (Dedeke, 2000)

- mapping IQ into the PSP/IQ (becomes AIMQ) (Kahn et al., 2002)
 - IQM – IQ measurement methodology (Eppler and Muenzenmayer, 2002)
 - IQ as a life-cycle (Liu and Chi, 2002).
- 2 *Frameworks* that push existing models in order to apply them to a web context
 - extension of IQF into web environments information contexts (Katerattanakul and Siau, 1999)
 - detection of IQ problems by users on the WWW (Klein, 2002a).
 - 3 Development of IQ conceptual models into machine *readable metrics*
 - quality metrics for information retrieval on the WWW (Zhu and Gauch, 2000)
 - classification of IQ metadata criteria (Naumann and Rolker, 2000)
 - using IPMAP to create machine readable (quality related) metadata about data (Shankar and Watts, 2003)
 - quality metrics used to create Wikipedia IQ evaluation tool (Stvilia et al., 2005).
 - 4 Practical *application of IQ guidelines* to build user-resources and ‘how to..’ frameworks for searchers of information – specifically user/searchers on the World Wide Web.
 - CARS checklist for IQ (Harris, 1997)
 - (web) evaluation criteria (Beck, 1997)
 - web wisdom (Alexander and Tate, 1999).

4 Conceptual models of IQ

4.1 *CIQF – categorical information quality framework (Wang and Strong, 1996)*

The valuable paradigm of context-driven IQ postulated by Wang and Strong (1996) allowed researchers to separate user/information interaction into two distinct contexts:

- 1 information production
- 2 information use.

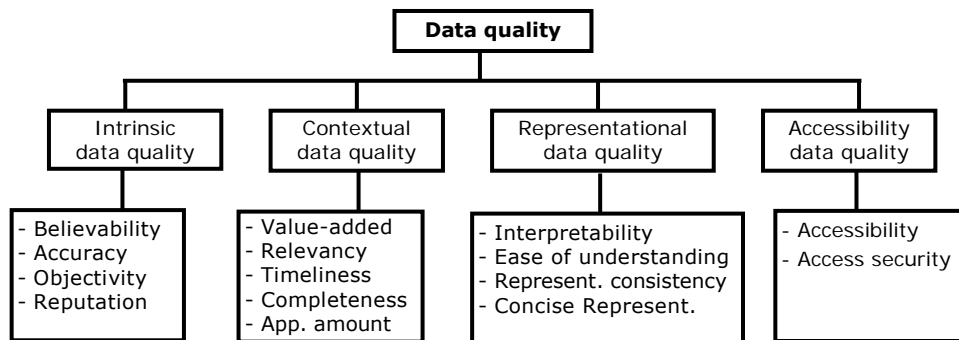
The further conceptualisation of IQ into categories associated with production or use proved to be a valuable methodology for identifying the ultimate dimensions proposed to be applied by users in their process of information interaction.

Wang and Strong (1996) built a contextually driven conceptual framework that categorised dimensions of IQ into four contexts (or types) of quality:

- 1 intrinsic IQ
- 2 contextual IQ
- 3 representational IQ
- 4 accessibility IQ.

Within these four categories, Wang and Strong identified 15 different dimensions of IQ. The CIQF framework, illustrated in Figure 1, clearly demonstrates that the process of determining categories for IQ, enables researchers to begin putting that which is, conceptually speaking, relatively intangible, into tangible descriptions which can then be explored empirically in concrete terms.

Figure 1 Categorized model of IQ/DQ



Source: Wang and Strong (1996)

4.2 SDQF – semiotic data quality framework (Shanks and Corbitt, 1999)

Shanks and Corbitt (1999) conceptualised IQ in relation to cultural meanings; that is; how IQ could be understood in terms of the quality related meanings imposed on it as a socially created construct. Investigated from this more philosophically driven approach, the authors built IQ into a semiotic framework comprised of four levels:

- 1 syntactic: concerned with the physical/empirical structure of information
- 2 semantic: concerned with the wholeness of information
- 3 pragmatic: concerned with usage of information
- 4 social: concerned with the socially driven meanings of information.

The semiotic framework recognises its own constructivist view-point that information as an entity is symbolic, and the framework acknowledges the building of imposed constructs in order to meaningfully classify the various characteristics of IQ. This type of conceptualisation of IQ is ultimately concerned with the application of symbolic representation of systems ‘quality’ in line with the view that communication and language are themselves symbolic (Budd, 2005; Goulding, 2005). By beginning at a conceptual level, researchers are able to contextualise an investigation of the more abstract or esoteric characteristics of ‘quality’ as a phenomenon.

It should be noted that subsequent semiotic (Shanks and Corbitt, 1999) approaches removed the ‘social’ construct (Price and Shanks, 2004, 2005a) of the 1999 model presented in Table 2.1. The author contends, however, that this social construction of IQ remains an important concept in the context of information retrieval based IQ research.

4.3 *Conceptual framework for measuring IS quality (Dedeke, 2000)*

Dedeke's framework was largely concerned with user perceptions of a system's quality, and identified those perceptions as being derived from the relationship between four IS components, namely:

- 1 interface attributes
- 2 data attributes
- 3 task attributes
- 4 hardware/software attributes.

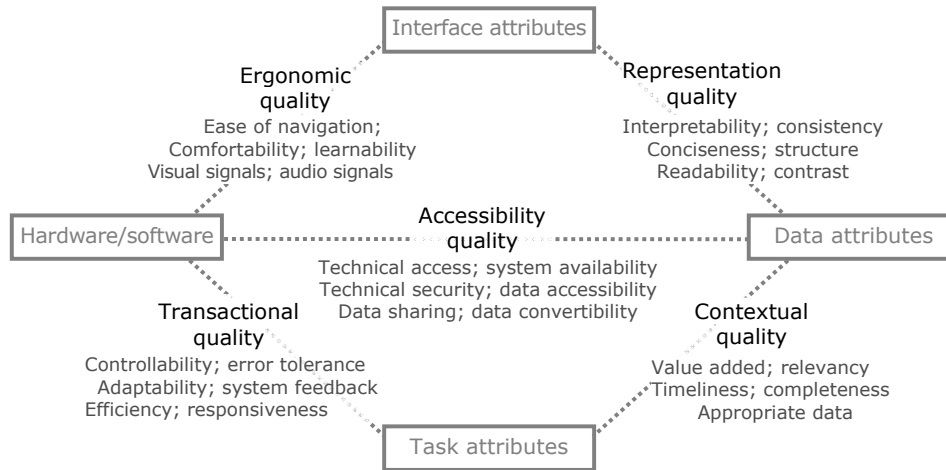
As illustrated in Figure 2, five categories of quality are identified within the relational space between the four named IS components. For example, 'contextual quality' is said to be found between a system's data attributes and a user's task attributes, while 'representational quality' can be found in the interactive space between a system's interface and data attributes.

Interestingly, even though Dedeke's framework was explicitly stated to be associated with systems quality, rather than 'IQ', three of the five named categories align with Wang and Strong's (1996) framework. Dropped from the framework is 'intrinsic quality' and added is:

- 1 transactional quality, said to reside between a system's hardware/software attributes and a user's task
- 2 ergonomic quality, described as being representative of the interactive space between a system's hardware/software and interface attributes.

Within the context of these five relational spaces between the system and data attributes, Dedeke named 28 different quality dimensions (illustrated in Figure 2) engaged by users to make value judgements of the system with which they interact.

The problem with Dedeke's framework is two fold. Firstly, although the model names *data attributes* as being one of a system's component parts, it conceptually cannot fit what Wang and Strong label the 'intrinsic' attributes (i.e., believability; accuracy; objectivity and reputation) of data/information into the overall framework. The only way around this omission is to consider systems quality and IQ as being completely separate entities. This raises the second problem with Dedeke's framework. Users rarely engage an information system for its own sake, but instead do so under the pretext of specific *information* tasks. It is the current researcher's contention, that users are not merely interacting with a system, but that they are interacting cognitively with the information contained within a system. If this is true, then intrinsic qualities such as believability, accuracy, and the like, must be recognised dimensions in any framework developed to investigate users perceptions of information systems quality. While it is agreed that automated systems quality, for example how well the component parts of an android work together, can probably be investigated without intrinsic IQ dimensions, as soon as information (or data) becomes a component of the system, such as in an automated weather station, accuracy and believability type dimensions once again become central to perceptions of the system's quality. In other words, it does not matter how well a system works, if the information it provides contains errors, it is a reasonable expectation that this would have an adverse affect on users' perceptions of the system's quality.

