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Contextual Factors Influencing Perceived Importance and Trade-offs of Information Quality

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Abstract:

With the ever-increasing importance of information quality (IQ), research focuses mainly on two approaches, criteria and assessment. Researchers developed a number of frameworks, criteria lists, and approaches for assessing and measuring IQ. Several studies confirm that IQ is a multi-criteria concept, and its evaluation should consider different aspects. However, research and discussions with practitioners indicate that assessing and managing IQ in organizations remains challenging. Despite the subjective character of quality, foremost frameworks and assessment methodologies do not often consider the context in which the assessment is performed. Trade-offs between criteria are often not considered in most frameworks despite strong evidence in the literature that suggests trade-off relations exist. Underlying a user-centric view, this study analyses the importance of selected contextual factors and their impact on IQ criteria. Empirical data are gathered using a questionnaire approach. Results suggest significant context impacts and show that the perceived importance of information quality criteria changed over the last decade. Information and communication technology, available resources, the user role, the department, and the type of information systems influence respondents' perception of IQ. These factors are incorporated in a context-oriented IQ research framework.

Keywords: information quality, data quality trade-offs, context-oriented, data quality perceptions, data quality frameworks

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I. INTRODUCTION

The problem of insufficient information quality (IQ) is widespread and often cited as one of the key factors for the failure of information systems (IS). With growing volumes and complexities of data resources, managing data and information quality becomes an important success factor [Wixom and Watson, 2001]. Researchers find the issue of data quality and information quality challenging and address problems from various viewpoints and disciplines, including computer science, library and information science, and management information systems. This resulted in a number of approaches, frameworks, criteria lists, and metrics. However, understanding and definition of the domain are most inconsistent. The inherent subjective characteristic of the domain contributes to the variety of approaches and perceptions. As a result, most researchers do not differentiate clearly between aspects of data quality (DQ) and information quality (IQ). Consistent with previous studies, we do not differentiate between DQ and IQ and refer only to information quality (IQ) for the purposes of this study.

Examining individual IQ criteria, many researchers and practitioners agree that a clear understanding of the impact of context and relations between IQ criteria is crucial. Researchers claim that more studies are needed to further analyze the context and relationships between criteria [Eppler, 2001; Lee, 2003; Fisher et al., 2006; Scannapieco and Batini, 2006]. Lee [2003] and Foley [2011] examine the importance of context in IQ and how context influences the crafting of data quality rules and data quality assessments. IQ studies often mention the importance of trade-offs between IQ criteria [Ballou and Tayi, 1999; Eppler, 2001; Ballou and Pazer, 2003; Fisher et al., 2006; Scannapieco and Batini, 2006]. Complementing research in the area our research provides insights into trade-offs of IQ criteria and investigates how some context factors influence these trades-offs. Therefore, we revisit popular IQ frameworks under the focus of context and IQ trade-offs. Considering selected factors influencing IQ, we analyze several IQ criteria and identify some contextual factors affecting the perceived importance of IQ criteria. Based on our results, we extend the tradition of mostly static and criteria-based views of IQ and include context when considering IQ criteria.

Contributions of this article are twofold. From a research perspective, this study demonstrates the influence of context on IQ. Although this work examines only three factors, future research can either examine factors more closely or expand the number of context factors (see for example, Foley, 2011). Developing a unifying IQ framework is challenging, and thus we argue for consideration of context when adapting a IQ framework. This observation has implications from a practical perspective; IQ criteria and requirements depend on context. Any application of IQ frameworks to a particular organizational environment should consider this. Prioritizing IQ criteria and setting IQ requirements necessitate the consideration of the context in which the user applies a framework.

Despite the diversity in approaches and definitions, there is acceptance that IQ problems are progressively prevailing and crucial for organizations [Redman, 1996; Wand and Wang, 1996; Lee et al., 2002; Fisher and Kingma, 2001; Al-Hakim, 2007]. With the growth of communication and information technology (IT), the need for and consciousness of the importance of IQ management in organizations significantly increases [Al-Hakim, 2007]. Furthermore, IQ is a factor for the success of IS, estimated to cost U.S. businesses more than 600 billion dollars annually [Fisher et al., 2006].

Lists and frameworks of general and context specific criteria as well as measurement approaches exist from both database and management perspectives [Redman, 1996; Huang et al., 1999; Lee et al., 2002; Kahn and Strong, 2002; Pipino et al., 2002; Stvilia et al., 2007]. Studies confirm that IQ is a multi-criteria or multi-dimensional concept [Ballou and Pazer, 1995; Redman, 1996; Wand and Wang, 1996; Wang and Strong, 1996; Huang et al. 1999]. Many contributions do not differentiate between criteria, attributes, or dimensions of IQ and use the terms interchangeably. Due to the dependencies between IQ criteria, we do not use the word *dimension,* but refer to the observable characteristics of IQ as criteria. Several criteria can be classified and grouped into a category for better understanding. This does not imply that a single measurement for a IQ category can be achieved. Aiming to eliminate related IQ problems and improve IQ, a number of IQ management approaches and cases exist (e.g., Wang, 1998; Wang et. al., 1998; Fisher et al., 2006; Scannapieco and Batini, 2006).

Following the subjective character of quality, IQ is often referred to as data or information that is fit for use [Wang and Strong, 1996]. Data appropriate for one use may not be suitable in another context [Miller, 1996; Goodhue, 1995; Wang and Strong, 1996; English, 1999; Dedeke, 2000; Naumann and Rolker, 2000; Lee et al., 2002; Eppler, 2001; Tayi and Ballou, 1998; Al-Hakim, 2007]. Considering this subjective view of IQ, there is broad agreement that IQ must consider the context of data use and the perceptions of data users [Wang and Strong, 1996].

