BRANCHING INTO THE NEXT ERA OF QUALITY

Exploring shifts in quality perception and a dynamic quality intelligence model by **Danny Even Chen**

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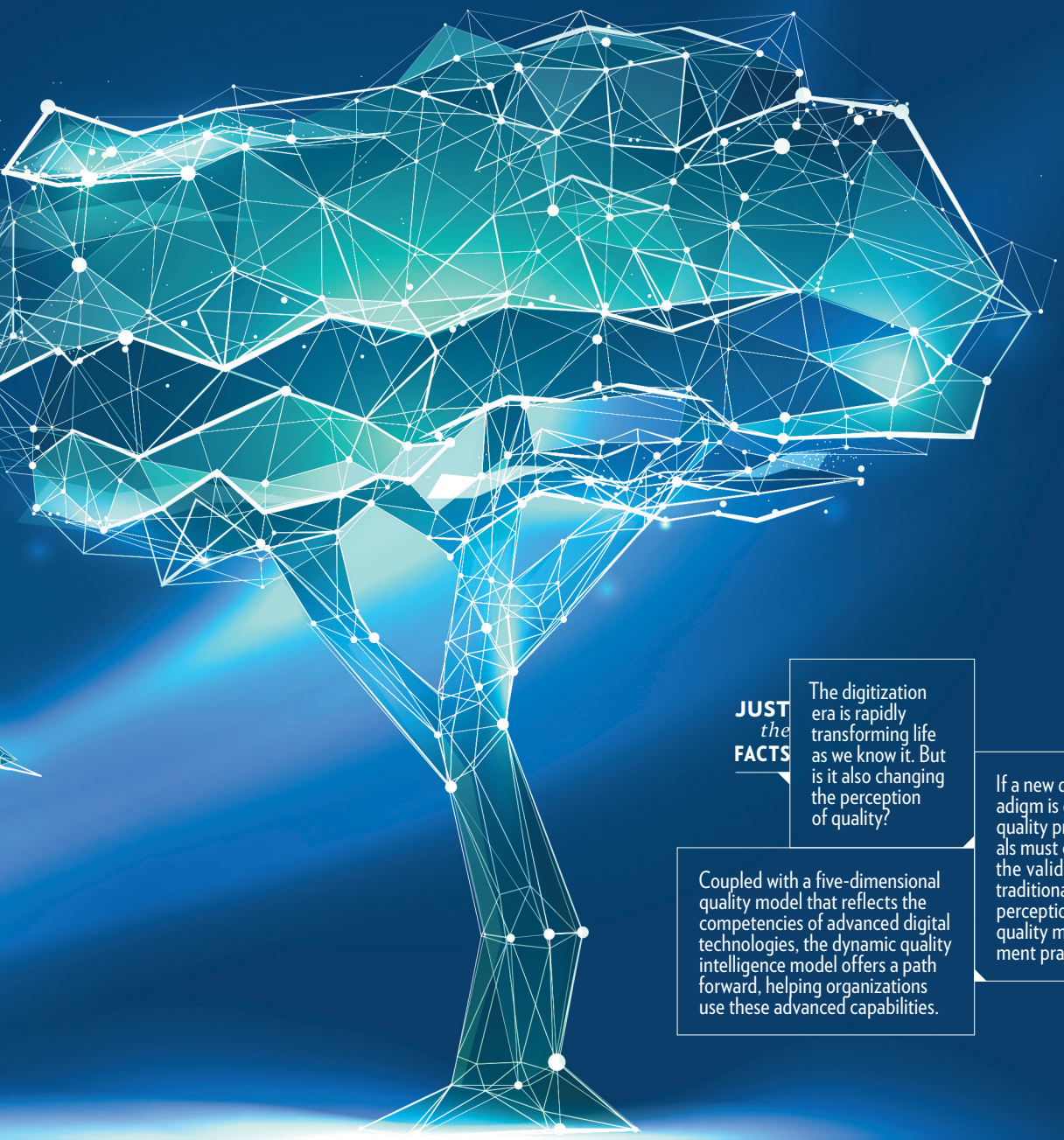


JUST *the* FACTS

The digitization era is rapidly transforming life as we know it. But is it also changing the perception of quality?

If a new quality paradigm is emerging, quality professionals must challenge the validity of traditional quality perceptions and quality management practices.

Coupled with a five-dimensional quality model that reflects the competencies of advanced digital technologies, the dynamic quality intelligence model offers a path forward, helping organizations use these advanced capabilities.