Figure 2 A conceptual framework for IS quality

Source: Dedeké (2000)

4.4 PSP/IQ (becomes AIMQ) (Kahn et al., 2002)

The product service performance/information quality (PSP/IQ) framework conceptualises user perceptions of quality into two contexts:

- 1 product quality
- 2 service quality.

Simply put, product quality is seen as being representative of the tangible attributes of the object which the user wishes to engage that is; *what* the user wants. Service quality, on the other hand, relates to the more intangible attributes of *how* the user acquires the wanted object. Kahn et al. (2002) postulate that when the ‘object’ (or product) is information, user perceptions of IQ are derived from the interplay between these two systems-driven contexts and two user-expectation driven contexts regarding whether the information either

- 1 conforms to specifications
- 2 meets or exceeds user expectations.

Figure 3 illustrates the matrix of relationships between these four constructs, which provide an environment where users then use sixteen IQ dimensions to make value judgements of whether the information is:

- 1 sound
- 2 dependable
- 3 useful
- 4 usable.

For example, information, as a product, is considered to be ‘sound’ if it conforms to specifications, but will be considered ‘useful’ if it meets or exceeds user expectations. Similarly, information, as a service, is considered ‘dependable’ if it conforms to specifications, but will be ‘usable’ if it meets or exceeds user expectations.

Figure 3 Mapping the IQ dimensions into the PSP/IQ model

		Conforms to specifications	Meets or exceeds consumer expectations
<i>Info quality</i>	Product quality	<u>Sound Information</u> - Free-of-error - Concise representation - Completeness - Consistent representation	<u>Useful information</u> - Appropriate amount - Relevancy - Understandability - Interpretability - Objectivity
	Service quality	<u>Dependable information</u> - Timeliness - Security	<u>Usable information</u> - Believability - Accessibility - Ease of manipulation - Reputation - Value-added

The four value judgements derived from the interplay between the contexts are each associated with specific IQ dimensions, engaged by users in their perceptions of IQ. For example, dimensions such as accuracy, conciseness, completeness, or consistency, are engaged by users as they determine whether information is ‘sound’. Alternatively, dimensions such as scope/depth, relevancy, and understandability are engaged to determine whether information is ‘useful’.

A major issue with the Khan et al., (2002) framework relates to the lack of robust conceptual exploration of the highly complex concepts at play. For example, the authors present perceptions of quality in relation to user ‘expectations’, yet the complexity of conceptual models of human behaviour such as ‘expectancy theory’ (Vroom, 1964) are not discussed. As a theory relating to users’ perception of the ‘outcome’ of a specific information behaviour, *expectancy* encompasses understanding complex cognitive relationships between the user and the object, between the user and pre-supposed perceptions of the object; between the user and perceptions of the effectiveness of their own interactive behaviour with the object and between the user and subsequent behaviours. The framework also does not differentiate between ‘meeting’ user expectations and ‘exceeding’ user expectations. These could, in fact, have profoundly different effects on perceptions of IQ. In addition, the event of information *not* meeting expectations is not specifically outlined in the framework. This does not appear to be an issue in that meeting and exceeding expectations are not separated as independent causal variables which can impact user perceptions and behaviour.

The current author contends that user interaction with an information system is essentially an ‘information behaviour’, and so inherits all the complex cognitive aspects of any sound information behaviour investigation. Even though the Khan et al. (2002) framework acknowledges that IQ perceptions are derived in the interplay between both system and information, and is therefore – in an isolated sense – conceptually logical,

without the user-behaviour focus, the concepts have not been pushed to determine their general validity. The result is an indiscriminate framework, with lists of IQ dimensions that could, in fact, fit into multiple areas of the matrix. For example, believability, accessibility and reputation are all described as IQ dimensions impacting whether users perceive information as ‘usable information’, however, all three could just as easily fit into dimension list associated with ‘dependable information’.

4.5 IQ as an evolutionary life-cycle (Liu and Chi, 2002)

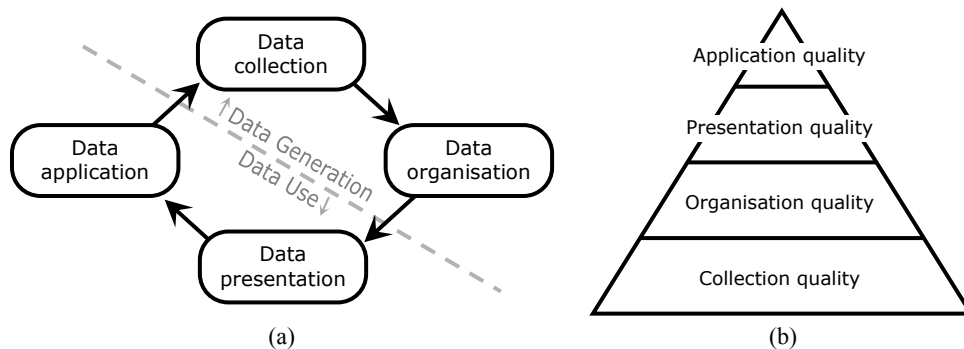
Liu and Chi’s (2002) ‘evolutional data quality’ framework, built largely on a foundation of Wang and Strong’s (1996) four category IQ model, conceptualises the process of user/information interaction into a *cycle* of four user/information interactive points:

- 1 information/data organisation
- 2 information/data presentation
- 3 information/data application
- 4 information/data collection.

As illustrated in Figure 4, Liu and Chi’s (2002) information life-cycle, as a concept, was not new to information systems research (Taylor, 1982; Herson, 1994). It did, however, represent one of the first times the life-cycle was appropriated to help determine a context for the identification of specific IQ dimensions. The evolutionary data quality model proposes that the stages of the life-cycle represent user/data interaction stages that evolve by building on one another. The model conceptualises the four named stages of user/information *interaction* into a cycle that incorporates the separation of IQ into

- 1 information/data *production*
- 2 information/data *use* contexts.

Figure 4 Evolutional data quality model, (a) data evolution life cycle (b) evolutionary data quality

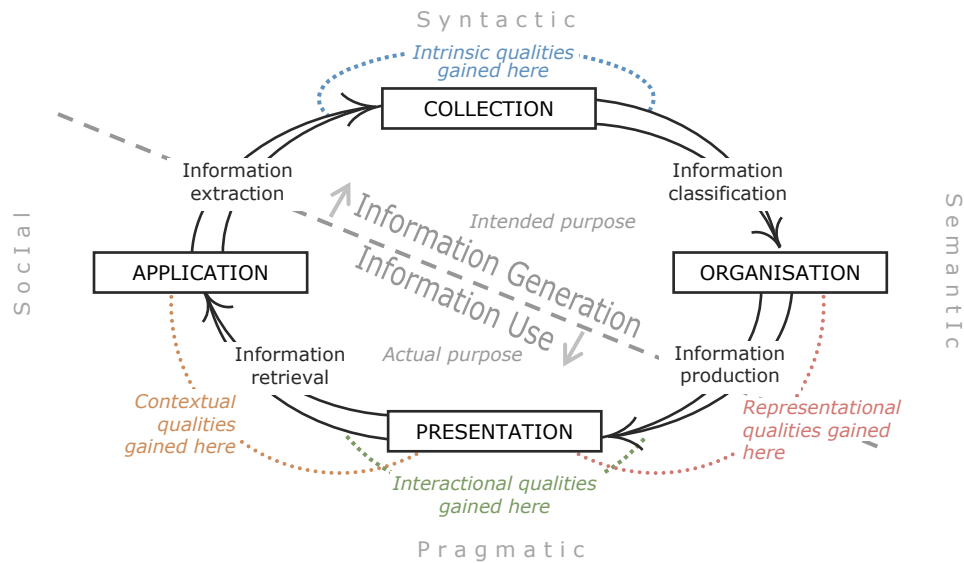


Source: Liu and Chi (2002)

5 A consolidated framework for investigating IQ in information systems

The current paper seeks to develop Liu and Chi's (2002) life-cycle conceptualisation of IQ by looking for synergies between the various conceptual models presented and placing them into a more detailed model which contextualises information interaction into this four-stage life-cycle. The revised model is presented in Figure 5 as a *combined conceptual/life-cycle model of IQ*.

