

Product and Service Performance Model for Information Quality: An Update

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Abstract

The Product and Service Performance Model for Information Quality (PSP/IQ Model) integrates definitions from the Total Quality Management literature, specifically quality as conformance to specifications and quality as meeting or exceeding customer expectations, with the product and service characteristics of information, producing a two by two framework. This paper highlights the assignment of the Wang-Strong IQ dimensions to the four quadrants of the PSP/IQ Model. Quadrant IQ values can be determined using the IQA Instrument to measure the associated IQ dimensions, thus providing a means for assessing an organization's IQ. The PSP/IQ Model provides the foundation for IQ assessment, benchmarking, and improvement over time.

1 Introduction

The Product and Service Performance Model for Information Quality (PSP/IQ Model) was first introduced at the 1997 Conference on Information Quality by Kahn, Strong and Wang [1997] (as shown in Appendix A). The attendees of IQ1997 were instrumental in providing data and comments for the refinement of this model. This paper presents the evolution of the PSP/IQ Model into its final form, which is described in [Kahn, Strong, & Wang, Forthcoming].

The PSP/IQ Model focuses on product or service delivery and on how quality can be assessed by specifications or by customer expectations. These are key quality aspects that are relevant to delivering better quality information. This paper describes the process of assigning the Wang-Strong IQ dimensions to the four quadrants of the PSP/IQ model, and the resulting final form of the PSP/IQ model. The application of the PSP/IQ Model to IQ assessment and benchmarking is briefly discussed.

2 The PSP/IQ Model

The PSP/IQ Model has its basis in two related areas. First is the general area of total quality management [Deming, 1986; Juran, 1988]. Four general views of quality have been presented in this literature, quality as excellence, quality as value, quality as conformance to specifications, and quality as meeting or exceeding consumer expectations [Reeves & Bednar, 1994]. While the view of quality has moved from excellence to meeting consumer expectations, all of these views of quality are in use today. Defining quality as excellence is problematic because it is subjective and provides no practical guidance for improving quality. Quality as excellence ignores the potentially high costs of achieving excellence. Defining quality as value captures tradeoffs between excellence and costs, but other attributes of importance to consumers may be ignored. Furthermore, quality as value blends excellence and worth resulting in a hybrid concept of affordable excellence. Thus, we focus on the latter two views of quality, quality as conformance to specifications, and quality as meeting or exceeding consumer expectations.

The advantage of *conformance to specifications* is that it usually can be defined and measured. In contrast to conformance to specifications, quality has been defined as *meeting or exceeding consumer expectations* [Reeves & Bednar, 1994]. Simply conforming to specifications is not enough, the product or service must meet or exceed what consumers expect from it. Since these consumer expectations may change over time, a quality product or service may not remain a quality product or service for long. While this definition may capture the essence of fitness for use, whether quality has been achieved can be difficult to measure. The preceding analysis leads us to adopt *conformance to specifications* and *meeting/exceeding consumer expectations* as the columns in our PSP/IQ model.

The second source for our model is the marketing literature. Recent quality literature has distinguished between *product quality* and *service quality*, e.g., [Zeithaml, Berry, & Parasuraman, 1990]. Product quality includes dimensions related to the features of the product. Service quality includes dimensions related to the process of delivering the service, in addition to the quality of the actual service received. Both product and service quality are important aspects of IQ. This leads us to adopt *Product Quality* and *Service Quality* as the two rows of the PSP/IQ Model.

The PSP/IQ model, summarized in Table 1, consists of four quadrants that capture how well organizations produce *sound* and *useful* information products and deliver *dependable* and *usable*

information services to information consumers. These four quadrants are formed from two rows, product and service quality, and two columns, conforms to specifications and meets or exceeds customer expectations. The *product quality* aspect of information addresses the tangible measures of accuracy, completeness, and freedom from errors, whereas the *service quality* aspect of IQ addresses the intangible measures of ease of manipulation, security, and accessibility of the information to consumers. *Conforms to specifications* captures the goals of information producers and IS professionals. *Meets or exceeds consumer expectations* captures the view that information must be useful to the tasks of information consumers.

	Conforms to Specifications	Meets or Exceeds Consumer Expectations
Product Quality	<p><u>Sound Information</u> The characteristics of the information supplied meet IQ standards.</p>	<p><u>Useful Information</u> The information supplied meets the information consumer task needs.</p>
Service Quality	<p><u>Dependable Information</u> The process of converting data into information meets standards.</p>	<p><u>Usable Information</u> The process of converting data information exceeds information consumer needs.</p>

Table 1: The PSP/IQ Model

The *sound information* or *soundness quadrant (product quality/conforms to specifications)* captures the concept of the basic characteristics needed to consider information to be of high quality, e.g., being accurate, complete, and free-of-error. For example, a database with 99% accuracy and completeness of inventory information would have high quality for this quadrant.