Advanced digital technologies are rapidly transforming our daily lives. These technologies are affecting current norms, traditional expectations and personal communication as well as behaviors. Innovative features are developed daily, often surpassing our expectations. Here is a concise list of recent significant phenomena: The COVID-19 pandemic has established remote working; powerful social networks are influencing human interactions; the vast array of mobile applications has created near-total dependency; and the recent boom in generative artificial intelligence (AI) is providing swift and comprehensive responses, altering our mindset.

After a lengthy career in quality management in the semiconductor and healthcare industries, I transitioned to academic research on quality matters. One question I have looked to answer is: Are digitization and the dynamic environment changing the perception of quality?

If, in fact, a new quality paradigm is emerging because of advanced digital technologies, it is essential for quality professionals to challenge the validity of traditional quality perceptions and quality management practices.

This article presents a novel structured quality method that starts with new stakeholders' experience and expectations, extends into a multi-dimensional perspective of quality value to an updated definition of quality that reflects digital transformation, and concludes with a dynamic quality intelligence model (DQIM) to help organizations evolve.

Digital transformation

Marshall McLuhan, an educator and a media scholar of the 1960s and 1970s, believed that technology plays a crucial role in shaping society and individual behavior. He argued that as technology evolves, it alters the way we think, communicate and perceive the world.

McLuhan viewed technology as an extension of human senses and abilities. He emphasized the importance of the sensory environment created by technology, leading to unique experiences and shaping our perception of reality. He predicted the internet would extend our cognitive abilities.

The accelerating pace of technological advancement fundamentally is changing subjective experiences and perspectives. Global trends over the past decade due to advanced digital technologies include:

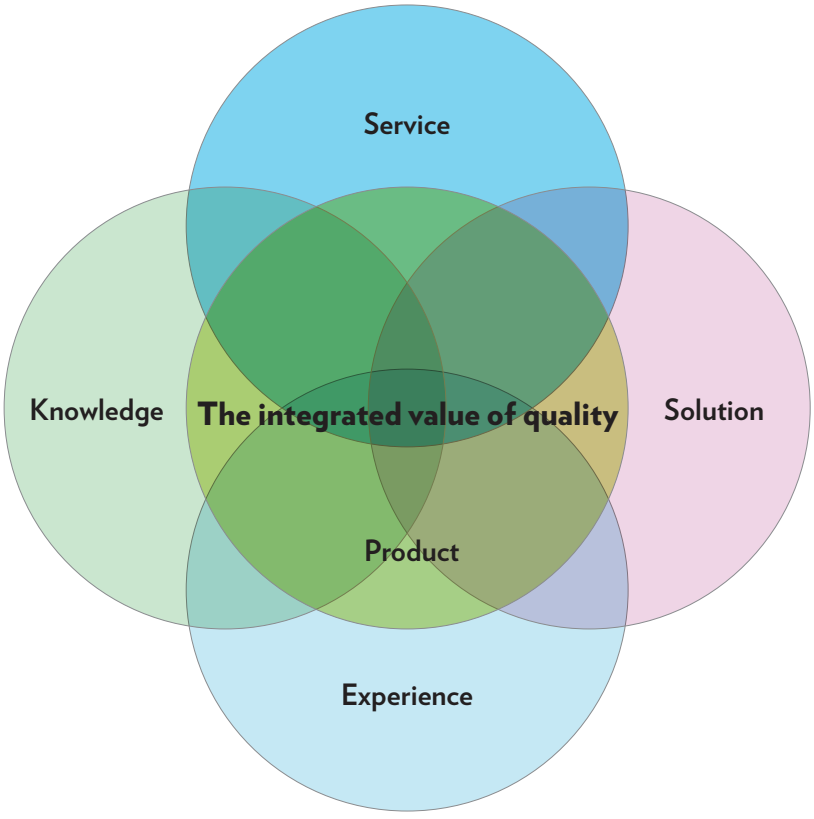
- **Societal changes:** Social networks and targeted information dissemination significantly shape stakeholders' perceptions and expectations of quality.
- **Technological revolution:** Software centrality affects product reliability and safety, while AI and digitization transform quality outcomes, creating new cybersecurity and interoperability challenges.
- **Global paradigm shifts:** COVID-19 accelerated remote servicing and new business models, driving unprecedented role evolution across industries.
- **Changing consumer expectations:** Stakeholders now demand immediate, personalized responsiveness alongside sustainability and ethical practices as fundamental quality requirements.

Are digitization and the dynamic environment changing the perception of quality?

As an outcome of these technologies, consider these common daily scenarios that were barely imaginable just a few years ago:

- Generative AI provides instant, human-like responses to complex questions.
- Online orders arrive within hours, transforming delivery expectations.
- Patients receive remote diagnoses without physical interaction.