Since IQ frameworks are important tools for defining IQ, we review related studies in Section II. Section III discusses the research focus and research methodology and Section IV presents results. Based on results and conclusion, we provide a context-oriented IQ research framework in Section V. Limitations and possible extensions of our research are discussed in Section VI and Section VII summarizes key findings.

II. IQ FRAMEWORKS AND DEPENDENCIES AMONG IQ CRITERIA

There are many IQ frameworks. For example, Ge and Helfert [2007a] analyzed different frameworks and their research implications. As Ge and Helfert's research suggests, the frameworks are developed within various contexts and applied to different scenarios. We further analyze selected IQ contributions and frameworks within various decision environments and types of information systems. Table 1 presents the results of twenty selected papers representing ten years of IQ studies (1996–2006). Over those ten years, the focus shifted from general frameworks describing IQ criteria to application or domain specific approaches.

Table 1: Selected IQ Frameworks and Decision Environment

Author and year of publication	Decision environment	Information systems type	Main IQ focus
Wang and Strong [1996]	Data bases	Client server / Database system / Data management	General IQ frameworks with criteria including accuracy, databases consistency, accuracy, timeliness, completeness, etc.
Redman [1996]	Data bases		
Miller [1996]	Information systems		
Ballou et al. [1998]	Data warehousing	Increasingly complex information manufacturing systems and data warehousing	Relation between IQ criteria (intrinsic, specification) and output (perception, expectation, value add, time)
Kahn and Strong [1998]	Information systems		
English [1999]	Data warehousing		
Ballou and Tayi [1999]	Data warehousing		
Cappiello et al. [2003]	Multichannel IS		
Rittberger [1999]	Information service providers in electronic market places	Decision environments within enterprises providing information services	Impact of DQ: User-centric and decision making view including: Content, presentation, interaction, system, provider and people
Chengalur-Smith et al. [1999]	Decision-making		
Helfert and Heinrich [2003]	Customer relationship management		
Jung et al. [2005]	Decision–performance		
Stylianou and Kumar [2000]	Information systems	Process oriented information systems within an Internet / networked environment	Criteria and assessment metrics and impact on processes
Berndt et al. [2001]	Healthcare		Assessment, improvement and factors of data quality management Content, form time
Xu et al. [2002]	Enterprise resource planning		
Amicis and Batini [2004]	Finance		
Xu and Koronios [2004]	E-business		
Knight and Burn [2005]	World Wide Web		
Kim et al. [2005]	E-business systems		
Li and Lin [2006]	Supply chain management		

Based on the general frameworks, questions related to the relationship between IQ criteria and output and impact were addressed. To illustrate some application domains, we selected a few contributions, although we acknowledge that there are several application contexts and research that contribute many application-specific frameworks, case studies, and approaches. Most frameworks differ in purpose, application, and criteria, but there are some common elements. Most frameworks include criteria such as accuracy, consistency, security, accessibility, and timeliness.

Furthermore, most of the reviewed IQ frameworks classify various criteria into categories, providing a hierarchical structure. However, a common and accepted structure of IQ categories is still missing. Definitions of single criteria are inconsistent and a variety of IQ frameworks use different terms such as dimensions, criteria, attributes, or metrics. A review of prominent IQ frameworks also outlines the variety of IQ approaches and definitions. As the numerous criteria lists and frameworks indicate, IQ is perceived differently depending on various contextual factors. The IQ criteria and their importance within each framework vary and dependencies between different IQ criteria are largely not represented.

Recognizing the importance of context in IQ and with a particular focus on dependencies between IQ criteria, our research aims to investigate contextual factors of IQ. To provide a theoretical foundation for our research, we identify typical relationships between selected IQ criteria. Analyzing foremost research, we develop a set of dependencies [Ballou and Pazer, 1995; Ballou and Tayi, 1999; Huang et al., 1999; Eppler, 2001; Ballou and Pazer, 2003; Missier et al., 2003; Fisher et al., 2006; Scannapieco and Batini, 2006]. Based on these studies, we focus on eight important IQ criteria most relevant to dependencies among IQ criteria. Thus, the eight IQ criteria identified are selected for further investigation.

III. RESEARCH MODEL AND METHOD

Research Model and Hypotheses

Accepting the subjective character of quality, we acknowledge that a generic or unified framework is difficult or impossible to achieve. The perception of IQ and the importance of IQ criteria may change between various domains [Helfert et al., 2009]. In contrast to developing another framework or criteria list, we contribute to the understanding of factors affecting the importance of IQ criteria. Based on three main factors, we provide insight into the perception of the importance of IQ criteria. To understand contextual factors and their perception, we believe that relationships between IQ criteria play a central role. Without considering trade-offs between IQ criteria, the influence of contextual factors and the priorities of criteria may be misrepresented. Considering indications in literature, we focus on three contextual factors: ICT, resources, and decision environment. We assume that these factors influence perceptions of IQ, discussed in three guiding hypotheses.

