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Information Quality Measurement Using Quality Function Deployment – A Korean Case Study

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ABSTRACT

Contemporary business organizations understand the criticality of quality of data, yet they struggle to enhance it. Establishing, enhancing, and maintaining information quality in organizational information systems has been the focus research and industry for the last two decades. There is, however, nothing denying the fact that improvements in information quality require its objective assessment. This objectivity is necessitated due to the range of information quality dimensions, where lacking quality in each dimension affects other dimensions. Therefore, such an assessment provides for actionable learning that facilitates tangible improvements in system and practice. This paper presents a case study on assessment of information quality in a manufacturing organization. It utilizes product perspective of information applied to six sigma methodology, analytical hierarchy process to find the correlation between various information quality dimensions, and quality function deployment to develop critical to quality trees.

Keywords

Information quality, information quality dimensions, quality function deployment.

INTRODUCTION

With the proliferation of information technologies in business environment, organizations are capturing more data than ever before. However, the utility of the collected data is as good as the quality standards that it conforms to. As a consequence of this, for the past two decades research and industry has focused on resolving information quality (IQ) issues. However, despite of the significant attention, most of IQ frameworks only work for specific application context according to those purposes due to subjective aspect of quality (Knight and Burn 2005). Additionally, most of IQ frameworks are ad hoc, intuitive and incomplete and cannot produce robust and systematic measurement models (Stvilia et al. 2007). Nevertheless, in order to manage IQ, the first requirement is evaluation of the quality of information held in their systems or procedures. However, obtaining accurate measurement and cost-effective assessments of IQ has been prevented by the complexities of information systems and the subjective nature of IQ (Madnick et al. 2009). Total quality management (TQM) philosophy has been widely accepted for its improvement potential and applied to a variety of fields and areas of practice (Elizabeth et al. 2006). Using TQM, Wang et al. (1998) introduced a product perspective of IQ research called Total Data Quality Management (TDQM). TDQM treats information as a product and treats information systems as the assembly line to produce information and information stakeholders as customers that use information for better decision making or organizational management. Even though TDQM methodology provides full range of IQ management containing four steps, i.e. define, measure, analyze, and improve, yet these steps are generic and at a high level of abstraction to objectively assess IQ. Lee and Haider (2011) propose a six-sigma based an IQ management framework identifying, measuring, analyzing, sustaining, and improving IQ. This framework takes a productive perspective of information and applies six-sigma principle to IQ. This paper reports the findings of a case study in a Korean manufacturing organization, where this framework was applied. It reports the findings from the IQ assessment aspect of the framework and assesses IQ using AHP (analytic hierarchy process) and QFD (quality function deployment). This paper starts with an overview of the product perspective of information, followed by a description of a six sigma based IQ framework. The paper then describes the case study and concludes by identifying the major findings of the case study.

PRODUCT PERSPECTIVE OF INFORMATION

Wang et al. (1998) argues that IQ should be controlled first before an attempt is made to manage it. In order to control IQ, it is important to assess quality if information residing in the organizational information systems. However, it is relatively easy to ascertain the quality of information relating to specific IQ dimensions, but assessing the impact of an IQ dimension on other dimensions is extremely difficult. Nevertheless, by understating how each IQ dimension works and how it affects other IQ dimension is critical for controlling overall quality of information being captured, processed, and maintained in the organizational information systems. Treating information as a product is to provide a well-defined product process and produce high quality information product rather than treating information solely as the by-product of business process execution. Table 1 shows the analogy between product manufacturing and information manufacturing to manage information as a product.

	Product Manufacturing	Information Manufacturing
Input	Raw Material	Raw Data
Process	Assembly Line	Information System
Output	Physical Products	Information Products

Table 1. Products vs. Information Manufacturing

Source: (Wang et al. 1998)

Six-sigma is an organized and systematic method and the scientific method to make reductions in defect rates (Linderman et al. 2003). Applying six-sigma methodology to IQ assessment, therefore, provides benefits, such as defining critical factors to quality, measuring current quality (sigma) level, analyzing deficiencies in information and identifying the root causes of poor information, improving quality of information products, and controlling standardized IQ assessment framework.

SIX-SIGMA BASED IQ FRAMEWORK

Using a product perspective of information, the authors developed an IQ assessment framework (see Lee and Haider 2011). Figure 1 illustrates the IQ framework, which consists of four phases, i.e. establishing IQ requirements, identifying IQ dimensions, implementing six-sigma, and assessing IQ. These phases are described below.

- Establishing stage, i.e. to establish IQ objectives and requirements from customers of information to ascertain their information related issues/problems/complaints, and how to transform the complaints in accordance with the business rules.
- Identifying stage, i.e. the pre-processing of the IQ measurement and analysis. As IQ cannot be 'objectively' measured due to the complexities of IQ dimensions; the 'identifying stage' reveals details, correlation, and impact of IQ dimensions on each other as well as overall IQ.
- Implementing stage, i.e. the measurement of IQ. In this stage, the identified IQ dimensions in identifying stage are applied. IQ dimensions are measured and analysed by revealing critical factors and root causes of poor information.
- Assessing stage, i.e. to compare current IQ measurement results with improved IQ measurement results though continuous IQ monitoring.