The *dependable information* or *dependability quadrant (service quality/conforms to specifications)* captures the concept of the basic characteristics needed to consider the delivery of information to consumers to be of high quality. For example, if consumers regularly receive inventory information in a timely manner, then the basic service specifications for the information product are met.

The *useful information* or *usefulness quadrant (product quality/meets consumer expectations)* captures the concept that an information product can only meet/exceed consumer expectations if it is useful and relevant for consumers' tasks. For example, if consumers need

inventory information broken down by warehouse location, then the inventory information product is only of high quality if this breakdown exists.

The *usable information* or *usability quadrant* (*service quality/meets consumer expectations*) captures the concept that an information service can only meet/exceed consumer expectations if information consumers can easily and conveniently acquire and tailor that service to their needs. For example, consumers must be able to use the query language provided to retrieve easily the specific inventory information they need to make effective decisions.

The quadrants of the PSP/IQ model provide a view of IQ that is meaningful to decision-makers. Measures for each quadrant would provide information to these decision-makers for benchmarking the current status of IQ in their organizations. Since the Wang-Strong IQ dimensions [Wang & Strong, 1996] provide a means for measuring information quality, it follows that mapping the IQ dimensions into the quadrants has practical benefits.

3 Method for Mapping the IQ Dimensions to the PSP/IQ Quadrants

The Wang-Strong dimensions are mapped into the PSP/IQ quadrants according to whether they can be achieved by conformance to specifications or by considering the changing expectations of consumers performing organizational tasks. We also consider whether each IQ dimension is primarily an aspect of product quality or of service quality. Distinguishing IQ dimensions in this manner help IS professionals understand the requirements for delivering high-quality information.

A three-page questionnaire (see Appendix B) was developed to collect data for determining which IQ dimensions belong to each quadrant of the PSP/IQ Model. The first page of the questionnaire lists the characteristics of products, the characteristics of services, the definition of conforming to specifications, and the definition of meeting/exceeding consumer expectations. The second page lists the IQ dimensions in alphabetical order with the definition of each dimension. For each IQ dimension, the respondent checks only one of two boxes, one labeled product and the other service. The third page is similar, but the boxes are labeled conforms to specifications and meets/exceeds consumer expectations. This method separately determines the placement of each IQ dimension into one of the rows of our PSP/IQ model and into one of the columns. Using this questionnaire, data were collected from 45 professionals.

Each dimension was assigned as a product or service (i.e., selection of the appropriate PSP/IQ row) followed by its assignment as characteristic of conforms to a specification or meets and exceeds consumer expectations (i.e., selection of the appropriate PSP/IQ column). All dimensions had at least 60% agreement among respondents as to the assignment; the agreement for most dimensions was substantially higher. To validate these assignments, a composite variable was created representing the quadrant to which a respondent assigned a dimension. In all cases, this quadrant assignment agreed with the separate row/column assignments.

The name of each quadrant was developed to represent the essence of its constituent dimensions and the meaning of the respective column and row. The names are described in Table 1. The results of mapping the IQ dimensions into the four PSP/IQ quadrants are shown in Table 2. This mapping organizes the IQ dimensions in a manner useful for the purposes of IQ assessment and improvement.

	Conforms to Specifications	Meets or Exceeds Consumer Expectations
Product Quality	<u>Sound Information</u> IQ Dimensions: <ul style="list-style-type: none"> • Free-of-Error • Concise Representation • Completeness • Consistent Representation 	<u>Useful Information</u> IQ Dimensions: <ul style="list-style-type: none"> • Appropriate Amount • Relevancy • Understandability • Interpretability • Objectivity
Service Quality	<u>Dependable Information</u> IQ Dimensions: <ul style="list-style-type: none"> • Timeliness • Security 	<u>Usable Information</u> IQ Dimensions: <ul style="list-style-type: none"> • Believability • Accessibility • Ease of Operation • Reputation

Table 2: The PSP/IQ Model

The resulting dimension assignments and quadrant names in the final PSP/IQ model shown in Table 2 are different from initial PSP/IQ Model presented at IQ 1997 [Kahn, Strong & Wang 1997]. IQ researchers developed the initial model, whereas the final model represents the views of information consumers and IS professionals. Differences between the initial and final PSP/IQ models are described in Appendix A.