- H_1: Wang and Strong's [1996] research, which is the basis for many empirical studies, was completed in the mid-1990s, the start of an era characterized by intensive use of ICT and IS. Since then, factors and perceptions of ICT and IS changed. For IQ, we expect changes in perceptions since Wang and Strong's [1996] research fifteen years ago. Although we recognize that many other factors influence perception of IQ, we propose as *Hypothesis 1 (H_1)* that "the perceived importance of IQ is influenced by the expected information and communication technology (ICT). The perception has over time changed with the availability of information technology." Following the common view in IQ on information manufacturing systems, the term *ICT* is used broadly to include IT, communication and mobile devices, or applications used to gather, process, store, share, and use information by information consumers. We expect that the importance ranking of selected quality criteria changed in comparison to the initial study from Wang and Strong [1996]. Due to the importance and influence of ICT, we assume that a change in the perception of IQ may support the hypothesis, although other variables may contribute to the change.
- H_2: Considering constraints and limited resources, we expect an impact on trade-offs of IQ criteria [Ballou and Tayi, 1999]. Limited resources should affect the overall importance perceptions of IQ. We propose as *Hypothesis 2 (H_2)* that "the perceived importance of IQ is influenced by available resources." When data consumers are forced to consider trade-off relationships among IQ criteria under resource constraints, the importance rankings change.
- H_3: Literature supports that types of users and types of IS (i.e., operational system, control system, or planning system) result in different requirements and, consequently, different perceptions of IQ [Missier, 2003; Fisher et al., 2006]. For example, Goodhue's [1995] study suggests that system, task, and individual characteristics directly influence a user's evaluation of IS. The literature indicates that the department (organizational) plays an important role in a user's opinions and perspectives [Ballou and Pazer, 2003; Fisher et al., 2006; Al-Hakim 2007]. Uses of different types of IS incorporate different demands and lead to different user perceptions [Smith, 1997; Beynon-Davies, 2002]. This supports *Hypothesis 3 (H_3)* in which "the decision environment influences the perceived importance of IQ." We limit characteristics of the decision environment to four factors: (1) user role, (2) organizational department, (3) IS, and (4) task complexity. Ge and Helfert [2007b] describe other possible factors. The four environment variables lead to sub-hypotheses H_{3A} to H_{3D}.

Research Method and Instrument

We aim to provide insight into the contextual factor influencing the perception of IQ. By discussing the initial research framework, these contextual factors are refined and subsequently analyzed by applying a quantitative research approach. A questionnaire containing ten questions was designed using common constructs identified in literature. The questionnaire was sent to professionals and researchers. Results were analyzed using selected quantitative research techniques (section 3.4).

The questionnaire (see Appendix) was categorized into four sections: introduction, data characteristics, importance of IQ criteria, and trade-offs between IQ criteria. The purpose of the first paragraph in the introductory section was to introduce the respondent to the topic and, in combination with the cover letter, motivate the reader to complete the questionnaire. The second section, data characteristics, contained five questions related to respondent characteristics. Three user roles were classified as end user, system user, and managerial user. We included an open question so respondents could indicate the most important information system used.

The third and fourth sections focused on measurement of eight selected criteria. Consistent with previous studies related to IQ, we employed a 9-point Likert scale. This was particularly useful when determining user perceptions [Smith, 1997]. We asked respondents to rate the importance of each IQ criteria on a scale from 1 to 9, in which 9 was extremely important and 1 was not important. The definitions of the criteria were included so that respondents could understand the meanings of the criteria and interpret them consistently. The scaling was chosen to be able to compare results with a subsequent constant sum scaling question (Question 10).

Table 2: Examples of IQ Criteria Relationships

Item 1	Item 2	Source
Timeliness	Accuracy	Eppler [2001] adapted, Ballou and Tayi [1999], Ballou and Pazer [2003], Scannapieco and Batini [2006]
Timeliness	Believability	Eppler [2001] adapted
Timeliness	Consistent representation	Scannapieco and Batini [2006] adapted
Timeliness	Completeness	Scannapieco and Batini [2006]
Completeness	Accuracy	Ballou and Tayi [1999],Cappiello Francalanci and Pernici [2003], Fisher et al. [2006]
Completeness	Consistent representation	Ballou and Pazer [2003], Scannapieco and Batini [2006] adapted
Completeness	Conciseness	Eppler [2001] adapted, Fisher et al. [2006] adapted
Accessibility	Security	Huang, Lee, and Wang [1999], Eppler [2001], Fisher et al. [2006]
Accessibility	Accuracy	Missier et al. [2003]

Complementing previous IQ studies, we included constant sum and comparative scaling to consider the relative importance of the IQ criteria. In Question 10, a total of 40 points could be allocated to eight criteria. The primary advantage of the constant sum scale is that it allows for fine discrimination among stimulus objects without requiring too much time [Malhotra, 1996]. In addition to constant sum, we used paired comparison scaling in Question 9, the most widely used comparative scaling technique [Malhotra, 1996]. The respondent was presented with two criteria, each of the relationships identified in Table 2. The respondents were asked to select IQ criteria that are more important according to his/her perception.

Procedure and Data Gathering

During development of the questionnaire, we discussed the questions with both academics and practitioners. A pre-test of the resulting questionnaire was conducted leading to some minor revisions in the outline of the survey and phrasing of the questions. To refine the questionnaire further, we completed three pre-test cycles.

After finalizing the questionnaire, we invited subjects to participate. Although random sampling was not feasible for this study, 2,558 people received information about the survey via different means spanning a wide spectrum of professionals and students with practical experience. The survey was sent out in the first quarter of 2008 with a closing date of March 1, 2008. Initially, 1952 students of both the Dublin City University Business School (Ireland) and the European School of Business (Reutlingen, Germany) were addressed. Because the target student population must complete mandatory internships (minimum six months duration), a large percentage of targeted students had practical experience in the business domain since final year students were primarily addressed. However, it cannot be completely excluded that younger and less-experienced students completed the questionnaire. In addition, the survey was publicized through a newsletter of the International Association of Information and Data Quality addressing an addition 364 people. And 242 people associated with the "Deutsche Gesellschaft für Informations—und Datenqualität" were addressed through an online community. When addressing subjects, the link to the questionnaire was preceded by a cover letter (e-mail, Web-posting) explaining the nature of the study and its criticality. The time required to complete the survey (five to seven minutes) was also noted.

