The Combined Conceptual Life-Cycle Model of Information Quality: Part 1, An Investigative Framework

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.

Introduction

Information Quality (IQ) is a complex, multi-dimensional construct (Ballou *et al*., 1998; Klein, 2001; Aladwani *et al*., 2002; Lee *et al*., 2003a; Gendron *et al*., 2004), 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 & 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 context of the research is 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 firstly establish the common elements of user perceptions of information quality. It then proposes a conceptual framework by which researchers can develop context specific investigations into IQ as a user-perception driven phenomenon.

What is "Information Quality"?

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 & 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 & Shankaranarayanan, 2005; Neely, 2005; Song & Zahedi, 2006). The great value in assigning a context to IQ is that it:

1.) Enables researchers to conceptualise the processes involved in any user/information interaction processes (Wang & Strong, 1996; Shanks & Corbitt, 1999; Dedeke, 2000; Eppler & Wittig, 2000; Kahn *et al.*, 2002; Eppler & Muenzenmayer, 2002; Moraga *et al.*, 2006);
2.) Facilitates the process of associating characteristics (called "dimensions") with the information, which can be used as value-judgment criteria (Kahn *et al.*, 2002; Pernici & Scannapieco, 2002; Chang *et al.*, 2005);
3.) Helps researchers to better understand what criteria users may employ in their value-judgements of information (Chung *et al.*, 2002; Li & Lin, 2006; Knight 2007)

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 as high quality, may not possess sufficient attributes for another use (Tayi & Ballou, 1998). Secondly, it conceptualises the user *action* of user/information interaction and value-judgement 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 information quality an investigative *context* (Strong *et al.*, 1997a & 1997b) in that it implies information quality cannot be defined and assessed outside of the reason for which it exists.

Shanks & Corbitt (1999) contend that IQ should be assessed within the context of its generation, while Katerattanakul & 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 & 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; Kopcso *et al.*, 2001; Klein, 2002a & 2002b; Croft & Peterson, 2002; Toms *et al.*, 2005; Forslund, 2007; Knight, 2007; Varlander, 2007).

So "fit-for-purpose" recognises the reality 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 information quality 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 is understanding 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.

Frameworks & Models of IQ: Literature Review

Table 1 summarises twenty one IQ frameworks collated from the decade of systems IQ research. While varied in their approach and application, the frameworks share a number of definitive characteristics regarding their classifications and descriptions of the dimensions of information quality.

Table 1: Comparison of information quality Frameworks (1996 – 2007)

Yr	Author	Model	Constructs		
1996	(Wang & Strong, 1996)	A Conceptual Framework for Data Quality Summary: » 4 Categories » 16 Dimensions	**Category**		**Dimensions**
			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
	(Zeist & Hendriks, 1996)	Extended ISO Model Summary: » 6 Quality characteristics » 32 Sub-characteristics	**Characteristics**		**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
1997	(Beck, 1997)	Evaluation Criteria for web information sources Summary: » 5 Criteria	**Criteria**		**Dimensions**
			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
	(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)**		**Dimensions to be assessed**
			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
1999	(Alexander & Tate, 1999)	Applying a Quality Framework to Web Environment Summary: » 6 Criteria	**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
	(Katerattanakul et al, 1999)	IQ of Individual Web Site Summary: » 4 Quality Categories (adapted from Wang & Strong)	**Category**		**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
	(Shanks & Corbitt, 1999)	Semiotic-based Framework for Data Quality Summary: » 4 Semiotic descriptions » 4 goals of IQ » 11 dimensions	**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

Table 1 (cont…): Comparison of information quality Frameworks (1996 – 2008)