Figure 5 Combined conceptual/life-cycle model of IQ (see online version for colours)



6 IQ as a life-cycle concept

6.1 Information use and information production

The combined conceptual/life-cycle (CC/LC) model of IQ firstly sees the classification of information purpose (called 'generation') and user's retrieval purpose (called 'information use') as useful to any investigation into IQ because it puts into a context, the reason a user should interact with specific information. The model therefore assumes that *the common characteristics, or dimensions, of IQ engaged by users, and their level of critical importance to users' value judgements, will vary depending on whether a researcher is examining data quality perceptions from an information production, or information retrieval perspective.*

6.2 Information interaction

The CC/LC model of IQ demonstrates a level of synergy between the conceptual models previously discussed, but also superimposes a set of user/information 'actions' that take place dependent on the stage of life-cycle information interaction. These actions

are representative of typical user/information interactions that take place during the IQ life-cycle, and include:

- 1 information classification (Palmquist, 1996; Bates, 1989, 2002; Wu et al., 2001)
- 2 information production (Shankaranarayan et al., 2000; Kovac and Weickert, 2002; Scannapieco et al., 2002)
- 3 information retrieval (Spink and Saracevic, 1998; Fidel et al., 2004)
- 4 information extraction (Gaizauskas and Robertson, 1997; Toms, 1997).

It is important to note that the terminologies used here are not exhaustive, but merely represent typical user/information interactions in a continuous process conceptualised in the literature as the information life-cycle. Information *collection*, for example, includes such actions as the gathering, grouping and sorting of data, the latter of which could also be regarded as an action of information *classification*. The IQ life-cycle then, represents a continuum of user/information interaction, and understanding these interactions helps to identify the types of demands, and related IQ value judgements, users might make of the information they encounter.

6.3 Quality perceptions within a life-cycle

Figure 5 presented the CC/LC model of IQ and where in this life-cycle the four broad level categories of IQ named by Wang and Strong (1996) and Wang (1998) are engaged by information users in the process of their IQ value judgements. The over-arching assumption of the CC/LC model is that *IQ dimension importance and the value-judgements made in relation to them is heavily dependant on where in the life-cycle user/information interaction takes place*. This is consistent with Wang and Strong's (1996) contention that IQ, as a construct and a value, is essentially contextually driven.

This contextual approach to investigating user perceptions of IQ is mirrored in virtually all of the IQ frameworks presented in Appendix, where authors first contextualise their investigation into

- 1 broad categories (Wang and Strong, 1996; Katerattanakul and Siau, 1999; Dedeke, 2000; Eppler and Muenzenmayer, 2002)
- 2 assessment classes/types (Naumann and Rolker, 2000; Zhu and Gauch, 2000; Kahn et al, 2002, Liu and Chi, 2002)
- 3 criteria/contexts (Beck, 1997; Harris, 1997; Alexander and Tate, 1999; Shanks and Corbitt, 1999; Sturges and Griffin, 2003; Song and Zahedi, 2006).

The naming of specific IQ dimensions, whether the studies are theoretically or user-data driven, are then described in the context of these higher classification types.

7 IQ as a set of 'dimensions'

Despite the varied research contexts of the IQ frameworks and models presented in Appendix, an analysis of the *constructs* column reveals a remarkable commonality amongst the eventual elements identified by researchers as being important 'dimensions'

of IQ. These include such traditional dimensions as accuracy, consistency, timeliness, completeness, accessibility, objectiveness and relevancy. Table 1 provides a summary of the most common dimensions and the frequency with which they are included in the twenty one IQ frameworks of Appendix. Dimensions are named, and the number of times they appear in Appendix is recorded, followed by a short definition of each dimension.

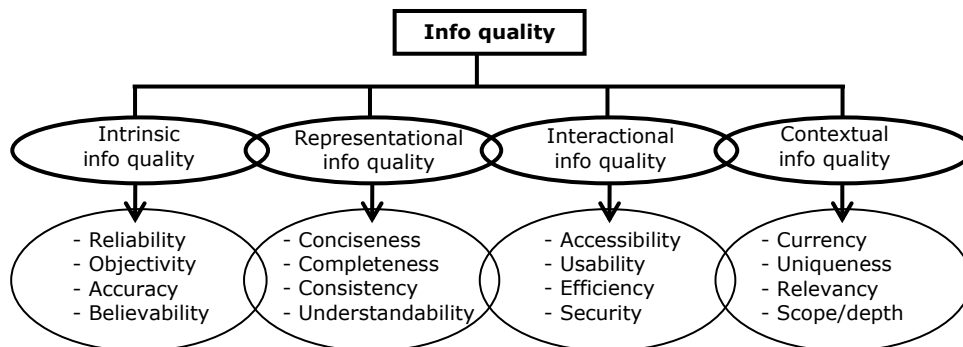
Table 1 The common dimensions of IQ/DQ (1996–2007)

	<i>Dimension</i>	<i># of times</i>	<i>Definitions and relating dimensions</i>
1	Reliability	17	The degree to which information is worthy of being depended on. Is built from other dimensions relating to authority, authorship and reputation.
2	Accuracy	14	The degree to which information is correct, or free from error.
3	Timeliness/currency	14	The degree to which information is up-to-date, relative to the task at hand.
4	Scope/depth	13	The degree to which the amount of information available from a source has the appropriate amount (or coverage) of information required.
5	Relevancy	12	The degree to which information is applicable and helpful for the task at hand. Includes other dimensions such as useful.
6	Accessibility and availability	10	The degree to which information is easily retrievable by information seekers. Refers to both a physical access (i.e., through a network or internet) and cognitive access (i.e., easily read).
7	Usability	9	The degree to which information is can be easily found (i.e., navigated) and easily used.
8	Consistency	8	The degree to which information is presented in an orderly, logical format that is compatible with other information contained within the same place.
9	Objectivity	8	The degree to which information is aware of (i.e., stated), or free from bias.
10	Understandability	9	The degree to which information is capable of being understood or interpreted.
11	Completeness	9	The degree to which all the necessary parts or elements of the required information are present.
12	Security	9	The degree to which information is considered safe because of appropriate restricted access.
13	Value-added	8	The degree to which information delivers benefit by providing unique or distinct material.
14	Concise	6	The degree to which information is expressed in a compact, easy to understand manner.
15	Believability	5	The degree to which information is regarded as true or credible, and therefore capable of being believed.
16	Efficiency	3	The degree to which information is able to quickly meet the 'information needs' of a searcher.

The 16 dimensions identified in Table 1 summarise the common dimensions of IQ identified in much of the information systems IQ literature over the last decade. Figure 6 presents these 16 dimensions in the context of the proposed categories associated with the CC/LC model of IQ.

Conceptually, the model is comparable to Wang and Strong's (1996) in that it conceptualises the IQ dimensions into four IQ categories, with the only difference being the renaming of 'accessibility IQ' to 'interactional IQ', making all four categories adjective named. The overall conceptual landscape of the IQ dimensions associated with each category also differs slightly. Where Wang and Strong named 15 dimensions the current framework names 16 with notably more dimensions associated with the interactional (previously 'accessibility') IQ category.

Figure 6 The categories and dimensions of the CC/LC model of IQ



In addition, the current model is driven to consider the assertion from Bovee et al. (2003) that descriptors such as 'reputation' imply information integrity, rather than provide a quantifiable construct with which to measure actual IQ. Accordingly, the previous intrinsic IQ dimension of *reputation* (Wang and Strong, 1996; Wang, 1998) has been replaced with *reliability*, a measurable construct that facilitates users' value judgements in relation to intrinsic IQ.

The current model also moves the *completeness* dimension out of the contextual IQ category, and into representational IQ. This is considered an important deviation from the original model because, unlike the original model, representational IQ is *not* seen as indicative of the format of information. Instead, representational IQ is the 'content' of the information. It is seen as the *tangible representation of interaction between information-output and information-producer, and the cognitive interaction between information-content and information-receiver*. Finally, the interactional (previously *accessibility*) IQ category includes two additional constructs, usability and efficiency.