Data Analysis and Methodology

To examine H_1, we employed the same statistics associated with the frequency distributions (mean and standard deviation) proposed by Wang and Strong [1996]. Likewise, the data analysis for H_2 was conducted using the same frequency distributions. Correlations between the items were calculated to investigate trade-offs. For H_3, we used cross-tabulation. We recognize that because of the presence of several cross tabulations, this might be an inefficient method of examining relationships [Malhotra, 1996]. Nevertheless, we chose to use this method to be in a position to collapse several categories and allow flexibility in the analyses.

We analyzed our hypotheses further using chi-square statistic (χ^2), a common measure to test the statistical significance associated with cross tabulation [Nelson, 1982; Malhotra, 1996]. We also use the phi-coefficient (r_{phi}) to assess the magnitudes of the relationships between variables. Since binary variables (e.g., preference in a trade-off vs. user type) were expected to relate to one other, r_{phi} was appropriate. The statistics are based on absolute counts of the variables to provide a better overview; percentages are shown in Table 9. To investigate the relationship between IQ and the decision environment further, regression analysis was used.

IV. RESULTS AND DISCUSSION

The final survey closed on March 1, 2008, with 234 respondents, an estimated response rate of 9.12 percent. The low response rate could be explained by distribution of the survey via multiple methods, including mailing lists that usually result in low response rates. A significant number of respondents did not complete the questionnaire entirely, leading to 120 completed and usable responses. After completing Questions 1 and 2, thirty-nine respondents decided not to finish the questionnaire. A further sixty-seven respondents decided not to answer Question 3. Respondents who answered Question 3 were likely to complete the survey. Despite the low number of valid responses and the relatively high drop-out rate, the data indicate a sufficient distribution of responses. To balance the low response rate, we decided to qualitatively reflect and enrich our results by interpretation.

Influence of ICT (H_1)

Asking for importance ratings, Questions 8 and 10 were designed in a way to allow comparability. By using Likert scales in Question 8, we also allowed comparability to Wang and Strong's [1996] study. Table 3 depicts the results from Question 8, which asked respondents to rate how important the data criteria are from 1 (not important at all) to 9 (extremely important). Although Wang and Strong's [1996] anchors ranged from 1 (not important) to 9 (very important), our results can be compared to Wang and Strong's [1996] study.

Table 3: Ranking of IQ Criteria Using Likert Scale

Rank*	Criteria	Mean	Min.	Max.	S.D.
1	Accurate	8.02	1	9	1.730
2	Accessible	7.51	1	9	1.840
3	Complete	7.44	1	9	1.729
4	Timely	7.38	1	9	1.743
5	Believable	7.20	1	9	1.921
6	Secure	7.09	1	9	1.988
7	Consistently Represented	7.03	1	9	1.827
8	Concise	6.64	1	9	1.751

*Mean descending S.D. = Standard Deviation

All items ranged from 1 to 9 with a mean higher than 5. Thus, all of the items surveyed are considered to be important IQ criteria. The criterion accuracy shows a mean value above 8 and is the most important item in this study, ranking first in Table 3. The standard deviation for each item was below 2. As the most important criterion, accuracy shows the second lowest standard deviation of 1.730. This supports the view of a relatively homogenous belief to prioritize accuracy as the most important criterion of IQ.

When comparing results to Wang and Strong's [1996] study, a shift in IQ perception is observable. An extract of Wang and Strong's study is summarized in Table 4. When comparing the two results, the mean values must be reversed and, thus, show a similar observation as in our study. The standard deviation ranges from 1.135 to 2.432, whereas it ranges from 1.729 to 1.988 in our study (responses to Question 8). When comparing the item rankings of the results in our survey with Wang and Strong's research, most IQ criteria are prioritized similarly (Table 5) indicating a consistent view of IQ.

Table 4: Extract of Wang and Strong's [1996] Findings (Adapted)						
Rank*	Criteria	Mean	S.D.	Min.	Max.	Mean reversed
1	Accurate	1.771	1.135	1	7	8.229
2	Believable	2.707	1.927	1	9	7.293
3	Up-to-date	2.963	1.732	1	9	7.037
4	Complete	3.229	1.814	1	9	6.771
5	Accessible	3.370	1.899	1	9	6.63
6	Concise	3.994	2.016	1	9	6.006
7	Data are secure	4.436	2.432	1	9	5.564
8	Consistently formatted	4.596	2.141	1	9	5.404
*Mean reversed descending; No. of cases = 355						

Table 5: Comparison Between Current Study and Wang and Strong [1996]			
Criteria	1996	2008 (Q8)	2008 (Q10)
Accurate	1	1	1
Believable	2	5	4
Up-to-date/Timely	3	4	6
Complete	4	3	3
Accessible	5	2	2
Concise	6	8	8
Data are secure/Secure	7	6	5
Consistently Formatted	8	7	7

For three criteria (believability, timeliness, and accessibility), our results of Questions 8 and 10 show a statistically different priority than in the earlier study of 1996 (ranked more than two positions higher or lower). The different prioritization of IQ criteria may support hypothesis H_1 , in which we assume that the importance ranking of the selected IQ criteria changed over time. We acknowledge that the shift in IQ perception and importance could be caused by several other factors than ICT. These factors include differences in the sample or the survey procedures (paper-based vs. online). Since it will be demonstrated that users affect the result (IT versus non-IT, H_{3A}), ICT might be an intrinsic issue. IT people might use different ICT than non-IT people. Thus, the difference between this study and Wang and Strong's [1996] study may be in user distribution, not in the ICT.[1] Nevertheless, assuming that ICT had a significant impact over the years, our observation may be a reasonable indicator for hypothesis H_1.

