CONSTRUCTING A STAGED CAPABILITY MATURITY MODEL FOR INFORMATION QUALITY MANAGEMENT: APPLYING THE DELPHI METHOD FOR CONSENSUS BUILDING WITHIN AN INFORMATION QUALITY EXPERT PANEL

(Research-in-Progress)

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Abstract: Contemporary organisation are producing and storing more information then ever before in history. The resulting information overload, combined with the lack of quality assurance for information management, has led to a questionable state of information quality in many organisations. Furthermore, assessing, enhancing, and managing information quality has proven to be a notoriously difficult undertaking. Consequently, this paper presents a capability maturity model approach for information quality management. The paper firstly presents a set of criteria, as identified from extensive literature review and exploratory case studies, which are thought to be of importance when considering a holistic approach for information quality management. We then present the results of a Delphi study, which was used to validate those criteria and group them into a staged capability maturity model. The resulting Information Quality Management Capability Maturity Model may help organisations in assessing their existing Information Quality Management practices, and in identifying potential gaps and improvement strategies.

Key Words: Data/Information Quality Management, Capability Maturity Model, Delphi Method

INTRODUCTION

Information and Communication Technologies have been evolving at an ever accelerating rate in the relatively recent times. Such a rapid progress has made the production, collection, and storage of information very efficient and inexpensive. Consequently, contemporary organisations are dealing with more information than ever before in history [1]. However, this information overload has among others led to a decrease in the quality of the available information. Information accuracy, completeness, timeliness, relevancy, and so on have proven to be notoriously difficult to assess and manage. Furthermore, even though quality assurance methodologies have played a crucial part in the software engineering and manufacturing industries for decades [2-5], Information Quality (IQ) assurance is only practised in a minority of contemporary organisations [6]. This is despite the fact that many such organisations hugely depend on quality information for every-day business operations, and even their very survival in today's competitive business environments [7].

This paper contributes to Information Quality Management (IQM) research by presenting a set of factors,

as identified from extensive literature review and exploratory case studies, which are thought to be of importance for IQM efforts. We then present the results of a Delphi study, which was used to organise those factors into staged capability maturity levels. Thus, the resulting Information Quality Management Capability Maturity Model (IQM-CMM) may aid in evaluating organisational IQM practices, and in developing IQM improvement strategies.

BACKGROUND

Quality management has been an integral component of software engineering and manufacturing industries for decades [2-5]. What's more, quality assurance has been described as being fundamental to organisational success and growth [8, 9]. The Total Quality Management (TQM) movement started with the development of the statistical control charts by Walter Shewhart in 1925 [10]. Since then, many researchers, whom we now call "quality gurus", including Juran [11], Crosby [12], Deming [13], and Ishikawa [14] have contributed a great deal to quality management theories. Additionally, many other researchers [15-23] have proposed a wide range of Critical Success Factors (CSFs) for TQM implementations. However, the Total Data Quality Management (TDQM) program at MIT has been instrumental in the adaptation of TQM theories to the area of Information Quality [24-26], by drawing the analogy between the manufacture of tangible products and Information Products (IP).

Crosby [12] was the first to propose the idea of quality management maturity. His ideas have since been adapted by IBM [27] and SEI [2, 3] to software engineering, and by several other researchers [28-31] to information management and information quality management. In this paper, we further adapt Crosby's ideas to the development of an Information Quality Management Capability Maturity Model (IQM-CMM). Where other IQM Maturity Models [28-31] were proposed by researchers, we have built our IQM-CMM inductively from exploratory case studies and Delphi surveys, thus combining numerous perspectives from IQ academics and practitioners (i.e. IQ experts).

RESEARCH METHODOLOGY

The IQM-CMM was developed in two stages. Stage one identified a range of Information Quality Management (IQM) Capability Maturity indicators/factors, through exploratory case studies and extensive literature review. The maturity indicators were examined from three perspectives: Organisational, Social, and Technological (Figure 1).