Yr	Author	Model	Constructs		
2000	(Dedeke, 2000)	Conceptual Framework for measuring IS Quality Summary: » 5 Quality Categories, » 28 dimensions	**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	Controllability, Error tolerance, Adaptability, System feedback, Efficiency, Responsiveness	
			Contextual Quality	Value added, Relevancy, Timeliness, Completeness, Appropriate data	
			Representation Quality	Interpretability, Consistency, Conciseness, Structure, Readability, Contrast	
2000	(Naumann & Rolker, 2000)	Classification of IQ Metadata Criteria Summary: » 3 Assessment Classes » 22 IQ Criterion	**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	
	(Zhu & Gauch, 2000)	Quality metrics for information retrieval on the WWW Summary: » 6 Quality Metrics	**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	
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	**Characteristics**	**Sub-characteristic**	
			Functionality	*Suitability*, Accuracy, *Interoperability*, *Compliance*, Security, Traceability	
			Reliability	Maturity, Fault tolerance, Recoverability, Availability, Degradability	
			Usability	Understandability, Learnability, Operability, Luxury, Clarity, Helpfulness, Explicitness, user-friendliness, Customisability	
			Efficiency	Time behaviour, Resource behaviour	
			Maintainability	Analysability, Changeability, Stability, Testability Manageability, Reusability	
			Portability	*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	**Quality Type**	**Classification**	**Dimension**
			Product Quality	Sound Information	Free-of-Error, Concise, Representation, Completeness, Consistent Representation
				Useful Information	Appropriate Amount, Relevancy, Understandability, Interpretability, Objectivity
			Service Quality	Dependable Information	Timeliness, Security
				Useable Information	Believability, Accessibility, Ease of Manipulation, Reputation, Value-Added
	(Liu & Chi, 2002)	Evolutional Data Quality	**Quality Type**	**Dimension**	
			Collection Quality	Accuracy, Objectivity, Trustworthiness, Completeness, Clarity	
			Organisation Quality	Reliability, Consistency, Storage Efficiency, Retrieval Efficiency, Navigability	
			Presentation Quality	Semantic Stability, Faithfulness, Neutrality, Interpretability, Formality	
			Application Quality	Ease of Manipulation, Timeliness, Privacy, Security, Relevancy, Appropriate Amount of Data	
	(Eppler & Muenzenmayer, 2002)	Conceptual Framework for IQ in the Website Context Summary: » 2 Manifestations, » 4 quality categories, » 16 Quality dimensions	**Quality Type**	**Categories**	**Dimensions**
			Content Quality	Relevant Information	Comprehensive, Accurate, Clear, Applicable
				Sound Information	Concise, Consistent, Correct, *Current*
			Media Quality	Optimized Process	Convenient, *Timely*, Traceable, Interactive
				Reliable Infrastructure	Accessible, Secure, Maintainable, *Fast*

Table 1 (cont…): Comparison of information quality Frameworks (1996 – 2007)

Yr	Author	Model	Constructs
	(Klein, 2002a)	5 IQ Dimensions (chosen from Wang & Strong's 15 Dimensions.	**IQ Dimensions — Preliminary Factors** Accuracy: Discrepancy, Timeliness, Source/Author, Bias/Intentionally False Information Completeness: Lack of Depth, Technical Problems, Missing Desired Information, Incomplete When Compared with Other Sites, Lack of Breadth Relevance: Irrelevant Hits When Searching, Bias, Too Broad, Purpose of Web Site Timeliness: Information is Not Current, Technical Problems, Publication Date is Unknown Amount of Data: Too Much Information, Too Little Information, Information Unavailable
2003	(Shankar & Watts, 2003)	Theoretical Model for Data Quality Assessment.	**IQ Dimensions — Preliminary Factors** Object: Accuracy, Completeness, Timeliness User: Believability, Relevance
	(Sturges & Griffin, 2003)	Tool for Archaeological website quality evaluation Summary: » 5 contexts » 14 'named' dimensions (up to 10-15 more implied) (much borrowed from Smith,1997)	**Criteria — Explanation** Scope: subject breadth - comprehensiveness; subject depth - appropriate level to audience Purpose/Audience: consistency, appropriateness Content: accuracy, authority, copyright, currency, uniqueness, links, quality, and overall quality Graphic & Media Design: attractive, well organised, good quality illustrations, navigational aids Workability: user friendliness, computer environment, searching, browsability and organization, interactivity, connectivity
2004	(Tombros, Ruthven & Jose, 2003)	5 dimensions for judging quality in web pages The arrow (right) is the IQ part of the model.	**Web Feature — Metric/Criterion** Text: Content, Numbers, Titles/Headings, Query Terms, Text Quantity Structure: Layout, Links, Links Quality, Table Layout Quality → Scope/Depth, Authority/Source, Recency, General Quality, Content Novelty Non-textual: Pictures Physical Properties: Page Not Found, Page Location, Page Already Seen, Others
2005	(Stvilia *et el.* 2005)	Application of 7 known IQ metrics to automated system (evaluation) tool, to measure IQ of Wikipedia content	**Metrics — measured by automated tool — Related Dimensions** Authority/Reputation: by the *authors* of the material — Reliability Completeness: by broken hypertext links within articles Complexity: by the readability of the content — Understandability Informativeness: by diversity of content — Value-Added Consistency: by number of non-unique authors Currency: by how current (up-to-date) content is Volatility: by time taken to fix erroneous content — Security, Believability
2006	(Song & Zahedi, 2006)	IQ dimensions that influence users judgments of Web-based Health infomediaries	**Construct — Author's description — Related Dimensions** Adequacy: completeness, coverage (scope), and level of bias in information — Completeness, Coverage, Scope/Depth Relevance: practical (personal) applicability of information to individual user — Applicability Usefulness: (overall) perceived usefulness of information [*TAM of info not system*] — Accessibility & Availability Reliability: accuracy and credibility — Accuracy, Credibility Understandability: clarity and ease of comprehension – i.e.; accessibility of health jargon [*TAM of info, not system*] — Understandability Ease of Use: [TAM] ease of (system) navigation — Efficiency, Usability Interactivity: benevolence and personalisability — Value-Added, HI's Trust signs: policies & security, disclosures & ownership, — Objectivity, Security
2007	(Varlander 2007)	Role of Quality dimensions in user experiential consumption.	**Dimension — Role of dimension in experiential consumption** Descriptive: The provision of 'hard facts'. E.g. the beach is within 50 m, the room is 20m2, the hotel has 3 stars, etc. Emotive: Subjective expression of views. The provision of 'soft facts' and personal experiences. Imperative: Support in decision-making, provision of alternatives or help and advice in choosing the best alternative. 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. 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. Decodable: The consumers' mastery of the medium. Internet readiness. Website design.