Influence of Available Resources (H_2)

In contrast to Question 8 in which we used a 9-point Likert scale, Question 10 used constant-sum scaling. Respondents were asked to distribute 40 points among the criteria, forcing respondents to trade-off criteria. Since respondents had to consider resource limitations, they were not able to list all criteria with high importance. This resource constraint results in differing answers between Questions 8 and 10 (Table 3 and Table 6). Enforcing trade-offs resulted in a more selective pattern with higher differences between mean values that ranged from 7.56 (accuracy) to 3.27 (conciseness). Again, the item accuracy ranks first with a mean of 7.56, followed by accessibility with 7.02, and completeness with 5.80. All criteria included responses with zero ratings.

Table 6: Ranking of IQ Criteria Using Constant-Sum Allocation					
Rank*	Criteria	Mean	Min.	Max.	S.D.
1	Accurate	7.56	0	20	3.326
2	Accessible	7.02	0	40	5.155
3	Complete	5.80	0	20	2.917
4	Believable	4.57	0	20	3.076
5	Secure	4.20	0	15	3.051
6	Timely	4.17	0	20	2.996
7	Consistently represented	3.40	0	10	2.286
8	Concise	3.27	0	10	2.149
*Mean		S.D. = Standard Deviation			

Table 8 illustrates the correlations between the items. All correlations were negative. In contrast, the correlations relating to the evaluation of IQ criteria without trade-offs were all positive (Table 7). This shows the nature of

[1] We thank an anonymous reviewer for suggesting this relationship.

Question 10, which successfully forced respondents to trade-off criteria. Points assigned to one criterion cannot be assigned to another. The tendency is that, if one criterion receives more points, another receives fewer points and leads to the negative correlations observed.

Table 7: Inter-Item Correlation Matrix Between IQ Criteria Using Likert Scale

Accessible	Accurate	Believable	Complete	Concise	Consistently represented	Secure	Timely
1.000							
0.760	1.000						
0.507	0.611	1.000					
0.509	0.645	0.595	1.000				
0.356	0.397	0.479	0.584	1.000			
0.397	0.385	0.486	0.526	0.583	1.000		
0.359	0.498	0.459	0.450	0.412	0.464	1.000	
0.412	0.478	0.516	0.597	0.475	0.520	0.377	1.000

Influence of Decision Environment—User Type (H_{3A})

Regarding the user type, we analyze selected trade-offs in more detail by comparing the responses of non-IT and IT users. First, we select the completeness–conciseness trade-off. Among IT users, 66.67 percent rank conciseness more important than completeness, whereas non-IT regard completeness (78.99 percent) as more important (Table 9). We calculated a relatively high χ^2_{test} value (9.50) supporting hypothesis H_{3A}. The value for r_{phi} was 27.25 percent, which shows the highest relationship detected for the control variable user type. However, these results should be interpreted with caution; frequency of IT personnel preferring completeness was 3. This poses a limitation on the statistical test, especially when a cell has a frequency below 5 [Malhotra, 1996]. Since the other three cells used in the test had counts above five and the data seems to be backed by respective literature [Turban et al. 2006], the results are still presented. It should be noted that the relationship found needs to be statistically confirmed by future studies.

Table 8: Inter-Item Correlation Matrix Between IQ Criteria Using Constant-Sum Allocation

	Accessible	Accurate	Believable	Complete	Concise	Consistently represented	Secure	Timely
Accessible	1.000							
Accurate	-0.034	1.000						
Believable	-0.120	-0.068	1.000					
Complete	-0.168	-0.196	-0.068	1.000				
Concise	-0.397	-0.049	-0.078	-0.069	1.000			
Consistently represented	-0.204	-0.394	-0.031	-0.128	0.225	1.000		
Secure	-0.339	-0.058	-0.155	-0.191	-0.045	-0.211	1.000	
Timely	-0.045	-0.212	-0.413	-0.192	-0.170	0.053	-0.111	1.000

As the fourth strongest negative correlation, the relationships between accessibility and security are interesting (Table 8). We obtain an r_{phi} value of 18.40 percent. $r_{phi}{}^2$ was 3.38 percent, indicating that 3.38 percent of the variation in the preference for security was explained by the variance of the user role (either IT or non-IT). A test of statistical significance using χ^2 resulted in a value of 4.33, indicating significance at the 0.05 level.[2] We found that 77.78 percent of IT personnel favored security in the accessibility–security trade-off. In contrast, only 43.02 percent of the non-IT users prioritized security over accessibility. Table 9 summarizes the responses related to non-IT and IT support.

As discussed above, we aimed to enrich and strengthen our results by comparing them with supporting literature. Compared to a decade ago, recent IS literature extensively discusses security issues [Laudon and Laudon, 2005; Turban et al., 2006]. As Turban et al. [2006, p. 674] state, "Computer control and security have recently received increased attention." It can be argued that IS professionals are increasingly receptive to data security issues. They are aware of the challenges necessary to protect the organization's IS. However, with increased number of

[2] The critical value for χ^2, depending on both degrees of freedom and the probabilities of the test rejecting H_0 when it is in fact correct (Type I error), is taken from Nelson [1983 appendix Table 4]. Since a first order relationship is analyzed the degree of freedom is 1. For a Type I error probability of 0.05 the critical value of X^2 is 3.841.