8 Discussion: CC/LC model of IQ (categories and dimensions)

In the literature review, IQ was proposed to be an evolving, moving entity, with user interaction taking place throughout the information life-cycle. Value-judgements, therefore, are made at multiple stages of interaction, by both the producers and retrievers of information. The proposed CC/LC model of IQ seeks to contextualise user/information interaction in a way that provides a better investigative framework from which to examine user perceptions of IQ. The specific IQ characteristics, or dimensions, are considered to be clusters of similar types of dimensions, which fall into four broad classifications, namely; intrinsic IQ; representational IQ; interactional IQ and contextual IQ.

8.1 *Intrinsic IQ*

In the context of the CC/CL model of IQ, intrinsic IQ is seen as being determined by the integral characteristics of information. That is, those essential characteristics considered to give information its degree of integrity. The dimensions associated with intrinsic IQ include:

- 1 reliability
- 2 accuracy
- 3 objectivity
- 4 believability.

As a construct, reliability is an IQ dimension built on observable characteristics such as authorship, which implies other IQ attributes such as *authority* and *reputation*. (Keast et al., 2001; Pernici and Scannapieco, 2002). Importantly, reliability denotes the presence of dimensions such as *objectivity*, *accuracy* and *believability*, in that without these characteristics, information would be considered, by the discerning recipient, to be unreliable. All four of these dimensions then, are considered ‘intrinsic’ characteristics of information, and must exist within (considered to be) quality information, regardless of its system context.

Importantly, like the clusters of dimensions associated with each of the four IQ categories: reliability, accuracy, objectivity and believability are seen as being co-dimensions (Michnik and Lo, 2007) of the same construct, in that not only are they often judged using the same information characteristics, but they often imply each other’s presence. For example, believability describes the so called credibility of information, and like reliability, is intrinsically linked with characteristics such as authorship, and co-dimensions like accuracy and objectivity.

8.2 *Representational IQ*

Where dimensions such as reliability, believability, accuracy and objectivity represent the intrinsic nature of information, the dimensions of

- 1 conciseness
- 2 understandability
- 3 completeness
- 4 consistency; represent the ‘*representational*’ characteristics of IQ.

Conceptually, these four dimensions characterise the representation of the actual information, constituting not so much the format (or presentation) of the data – as was proposed in the Wang and Strong (1996) framework, but the actual content contained within the data.

Bovee et al. (2003) contend that characteristics such as completeness and consistency physically represent integrity IQ, the way that previously discussed characteristics such as reliability and believability imply integrity IQ. This is summed up by what the author calls information’s *existence*, in that these types of information characteristics, unlike intrinsic characteristics, require the information to be viewed and examined in order for a value-judgement to be made.

From an information production perspective, the CC/LC contends that the dimensions of conciseness, understandability, completeness and consistency are demonstrative of the *skill* level of the information producer. Moreover, they also engender the information retriever to engage their own skill-set when making value-judgements related to them. Put simply, the user will make representational IQ value-judgements relative to their own cognitive ability and skill.

8.3 Interactional IQ

In the CC/LC model of IQ, interactional characteristics of information are gained at the pragmatic (Shanks and Corbitt, 1999; Price and Shanks, 2005a), or presentation (Liu and Chi, 2002) stage of the IQ life-cycle. The model contends this is where users make value judgements of information according to their technical/interactive experience and skills. Importantly, these value-judgements do not so much relate to the actual content of information, or more specifically a user's cognitive interaction with the content of information. The perceptive IQ value judgements made in regards to

- 1 usability
- 2 accessibility
- 3 efficiency
- 4 security

Relate to the more motor aspects of user/information interaction, and include such characteristics as how easily information can be located or found and retrieved.

With this said, the model also recognises the inter-connectivity of IQ dimensions in general. As a characteristic of information, in the context of interactional IQ, *efficiency* would typically represent the ease with which information can meet a user's information need, and be value-judged according to users being able to quickly find what they are looking for. That is, navigability. It is therefore related to other interactional IQ dimensions such as usability and accessibility. Efficiency also, however, implies other information characteristics such as consistency and conciseness, which are classified as representational IQ dimensions. This brings up an important point about the development and structure of the CC/LC model of IQ. As a framework, the CC/LC has been developed to guide the conceptual classifications of the multi-dimensional phenomenon that is IQ. In conceptualising something of the interactive user/information processes involved with information creation, presentation, seeking, value-judgements, and ultimate retrieval, the model recognises that information production and information use are a continuum, and – although for the sake of clarity there is a definitive structure to the framework, where one section begins and another ends, is, and should be, relatively fluid.

8.4 Contextual IQ

Contextual IQ is made up of such quality dimensions as:

- 1 currency (up-to-date/recency)
- 2 uniqueness (innovativeness)
- 3 relevancy
- 4 scope/depth.

Most often it relates to the actual content of information, and is directly related to the information needs of the information seeker (Toms et al., 2005). Where value-judgements are made of the dimensions associated with representational IQ according to the seekers own information skill, contextual IQ value-judgements are made according to what the seeker is specifically looking for. This direct relationship between contextual IQ dimensions and user information need may account for why the associated dimensions of contextual IQ have become a central focus in systems and Web IQ research, as they are the characteristics which best represent *why* the user is engaging the system.

Recent research into systems, and particularly Web IQ (Eppler and Muenzenmayer, 2002; Sturges and Griffin, 2003; Tombros et al., 2003; Savolainen and Kari, 2006; Song and Zahedi, 2006) have positioned the contextual and interactional IQ related dimensions as central to information seekers' value-judgement processes. This view is mirrored in much of the information seeking behaviour (ISB) and information retrieval (IR) research, where the relevancy dimension is considered of particular importance (Cosijn and Ingwersen, 2000; Dziadosz and Chandrasekar, 2002; Marton, 2003; Vakkari and Sormunen, 2004; Whitmire, 2004; Savolainen and Kari, 2006).

Table 2 Categories and dimensions of IQ, and factors that influence user perceptions

<i>IQ categories</i>	<i>IQ dimensions</i>	<i>General impacting factors*</i>	
		<i>Information producer</i>	<i>Information retriever</i>
Intrinsic IQ	Reliability	Producer's knowledge of the subject	User's knowledge
	Objectivity		
	Accuracy		
	Believability		
Representational IQ	Conciseness	Producer's informatic and/or language skill	User's informatic and/or language skill
	Completeness		
	Consistency		
	Understandability		
Interactional IQ	Accessibility	Producer's motivation to deliver information	User's experiential skill using the system
	Usability		
	Efficiency		
	Security		
Contextual IQ	Currency	Producer's knowledge of their user	User's information need or task
	Uniqueness		
	Relevancy		
	Scope/depth		

Notes: *Impacting factors: the general impact factors are a broad sweep of user characteristics in relation to whether a user is an information producer or information retriever. 'Individual differences' between producers and receivers are seen as further impacting these general characteristics.

Contextual IQ presents the greatest challenge to information producers because currency, relevancy, uniqueness, and scope/depth are highly relative terms. That is; the 'right', or 'right amount' of information or detail depends on contextual elements such as a seeker's individual information need (Bryant, 2000; Prabha et al., 2007), and these are elements that the information producer may have little to no control over. For the information producer then, contextual IQ relies on them knowing their audience, and is an important element of IQ production only if the producer would have the seeker reuse their system (Knight, 2008).

Table 2 presents the 16 dimensions of the CC/LC model of IQ in the context of each of their categories, along with the general impacting factor seen to govern users' IQ decision making and perceptions.

9 Contribution

9.1 Contribution and implications

Wang and Strong (1996) established the now widely accepted paradigm that systems quality, as it relates to data/IQ, is information that is 'fit-for-use/purpose'. This recognises that IQ is determined in the context of specific user/information interactions. The CC/LC of IQ provides a conceptual framework by which the specific contexts of user/information interaction can be established, facilitating a contextual understanding of the various dimensions proposed to be central to IQ.