The frameworks cited in Table 1 have a rich and varied history and systems context. The list includes;

1.) Conceptual IQ identification models;
   - CIQF - Categorical Information Quality Framework (Wang & Strong, 1996);
   - SDQF - Semiotic Data Quality Framework (Shanks & Corbitt, 1999);
   - Conceptual Framework for measuring IS Quality (Dedeke, 2000);
   - Mapping IQ into the PSP/IQ (becomes AIMQ) (Kahn *et al.*, 2002);
   - IQM - Information Quality Measurement Methodology (Eppler & Muenzenmayer, 2002)
   - IQ as a Life-Cycle (Liu & Chi, 2002)

2.) Frameworks that push existing models in order to apply them to a Web environment
   - Extension of IQF into Web environments information contexts (Katerattanakul *et al.*, 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 World Wide Web (Zhu & Gauch, 2000)
   - Classification of IQ Metadata Criteria (Naumann & Rolker, 2000)
   - Using IPMAP to create machine readable (quality related) metadata about data (Shankar & Watts, 2003)
   - Quality metrics used to create Wikipedia IQ evaluation tool (Stvilia *et el.*, 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 Information Quality (Harris, 1997)
   - (Web) Evaluation Criteria (Beck, 1997)
   - Web Wisdom (Alexander & Tate, 1999).

Conceptual Models of IQ

CIQF - Categorical Information Quality Framework (Wang & Strong, 1996)

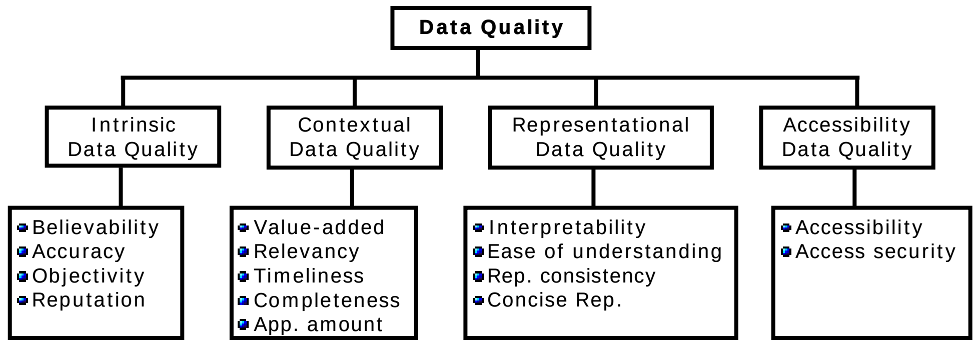
The valuable paradigm of contextual IQ postulated by Wang & Strong (1996) allowed the authors to separate user/information interaction into two distinct contexts; (1) information production; and (2) information use. The further conceptualisation of IQ into categories associated with production or use proved to be a valuable methodology for identifying the ultimate dimensions proposed to be applied by users in their process of information interaction.