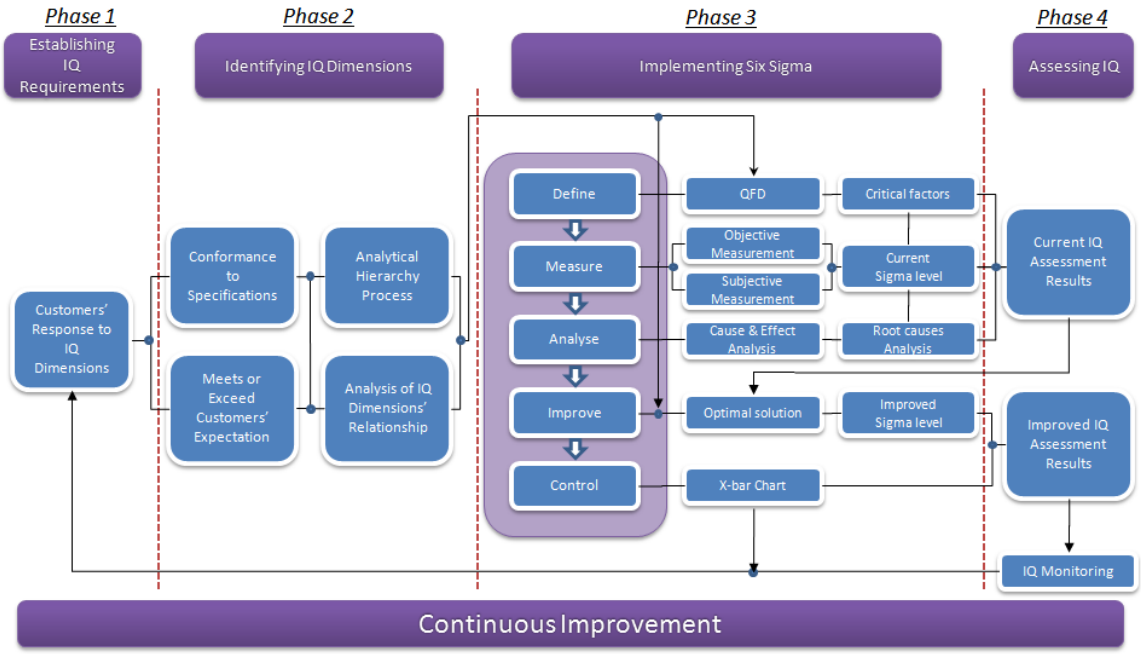


Figure 1. Six-sigma based IQ Framework

Source (Lee and Haider 2011)

THE CASE STUDY

Company A (a leading electronics manufacturer in Seoul, Korea) has centralized IT operations. This means that although the subsidiaries and other offices around the globe have their own IT functions, yet the subsidiaries and other operating offices are required to update information regarding their operation to the company headquarters.

Information Producer	30
Information User	24
Information manager	8
Information owner	3
Information custodian	3

Less than 1 year	8
1 to 3 years	18
4 to 7 years	20
8 to 11 years	16
more than 11 years	6

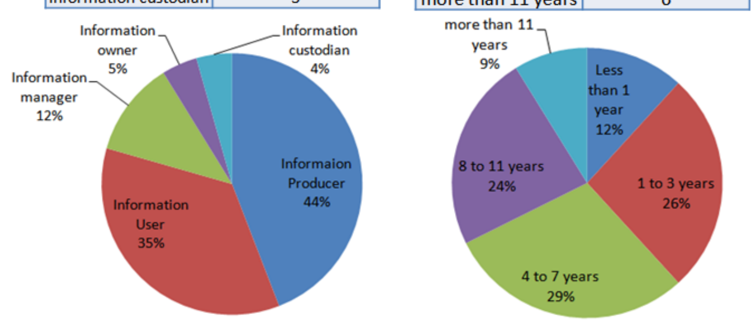


Figure 2. Respondents' profiles

This issue has been happened not only the purchasing procures but also overall divisions in company A. In order to reveal relative importance of IQ dimensions and their mutual relationships, a survey was conducted at the purchase division of the company headquarters in Seoul in between June and July; 2011.The details of the respondents' profiles are illustrated in the figure 2.

Establishing IQ requirement

The first step of 'establishing IQ requirement' seeks information stakeholders' requirement. Figure 3 illustrates the flow of work in purchasing department and highlights its information stakeholders. However, it should be noted that master data management interface in supplier relationship management of company A is an on-line system that enables company A and various suppliers to standardize master data, e.g. parts numbers, order sequences, systems, data associated producing through domestic B2B or international B2B. Over the whole purchasing flow, there have different types of information stakeholders with different point of view to IQ requirements; we selected those who are involved in MDM (Master Data Management) interface in company A as information customers, i.e. IT innovation and purchasing divisions.

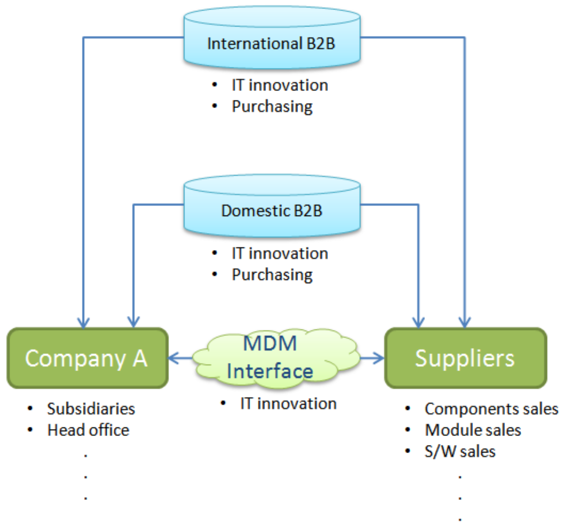


Figure 3. Flow of Purchasing and Information Stakeholders

We identified the information stakeholders as information producers, users, managers, owners, and custodians. Table 2 explains the information manipulation tasks associated with each of these categories at company A.

Type	Definition
Information producer	The person who generates information through processes by stimulating information.
Information user	The person responsible for viewing, amending, updating the content of the information assets. This can be any user of the information in the inventory created by the Information Owner.
Information manager	The person responsible for collecting and managing of information from one or more sources and distributing of that information to one or more information customer.
Information owner	The person responsible for classifying, sorting of information to provide an appropriate level of information and creating an inventory of each type of information.
Information custodian	The person responsible for overseeing and implementing the necessary safeguards to protect the information assets, at the level classified by the Information Owner.