Table 9: Selected Cross-Tabulation of Factors Related to Decision Environment and IQ Trade-Offs								
Decision Environment		Trade-off A		Trade-off B		Trade-off C		N
		Accessible	Secure	Complete	Concise	Timely	Consistent Represen-tation	
User Type	Non IT	57.98%	42.02%	78.99%	21.01%			119
	IT support	22.22%	77.78%	33.33%	66.67%			9
Business Activities	Support Activities					38.10%	61.90%	63
	Primary Activities					58.46%	41.54%	65
Depart-ment	HR	17.65%	82.35%					17
	Other	61.26%	38.74%					111

passwords, increased levels of security, and access or authorization barriers, the system might be less frequently used [Laudon and Laudon, 2005]. As our results suggest, accessibility seems to be regarded as more important than twelve years ago when Wang and Strong [1996] completed their study. Accessibility may be a challenge for current IS because enterprises develop increasingly sophisticated access restrictions, seeking to protect data more effectively. Considering the proliferation of data, IS professionals may pay particular attention to consistent representation and conciseness. A study by Klein and Callahan [2007] comparing IS professionals' and data consumers' perceptions of the importance of criteria of IQ found that IS professionals' ratings of concise representation are higher than those of the data consumers' ratings. This is consistent with the prominence of the conciseness criteria in the underlying study by IS professionals as shown in Table 9, trade-off B.

Influence of Decision Environment H_{3B} (Type of Business Activity)

We categorized and analyzed responses along Porter's [1985] value chain activities. The results are summarized in Table 9, by which we identify as the most significant result the timeliness-consistently trade-off. A test of statistical significance using the χ^2 test resulted in a value of 5.31, which supports hypothesis H_{3b}. The relationship strength r_{phi} was 20.37 percent.

Reflecting these results with literature and case studies, it is reasonable that primary activities such as logistics have a stronger need for timely data than support activities such as finance and accounting do. Operational departments including logistics typically need up-to-date and real-time data (e.g., inventory levels) to perform production or operational processes. In contrast, accounting and invoicing activities may be not as time-critical. Considering trade-offs, support activities tend to prioritize consistent representation in contrast to other criteria. However, we note that consistency and timeliness have been rated as important. The prominence of timeliness by respondents belonging to primary activity departments confirms that operational systems are designed for real-time purposes (refer to Table 9 trade-off C).

Due to limited responses related to each organizational department, our initial department categories were assigned to broader classes. From our responses, emphasis on human resources (HR) was observed; 13.3 percent of all valid responses were reported to be associated with an HR department. We conducted a separated analysis for responses related to HR. The strongest deviation regarding the HR department was again related to the accessibility–security trade-off. 82.35 percent of the respondents belonging to an HR department ranked security over accessibility, in contrast to 38.74 percent in other departments. Analyzing the strength and validity of the relationship, an r_{phi} value of 29.78 percent and a χ^2_{test} value of 11.35 were calculated. The cross-tabulation values are shown in Table 9.

Our results support the assumption that HR data in companies may be viewed as delicate. Discussions and concerns in 2009 about the Deutsche Bahn (German railway) and its way of handling employee data in an anti-corruption campaign in Germany are examples of how delicate an issue HR data may be [Deutsche Welle, 2009]. However, there may be several other reasons for this result. HR may have a better IS or HR personnel may be more computer literate and do not experience the same difficulties with access of relevant data than other departments and, consequently, prioritize security.

Influence of Decision Environment H_{3C} (IS Type)

When asked directly for the IS type, a significant correlation (χ^2=5.04) was found for the complete-concise trade-off. Therefore, we calculated a three (operational system, control system, planning system) by two (complete, concise) cross-tabulation (see Appendix). Conciseness of data was more strongly emphasized by users of operational systems. However, the majority of respondents of each IS type prioritized completeness over conciseness (operational system: 67.9 percent, control system: 86.6 percent, and planning system: 70.8 percent).

Influence of Decision Environment H_{3D} (Task Complexity)

Contrary to our expectation, correlations between the perceived task complexity and IQ criteria in Questions 8 and 10 did not yield significant results. The regression model used was a linear univariate form $Y_i = (b_0 + b_1X_i) + \varepsilon$, where X is perceived task complexity, Y is one of the eight IQ criteria, and ε is error term. Neither of the regressions performed resulted in a significant relationship between the tested predictor variable perceived task complexity and the outcome variable of a specific IQ criterion. The linear regression measure R^2 ranged from 0.000 to 0.041. Therefore, we decided not to analyze the related responses further. However, we suggest that further research investigate this observation.

V. CONCLUSION AND CONTEXT-ORIENTED IQ FRAMEWORK

Our study examines some contextual factors influencing the perceived importance and trade-offs of IQ criteria. We gathered empirical data and analyzed aspects along three guiding hypotheses related to the influences of ICT (H_1), available resources (H_2), and the decision environment (H_3) with their occurrences of user type, type of business activity, and IS type. Our results suggest an influence of these three variables on the perceived importance of IQ, noticeably in ranking IQ trade-offs.

Comparing our results with Wang and Strong's [1996] study, we observe a significant difference in the importance of accessibility. A possible explanation for the shift is increased attention that security received recently. Since accessibility and security have inverse relationships, the attention to security may hamper accessibility, which in turn gets increased attention and importance ratings. Particularly, we observe this focus on accessibility by the non-IT support group, which significantly outweighed IT support respondents. Thus, there is indication for H_1 that the ICT is a significant influencing factor on IQ perception. When enforcing trade-off and resource limitations, we found evidence for H_2, postulating an influence of available resources on IQ.

We evaluated the influence of the decision environment. Our results suggest that a departmental role and the type of IS influence IQ. The relationship is weak; however, our results show that the department and the IS affiliations influence the preferences for certain IQ criteria. To support quantitative results, we discuss the findings in the context of empirical evidence. Such evidence is also found for the user role. However, following the limitation that in the χ^2 tests more than 20 percent of the cells had a frequency below 5, statistical significance cannot be shown distinctively for the user role (H_{3A}). Nevertheless, we consider H_{3B} and H_{3C} supported. In general H_3, which hypothesizes that the perceived importance of IQ is influenced by the decision environment, can be supported with caution by this research. However, the results should be confirmed by further studies.