FIGURE 1 Five-dimensional quality model



- Digital assistants predict user preferences before expression.
- AI-powered customer service replaces traditional human interactions.

Traditional quality concepts that served organizations well for decades now are being challenged by these technological advancements and daily scenarios. These developments are raising questions for quality professionals, such as:

- Do these traditional quality definitions suffice?
- How should quality practices evolve in response?
- Do these phenomena lead to the emergence of new quality roles?

Established quality definitions

For decades, quality has been based on consistent frameworks. ISO 9000:2015 defines quality as "The degree to which a set of inherent characteristics of an object fulfills requirements."[1] This definition evolved only slightly in the 2005 version of the standard, and remains fundamentally product and service focused.

Over the past 100 years, quality thought leaders have established complementary definitions of quality:

- Joseph M. Juran: Fitness for use.
- Philip B. Crosby: Conformance to requirements.
- David Garvin: Value-based approach.
- W. Edwards Deming: Meeting or exceeding customer expectations.
- Genichi Taguchi: Loss to society from product's function.

These definitions have served as the foundation of quality management systems worldwide and remain valid. It is important to note that these definitions are not mutually exclusive. In fact, they often complement one another. A product that is fit for use, for example, likely also meets customer requirements and provides value.

It also is important to consider the specific context in which a product or service is being used. What is considered high quality in one situation may not be considered high quality in another. Norms have changed the attitude and quality perception of customers, consumers and users all over the world.

The quality perception shift

Recent studies by McKinsey and Gartner indicate significant shifts in quality matters driven by technology:

- According to McKinsey & Co.'s 2022 study on Industry 4.0 implementation across manufacturing organizations, organizations reduced quality costs by 10-20% through digital quality management systems, predictive analytics and automated inspection processes.[2]
- Research by Gartner and the Chartered Quality Institute on Quality 4.0 and customer experience highlights the need for organizations to align their quality management strategies with evolving customer expectations.[3]

Recent scholarly research indicates that the current conventional perspectives on quality may not adequately capture their complexity in the digital era. The research highlights a shift in the expectations of engaged stakeholders, not limited to customers and consumers, regarding traditional quality perception within the digital landscape.

Quality has evolved from static and objective to a dynamic, consumer-focused concept shaped by technology and digital transformation. Increasingly, traditional quality management paradigms are insufficient to address the complexities and rapid changes of the 21st century, necessitating a new, more flexible and adaptable approach.[4-6]

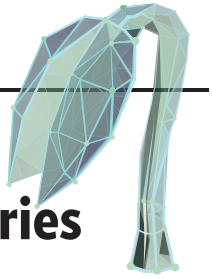


TABLE 1 How the dimensions interact across industries

Dimension/ industry	Product	Service	Solution	Knowledge	Experience	The integrated quality value
Healthcare	Smart medical devices with predictive analytics	Preventive care, remote monitoring	AI-driven diagnostic systems	Real-time patient health insights	Seamless healthcare journeys	Personalized health solutions
Financial services	AI-powered investment platforms	Personalized financial advisory	Adaptive wealth management tools	Actionable market insights	Frictionless, user-friendly banking	Optimized financial decision making
High school education	Interactive 3D learning content	On-demand virtual tutoring	AI-driven learning paths	Acquiring analytics skills	Immersive and engaging education	Lifelong personalized learning
Public transportation	High-efficiency transport vehicles	Mobility-as-a-service platforms	Real-time route optimization	Predictive journey analytics	Comfortable, safe and convenient travel	Seamless mobility solutions

AI = artificial intelligence

Comprehensive AI analysis of quality terminology's evolution demonstrates significant shifts toward experience-focused and technology-integrated language (see the sidebar, "Quality Language Evolution," p. 20).

The engaging stakeholders

Traditionally, quality is defined as meeting the expectations and satisfaction of customers and consumers. The emergence of advanced digital technologies has expanded the range of impacted populations to include communities, regulators, suppliers, employees, gatekeepers, celebrities and more. Each stakeholder may represent different expectations and perceptions that drive multiple dimensions of quality. For example, communities are looking for sustainability while regulators are concerned about complying with applicable standards.

Five-dimensional quality model

Considering the global trends and newest daily scenarios, as well as the research mentioned earlier, three additional dimensions should be added to quality: solution, knowledge and experience. The powerful generative AI, including text-to-image capability, provides unprecedented integrated value of solutions, knowledge and experience that no one could even have dreamed of a few years ago.