Table 2. Information related task descriptions

Identifying IQ dimensions

The survey instrument consists of three sections, i.e. general information regarding IQ initiatives, relative importance of IQ dimensions, and the relationship of IQ dimension with each other. The general information section focuses on job descriptions and field experience so that results could be classified according to job descriptions as well as experience of knowledge workers with IQ. In the relative importance of IQ dimensions section, questions are asked about IQ dimensions and their relative importance to other dimensions so that pair-wise comparison of IQ dimensions is carried out. The end result of this process is an ordered list of IQ dimensions based on their weight relative to other IQ dimensions. Table 3 illustrates examples of how responses from information stakeholders were mapped to IQ dimensions.

Customer Responses	IQ Requirements	IQ Dimensions
Data does not reflect reality.	Information should be correct, reliable, and certified free of error.	Free of error
Data is no more valid for the task.	Information should be up-to-date for the task at hand.	Timeliness
: :	: :	: :
Data is not available when required.	Information should be available or easily and quickly retrievable.	Accessibility
Data is duplicated or redundant.	Information should be restricted and hence kept secure.	Conciseness

Table 3. Converting Customer Response to IQ dimensions

Since there are many IQ dimensions, it is impossible to assess each IQ dimensions at the same time. Therefore, we classified IQ dimensions into 'conformance to specification' and 'meets or exceeds customer's expectation' broadly. The hierarchy of IQ dimensions is based on PSP/IQ Model (Kahn and Strong 1998). The six IQ dimensions in the 'conformance to specification' have been selected to assess their quality. These dimensions are 'free of error', 'conciseness', 'completeness', 'consistency', 'timeliness' and 'security'. However, in order to gain the relative importance of all IQ dimension in the IQ hierarchy and implement the results to QFD, AHP survey questions contains all IQ dimension and their relative importance were computed.

AHP (Analytic Hierarchy Process)

Information gathered from the survey was collated and AHP was applied to the data collected. Table 4 shows the results of the AHP applied to the respondents and hierarchy of IQ dimensions. The survey results indicate the 'meets or exceeds customer's expectation' is slightly higher than the 'conformance to specifications'. It is, therefore, not unreasonable to postulate that being a manufacturing organization, company A, is aware of importance of both customers and product manufacturing based quality perspectives.

	Categories		Quality Perspective		IQ Dimensions	Weight	Local order
Information Quality Dimensions for improvement	Conformance to Specifications	0.474	Information Product Quality	0.638	Free of Error	0.290	1
					Conciseness	0.284	2
					Completeness	0.215	3
					Consistency	0.211	4
			Information Service Quality	0.362	Timeliness	0.502	1
					Security	0.498	2
	Meets or Exceeds Customer's Expectations	0.526	Information Product Quality	0.314	Appropriate Amount	0.065	5
					Relevancy	0.240	2
					Ease of Understanding	0.167	3
					Interpretability	0.163	4
					Objectivity	0.365	1
			Information Service Quality	0.686	Believability	0.510	1
					Accessibility	0.102	3
					Ease of Operation	0.073	4
					Reputation	0.315	2

Table 4. Summary of AHP applied to Respondents' Responses

This is because information users, custodians, and managers can easily see the impact of the quality, or lack of quality of information, on their work. It, therefore, relates easily to 'conformance to specification' than 'information service quality' perspective, which is more abstract and relative in terms of task, user, or context. On the other hand, it is obvious that the weight of 'information service quality' is higher than the 'information product quality' in the 'meets or exceeds customer's expectations' category, because the 'information service quality' is more connected with subjective perspective.

Table 5 and 6 illustrate how IQ dimensions differs with job descriptions. Table 5 summarizes the responses of information producers, whereas table 6 summarizes the responses from information users.

	Categories		Quality Perspective		IQ Dimensions	Weight	Local order
Information Quality Dimensions for improvement	Conformance to Specifications	0.454	Information Product Quality	0.620	Free of Error	0.328	1
					Conciseness	0.258	2
					Completeness	0.214	3
					Consistency	0.200	4
			Information Service Quality	0.380	Timeliness	0.559	1
					Security	0.441	2
	Meets or Exceeds Customer's Expectations	0.546	Product Quality	0.403	Appropriate Amount	0.059	5
					Relevancy	0.263	2
					Ease of Understanding	0.149	4
					Interpretability	0.165	3
					Objectivity	0.364	1
			Service Quality	0.597	Believability	0.538	1
					Accessibility	0.104	3
					Ease of Operation	0.060	4
					Reputation	0.298	2

Table 5. Summary of Information Producers Responses

	Categories		Quality Perspective		IQ Dimensions	Weight	Local order
Information Quality Dimensions for improvement	Conformance to Specifications	0.413	Information Product Quality	0.657	Free of Error	0.240	2
					Conciseness	0.324	1
					Completeness	0.220	3
					Consistency	0.216	4
			Information Service Quality	0.343	Timeliness	0.434	2
					Security	0.566	1
	Meets or Exceeds Customer's Expectations	0.587	Information Product Quality	0.224	Appropriate Amount	0.078	5
					Relevancy	0.148	4
					Ease of Understanding	0.225	2
					Interpretability	0.177	3
					Objectivity	0.372	1
			Information Service Quality	0.776	Believability	0.455	1
					Accessibility	0.126	3
					Ease of Operation	0.092	4
					Reputation	0.327	2

Table 6. Summary of Information Users Responses

In the first category from the two tables, the difference between the 'conformance to specifications' and the 'meets or exceeds customer's expectations' from information producers and users is not considerable, but the 'information product quality' and the 'information service quality' in the meets or exceeds customer's expectations has significant disparity. For instance, whereas the gap between the 'information product quality' and the 'information service quality' from information users is 0.552, the gap from information producers is only 0.194. This result can easily be justified according to the job descriptions of information producers and information users. The information producer generates information through processes by simulating information; whereas information user is responsible for viewing, amending, updating the content of the information. In this regard information users are intimately linked with 'fitness for use' perspective of IQ and they strongly consider customers' viewpoints than information producers. There are also remarkable differences in the IQ dimensions as an assessment item. The 'free of error' dimension ranks first in the local order by information producers, on the other hand 'conciseness' dimension ranks first in the local order by the information users. In addition, 'completeness' and 'consistency' has the same rank from both information producers and users. This rank difference can be interpreted as that the information producers' main task is to generate information, and thus correct information is more important to them. In contrast to the information producers, the 'conciseness' dimension is more emphasized by information users because it can be the critical factor for them to perform their task. In this regard, the higher value of the 'ease of understanding' and 'ease of operation' dimensions by information user than information producer is also understandable.