At the broadest level, the CC/LC model of IQ establishes the two most divergent information contexts as being information-production versus information-retrieval. Establishing this fundamental difference in context is seen as being central to any investigation of user IQ perceptions (Strong et al., 1997a, 1997b; Tayi and Ballou, 1998). This is because, while the individual IQ categories and dimensions remain the same, how the user engages these elements can vary sharply, depending on whether they are the producer or retriever of the system's information. For example, how users engage their perceptions relating to the issue of copyright, seen as being part of the *security* IQ dimension, could be quite different depending on whether they were producing or trying to retrieve material. Pay-for-view, another element of security IQ, would also find producers and retrievers on opposite ends of the security spectrum.

The CC/LC model of IQ provides for researchers, a framework by which to engage users and information system in a contextual, and therefore meaningful way. It does this by:

- 1 separating information production and information retrieval into separate information contexts, thereby allowing the researcher to develop an understanding of how these two distinct groups of users might engage individual dimensions of IQ
- 2 placing the IQ categories and dimensions into a user/information interaction life-cycle, thereby allowing the researcher to conceptualise and empirically test the types of value-judgements users might actually make at specific points of user/information interaction.

10 Conclusions and future research

The CC/LC model of IQ was developed for, and has been empirically tested in, the research project '*User Perceptions of Information Quality in World Wide Web Information Retrieval Behaviour*' (Knight, 2008), which used the framework to investigate the IQ perceptions of 80 'high end' academic users who frequently engage the web for the retrieval of high quality information. The current paper presents the theory and concepts associated with the model, which were used to develop a 44 question survey examining users' perceptions of IQ when interacting with information on the web.

'Part 2' of the current research is presented in the follow-up paper '*The Combined Conceptual Life-Cycle Model of Information Quality: Part 2, Investigating User Perceptions of Web IQ*', which presents the user results associated with the research project. User results are examined in the context of the four IQ categories and the 16 dimensions associated with the CC/LC model of IQ framework.

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References

- Aladwani, A.M. and Palvia, P.C. (2002) 'Developing and validating an instrument for measuring user-perceived web quality', *Information & Management*, Vol. 39, No. 6, pp.467–476.
- Alexander, J.E. and Tate, M.A. (1999) *Web Wisdom: How to Evaluate and Create Information Quality on the Web*, Erlbaum, Mahwah, NJ.
- Ballou, D.P., Wang, R., Pazer, H.L. and Tayi, G.K. (1998) 'Modelling information manufacturing systems to determine information product quality', *Management Science*, Vol. 44, No. 4.
- Bates, M.J. (1989) 'The design of browsing and berrypicking techniques for the on-line search interface', *On-line Review*, Vol. 13, No. 5, pp.407–431.
- Bates, M.J. (2002) 'The cascade of interactions in the digital library interface', *Information Processing and Management*, Vol. 38, pp.381–400.
- Beck, S. (1997) *Evaluation Criteria: The Good, The Bad & The Ugly; or Why It's A Good Idea To Evaluate Web Sources*, available at <http://www.lib.nmsu.edu/instruction/evalcrit.html>.
- Bovee, M., Srivastava, R.P. and Mak, B. (2003) 'A conceptual framework and belief-function approach to assessing overall information quality', *International Journal of Intelligent Systems*, Vol. 18, No. 1, pp.51–74.
- Brooks, T.A. (2003) 'Web search: how the web has changed information retrieval', *Information Research*, Vol. 8, No. 3.
- Bryant, S.L. (2000) 'The information needs and information seeking behaviour of family doctors: a selective literature review', *Health Libraries Review*, Vol. 17, No. 2, pp.83–90.
- Budd, J.M. (2005) 'Phenomenology and information studies', *Journal of Documentation*, Vol. 61, No. 1, pp.44–59.

- Chang, I.C., Li, Y.-C., Hung, W.-F. and Hwang, H.-G. (2005) 'An empirical study on the impact of quality antecedents on tax payers' acceptance of internet tax-filing systems', *Government Information Quarterly*, Vol. 22, No. 3, pp.389–410.
- Chang, S.-J. and Lee, Y. (2001) 'Conceptualizing context and its relationship to the information behaviour in dissertation research process', *New Review of Information Behaviour Research*, Vol. 2, pp.29–46.
- Chung, W.Y., Fisher, C. and Wang, R. (2002) 'What skills matter in data quality', *Proc. of the 7th International Conference on Information Quality, (MIT IQ Conference)*, pp.331–342.
- Cosijn, E. and Ingwersen, P. (2000) 'Dimensions of relevance', *Information Processing & Management*, Vol. 36, No. 4, pp.533–550.
- Croft, D.R. and Peterson, M.W. (2002) 'An evaluation of the quality and contents of asthma education on the World Wide Web', *Chest [NLM - MEDLINE]*, Vol. 121, No. 4, p.1301.
- Dedeke, A. (2000) 'A conceptual framework for developing quality measures for information systems', *Proc. of 5th International Conference on Information Quality*, pp.126–128.
- Dziadosz, S. and Chandrasekar, R. (2002) 'Do thumbnail previews help users make better relevance decisions about web search results?', *Proc. of the 25th Annual International ACM SIGIR Conference on Research and Development in information retrieval*, Tampere, Finland, pp.365–366.
- Eppler, M.J. and Wittig, D. (2000) 'Conceptualizing information quality: a review of information quality frameworks from the last ten years', *Proc. of 5th International Conference on Information Quality*, pp.83–96.
- Eppler, M. and Muenzenmayer, P. (2002) 'Measuring information quality in the web context: a survey of state-of-the-art instruments and an application methodology', *Proc. of 7th International Conference on Information Quality*, pp.187–196.
- Even, A. and Shankaranarayan, G. (2005) 'Value-driven data quality assessment', *Proc. of 10th International Conference on Information Quality*.
- Fidel, R., Pejtersen, A.M., Cleal, B. and Bruce, H. (2004) 'A multidimensional approach to the study of human-information interaction: a case study of collaborative information retrieval', *Journal of the American Society for Information Science & Technology*, Vol. 55, No. 11, pp.939–953.
- Forslund, H. (2007) 'Measuring information quality in the order fulfilment process', *International Journal of Quality & Reliability Management*, Vol. 24, No. 5, pp.515–524.
- Gaizauskas, R. and Robertson, A. (1997) 'Coupling information retrieval & information extraction: a new text technology for gathering information from the web', *Proc. of RIAO 97: Computer-Assisted Information Searching on the Internet*, Montreal, Canada, pp.356–370.
- Gendron, M., Shanks, G. and Alampi, J. (2004) 'Next steps in understanding information quality and its effect on decision making and organizational effectiveness', *Proc. of DSS 2004 Conference*, pp.283–294.
- Goulding, C. (2005) 'Grounded theory, ethnography and phenomenology: a comparative analysis of three qualitative strategies for marketing research', *European Journal of Marketing*, Vol. 39, Nos. 3–4, pp.294–308.
- Harris, R. (1997) *Evaluating Internet Research Sources*. *Virtual Salt*, available at <http://www.virtualsalt.com/evalu8it.htm> (accessed on February 2005).
- Hawkins, D.T. (1999) 'What is credible information?', *ONLINE Magazine*, Vol. 23, No. 5, pp.86–89.
- Heron, P. (1994) 'Information life cycle: its place in the management of US Government information resources', *Government Information Quarterly*, Vol. 11, No. 2, pp.143–170.