A new five-dimensional quality model reflects the competencies of advanced digital technologies (see Figure 1, p. 17). The dimensions are:

1. **Product.** Tangible aspects include performance, reliability, durability and attributes such as brand value, design and sustainability.
2. **Service.** Delivery elements (such as responsiveness and empathy) and process elements (such as efficiency, timeliness and professionalism).
3. **Solution.** Effectively integrating and bundling products and services to solve specific customer problems while also considering completeness, compatibility, scalability and sustainability.
4. **Knowledge.** Providing accurate, relevant and timely information while also considering accessibility, clarity and applicability.
5. **Experience.** The holistic customer journey, which encompasses expectations, interactions, emotions, feelings, trust and subjective evaluation of value.

Table 1 contains examples of how these five dimensions interact across various industries. These examples demonstrate the integrating effect of the five quality dimensions to address stakeholders' dynamic perceptions due to the accelerated features of advanced digital technologies.

A new five-dimensional quality model reflects the competencies of advanced digital technologies.

Based on these five dimensions, I propose the core definition of quality as:

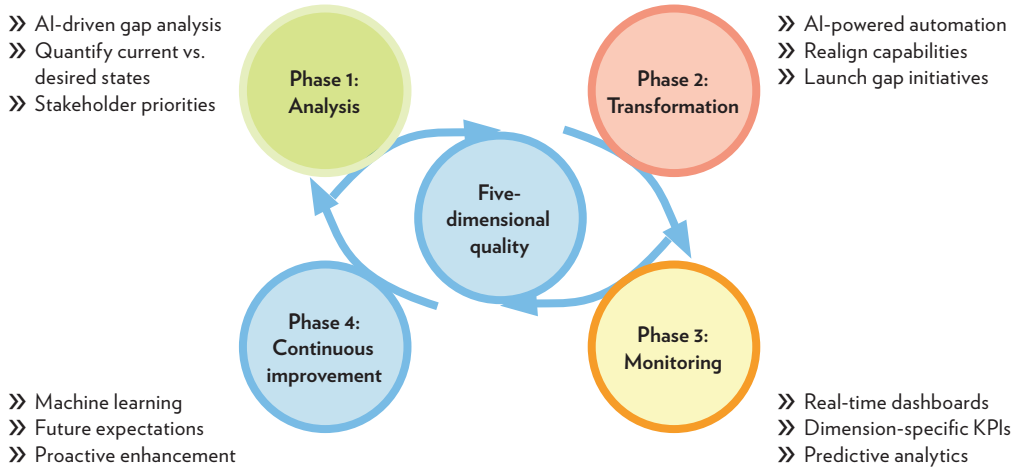
"The integrated value that fulfils stakeholders' evolving perceptions."

The definition is extended by a statement considering the effect of advanced digital technologies:

"This integrated quality value is delivered through five synergistic dimensions—product, service, solution, knowledge and experience—that are enhanced continuously through intelligent use of advanced technologies."

FIGURE 2 **DQIM framework**

A framework for quality in the digital era



AI = artificial intelligence **DQIM** = dynamic quality intelligence model **KPI** = key performance indicator

Implications of this proposed definition may require organizations to transform their structure, allocations, quality processes, practices, skills and quality goals.

DQIM

The DQIM framework includes four cyclic phases to help organizations use advanced digital technology capabilities. Along each phase, gap analysis should be conducted with regard to the five quality dimensions toward the desired state of the quality value for engaged stakeholders. (See Figure 2.)

Phase one: Analysis.

» Identify the applicable stakeholders' quality perception gaps using AI-driven tools (such as sentiment analysis, natural language processing and predictive analytics).
» Quantify each stakeholder's current vs. desired quality state for each quality dimension.
» Identify potential improvements according to stakeholders' weighted priorities.

Phase two: Transformation.

» Implement AI-powered process automation and decision support.
» Realign organizational capabilities to meet the new desired quality states.
» Launch initiatives to address identified gaps using digital technologies.

Phase three: Monitoring.

» Deploy real-time quality performance dashboards.
» Track the five-dimension specific key performance indicators (KPI) with automated reporting.
» Identify emerging quality trends using predictive analytics.

Phase four: Continuous improvement.

» Apply machine learning (ML) to refine quality strategies.
» Assess future quality expectations.
» Feed new insights to phase one to enhance quality measures proactively before gaps emerge.

Table 2 (p. 20) highlights the main differences between several traditional quality approaches and DQIM.

Financial services example

A bank used the DQIM framework to address the increase in business partners leaving.