Analysis of IQ Dimensions' Relationship

The results of survey section three contain the relationship of each IQ dimension in the 'information product quality' of the 'conformance to the specification'. As mentioned in the beginning of this section, since the survey is conducted in a manufacturing organization, only four IQ dimensions, i.e. 'free of error', 'conciseness', 'completeness', and 'consistency' were analyzed. Based on the definition of the four IQ dimensions, the most related IQ dimensions against each four dimension were determined to discover how much they affect each other. The 'free from error' dimension embraces the information attribute that are related to reflecting the real-world such as correctness, reliability, and certifying values. Therefore, the set of IQ dimensions, i.e. 'reputation', 'ease of operation', 'consistency', 'conciseness', and 'interpretability' were chosen as the list for respondents to rate the relative importance of 'free from error' against. Figure 4 shows the results of 'free from error' IQ dimension. From all respondents' point of view, 'reputation' is outlined as the most related dimension with 34% to 'free from error'. The 'reputation' means the information that is trusted or highly regarded in terms of their source or contents. In other words, 'reputation' represents the raw information sources that are used to create the information product. The quality of 'free from error', therefore, interacts strongly with the 'reputation' compared to the rest of dimensions.

Interestingly, while the 'ease of operation' is rated by 27% of information producers, no one in the information users choose this dimension. It appears likely to us that the information users prefer to use information from reliable sources for correctness rather than 'ease of operation'; given the fact that the 'reputation' dimension is rated by 42% of the respondents as having an important relationship with 'free from error' in the information users group.

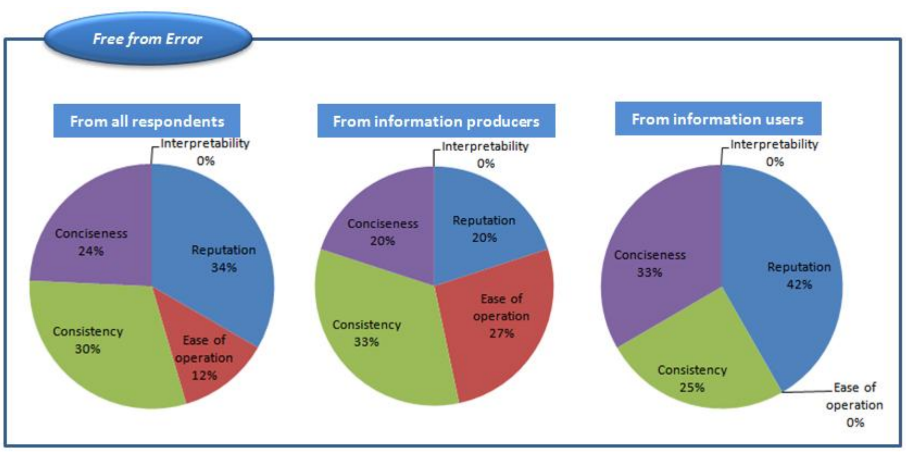


Figure 4. Relationship of 'Free from Error' IQ Dimension

The 'completeness' dimension represents the information attribute that is of sufficient breath, depth, and scope for the task at hand. Therefore, the set of IQ dimensions which are regarded as the most related dimensions, include, 'objectivity', 'ease of operation', 'relevancy', 'timeliness', and 'believability' with the 'completeness' were asked to the respondents. Figure 5 shows the relationship of 'completeness' with other dimensions. From all respondents' point of view, 'relevancy' is outlined as the most related dimension with 55% response to ‘completeness’. Given the attribute of ‘relevancy’, it should not surprise us that the dimension marks the highest relationship percentage. The attributes of ‘relevancy’ relate to the information that is applicable and helpful for the task at hand. As the dimension is mostly related to supporting a given process, helping decision making, adapting to other application and linkage, there is a striking connection between ‘completeness’ and ‘relevancy’. This connection is supported here, since both information producers and users groups gave the highest percentage to the ‘relevancy’ dimension even though the information users rated it 13% higher than information producers.

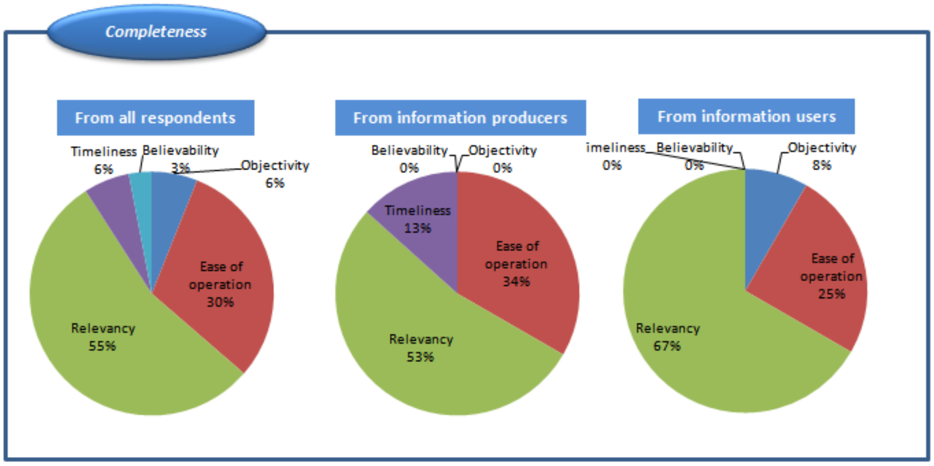


Figure 5. Relationship of ‘Completeness’ IQ Dimension

The ‘consistency’ dimension embodies the information attribute that is always presented in the same format and is compatible with previous information. Therefore, the set of IQ dimensions related to this dimension include, ‘free from error’, ‘timeliness’, ‘completeness’, ‘interpretability’, and ‘ease of operation’ were asked to the respondents. Figure 6 shows the relationship of ‘consistency’ with these dimensions as deemed by the survey respondents. From all respondents’ point of view, ‘interpretability’ has the highest score with 37%, whereas ‘timeliness’ is second with 27%, followed by ‘completeness’ rated as 18%. A sharp contrast is drawn between the two groups toward the relationship with ‘consistency’; whereas information producers indicate that ‘timeliness’ is most related with ‘consistency’ dimension, ‘interpretability’ was chosen by information users as the most related dimension for ‘consistency’. The significant disparity seems to be explained by the difference task roles of the two groups. In general, information producers are supposed to generate information based on their task. As the ‘timeliness’ concerns how long the information remains valid it can be related to the compatibility with previous information when they generate new information.