One of the original IQ dimensions, value-added, was dropped in the final PSP/IQ Model [Kahn, Strong, & Wang, Forthcoming]. Value-added was dropped because statistically it was inconsistent with the other dimensions in the Usability Quadrant.

4 Using the PSP/IQ Model

While the PSP/IQ model provides a useful conceptual framework for managers, the value of the model is enhanced by the ability to measure an organization's IQ in each quadrant. The IQA Instrument [CRG, 1998] measures the values for the fifteen IQ dimensions, which can be used to compute IQ values for each quadrant.

The IQA Instrument is a 4-page questionnaire used to assess IQ in organizations. There are 65 IQ assessment items, four to five items per dimension, in the questionnaire. The scale used in assessing each item ranges from 0 to 10 where 0 is labeled "Not at All", the mid-point of the scale, 5, as "Average" and 10 is labeled "Completely." Values for each quadrant of the PSP/IQ model are computed as the mean of the values of its constituent dimensions. Typically, the respondents within a single organization focus their IQ assessment answers on one set of information of importance to their organization, e.g., patient information in healthcare organizations.

The IQA Instrument has been validated. IQ researchers reviewed the survey items to check that the items covered the dimension and did not include items that overlapped dimensions. Users of information reviewed the items to check that the items are meaningful to information consumers and other respondents. A pilot test was also conducted.

The numeric quadrant values provide an understanding of the current state of IQ in an organization. The relative magnitude of these quadrant values highlights problem areas. After a quality improvement effort, the IQA Instrument can be re-administered to evaluate the impact of the improvement process.

The IQA Instrument collects the respondent's role in the organization. Respondents representing the three information manufacturing roles, i.e., information collectors, information consumers, and IS professionals [Strong, Lee, & Wang, 1997a, 1997b] are potentially useful for assessing IQ in organizations. Information consumers and IS professionals, especially, are key respondents of the IQA Instrument. These are the roles most pertinent in the overall information quality assessment process.

The quadrants can be evaluated separately for each information manufacturing role, specifically information consumers and IS professionals. These two groups do not always agree on the state of IQ. The magnitude of the gap between their assessments can pin point problems

areas. Before real improvement can be obtained, information consumers and IS professionals need to have a common target.

The above applications of the PSP/IQ model are intra-organizational. That is, a single organization can assess its IQ over time by quadrants and roles. Organizations, however, are often concerned with their performance with respect to their competitors, or inter-organizational analysis. The IQA Instrument provides a benchmark of the current status of IQ in an organization. IQ data collected from several organizations can be used for benchmarking.

The combination of the PSP/IQ model, the IQA Instrument, and techniques for analyzing IQ assessment by quadrants and roles provide a useful methodology for assessing, benchmarking, and improving IQ in organizations. This methodology, which we call the AIMQ (AIM Quality) methodology, provides a rigorous and pragmatic basis for IQ assessments and benchmarks. It is described in [Wang, Strong, Kahn & Lee, 1998].

5 Conclusion

The PSP/IQ model captures the important aspects of delivering high-quality information products and services to information consumers. The refined PSP/IQ model consolidates the dimensions into four quadrants, sound information, dependable information, useful information, and usable information (Tables 1 and 2). These four quadrants represent IQ aspects that are relevant to IQ improvement decisions.

The IQA Instrument measures IQ for each of the IQ dimensions, which are aggregated into a value for each quadrant. These measures provide information needed for assessing IQ and deciding where to focus IQ improvement efforts.

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Appendix A: The Initial Product-Service Model

The PSP/IQ Model was first introduced at the 1997 Conference on Information Quality [Kahn, Strong and Wang 1997]. This Appendix presents the initial model and explains briefly the differences between the initial model presented at the IQ 1997 conference and the final version of the model described in the main body of the paper.

In the initial model, the objectives of each quadrant was defined using the definition of the respective row (e.g., a product or service property) and column (e.g., a property of conformance to specification or a property related to customer expectations). Properties of a product were assumed to be tangible whereas, properties of a service were assumed to be intangible. Properties related to conformance to specifications can be defined, as in a specification, and can be measured or evaluated with respect to the specification. On the other hand, characteristics related to customer expectations change over time and are task-dependent. These characteristics are usually more difficult to measure and evaluate.

To assign the IQ dimensions to quadrants for the initial model, we started with the following general sense of the characteristics of dimensions belonging to each quadrant. The IQ dimensions in the *Product Quality/Conformance to Specifications Quadrant* are tangible and usually measurable. These dimensions are independent of task and decision. The dimensions in this quadrant correspond to the traditional measures of IQ.