» **Analysis:** AI-powered sentiment analysis revealed knowledge gaps in digital service offerings.
» **Transformation:** A predictive support system was developed.
» **Monitoring:** Real-time service dashboards were created, including knowledge, solutions and experimental factors.
» **Continuous improvement:** ML was used to anticipate future service needs.

TABLE 2 Differences between traditional quality approaches and DQIM

Aspect	Traditional approaches (DMAIC, lean, TQM)	DQIM approach
Focus	Product and service	Five-dimensional quality (including solution, knowledge, experience)
Information processing	Sample-based, retrospective	Comprehensive, real-time, predictive
Decision making	Expert-driven, manual	AI-augmented, data driven
Adaptation speed	Periodic reviews and updates	Big data continuous monitoring and adjustment
Stakeholder insights	Survey-based, limited	AI-based sentiment, behavior analytics
Improvement cycle	Periodic	Adaptive and dynamic

AI = artificial intelligence
DMAIC = define, measure, analyze, improve and control
DQIM = dynamic quality intelligence model
TQM = total quality management

Risk and mitigation management

DQIM uses various advanced tools. Its responsible implementation should consider several obstacles, including:

- **Algorithmic bias:** AI systems may perpetuate or amplify existing biases if not designed and monitored properly. Ensure inclusive data sets and algorithm audits.
- **Over-reliance on automation:** Diminishing human judgment in quality decisions may miss contextual factors. Ensure critical decisions retain human oversight.
- **Data privacy concerns:** Collecting comprehensive quality data raises important privacy questions. Adopt privacy data governance policies.
- **Access gap:** Not all stakeholders have equal digital access or literacy. Design with digital skills in mind.

Organizations implementing DQIM should establish governance frameworks that address these risks while maximizing the benefits of DQIM quality management.

Getting started with DQIM

Figure 3 illustrates the four-phase DQIM implementation roadmap, which is designed to help organizations transform their quality management capabilities systematically.

Phase one—assess: Establishes the foundation by evaluating current digital capabilities and data infrastructure, identifying skill gaps in AI and data analytics, and benchmarking against industry standards across all five quality dimensions.

Phase two—pilot: Focuses implementation efforts by beginning with pilot projects in two to three quality dimensions, measuring results and refining approaches, then expanding to other dimensions based on lessons learned.

Phase three—scale: Extends DQIM across the organization by combining quality expertise with data science capabilities, ensuring executive sponsorship and stakeholder representation, and developing integrated training programs.

Phase four—govern: Establishes comprehensive oversight by creating transparent AI quality policies, implementing responsible data governance and maintaining human oversight of critical quality decisions.

This cyclical approach ensures continuous improvement, with governance insights feeding back into assessment activities, creating an adaptive framework that evolves with technological advancement and stakeholder expectations.

Measuring success

To gauge DQIM success, consider measuring the following KPIs:

QUALITY LANGUAGE EVOLUTION

A systematic analysis of quality terminology conducted in April 2025 using Google Gemini's natural language processing capabilities examined more than 110 publications, industry reports and corporate quality statements of the past decade.

The analysis identified a clear evolution in quality language, with significant increases in terminology related to customer experience integration, hyper-personalized offerings and data-driven quality control compared to the previous decade.

All these terms and phrases are expanding the traditional quality perception of products and services. This empirical evidence validates the expanding quality perception beyond traditional product-service boundaries.

—D.E.C.

FIGURE 3 DQIM implementation roadmap

AI = artificial intelligence **DQIM** = dynamic quality intelligence model

» Reduction in quality-related issues (percentage).
» Improvement in stakeholder satisfaction scores.
» Predictive accuracy of quality issues.
» Time to identify and address quality gaps.
» Return on quality investment.

Into the next era

Embracing advanced digital technologies is doubling the effect on quality. On one hand, it alters stakeholders' perceptions, norms and behaviors (traditionally, customers and consumers). On the other hand, it enables the organization to achieve its desired state across multiple quality dimensions.

The digitization era is an unprecedented opportunity for quality professionals to foster a new paradigm to create competitive quality value.

The five-dimensional quality model and DQIM offer a path forward—where quality is dynamic, contextual and co-created.

This transformation requires:

» Leadership commitment to integrating digital capabilities into quality management.
» Investment in AI and data analytics infrastructure and skill to gain actionable quality insights.
» A culture of continuous learning and adaptability.

The proposed new definition of quality acknowledges that quality in the digital era is dynamic, multidimensional and increasingly personalized. Those who adopt this mindset will lead their organizations into the next era of quality. **QP**

editor's **NOTE** Online references can be found on this article's webpage at qualityprogress.com.

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