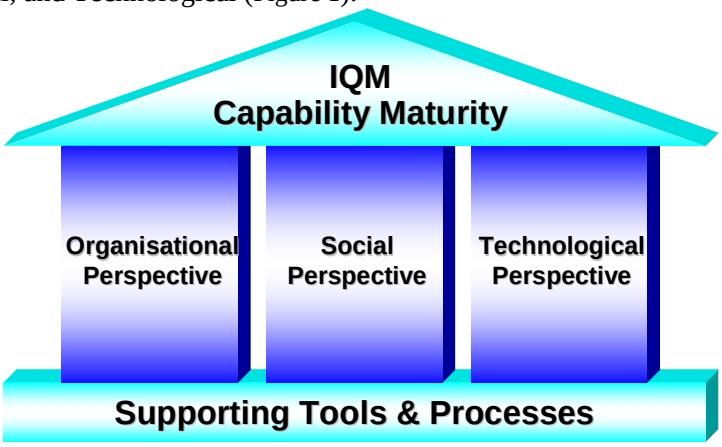

Figure 1 IQM Capability Maturity Framework (developed by the authors)

Stage two involved a two round Delphi Study, which was used to validate and group individual maturity indicators into staged levels. A number of additional Maturity Indicators were identified in the Delphi study as well. The first round of the Delphi study was conducted at the 11th International Conference on Information Quality (ICIQ06), which was held at the Massachusetts Institute of Technology (MIT), Cambridge, USA. Study participants included a wide range of world's leading Information Quality (IQ) practitioners and academics. The second round was conducted online and additionally included members of the International Association for Information and Data Quality (IAIDQ). The first round included 21 participants and the second round included 19 participants.

The participants were initially presented with a set of 45 potential Maturity Indicators, and asked to place each Maturity Indicator into the lowest Capability Maturity Level they thought it should belong to (see the appendix for the questionnaire). Thus, the resulting IQM-CMM should consist of evolutionary (staged) levels, where each subsequent level addresses more advanced IM & IQM issues. Stage three (not covered in this paper) will ensure further external validation though the application of the model in multiple case studies.

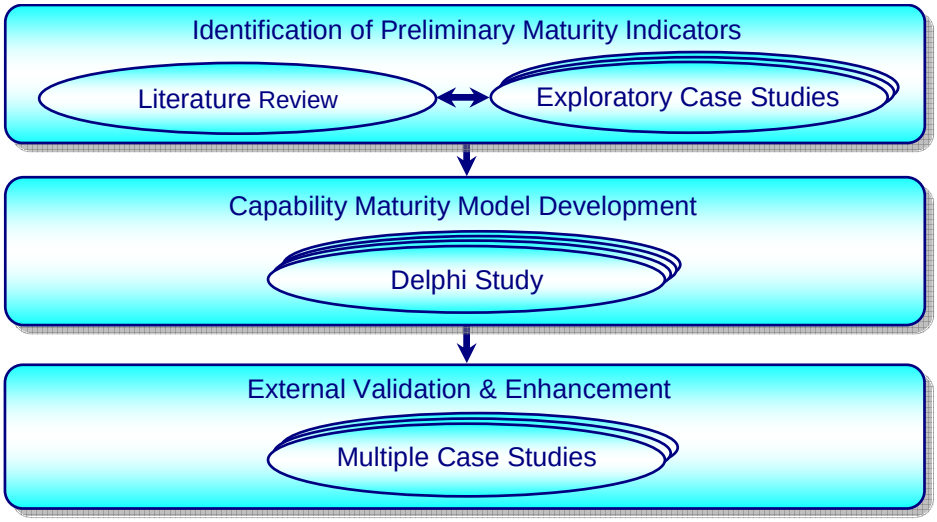

Figure 2 Research Methodology (developed by the authors)