In summary, our work shows that individuals' perceptions are influenced by distinct factors, including the underlying ICT, the resources available, and the decision environment. Foremost research does not often consider any contextual factors and aims to provide a general IQ framework. Based on our results, we argue that context is an important element of IQ, and a suitable IQ framework should consider context characteristics.

Although previous frameworks provide many suitable assessment techniques, the challenge remains to adapt these techniques to context specific variables (e.g., ICT, resources availability, and decision environment). IQ is usually measured using several assessment techniques and aggregated measurement scores in a single IQ measure. According to the importance of IQ criteria, measurements are prioritized and weighted.

Extant frameworks suggest a static measurement approach, by which assessment techniques are provided and scores aggregated. In contrast to known IQ frameworks, in our work we include the context criteria as input for IQ measurement to prioritize and adjust the weighting of suitable IQ measures. Depending on the ICT, the available resources, and the decision environment, IQ results in different requirements. Consequently, IQ criteria receive different weightings (priorities). This is indicated in Figure 1, in which we illustrate that context specific factors can be used to derivate IQ requirements and priorities of IQ criteria. Figure 1 further illustrates the three factors that are the subjects of this study; other factors may still be possible. In this way, the context-factors adjust IQ measures and assessment techniques according to the context in a given situation. Complementing previous IQ frameworks with this approach, existing frameworks can be made context-oriented. To apply this approach in practice, our research provides indication for selecting and prioritizing IQ criteria. This allows selection of a common IQ assessment approach proposed in many other frameworks (e.g., Lee et al., 2002) and adaptation of assessment techniques and weights to a specific context.

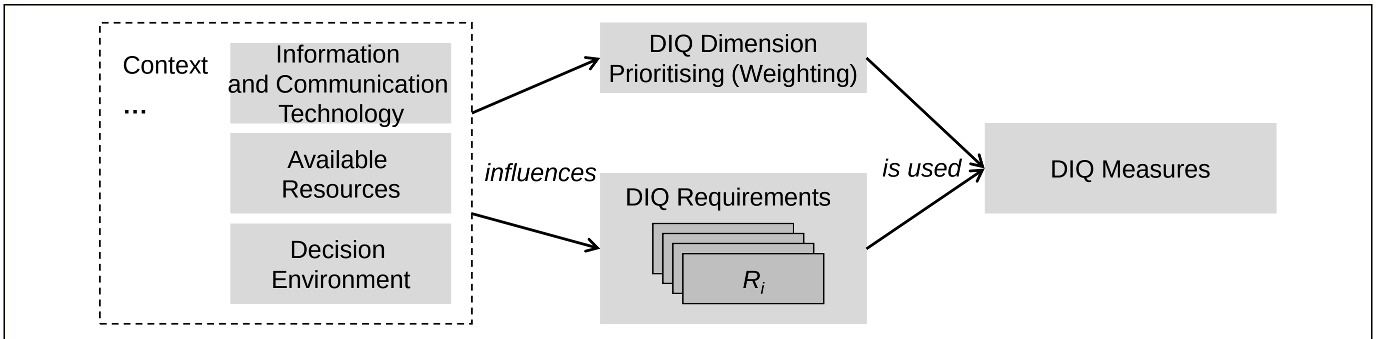

Figure 1. A Context-Oriented IQ Research Framework

The importance and weighting of IQ criteria as well as the assessment approach may change over time for reasons such as changes in the decision environment, availability resources, or changes in ICT. Therefore, the revision of context-specific measurements and priorities should be conducted on a regular basis to maintain the topicality of the measurement and criteria.

VI. CRITICAL REVIEW AND LIMITATIONS

We propose a research model and provide an analysis of influencing factors on the perceived importance of IQ criteria. Based on our results, we argue that context factors should be considered in IQ frameworks. Our framework and results offer a valuable contribution to the IQ domain. As highlighted in our discussion above, contextual criteria are currently not represented by IQ research, which provides numerous frameworks, criteria, and methodologies to guide the enterprise in the assessment, analysis, and improvement of IQ. Our research and discussion demonstrate the importance of context in rating IQ. The numerous IQ frameworks for different application scenarios highlight the significance of context. The approach proposed here for including context factors in IQ frameworks allows considering context variables such as ICT, available resources, and decision environment. We demonstrate that users perceive changes in context variables, resulting in different importance rankings for IQ criteria. Furthermore, our results emphasize that traditional, static applications of IQ frameworks may not provide a clear view of the nature of IQ.

Due to time and resource constraints, there are limitations in our approach and data gathering. Concerning the subjects of the study, there may be a bias in the sample toward younger subjects (students) and people interested in IT and IQ. Still, as the students generally had practical business experiences and the department affiliation of the respondents was recorded, we believe that the findings can generalize across contexts and also hold for average professionals. In addition, we compare results with the study of Wang and Strong [1996] and reverse the attitude scales. This might have an effect on results [Belson, 1966]. Due to limitations of the online survey environment, we surveyed certain criteria, not the criteria of Wang and Strong's [1996] study. Another possible limitation is the selection of analysis techniques and the focus on χ^2 tests and regression analysis. However, the techniques appear to be appropriate for the study. In addition, the selection and detail level of our control variables limit the study. We detail the factor of decision environment in finer subcategories, whereby resources and ICT presented a relatively broad construct. This does not guarantee consistent interpretation among subjects. Also, we did not analyze the independence of the context factors (ICT, available resources, and decision environment) in detail. The factors could overlap, which should be analyzed in further research. We specified only three main context factors. However, we expect that further factors can be identified in further research. Another point for future contemplation is possible interdependency between H_1 and H_{3A}. If users are influenced by the results (IT versus non-IT, H_{3A}), ICT might be intrinsic. IT people might use different ICT than non-IT people do. Thus, the difference between this study and Wang and Strong's [1996] study may be in the user's distribution, not in the ICT.[3]