- Kahn, B.K., Strong, D.M. and Wang, R.Y. (2002) 'Information quality benchmarks: product and service performance', *Communications of the ACM*, Vol. 45, No. 4, pp.184–192.
- Katerattanakul, P. and Siau, K. (1999) 'Measuring information quality of web sites: development of an instrument', *Proc. of the 20th International Conference on Information Systems (ICIS'99)*, Charlotte, North Carolina, USA, pp.279–285.
- Keast, G., Toms, E.G. and Cherry, J. (2001) 'Measuring the reputation of web sites: a preliminary exploration', *Joint Conference on Digital Libraries (JCDL'01)*, 24–28 June 2001, Roanoke, Virginia, USA, pp.77–78.
- Klein, B.D. (2001) 'User perceptions of data quality: internet and traditional text sources', *Journal of Computer Information Systems*, Vol. 41, No. 4, pp.9–18.
- Klein, B.D. (2002a) 'When do users detect information quality problems on the World Wide Web?', *8th Americas Conference on Information Systems*, pp.1101–1103.
- Klein, B.D. (2002b) 'Internet data quality: perceptions of graduate and undergraduate business students', *Journal of Business and Management*, Vol. 8, No. 3.
- Knight, S.A. and Burn, J.M. (2005) 'Developing a framework for assessing information quality on the World Wide Web.', *Informing Science*, Vol. 8, pp.159–172.
- Knight, S.A. (2008) *User Perceptions of Information Quality in World Wide Web Information Retrieval Behaviour*, Doctoral dissertation, School of MIS, Edith Cowan University.
- Kopcsó, D., Pipino, L. and Rybolt, W. (2001) 'Factors affecting the assessment of web site quality', *Proc of 9th European Conference on Information Systems Bled*, Slovenia, 27–29 June, Global Co-operation in the New Millennium.
- Kovac, R. and Weickert, C. (2002) 'Starting with quality: using TDQM in a start-up organization', *Proc. of the 7th International Conference on Information Quality, MIT IQ Conference*, pp.69–78.
- Lee, Y.W., Strong, D.M., Kahn, B.K. and Wang, R.Y. (2002) 'AIMQ: a methodology for information quality assessment', *Information & Management*, Vol. 40, No. 2, p.133.
- Lee, Y., Kozar, K.A. and Larsen, K.R.T. (2003) 'The technology acceptance model: past, present, and future', *Communications of the AIS*, Vol. 12, No. 50.
- Leung, H.K.N. (2001) 'Quality metrics for intranet applications', *Information & Management*, Vol. 38, No. 3, pp.137–152.
- Li, S. and Lin, B. (2006) 'Assessing information sharing and information quality in supply chain management', *Decision Support Systems*, Vol. 42, No. 3, pp.1641–1656.
- Liu, L. and Chi, L. (2002) 'Evolutional data quality: a theory-specific view', *Proc. of the 7th International Conference on Information Quality, (MIT IQ Conference)*, pp.292–304.
- Marton, C. (2003) 'Quality of health information on the web: user perceptions of relevance and reliability', *New Review of Information Behaviour Research*, Vol. 4, No. 1, pp.195–206.
- Michnik, J. and Lo, M-C. (2007) 'The assessment of the information quality with the aid of multiple criteria analysis', *European Journal of Operational Research*, article in press, corrected proof, November 2007.
- Moraga, Á., Calero, C. and Piattini, M. (2006) 'Comparing different quality models for portals', *Online Information Review*, Vol. 30, No. 5, pp.555–568.
- Naumann, F. and Rolker, C. (2000) 'Assessment methods for information quality criteria', *Proc. of 5th International Conference on Information Quality*, pp.148–162.
- Neely, M.P. (2005) 'The product approach to data quality and fitness for use: a framework for analysis', *Proc. of 10th International Conference on Information Quality*.
- Neus, A. (2003) 'Evolving knowledge: empowering information users', *Proc. of the 8th International Conference on Information Quality*, pp.41–50.
- Palmquist, R.A. (1996) 'The search for an internet metaphor: a comparison of literatures', *American Society of Information Science Conference*.
- Pernici, B. and Scannapieco, M. (2002) 'Data quality in web information systems', *Proc. of ER-2002, 21st International Conference on Conceptual Modeling*, Tampere, Finland.

- Prabha, C., Connaway, L.S., Olszewski, L. and Jenkins, L.R. (2007) 'What is enough? Satisficing information needs', *Journal of Documentation*, Vol. 63, No. 1, pp.74–89.
- Price, R. and Shanks, G. (2004) 'A semiotic information quality framework', *Proc. IFIP International Conference on Decision Support Systems (DSS2004): Decision Support in an Uncertain and Complex World*, Prato, July.
- Price, R. and Shanks, G. (2005a) 'A semiotic information quality framework: development and comparative analysis', *Journal of Information Technology*, Vol. 20, pp.88–102.
- Rieh, S.Y. (2000) 'Information quality and cognitive authority in the World Wide Web', in Belkin, N.J. (Advisor): *Dissertation Research at Rutgers University School of Communication, Information, and Library Studies*.
- Savolainen, R. and Kari, J. (2006) 'User-defined relevance criteria in web searching', *Journal of Documentation*, Vol. 62, No. 6, pp.685–707.
- Scannapieco, M., Pernici, B. and Pierce, E. (2002) 'IP-UML: towards a methodology for quality improvement based on the IP-MAP framework', *Proc of the 7th International Conference on Information Quality (ICIQ-02)*.
- Schamber, L., Eisenberg, M. and Nilan, M. (1990) 'A re-examination of relevance: toward a dynamic, situational definition', *Information Processing & Management*, Vol. 26, No. 6, pp.755–776.
- Shankar, G. and Watts, S. (2003) 'A relevant, believable approach for data quality assessment', *Proc. of 8th International Conference on Information Quality*, pp.178–189.
- Shankaranarayanan, G., Wang, R.Y. and Ziad, M. (2000) 'Modeling the manufacture of an information product with IPMAP', *Proceedings of Conference on Information Quality*, Massachusetts Institute of Technology, pp.1–16.
- Shanks, G. and Corbitt, B. (1999) 'Understanding data quality: social and cultural aspects', *Proc. 10th Australasian Conference on Information Systems*, pp.785–797.
- Smith, A.G. (1997) 'Testing the surf: criteria for evaluating internet information resources', *The Public-Access Computer Systems Review*, Vol. 8, No. 3, available at <http://info.lib.uh.edu/pr/v8/n3/smit8n3.html>.
- Song, J. and Zahedi, F.M. (2006) 'Trust in health infomediaries', *Decision Support Systems*, Vol. 43, No. 2, pp.390–407.
- Spink, A. and Saracevic, T. (1998) 'Human-computer interaction in information retrieval: nature and manifestations of feedback', *Interacting with Computers*, Vol. 10, No. 3, pp.249–267.
- Strong, D.M., Lee, Y.W. and Wang, R.Y. (1997a) 'Data quality in context', *Communications of the ACM*, Vol. 40, No. 5, pp.103–110.
- Strong, D., Lee, Y. and Wang, R. (1997b) '10 potholes in the road to information quality', *IEEE Computer*, Vol. 30, No. 8, pp.38–46.
- Sturges, P. and Griffin, A. (2003) 'The archaeologist undeceived: selecting quality archaeological information from the internet', *Informing Science Journal*, Vol. 6, pp.221–232.
- Stvilia, B., Twidale, M.B., Smith, L.C. and Gasser, L. (2005) 'Assessing information quality of a community-based encyclopedia', *10th International Conference on Information Quality*.
- Tayi, G.K. and Ballou, D.P. (1998) 'Examining data quality', *Communications of the ACM*, Vol. 41, No. 2, pp.54–57.
- Taylor, R.S. (1982) 'Value-added processes in the information life cycle', *Journal of the American Society for Information Science*, Vol. 33, No. 5, pp.341–346.
- Tombros, A., Ruthven, I. and Jose, J.M. (2003) 'Searchers' criteria for assessing web pages', *Proc. 26th Annual International ACM SIGIR Conference on Research and Development in Information Retrieval*, Toronto, Canada, 28 July–01 Aug 2003, pp.385–386.
- Toms, E.G. (1997) 'Information interaction: providing a framework for information architecture', *Journal of the American Society for Information Science & Technology*, Vol. 53, No. 10, pp.855–862.