The IQ dimensions in the *Product Quality/Customer Expectations Quadrant* are dependent on the specific tasks and decisions of the information consumer. IQ dimensions in this quadrant relate to providing an information product that the information consumer can understand and interpret and make valid inferences from it.

The IQ dimensions in the *Service Quality/Conformance to Specifications Quadrant* relate to providing information consumers the information product through a service that can easy to use and provides information customized to their needs. Like any service, information delivery is an event that can be only evaluated after the event occurs.

The IQ dimensions in *Service Quality/Customer Expectations Quadrant* relate to providing the information consumer with a service. These dimensions distinguish one service from another from a consumer's point of view based on the task or decision at hand. The effectiveness of the decision made or the task performed is improved as a direct result of the information provided.

Using the above distinctions between the columns and rows of the PSP/IQ Model and the general quadrant definitions, the authors and other IQ researchers brainstormed and assigned the sixteen Wang-Strong IQ dimensions [Wang & Strong 1996] to the specific PSP/IQ quadrants. The group did not restrict a single IQ dimension to only one quadrant. Our assignments are shown in Table A. IQ dimension assignments that are different from the assignments in final model (Table 2) are shown in italics.

	Conforms to Specifications	Meets or Exceeds Consumer Expectations
Product Quality	<ul style="list-style-type: none"> • Free-of-Error • Completeness • Consistent Representation • <i>Believability</i> • <i>Timeliness</i> 	<ul style="list-style-type: none"> • Relevancy • Understandability • Interpretability • Objectivity • <i>Reputation</i>
Service Quality	<ul style="list-style-type: none"> • Timeliness • Security • <i>Consistent Representation</i> • <i>Concise Representation</i> • <i>Ease of Operation</i> • <i>Accessibility</i> 	<ul style="list-style-type: none"> • <i>Appropriate Amount</i> • <i>Value-Added</i>

Table A: The Initial PSP/IQ Model

While the initial model represents the agreement of several IQ researchers, the final PSP/IQ model represents the shared view of 45 independent information consumers and IS professionals. The assignment of IQ dimensions by IQ researchers in the initial model presented at IQ 1997 was a preliminary version, since it is not necessarily from the perspective of the information consumer, the ultimate user of the PSP/IQ model. Information consumers rather than IQ researchers provide a more practical and usable dimension assignment to quadrants. Section 3 of the paper describes the information consumer oriented methodology used to finalize the dimension assignments in the PSP/IQ model.

The assignments of approximately half the dimensions differ between the initial model and the final model. Specifically, there are nine dimensions in italics in Table A. On closer examination, however, there are also major similarities between the initial and final models. First, we examine the similarities.

In the *Product quality/conforms to specifications Quadrant*, the initial model contains three of the four final model dimensions, free-of-error, completeness, and consistent representation. In

the *Service quality/conforms to specifications Quadrant*, both dimensions in the final model, timeliness and security, are in the initial model. In the *Product quality/customer expectations Quadrant*, four of the five dimensions are the same as those in the final model, relevancy, understandability, interpretability, and objectivity. Only in the fourth quadrant, *product quality/customer expectations*, do the initial and final models differ substantially.

Now consider the differences between the two models. Many of the differences are whether a dimension refers to a product or a service. For example, in the initial model, we could not decide and assigned two dimensions, consistent representation and timeliness, to both the product and the service quadrants of conforms to specifications. The questionnaire respondents clearly indicate that timeliness is a dimension of service quality and consistent representation is a dimension of product quality. Furthermore, concise representation is also a product dimension rather than a service dimension. Information consumers clearly believe that data representations are a part of the product, not an additional service. In the consumer expectations column, providing an appropriate amount of data is viewed by information consumers as part of providing a quality product, not as an additional service.

Along the conforms to specifications-exceeds consumer expectations axis, information consumers agree that the two dimensions, ease of operations and accessibility, are service quality attributes, but they place them in the meets consumer expectations column. By doing so, they indicate that these dimensions are not easily specified and measured. Believability is the only dimension for which IQ researchers and information consumers disagreed on both the row and column. Researchers placed it in *Product quality/conforms to specifications Quadrant* while consumers placed it in *Service quality/exceeds expectations Quadrant*. Reputation, which is highly correlated statistically with believability, was also placed by consumers in the *Service quality/exceeds expectations Quadrant*. Finally, value-added, which was placed in the same quadrant in both models, was dropped for statistical reasons.