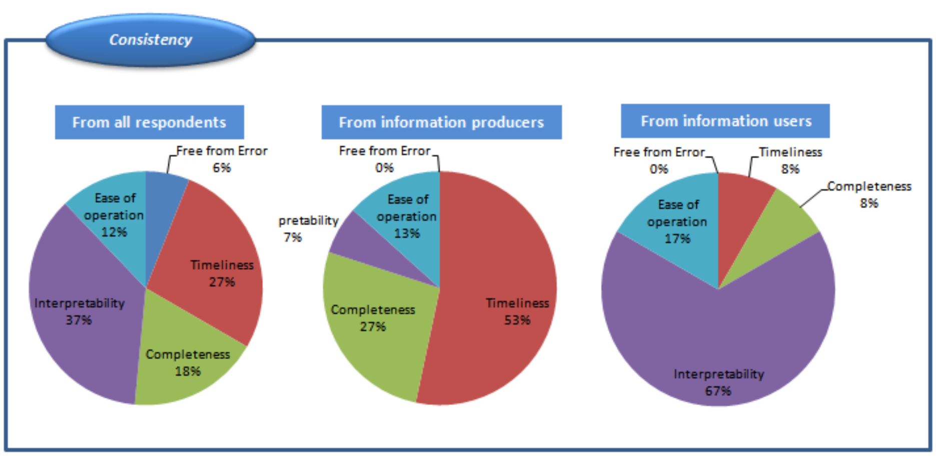


Figure 6. Relationship of ‘Consistency’ IQ Dimension

It is highly reasonable to note that 'interpretability' was ranked as the highest with 67% for the relationship with the 'consistency' by the information users. 'Interpretability' describes the attributes of the information that is appropriate language and units and clear definition, it has strong connection with the factors of the 'consistency' such as same format or compatibility from the information users' point of view.

The 'conciseness' dimension represents the information attributes that are compactly represented without being overwhelming. Therefore, the set of IQ dimensions related to this dimension including 'free from error', 'completeness', 'consistency', 'ease of understanding', and 'timeliness' were asked to the respondents. Figure 7 shows the relationship of 'conciseness' with other dimensions. From all respondents' point of view, the 'ease of understanding' dimension has the highest relationship with the 'conciseness'. Since 'ease of understanding' pursues the information that is to be clear without ambiguity and easily comprehended, it is highly reasonable that the 'conciseness' has the strongest relationship with the 'ease of understanding', as shown in figure 7. The reason why information users group ranked 'ease of understanding' higher than information producers group can be explained by the fact that information users, in general, amend, update, and view information and thus this dimension is helpful for their job.

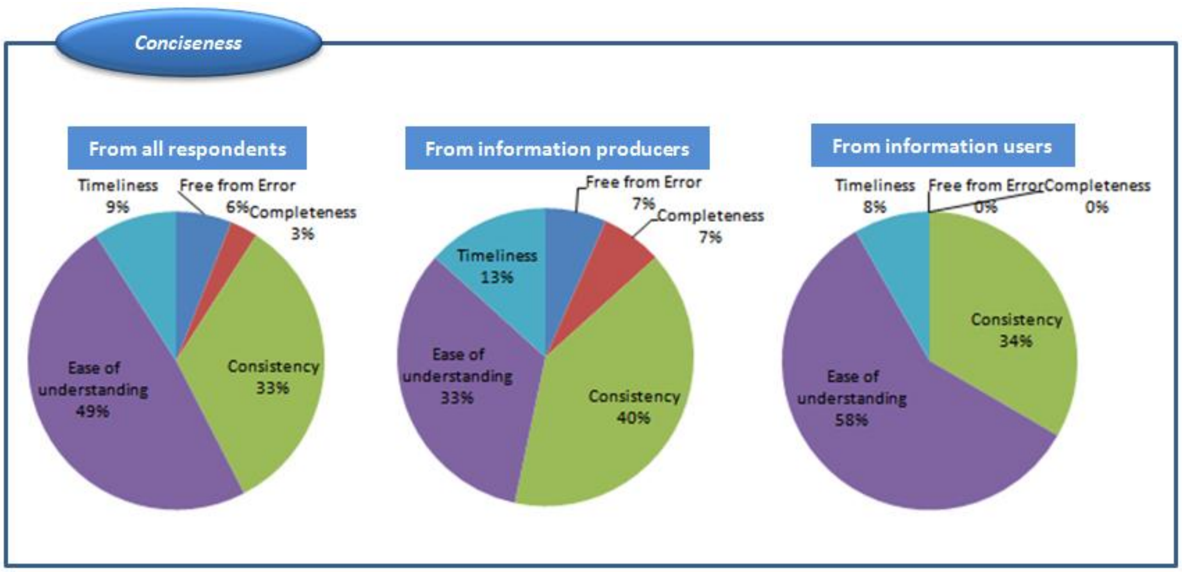


Figure 7. Relationship of 'Conciseness' IQ Dimension

IMPLEMENTING SIX-SIGMA

Define stage

The define stage consists of three steps, i.e. process, scope, and requirements. At process step, overall structure of information flow is drawn to provide a top down view of IQ from a business perspective. In the scope step, the scope of IQ from an information system perspective is defined to profile IQ dimensions and to identify problems related to IQ. In the requirements step, the specifications of each IQ dimension and IQ rule are defined to meet the customers' requirements utilizing the results of the phase 2 by creating the QFD to identify the correlation of each IQ dimension. Figure 8 shows the key components of define stage.