Wang & 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 & Strong identified fifteen 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. Wang & Strong's (1996) Categorised Model of IQ/DQ



SDQF - Semiotic Data Quality Framework (Shanks & Corbitt, 1999)

Shanks & 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 information quality. 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, 2004; 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 & Corbitt, 1999) approaches removed the "social" construct (Price & Shanks, 2004, 2005a) of the 1999 model presented in Table 2.1. The author contends, however, that this social construction of information quality remains an important concept in the context of information retrieval based IQ research.

Conceptual Framework for measuring IS Quality (Dedeke, 2000)

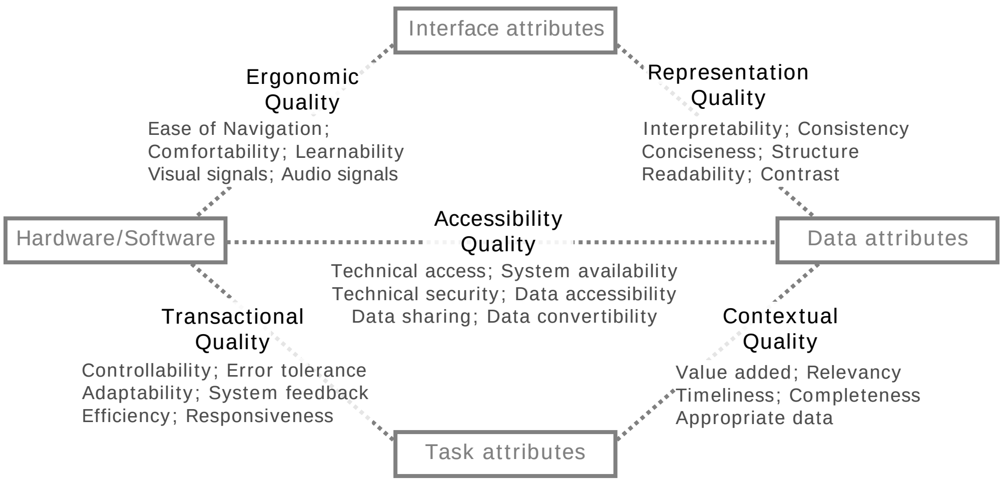
Dedeke's framework was largely concerned with user perceptions of a system's quality, and identified those perceptions as being derived from the relationship between four IS components, namely; (1) Interface attributes; (2) Data attributes; (3) Task attributes; and (4) Hardware / Software attributes.

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 'information quality', three of the five named categories align with Wang & 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, and (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 names twenty eight different quality dimensions (illustrated in figure 2) engaged by users to make value judgements of the system with which they interact.

Figure 2. A conceptual framework for IS quality (Dedeke, 2000)



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 & 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 information quality 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.

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; and (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; or (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; or (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**
Info Quality	**Product Quality**	Sound Information • Free-of-Error • Concise Representation • Completeness • Consistent Representation	Useful Information • Appropriate Amount • Relevancy • Understandability • Interpretability • Objectivity
Function Quality	**Service Quality**	Dependable Information • Timeliness • Security	Usable Information • 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 of 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 – 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".

IQ as an Evolutionary Life-Cycle (Liu & Chi, 2002)

Liu & Chi's (2002) "Evolutional Data Quality" framework, built largely on a foundation of Wang & 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.

Illustrated in figure 4, Liu & Chi's (2002) information life-cycle, as a concept, was not new to information systems research (Taylor, 1982; Hernon, 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 evolutional 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*; and (2) information/data *use* contexts.

Figure 4. Liu & Chi's Evolutional Data Quality model (2002)