The Delphi Method

The Delphi technique was developed in the 1950s by the Rand Corporation to forecast the impact of technology on warfare [32, 33]. The name itself refers to the Delphi Greek oracle Pythia, who forecasted future events from the temple of Apollo at Delphi [33, 34]. The Delphi method is a useful technique for discovering new issues and moving study participants towards consensus [35-37], and it is used to generate theories and hypotheses rather than to test them [38]. The method employs a series of questionnaires where each successive round summarizes the preceding round [39]. In each successive round participants are asked to re-evaluate their opinions based on the results from the previous round, thus moving towards group consensus [35, 40]. Accordingly, the Delphi technique is a useful method where judgemental information is necessary in order to solve complex problems [40-44]. The final round usually involves distribution of the results, providing an opportunity for the panel members to agree or disagree with the findings [45]. It has also been argued that Delphi provides forecasts that are more accurate than those from unstructured groups [46]. The main aspects of a Delphi study are anonymity, controlled feedback, statistical group response [46, 47], and expert panel selection and composition [43, 48, 49]. Hence, the selections of panellists cannot be random; they have to be selected based on their

expert knowledge [50, 51]. Furthermore, panellists from various backgrounds should be selected, so that more holistic results can be obtained [35, 40, 52]. Thus, validity and reliability of results obtained through Delphi studies are attained by obtaining a consensus of expert judgements [53, 54]. Fowles [55] argued that panel sizes should be no less than seven participants, and others argued that panels should contain between 10 and 50 participants [43, 56-59]. Delbecq [35] on the other hand, suggested that there is no set number of panellists required, providing there are enough panellists to facilitate the pooling of judgments. Prendergast [45] argued that increasing the panel size beyond 12 provides little group error reduction.

CONSTRUCTING THE INFORMATION QUALITY MANAGEMENT CAPABILITY MATURITY MODEL

Delphi study results were analysed using descriptive statistics, including the mean, the standard deviation, the median, and the interquartile range. The mean and median values were used to indicate the preferred Capability Maturity level for each Maturity Indicator, where 1 indicates the lowest and 5 the highest Information Quality Management Capability Maturity. Table 1 shows a partial summary of the Delphi study results. Interquartile ranges are commonly used in Delphi studies to indicate the degree of group consensus. When using a 5-point Likert scale, responses with a quartile deviation less than or equal to 0.6 can be deemed high consensus, those greater than 0.6 and less than or equal to 1.0 can be deemed moderate consensus, and those greater than 1.0 should be deemed low consensus [60, 61].

Table 1 Partial Summary of the Delphi Study Results (developed by the authors)

Evidence of this "Maturity Indicator" Exists in the Organisation	Round 1				Round 2			
	Mean	SD	Median	IR	Mean	SD	Median	IR
Information Modelling Management	1.88	0.92	2	1	2.09	0.53	2	0
IQ Requirements Management	3.21	0.98	3	1	2.73	0.46	3	0.75
IQ is Everyone's Responsibility!	4.11	1.33	5	1	4.36	1.33	5	0
Information Product Configuration Management	3.52	0.77	4	1	3.73	0.7	4	0
IQ Root-Cause-Analysis	3.47	0.96	4	1	3.64	0.85	4	1
IQM Cost-Benefit Analysis	3.47	0.90	4	1	3.64	0.73	4	0
Single Point of Truth (SPOT)	3.42	0.90	4	1	3.59	0.8	4	0.75
Information Quality Governance	4.5	0.70	4	0.5	3.77	0.97	4	0.75
Business Process Reengineering for IQ Improvement	4.5	0.70	5	0.5	4.77	0.69	5	0
IQ is in the Corporate Balanced Scorecard	4.5	0.70	5	0.5	4.68	0.89	5	0
…	…	…	…	…	…	…	…	…

The Delphi study results (including qualitative comments provided by the participants) were then further analysed to discover the most important aspects of each capability maturity level. Individual capability maturity indicators were grouped into categories which led to emerging themes of each level. The resulting Information Quality Management Capability Maturity Model is shown below.