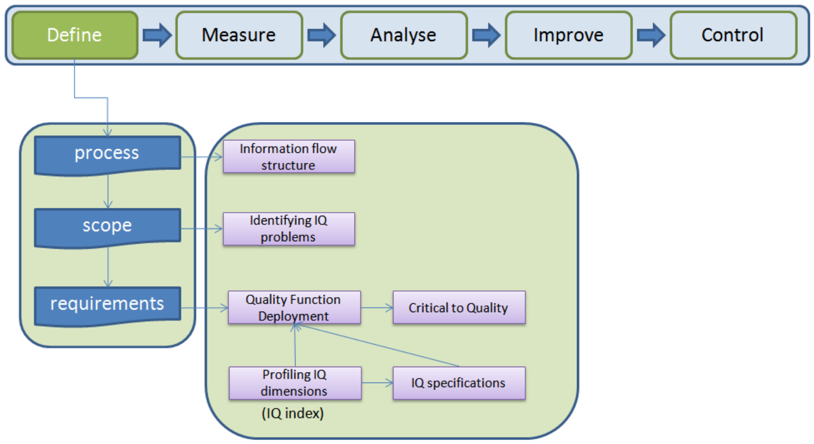


Figure 8. Key Components of Define Stage

Information associated with purchasing process starts from various divisions. For example, if R&D division aims at producing a proto-type product for mass production purpose, the initial information for purchasing starts from R&D division. Likewise, if the project starts from a certain division, the information is generated for the division with the project code, and then the information is generated throughout business processes such as logistics, sales, and business management. Information flow of company A is illustrated in the figure 9.

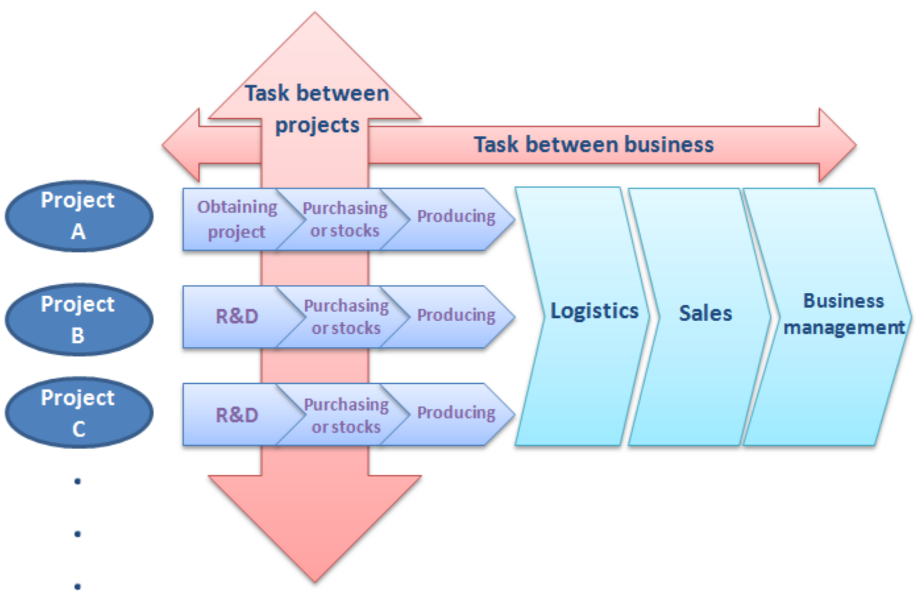


Figure 9. Information Flow of Company A

Scope step - Identifying IQ problems

Identifying IQ problems can be most important activities as it is obviously starting point of quality improvement and linked with outcomes. Company A has been suffered from information which is dealt with different data because of non-standardized information management. It causes different management of information according to the difference between projects and business. Figure 10 shows information related problems in company A.

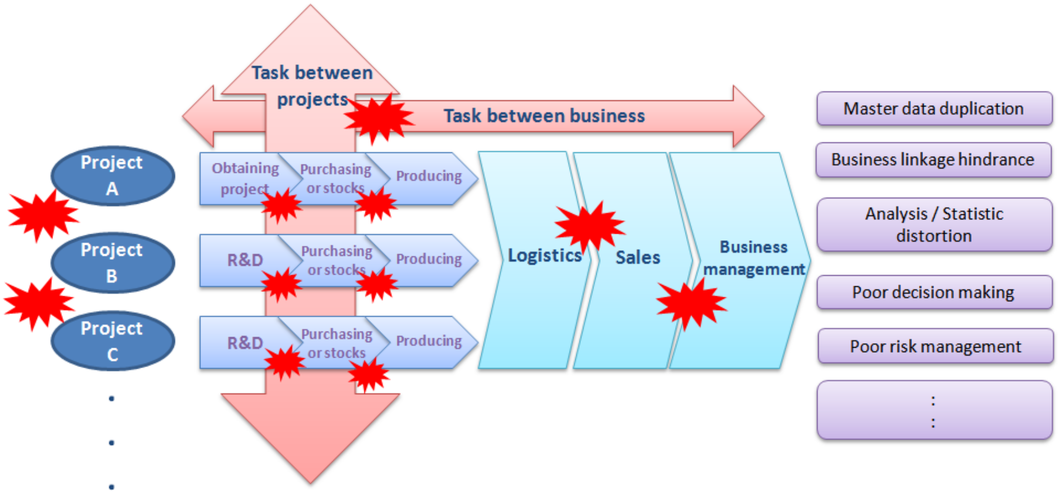


Figure 10. Information Related Problems in Company A

As the information throughout project life-cycle is differently handled, purchasing associated divisions have to manage information in their own policies. Tasks between projects and tasks between businesses also handle information in different management process. Even though the company A recognizes that information should be shared throughout all divisions, each division and subsidiaries operates their own information management system and it affects line of business effectiveness and decision making. In addition, it costs more money because handling information system in different way at one company causes duplicated investment for products components purchasing as well as wasting time. IQ related problems in company A were addressed.