- Toms, E.G., O'Brien, H.L., Kopak, R. and Freund, L. (2005) 'Searching for relevance in the relevance of search, in Crestani, F. and Ruthven, I. (Eds.): *CoLIS 2005, LNCS 3507*, pp.59–78.
- Vakkari, P. and Sormunen, E. (2004) 'The influence of relevance levels on the effectiveness of interactive information retrieval', *Journal of the American Society for Information Science & Technology*, Vol. 55, No. 11, pp.963–969.
- Varlander, S. (2007) 'Online information quality in experiential consumption: an exploratory study', *Journal of Retailing and Consumer Services*, Vol. 14, No. 5, pp.328–338.
- Vroom, V.H. (1964) *Work and Motivation*, Wiley, New York.
- Wang, R.Y. and Strong, D.M. (1996) 'Beyond accuracy: what data quality means to data consumers', *Journal of Management Information Systems*, Vol. 12, No. 4, pp.5–34.
- Wang, R.Y. (1998) 'A product perspective on total quality management', *Communications of the ACM*, Vol. 41, No. 2, p.58.
- Whitmire, E. (2004) 'The relationship between undergraduates' epistemological beliefs, reflective judgment, and their information-seeking behavior', *Information Processing & Management*, Vol. 40, No. 1, pp.97–111.
- Wilson, T. (1999) 'Exploring models of information behaviour: the 'uncertainty' project', *Information Processing & Management*, Vol. 35, No. 6, pp.839–849.
- Wu, M., Fuller, M. and Wilkinson, R. (2001) 'Using clustering and classification approaches in interactive retrieval', *Information Processing & Management*, Vol. 37, No. 3, pp.459–484.
- Zeist, R.H.J. and Hendriks, P.R.H. (1996) 'Specifying software quality with the extended ISO model', *Software Quality Management IV – Improving Quality*, pp.145–160.
- Zhu, X. and Gauch, S. (2000) 'Incorporating quality metrics in centralized/distributed information retrieval on the World Wide Web', *Proc. 23rd Annual International ACM SIGIR Conference on Research and Development in Information Retrieval*, Athens, Greece, pp.288–295.

Appendix

Comparison of information quality frameworks (1996–2007) (see online version for colours)

Yr	Author	Model	Constructs
1	(Wang and Strong, 1996)	A conceptual framework for data quality Summary: » 4 Categories » 16 Dimensions	Category Intrinsic IQ Accuracy, objectivity, believability, reputation Accessibility IQ Accessibility, security Contextual IQ Relevancy, value-added, timeliness, completeness, amount of info Representational IQ Interpretability, ease of understanding, concise representation, consistent representation
9			Dimensions
9			Characteristics
6			Sub-characteristics
	(Zeist and Hendriks, 1996)	Extended ISO Model Summary: » 6 Quality characteristics » 32 Sub-characteristics	Functionality Suitability, accuracy, interoperability, compliance, security, traceability Reliability Maturity, recoverability, availability, degradability, fault tolerance Efficiency Time behaviour, resource behaviour Usability Understandability, learnability, operability, luxury, clarity, helpfulness, explicitness, customisability, user-friendliness Maintainability Analysability, changeability, stability, testability, manageability, reusability Portability Adaptability, conformance, replaceability, installability
1	(Beck, 1997)	Evaluation criteria for web information sources Summary: » 5 Criteria	Criteria Accuracy Reliable, error-free, verified Authority Attributed authorship, publisher - info origin Objectivity Free of bias, purpose of the web page Currency Last update, working hyperlinks Coverage Topics, depth of material, uniqueness of material
9			Dimensions
9			Criteria
	(Harris, 1997)	User-focused checklist (CARS) to help researchers look for clues regarding website information quality Summary: » 4 Contexts » At least 16 dimensions	CARS (context) Credibility Trustworthy source, author's credentials, evidence of quality control, known or respected authority, organizational support. Accuracy Up to date, factual, detailed, exact, comprehensive, audience and purpose reflect intentions of completeness and accuracy Reasonableness Fair, balanced, objective, reasoned, no conflict of interest, absence of fallacies or slanted tone Support Listed sources, contact information, available corroboration, claims supported, documentation supplied
1	(Alexander and Tate, 1999)	Applying a quality framework to web environment Summary: » 6 Criteria	Dimensions Authority Validated information, author is visible Accuracy Reliable, free of errors Objectivity Presented without personal biases Currency Content up-to-date Orientation Clear target audience Navigation Intuitive design
9			Criteria
9			Category
	(Katerattanakul and Siau, 1999)	IQ of individual website Summary: » 4 Quality categories (adapted from Wang and Strong)	Dimension Intrinsic IQ Accuracy and errors of the content Accurate, workable, and relevant hyperlinks Contextual IQ Provision of author's information Representational IQ Organisation, Visual settings, Typographical features, consistency, Vividness / attractiveness Accessibility IQ Navigational tools provided

Comparison of information quality frameworks (1996–2007) (continued)
(see online version for colours)

Yr	Author	Model	Constructs															
1999	(Shanks and Corbitt, 1999)	Semiotic-based framework for data quality Summary: » 4 Semiotic descriptions » 4 Goals of IQ » 11 Dimensions	<table border="1"> <thead> <tr> <th>Semiotic Level</th> <th>Goal</th> <th>Dimension</th> </tr> </thead> <tbody> <tr> <td>Syntactic</td> <td>Consistent</td> <td>Well-defined/formal syntax</td> </tr> <tr> <td>Semantic</td> <td>Complete and Accurate</td> <td>Comprehensive, unambiguous, meaningful, correct</td> </tr> <tr> <td>Pragmatic</td> <td>Usable and Useful</td> <td>Timely, concise, easily accessed, reputable</td> </tr> <tr> <td>Social</td> <td>Shared understanding of meaning</td> <td>Understood, awareness of bias</td> </tr> </tbody> </table>	Semiotic Level	Goal	Dimension	Syntactic	Consistent	Well-defined/formal syntax	Semantic	Complete and Accurate	Comprehensive, unambiguous, meaningful, correct	Pragmatic	Usable and Useful	Timely, concise, easily accessed, reputable	Social	Shared understanding of meaning	Understood, awareness of bias
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2000	(Dedeke, 2000)	Conceptual framework for measuring IS quality Summary: » 5 Quality categories, » 28 dimensions	<table border="1"> <thead> <tr> <th>Quality category</th> <th>Dimensions</th> </tr> </thead> <tbody> <tr> <td>Ergonomic quality</td> <td>Ease of navigation, conformability, learnability, visual signals, audio signals</td> </tr> <tr> <td>Accessibility quality</td> <td>Technical access, system availability, technical security, data accessibility, data sharing, data convertibility</td> </tr> <tr> <td>Transactional quality</td> <td>Controlability, error tolerance, adaptability, system feedback, efficiency, responsiveness</td> </tr> <tr> <td>Contextual quality</td> <td>Value added, relevancy, timeliness, completeness, appropriate data</td> </tr> <tr> <td>Representation quality</td> <td>Interpretability, consistency, conciseness, structure, readability, contrast</td> </tr> </tbody> </table>	Quality category	Dimensions	Ergonomic quality	Ease of navigation, conformability, learnability, visual signals, audio signals	Accessibility quality	Technical access, system availability, technical security, data accessibility, data sharing, data convertibility	Transactional quality	Controlability, error tolerance, adaptability, system feedback, efficiency, responsiveness	Contextual quality	Value added, relevancy, timeliness, completeness, appropriate data	Representation quality	Interpretability, consistency, conciseness, structure, readability, contrast			
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2000	(Naumann and Rolker, 2000)	Classification of IQ metadata criteria Summary: » 3 Assessment classes » 22 IQ criterion	<table border="1"> <thead> <tr> <th>Assessment class</th> <th>IQ criterion</th> </tr> </thead> <tbody> <tr> <td>Subject criteria</td> <td>Believability, concise representation, interpretability, relevancy, reputation, understandability, value-added</td> </tr> <tr> <td>Object criteria</td> <td>Completeness, customer support, documentation, objectivity, price, reliability, security, timeliness, verifiability</td> </tr> <tr> <td>Process criteria</td> <td>Accuracy, amount of data, availability, consistent representation, latency, response time</td> </tr> </tbody> </table>	Assessment class	IQ criterion	Subject criteria	Believability, concise representation, interpretability, relevancy, reputation, understandability, value-added	Object criteria	Completeness, customer support, documentation, objectivity, price, reliability, security, timeliness, verifiability	Process criteria	Accuracy, amount of data, availability, consistent representation, latency, response time							
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Subject criteria	Believability, concise representation, interpretability, relevancy, reputation, understandability, value-added																	
Object criteria	Completeness, customer support, documentation, objectivity, price, reliability, security, timeliness, verifiability																	
Process criteria	Accuracy, amount of data, availability, consistent representation, latency, response time																	
2000	(Zhu and Gauch, 2000)	Quality metrics for information retrieval on the WWW Summary: » 6 Quality metrics	<table border="1"> <thead> <tr> <th>Assessment Class</th> <th>IQ Criterion</th> </tr> </thead> <tbody> <tr> <td>Currency</td> <td>Measured as the time stamp of the last modification of the document.</td> </tr> <tr> <td>Availability</td> <td>Calculated as the number of broken links on a page divided by the total numbers of links it contains.</td> </tr> <tr> <td>Information-to-noise ratio</td> <td>Computed as the total length of the tokens after pre-processing divided by the size of the document:</td> </tr> <tr> <td>Authority</td> <td>Based on the Yahoo.Internet Life (YIL) reviews [27], which assigns a score ranging from 2 to 4 to a reviewed site.</td> </tr> <tr> <td>Popularity</td> <td>Number of links pointing to a web page, used to measure the popularity of the web page</td> </tr> <tr> <td>Cohesiveness</td> <td>Determined by how closely related the major topics in the web page are</td> </tr> </tbody> </table>	Assessment Class	IQ Criterion	Currency	Measured as the time stamp of the last modification of the document.	Availability	Calculated as the number of broken links on a page divided by the total numbers of links it contains.	Information-to-noise ratio	Computed as the total length of the tokens after pre-processing divided by the size of the document:	Authority	Based on the Yahoo.Internet Life (YIL) reviews [27], which assigns a score ranging from 2 to 4 to a reviewed site.	Popularity	Number of links pointing to a web page, used to measure the popularity of the web page	Cohesiveness	Determined by how closely related the major topics in the web page are	
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Comparison of information quality frameworks (1996–2007) (continued)
(see online version for colours)