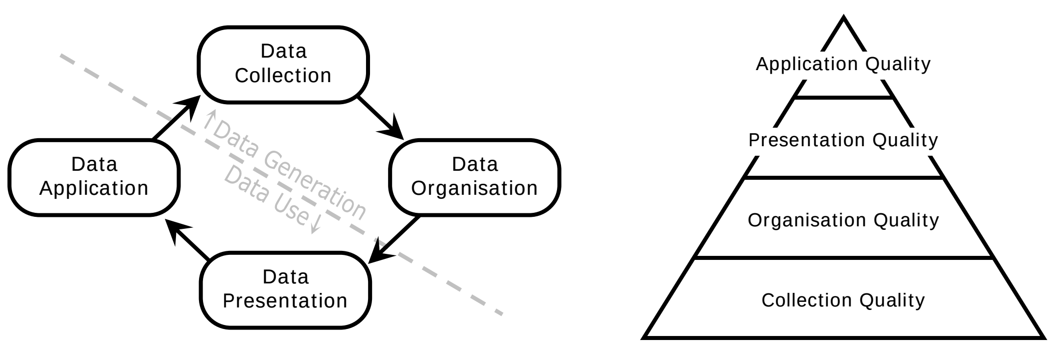


Fig 2a: Data Evolution Life Cycle

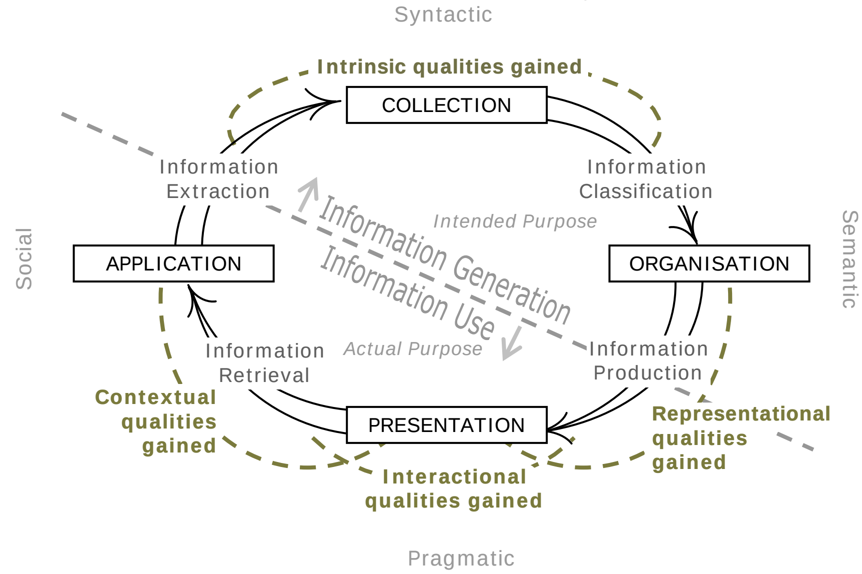
Fig 2b: Evolutional Data Quality

A Consolidated Framework for Investigating IQ in Information Systems

The current paper seeks to develop Liu & 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



IQ as a Life-Cycle Concept

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*.

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, 1998 & 2002; Wu, 2001);
2.) Information production (Shankaranarayan *et al.*, 2000; Kovac & Weickert, 2002; Scannapieco *et al.*, 2002)
3.) Information retrieval (Spink & Saracevic, 1998; Fidel *et al.*, 2004); *and*
4.) Information extraction (Gaizauskas & 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.

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 & 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-judgments made in relation to them is heavily dependant on where in the life-cycle user/information interaction takes place*. This is consistent with Wang & 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 table 1, where authors first contextualise their investigation into broad categories (Wang & Strong, 1996; Katerattanakul et al, 1999; Dedeke, 2000; Eppler & Muenzenmayer, 2002); assessment classes/types (Naumann & Rolker, 2000; Zhu & Gauch, 2000; Kahn et al, 2002, Liu & Chi, 2002); or criteria/contexts (Beck, 1997; Harris, 1997; Alexander & Tate, 1999; Shanks & Corbitt, 2000; Sturges & Griffin, 2003; Song & 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.

IQ as a set of "dimensions"

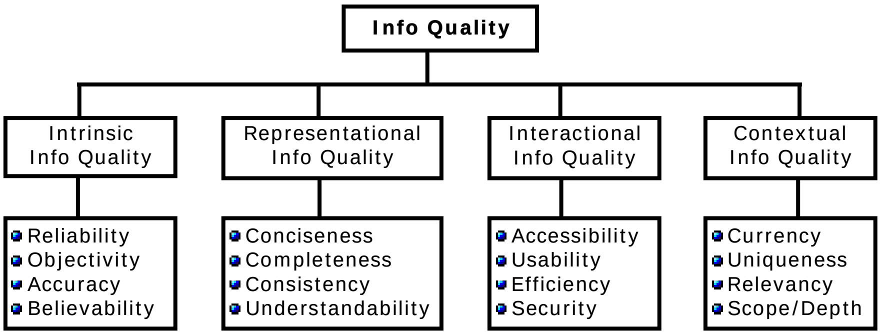
Despite the varied research contexts of the IQ frameworks and models presented in Table 1, an analysis of the *Constructs* column reveals a remarkable commonality amongst the eventual elements identified by researchers as being important "dimensions" of IQ. These include such traditional dimensions as accuracy, consistency, timeliness, completeness, accessibility, objectiveness and relevancy. Table 2 provides a summary of the most common dimensions and the frequency with which they are included in the twenty one IQ frameworks of Table 1. Dimensions are named and the number of times they appear in Table 1 is recorded, followed by a short definition of each dimension.