Appendix B: PSP/IQ Refinement Survey

INSTRUCTIONS for Product vs. Service

The sixteen dimensions of information quality on the survey describe desirable characteristics of information. Some of these characteristics are indicative of information as a **product**, while others are more appropriately associated with information as a **service**.

Classify each of the Dimensions as applying to information as either a **Product** or **Service**. Check the appropriate column, **Product** or **Service**. Use your first impression. Use the following definitions of characteristics of products and services to help complete this task.

CHARACTERISTICS OF A PRODUCT

- a tangible item
- when you buy a product, you own it
- can be produced and stored, then sold later
- can be used and often re-used later

CHARACTERISTICS OF A SERVICE

- a deed performed by one party/machine for another
- a service is experienced, used, or consumed
- a service is perishable; you cannot keep it
- are produced and consumed in the same time frame

INSTRUCTIONS for Conformance vs. Expectations

Quality can be measured as **Conformance to Specifications** or as **Meeting /Exceeding Customer Expectations**. Some of sixteen dimensions of information quality are indicative of information as **conforming to specifications**, while others are more appropriately associated with assessing quality information as **meeting/exceeding customer expectations**.

Classify each of the Dimensions as applying to information quality assessed as either conforming to specifications or as meeting or exceeding customer expectations. Check the appropriate column. Use your first impression. Use the following definitions of characteristics of **Conformance to Specifications** or **Meeting/Exceeding Customer Expectations** to help complete this task.

CONFORMING TO A SPECIFICATION

- a specification can be developed for the product or service
- defines how well the product or service meets specifications given the necessary attributes or characteristics
- conformance to specifications can be defined and measured
- has no defects relative to the product or service specifications

MEETING/EXCEEDING CUSTOMER EXPECTATIONS

- the product or service must meet/exceed what customers expect from it
- how well the product or service meets/exceeds customer expectations
- the extent to which a product or service meets/exceeds expectations may change over time
- customer expectations can be difficult to measure

Classify each of the Dimensions as either a Product or Service. Use the definitions on this and the preceding sheet. Use your first impression.

PRODUCT	SERVICE	Dimensions	Definitions
		Accessibility	the extent to which information is available, or easily and quickly retrievable
		Appropriate Amount of Information	the extent to which the volume of information is appropriate for the task at hand
		Believability	the extent to which information is regarded as true and credible
		Completeness	the extent to which information is not missing and is of sufficient breadth and depth for the task at hand
		Concise Representation	the extent to which information is compactly represented
		Consistent Representation	the extent to which information is presented in the same format
		Ease of Manipulation	the extent to which information is easy to manipulate and apply to different tasks
		Free-of-Error	the extent to which information is correct and reliable
		Interpretability	the extent to which information is in appropriate languages, symbols, and units, and the definitions are clear
		Objectivity	the extent to which information is unbiased, unprejudiced, and impartial
		Relevancy	the extent to which information is applicable and helpful for the task at hand
		Reputation	the extent to which information is highly regarded in terms of its source or content
		Security	the extent to which access to information is restricted appropriately to maintain its security
		Timeliness	the extent to which the information is sufficiently up-to-date for the task at hand
		Understandability	the extent to which information is easily comprehended
		Value-Added	the extent to which information is beneficial and provides advantages from its use

Classify each of the Dimensions as being a characteristic of Conforming to a Specifications or Meeting/Exceeding Customer Expectations. Use your first impression.

CONFORMS TO SPECIFICATION	MEETS OR EXCEEDS CUSTOMER EXPECTATIONS	Dimensions	Definitions
		Accessibility	the extent to which information is available, or easily and quickly retrievable
		Appropriate Amount of Information	the extent to which the volume of information is appropriate for the task at hand
		Believability	the extent to which information is regarded as true and credible
		Completeness	the extent to which information is not missing and is of sufficient breadth and depth for the task at hand
		Concise Representation	the extent to which information is compactly represented
		Consistent Representation	the extent to which information is presented in the same format
		Ease of Manipulation	the extent to which information is easy to manipulate and apply to different tasks
		Free-of-Error	the extent to which information is correct and reliable
		Interpretability	the extent to which information is in appropriate languages, symbols, and units, and the definitions are clear
		Objectivity	the extent to which information is unbiased, unprejudiced, and impartial
		Relevancy	the extent to which information is applicable and helpful for the task at hand
		Reputation	the extent to which information is highly regarded in terms of its source or content
		Security	the extent to which access to information is restricted appropriately to maintain its security
		Timeliness	the extent to which the information is sufficiently up-to-date for the task at hand
		Understandability	the extent to which information is easily comprehended
		Value-Added	the extent to which information is beneficial and provides advantages from its use