Yr	Author	Model	Constructs	Characteristics	Sub-characteristic
2001	(Leung, 2001)	Adapted extended ISO model for intranets Summary: » Adaptation of Zeist & Hendriks extended ISO model, applied to intranet environments » The grey, italic sub-characteristics are not considered needed to achieve IQ	Functionality Reliability Usability Efficiency Maintainability Portability	Suitability, accuracy, interoperability, compliance, security, traceability Maturity, fault tolerance, recoverability, availability, degradability Understandability, learnability, operability, luxury, clarity, helpfulness, explicitness, user-friendliness, customisability Time behaviour, resource behaviour Analysability, changeability, stability, testability manageability, reusability Adaptability, installability, replaceability, conformance	
2002	(Kahn et al., 2002)	Mapping IQ dimension into the PSP/IQ model Summary: » 2 Quality types, » 4 IQ classifications, » 16 IQ dimensions	Product quality Service quality	Sound information Useful information Dependable information Useable information	Free-of-error, concise, representation, completeness, consistent representation Appropriate amount, relevancy, understandability, interpretability, objectivity Timeliness, security Believability, accessibility, ease of manipulation, reputation, value-added
	(Liu and Chi, 2002)	Evolutional data quality	Collection quality Organisation quality Presentation quality Application quality	Accuracy, objectivity, trustworthiness, completeness, clarity Reliability, consistency, storage efficiency, retrieval efficiency, navigability Semantic stability, faithfulness, neutrality, interpretability, formality Ease of manipulation, timeliness, privacy, security, relevancy, appropriate amount of data	
	(Eppler and Muenzenmayer, 2002)	Conceptual framework for IQ in the website context Summary: » 2 Manifestations, » 4 Quality categories, » 16 Quality dimensions	Content quality Media quality	Relevant information Sound information Optimised process Reliable infrastructure	Comprehensive, accurate, clear, applicable Concise, consistent, correct, current Convenient, timely, traceable, interactive Accessible, secure, maintainable, fast
	(Klein, 2002a)	5 IQ Dimensions (Chosen from Wang and Strong's 15 dimensions)	Accuracy Completeness Relevance Timeliness Amount of Data	Discrepancy, timeliness, source/author, bias/intentionally false information Lack of depth, technical problems, missing desired information, incomplete when compared with other sites, lack of breadth Irrelevant hits when searching, bias, too broad, purpose of web site Information is not current, technical problems, publication date is unknown Too much information, too little information, information unavailable	

Comparison of information quality frameworks (1996–2007) (continued)
(see online version for colours)

Yr	Author	Model	Constructs
2003	(Shankar and Watts, 2003)	Theoretical model for data quality assessment.	<p>IQ dimensions</p> <p>Preliminary factors</p> <p>Object Accuracy, completeness, timeliness</p> <p>User Believability, relevance</p> <p>Criteria</p> <p>Explanation</p> <p>Scope Subject breadth - comprehensiveness</p> <p>Subject depth - appropriate level to audience</p> <p>Purpose/audience Consistency, appropriateness</p> <p>content Accuracy, authority, copyright, currency, uniqueness, links, quality, and overall quality</p> <p>Graphic & media design Attractive, well organised, good quality illustrations, navigational aids</p> <p>Workability User friendliness, computer environment, searching, browsability and organisation, interactivity, connectivity</p>
2004	(Tombros et al., 2003)	Tool for archaeological website quality assessment. Summary: » Five contexts » 14 'named' dimensions (up to 10-15 more implied) (much borrowed from Grady (1997))	<p>Web feature</p> <p>Text-Structure</p> <p>Quality</p> <p>Non-textual</p> <p>Physical Properties</p> <p>Metric/Criterion</p> <p>Content, numbers, titles/headings, query terms, text quantity</p> <p>Layout, links, links quality, table layout</p> <p>Scope/depth, authority/source, recency, general quality, content</p> <p>Pictures</p> <p>Page not found, page location, page already seen, others</p> <p>Metrics</p> <p>Authority/reputation By the "authors" of the material</p> <p>Completeness By broken hypertext links within articles</p> <p>Complexity By the readability of the content</p> <p>Informative by diversity of content</p> <p>Consistency By number of non-unique authors</p> <p>Currency By how current (up-to-date) content is</p> <p>Volatility By time taken to fix erroneous content</p> <p>Security, believability</p> <p>Related dimensions</p> <p>Reliability</p> <p>Understandability</p> <p>Value-added</p>
2005	(Stvilia et al., 2005)	Application of 7 known IQ metrics to automated system (evaluation) tool, to measure IQ of Wikipedia content	<p>Construct</p> <p>Adequacy Completeness, coverage (scope), and level (has information)</p> <p>Relevance Information to individual user</p> <p>Usefulness (Overall) perceived usefulness of information [TAM of info not system]</p> <p>Reliability Accuracy and credibility</p> <p>Understandability Clarity and ease of comprehension - i.e., accessibility of health jargon [TAM of info, not system]</p> <p>Author's description</p> <p>Completeness, coverage, scope/depth</p> <p>Applicability</p> <p>Accessibility and availability</p> <p>Accuracy, credibility</p> <p>Understandability</p> <p>Related Dimensions</p> <p>Completeness, coverage, scope/depth</p> <p>Applicability</p> <p>Accessibility and availability</p> <p>Accuracy, credibility</p> <p>Understandability</p> <p>Ease of Use [TAM] ease of (system) navigation</p> <p>Interactivity Benevolence and personalisability</p> <p>Value-added, ownership</p> <p>HT's Trust signs Policies and security, disclosures and ownership</p>
2007	(Varlander 2007)	Role of quality dimensions in user experiential consumption.	<p>Dimension</p> <p>Role of dimension in experiential consumption</p> <p>Descriptive The provision of 'hard facts'. E.g. the beach is within 50 m, the room is 20m2, the hotel has 3 stars, etc.</p> <p>Emotive Subjective expression of views. The provision of 'soft facts' and personal experiences.</p> <p>Imperative Support in decision-making, provision of alternatives or help and advice in choosing the best alternative.</p> <p>Social The social side of information. Serves the purpose of creating a relationship between consumer and sales representative and is important for creating trust and pleasure in consumption.</p> <p>Meta-linguistic Double-checking the understanding of the information. 'Is my booking correct?' 'Is the information on the Internet correct?' 'negotiate and agree upon the meaning of information.'</p> <p>Decodable The consumers' mastery of the medium. Internet readiness. Website design.</p>