Table 2. The Common Dimensions of IQ/DQ (1996 – 2007)

	Dimension	# of times	Definitions & Relating Dimensions
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 & 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 sixteen dimensions identified in Table 2 summarise the common dimensions of IQ identified in much of the information systems IQ literature over the last decade. Figure 7 presents these sixteen dimensions in the context of the proposed categories associated with the CC/LC model of IQ. Conceptually, the model is comparable to Wang & 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 & Strong named 15 dimensions, the current framework names 16, with notably more dimensions associated with the interactional (previously 'accessibility') IQ category.

Figure 7. The Categories & 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 & Strong, 1996; Wang 1998) has been replaced with *reliability*, a measurable construct that facilitates users' value judgments in relation to intrinsic IQ. The current model also moves the *completeness* dimension out of the contextual IQ category, and into representational IQ. 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.

CC/LC model of IQ: *Discussion (Categories & 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-judgments, 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.

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; and (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 & 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" (Wang & Strong, 1996) 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 & Lo, 2007), 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.

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; and (4) consistency; represent what Wang & Strong (1996) classified as 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, 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 authors' call 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-judgment 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-judgments related to them. Put simply, the user will make representational IQ value-judgments relative to their own cognitive ability and skill.

Interactional IQ

In the CC/LC model of IQ, interactional characteristics of information are gained at the pragmatic (Shanks & Corbitt, 1999; Price & Shanks, 2005a), or presentation (Liu & Chi, 2002) stage of the IQ life-cycle. The model contends this is where users make value judgments 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 judgments made in regards to (1) usability; (2) accessibility; (3) efficiency; and (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; navigatability. 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 information quality. 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.

Contextual IQ

Contextual IQ is made up of such quality dimensions as; (1) currency (up-to-date/recency); (2) uniqueness (innovativeness); (3) relevancy; and (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-judgments are made of the dimensions associated with representational IQ according to the seekers own information skill, contextual IQ value-judgments 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 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 & Muenzenmayer, 2002; Sturges & Griffin, 2003; Tombros *et al*., 2003; Savolainen & Kari, 2006; Song & Zahedi, 2006) have positioned the contextual and interactional IQ related dimensions as central to information seekers' value-judgment 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 & Ingwersen, 2000; Dziadosz & Chandrasekar, 2002; Marton, 2003; Vakkari & Sormunen, 2004; Whitmire, 2004; Savolainen & Kari, 2006).

Contextual IQ is problematic to information producers because currency, relevancy, uniqueness, and scope/depth are 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, 2007).

Table 3 presents the sixteen 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.

Table 3. Categories & Dimensions of IQ, and factors that influence user perceptions

IQ Category	IQ Dimensions	General Impacting Factors*	
		Information Producer	*Information Retriever*
Intrinsic IQ	Reliability, Objectivity, Accuracy, Believability	Producer's knowledge of the subject	User's knowledge
Representational IQ	Conciseness, Completeness, Consistency, Understandability	Producer's informatic and/or language skill	User's informatic and/or language skill
Interactional IQ	Accessibility, Usability, Efficiency, Security	Producer's motivation to deliver information	User's experiential skill using the system
Contextual IQ	Currency, Uniqueness, Relevancy, Scope/Depth	Producer's knowledge of their user	User's information need or task

*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.

Conclusion: *Implications and Future Research*

Implications

Wang & Strong (1996) established the now widely accepted paradigm that systems quality, as it relates to data/information quality, 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 model establishes the two most divergent information contexts as being information-producer or information-retriever. Establishing this fundamental difference in context is seen as being central to any investigation of user IQ perceptions (Strong *et al.*, 1997a & 1997b; Tayi & 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.

Future Research

The CC/LC model of IQ has been empirically tested in the research project ". . . . " (Author, YEAR), 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 forty four 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 sixteen dimensions associated with the research framework.

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