VII. SUMMARY

This research builds on the contribution of popular IQ frameworks and particularly focuses on eight IQ criteria of Wang and Strong's [1996] initial framework. Our review of the literature reveals typical trade-offs of IQ criteria and provides indications for different perceptions of IQ. Although not considered in most IQ frameworks, we argue that contextual variables are important when considering IQ. This observation is reflected in our research model and hypotheses, which direct us to suggesting factors influencing the perceived importance of IQ criteria. Focusing on three aspects—ICT, available resources, and decision environment—we propose three hypotheses that are

[3] We thank an anonymous reviewer for suggesting this interdependency.

subsequently tested using a quantitative research approach. Extending other studies, we employ constant-sum and comparative scaling. The results are critically reflected and interpreted by literature-based evidence.

Our research suggests that the importance of IQ criteria is influenced by various context factors and that the answers have changed since Wang and Strong's study. Our research demonstrates that the various priorities and inclusion of IQ criteria in various frameworks are influenced by context. In addition to available ICT, other variables such as available resources, user role, department, and IS type influence respondents' perceptions of IQ. This is an important observation, since this influence indicates that priorities of IQ are not based arbitrarily on subjective requirements but based on measureable context factors. Recent research supports this observation including Jung et al. [2005] who showed effects of contextual data quality and task complexity on decision performance. Research conducted by Klein and Callahan [2007] shows that the perceptions of information technology professionals and data consumers influence the importance of the dimensions of information quality. Jiang and Benbasat [2007] examined the effects of presentation formats and task complexity on online consumers' product understanding, indicating the complexity of understanding users' perception of IQ. Based on this research, we argue for the inclusion of context into IQ frameworks and assessments.

The contributions of this article have implications and are useful for research and practice. For research, we argue that a common unifying IQ framework may be possible only at a general level. When applying IQ frameworks, context needs to be considered. IQ research does not address this challenge. From a practical perspective, our research helps to raise awareness of the implications of context on IQ criteria and IQ trade-offs. Developing measurement systems for IQ would cater to these.

In further research, we aim to extend the number of context factors and extend the study along all fifteen criteria identified by Wang and Strong [1996]. To address some limitations of the study, we will extend the quantitative data analysis and complement the study by applying our context-oriented IQ framework in organizations. We recommend conduction of case studies based on our framework as well as similar empirical studies identifying cultural differences of IQ perceptions. Supported by the results in this article, we believe that the ability of organizations to identify impacts of contextual factors on general IQ criteria and assessment techniques is vital. The sole employment of traditional IQ frameworks does not allow for this. As a concluding remark, we report the results of Question 1 in which we asked if data consumers are satisfied with IQ at work. Interestingly, 67.1 percent state they are satisfied. It shows that despite frequently-reported losses and effects of poor IQ, more than two-thirds of the individuals at work are satisfied with IQ.

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APPENDIX A: SUMMARY OF KEY QUESTIONS INCLUDED IN THE QUESTIONNAIRE

Table A-1: Summary of Key Questions Included in the Questionnaire

Number	Question
1	Are you satisfied with your data quality at work, in general?
2	What did you have in mind in the previous question concerning your satisfaction level?
3	Please mark the system type you will refer to in the following question: Operational System, Control System, or Planning System.
4	In which department do you use the information system?
5	(Optional) Please state a name or description of the information system you will refer to in the following question.
6	Rate the average complexity of your activities for collecting, storing, and using the data concerning the respective information system.
7	What is your main role relative to the date?
8	How important is it to you that your data are:

	1 = Not important at all	2	3	4	5 = Averagely important	6	7	8	9 = Extremely important
Accessible*(1)	○	○	○	○	○	○	○	○	●
Accurate*(2)	○	○	○	○	○	○	○	○	●
Believable*(3)	○	○	○	○	○	○	●	○	○
Complete*(4)	○	○	○	○	○	○	○	○	●
Concise*(5)	○	○	○	○	○	○	●	○	○
Consistently represented*(6)	○	○	○	○	○	○	○	●	○
Secure*(7)	○	○	○	○	○	●	○	○	○
Timely *(8)	○	○	○	○	○	○	○	●	○

Number	Question
9	What is more important to you? That your data is rather (1) or rather (2)?

	Rather (1)	Rather (2)
(1) = timely or (2) = accurate	○	○
(1) = beliveable or (2) = timely	○	○
(1) = accessible or (2) = accurate	○	○
(1) = complete or (2) = concise	○	○
(1) = timely or (2) = complete	○	○
(1) = complete or (2) = consistently represented	○	○
(1) = accurate or (2) = complete	○	○
(1) = accessible or (2) = secure	○	○
(1) = timely or (2) = consistently represented	○	○

Table A-1: Summary of Key Questions Included in the Questionnaire — Continued	
10	Please assign 40 points. The more important a category for your data is, the more points you should give it. But the more points you give to one category, the fewer there are to give to other categories. Accessible Accurate Believable Complete Concise Consistently Represented Secure Timely

Cross-tabulation information system—complete vs. concise

Count		Complete vs. Concise		Total
		1	2	1
Information System	Operational system	38	18	56
	Control system	39	6	45
	Planning system	17	7	24
Total		94	31	125

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