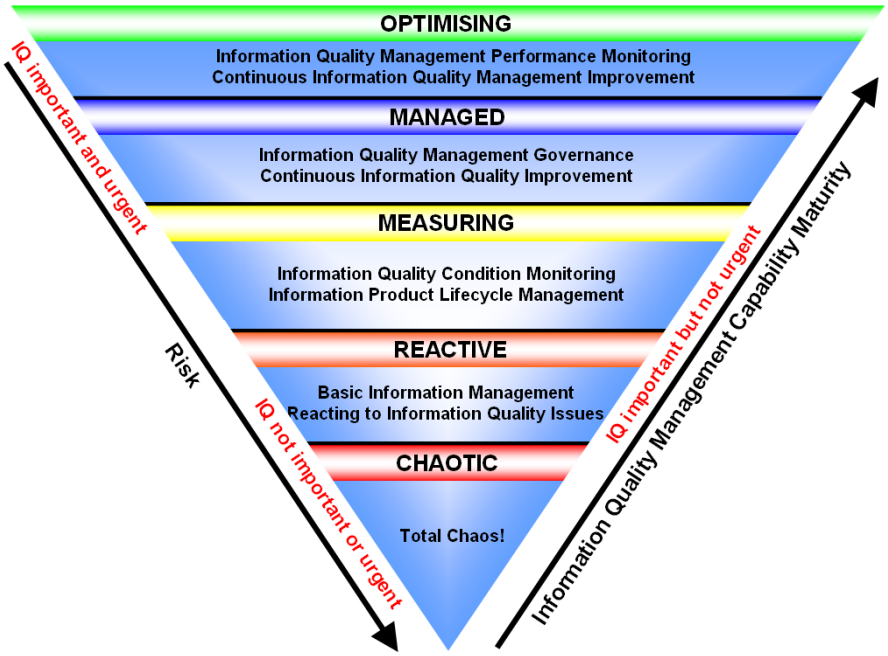

Figure 3 Information Quality Management Capability Maturity Model (developed by the authors)

The model above clearly illustrates five distinct evolutionary capability maturity levels, along with the main themes of each level. It is believed that this is a significant initial contribution to the development of a comprehensive set of tools and methodologies for information manufacturing process assessment and improvement.

CONCLUSION

The purpose of this paper has been to examine the breadth of IQM issues and practices, and organise them within a staged capability maturity model. That was achieved by initially identifying a large number of IQM success factors for from exploratory case studies, and subsequently validating and organising them into five evolutionary capability maturity levels through a two round Delphi study; thus, constructing the Information Quality Management Capability Maturity Model (IQM-CMM). This is considered as a significant initial contribution towards developing a complete Capability Maturity framework for IQM, with appropriate assessment tools and methodologies, which may enable organisations to assess and improve their own readiness and maturity in IQM.

FUTURE RESEARCH

We are currently in the process of conducting a second Delphi study, which investigates the significance of each Maturity Indicator. Thus, we hope to further validate them as well as identify the most important ones. We also plan to enhance the model by removing any synonymous indicators, categorising and organising indicators into a hierarchical structure, and developing a detailed set of assessment tools and methodologies. Furthermore we plan to apply the resulting IQM-CMM in a number of organisations for additional external validation, and enhancement.

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APPENDIX: DELPHI STUDY (ROUND 1) QUESTIONNAIRE

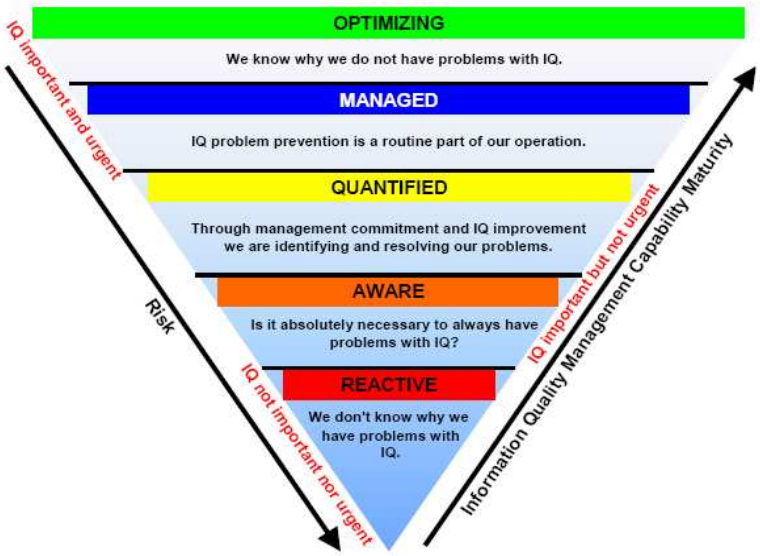
Information Quality Management Capability Maturity Questionnaire (Session 6B)

(Please direct any comments to: sasa.baskarada@unisa.edu.au)

Dear Colleague,

By completing this questionnaire, you are making a valuable contribution my PhD research. We sincerely appreciate your expert input and thank you for sharing your experiences and thoughts. This questionnaire should only take approximately 10 minutes to complete.