- Master data duplication: non-standardized information, inconsistency of same information
- Business linkage hindrance: Low efficiency of LOB, different operation of IS, lack of master data
- Analysis/statistic distortion: operating poor information, not solid information
- Poor decision making: utilizing biased information or not comprehensive information
- Poor risk management: incomplete management due to missing information

Requirement step

In order to complete IQ requirements, discovering IQ dimensions' relationships and determining each specification of each IQ dimensions should be prepared. Not only the main purpose of this step but also the most important outcome in the define phase is to extract CTQs. CTQ is a decisive factor for quality from customers' perspectives. In order to satisfy customers' expectation, extracting CTQs is crucial and QFD is useful tool to collect and understand customers' requirements to quality.

Quality Function Deployment

As shown in figure 11, the House of Quality (HOQ) is the kernel of QFD. Here, customer requirements (block number 1) matrix is replaced to customer responses collected from the phase 1 of IQ framework. Technical requirements (block number 2) matrix is represented in the hierarchy of IQ dimensions in the phase 2 of IQ framework. Inter-relationships matrix (block number 3) is calculated according to the results of AHP in the phase 2 of IQ framework. Correlation of IQ dimensions (block number 4) matrix is filled by the results of IQ relationship in the phase 2 of IQ framework and its directions of improvement (block number 5) are defined accordingly. Finally, in targets matrix (block number 6), objective or subjective measure and six-sigma level specification are defined to each IQ dimension respectively.

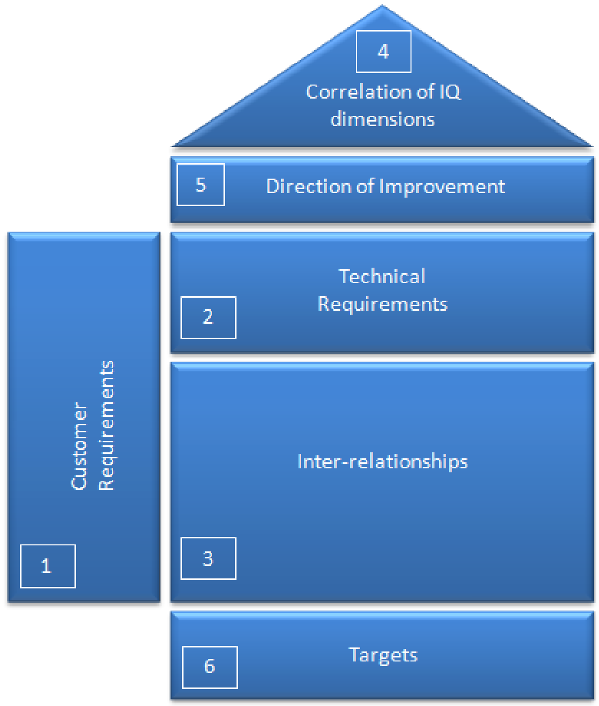
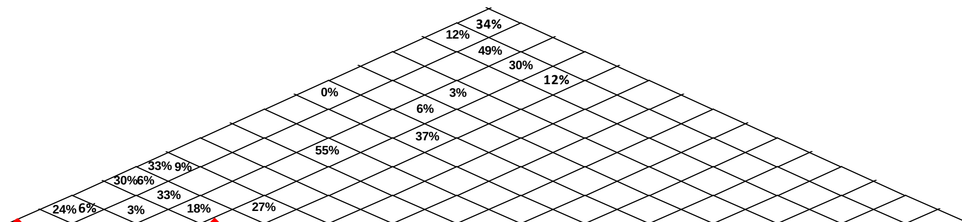


Figure 11. Quality Function Deployment (House of Quality)

Based on HOQ methodology, QFD of company A is filled out to extract CTQ. Firstly, customer requirements (block number 1) are listed on the QFD matrix. And then the weights of importance for customer requirements are assigned with the scale 5 to 1 based on the frequency from interview and survey data. The most frequent customer requirement is assigned scale 5 and the lowest frequency one is assigned scale 1. In the technical requirements (block number 2), all IQ dimensions are place in according the IQ hierarchy defined the phase 2 of IQ framework. Accordingly, each weights of importance of IQ dimension (as calculated from AHP in the phase 2) are allocated. In the inter-relationships matrix (block number 3), the importance value between customer responses and IQ dimensions is calculated, e.g. "high dependency to often changed data policies" is related to "free of error", "conciseness", "completeness", and so on. In this case the weight of importance of customers requirement is multiplied by each related the weight of importance of IQ dimension. When the inter-relationship matrix is conducted, filling the matrix with stakeholders who are actually involved in the information flow is critically important in order to clearly know which customers requires are associated with certain IQ dimensions. Based on the results of relationships of IQ dimension in the phase 2 of IQ framework, the relationship rate is filled in the correlation of IQ dimensions (block number 4) matrix respectively. For example, as the "completeness" dimension has 27% of relationship with "Timeliness" dimension, the relationship value is filled in the matrix between "completeness" and "Timeliness" in the correlation of IQ dimensions. Here the direction of improvement (block number 5) indicates of mutual inter-relationship. Finally, targets matrix (block number 4) contains assessments methods for each IQ dimension about objective or subjective measurement of IQ as well as each IQ specification. In addition, CTQs are determined based on the results of interrelationship results. Here, 'believability', 'timeliness' and 'conciseness' are determined as CTQs of company A. Figure 12 shows the QFD results of company A.