This doctoral research project aims to develop an Information Quality Management Capability Maturity Model. The model comprises five Maturity Levels that represent an evolutionary path of increasingly structured and methodically more mature IM & IQM processes. The Maturity Levels shown on the right have been adopted from Crosby's Quality Maturity Grid. Please provide any additional comments for each Level in the table below, and suggest any potentially more suitable names on the dotted lines. Furthermore, a list of "Maturity Indicators" is provided at the back of this page. For each "Maturity Indicator" please tick the "lowest" Maturity Level, in which you believe it should be present. For example, by ticking "QUANTIFIED", you are saying that the "Maturity Indicator" is only present in levels "QUANTIFIED" and above. Please also include any other "Maturity Indicators" you believe should be considered.



Maturity Level Please suggest any potentially more suitable names	Please provide any additional comments for each Capability Maturity Level
Level 5: OPTIMIZING (……)	
Level 4: MANAGED (……)	
Level 3: QUANTIFIED (……)	
Level 2: AWARE (……)	
Level 1: REACTIVE (……)	

We would be most grateful if you provided your name and email address so that you can help us further develop and validate this model through a Delphi study. **In return for your cooperation we will provide you with the final results of the study!**

Name: _____ **email:** _____

PLEASE TURN PAGE OVER

For each "Maturity Indicator", please tick the lowest Maturity Level in which you believe it should be present.

	Evidence of this "Maturity Indicator" exists in the organization	REACTIVE	AWARE	QUANTIFIED	MANAGED	OPTIMIZING
1	Conceptual Data Modeling (concepts & relationships)					
2	Logical Data Modeling (attributes, primary/foreign keys, normalization)					
3	Physical Data Modeling (implementation in a DBMS, any physical considerations)					
4	Templates for presentation of Information Products					
5	Information Product Classification (e.g. public, restricted, confidential)					
6	Information System Stakeholder Identification					
7	IM Roles and Responsibilities					
8	Information Stewardship and Ownership					
9	DBMS Constraints (business rules, referential constraints, etc.)					
10	Information storage and archival procedures					
11	Specification of Derived Information Products					
12	Security Requirements (for receipt, processing, storage & output)					
13	IQM Team & Project Management					
14	IQ Requirements Specification					
15	IQM Policies					
16	IQM Education, Training & Mentoring					
17	IQ is Everyone's Responsibility!					
18	IQM Roles & Responsibilities					
19	(Offsite) Backup of any critical Information					
20	Secure transmission of any classified information					
21	Access Control for input/access/edits					
22	Procedures for correction and resubmission of erroneously entered information					
23	Scripted (SQL Based) Data Cleansing					
24	Information Product Configuration Management					
25	Disposal Management (of sensitive information)					
26	IQM Procedures based on industry best practices have been defined and are used					
27	IQ Risk Management & Impact Assessment					
28	IQ Metrics and IQ Assessment					
29	Redundant Storage Management (some information may need to be stored redundantly)					
30	Meta-Information Management					
31	Real-Time Information Capture (information is entered only once; no manual copying)					
32	Erroneous transactions are identified dynamically without being processed					
33	Information Profiling					
34	Information Enhancement (from external sources)					
35	Enterprise Architecture has been developed and documented					
36	Procedures for critical review, identification and handling of errors contained in the output					
37	An overall IQM plan, which promotes Continuous Improvement, is in place					
38	IQ Root-Cause-Analysis					
39	IQM Cost-Benefit Analysis					
40	IQM alignment with ICT and organizational strategies					
41	IQ Accountability					
42	Information Integration Management					
43	Single Point of Truth (Data Warehousing)					
44	Audit Trail (information creation/access/edits are logged)					
45	Extract Transform Load (ETL)					
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47						
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51						
52						
53						

Please suggest any additional "Maturity Indicators" in the blank lines above.

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