Direction of improvement																
HOWS / WHATS	Weights of Importance	Conformance to Specification						Meets or Exceeds Customer's Expectations								
		Information Product Quality				Information Service Quality		Information Product Quality					Inforamtion Service Quality			
		Free of Error	Conciseness	Completeness	Consistence	Timeliness	Security	Appropriate Amount	Relevancy	Ease of Understand	Interpretability	Objectivity	Believability	Accessibility	Easy of Operation	Reputation
Weights of importance		0.290	0.284	0.215	0.211	0.502	0.498	0.065	0.240	0.167	0.136	0.365	0.510	0.102	0.073	0.315
High dependency to often chagened data policies	2	0.580	0.568	0.430	0.422	1.004			0.480	0.334		0.730	1.020		0.146	0.630
lack of license to assess IQ	1													0.102		
Difiiculty of data trace	2				0.422				0.480						0.146	
data distortion when integrating	3		0.852	0.645	0.633										0.219	
Long process time to update data	3		0.852			1.506									0.219	
My information is open to everyone	1						0.498									
Manual data handling always makes poor information.	4	1.160											2.040		0.292	
poor definition of data cycle.	3		0.852			1.506			0.720					0.306		
Lack of data ownership	5	1.450							1.200		0.680		2.550		0.365	1.575
Lack of professionall skill to IQ	3	0.870	0.852	0.645	0.633	1.506	1.494	0.195	0.720	0.501	0.408	1.095	1.530	0.306	0.219	0.945
Late delivery of information	3					1.506								0.306	0.219	
various foramt of data	4	1.160	1.136	0.860	0.844			0.260	0.960	0.668				0.408	0.292	
undefined tolerance of each IQ dimensions	3	0.870	0.852	0.645	0.633	1.506	1.494	0.195	0.720	0.501	0.408	1.095	1.530	0.306	0.219	0.945
Lack of understanding which data is more important for the task	2	0.580	0.568	0.430	0.422	1.004	0.996	0.130	0.480	0.334	0.272	0.730	1.020	0.204	0.146	0.630
various way to enter data	3	0.870								0.501					0.219	
too much data that are not often used in IS	3							0.195	0.720						0.219	0.945
poor understatanding of data stucture	3		0.852							0.501	0.408	1.095		0.306	0.219	
Difficulty of Real-time analysis	2														0.146	
Un-synchronized data with business framework	4				0.844				0.960	0.668					0.292	
Too much transaction code	3		0.852	0.645	0.633										0.219	
poor definition of data entity	3		0.852	0.645	0.633	1.506	1.494		0.720	0.501		1.095	1.530	0.306	0.219	0.945
non-standarized data representation	5	1.450	1.420	1.075	1.055	2.510	2.490	0.325	1.200	0.835	0.680	1.825	2.550	0.510	0.365	1.575
Too much restrction to assess data	2						0.996							0.204	0.146	
Too much time to retreive data from repository	3	0.870	0.852	0.645	0.633	1.506	1.494	0.195	0.720	0.501	0.408	1.095	1.530	0.306	0.219	0.945
Lack of data storage	1							0.065							0.073	
Assessment methodology		O	O,S	S	S	O,S	O	O,S	S	S	S	S	S	O,S	S	S
Six sigma specification																
Absolute importance		9.860	11.360	6.665	7.807	15.060	10.956	1.560	10.080	5.845	3.264	8.760	15.300	3.570	4.818	9.135
CTQ selection			3			2							1			

Figure 12. QFD Results of Company A

Critical to Quality

From the requirement step of QFD as shown in figure 13, the CTQs and their root causes are as follows.

- Believability: data policy dependency, manual handling, lack of data ownership, handling skills, undefined tolerances, poor understanding data usages, poor data entity definitions, non-standardized data representation, data retrieval time
- Timeliness: data policy dependency, response time, poor data cycle definition, handling skills, various formats, undefined tolerances, poor understanding data usages, poor data entity definitions, non-standardized data representation, data retrieval time
- Conciseness: data policy dependency, data distortion while integrating, response time, poor data cycle definition, handling skills, poor understanding of data structure, various transaction code, poor data entity definitions, non-standardized data representation, data retrieval time

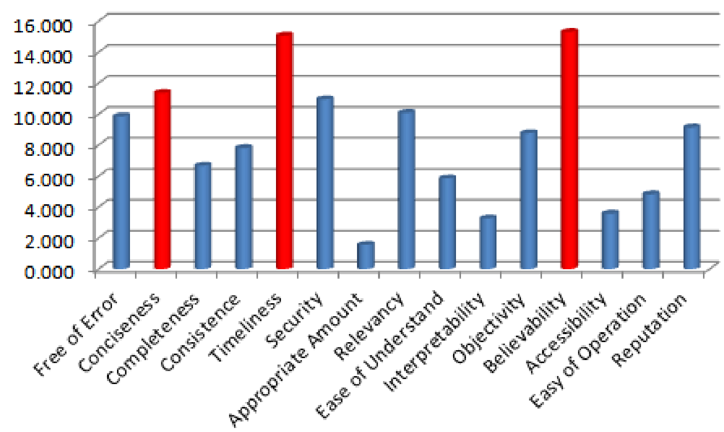


Figure 13. CTQs Selection from QFD Results

These CTQs represent the key measurable characteristics of information in Company A, which must be whose performance standards or specification limits must be met in order to information stakeholders. Now that these four dimensions have been identified Company A needs to align needs to introduce improvements in systems and practice to align IQ stakeholders' requirements with the information being captured, processed, and stored in the organization.

CONCLUSION AND FUTURE WORK

In this paper, we have presented the case study IQ assessment in a Korean manufacturing organization. The paper has handled the issue of objective assessment of IQ dimensions. It has explained how qualitative responses can be converted to quantitatively measureable IQ dimensions with the help of statistical tools and methodologies. A major contribution of this paper is the demonstration of how individual IQ dimension affects other dimensions, by highlighting the relationship between them. This case study presented in this paper reports the findings from the assessment phase of the six sigma based IQ management framework proposed by Lee and Haider (2011). In the next step, the findings (in particular the CTQs and dimensions relationships) will be utilized to suggest improvements in IQ at company A. These improvements will then be monitored using X-bar charts to assess each dimension of quality within the safe limits as ascertained from Company A's information systems and workflows.

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