IJQRM
22,1

Guest editorial

About the Guest Editors *Robert Hunt is Associate Professor in Management, Director, Centre for Management Innovation and Technology and Director, Master of Management program at Macquarie University's Graduate School of Management. He lectures in Operations Management, Technology Strategy, and Project-Based Management in the MGSM's Postgraduate Diploma, Master of Management, and MBA programs. He is principal of the consulting company Corporate Insight P/L, and has published more than 50 papers, books, management monographs, videos and case studies. In 2002 he was awarded the Akao Prize for his contributions to the development and dissemination of QFD.*

Catherine Killen is a Lecturer with the Management, Policy and Practice Group of the Faculty of Engineering at the University of Technology, Sydney, Australia. She has a Bachelor of Science in Mechanical Engineering from the University of Virginia (USA), and a Master of Engineering Management from the University of Technology, Sydney. Her fields of interest are Technology and Innovation Management and Product Portfolio Management. She has a long-term interest in QFD and is an associate of the Centre for Management Innovation and Technology at the Macquarie University Graduate School of Management.

Quality function deployment (QFD) is a practice-based methodology. Ever since its development during the 1960s in Japan, QFD has continued to generate positive results in an increasing number of applications. QFD has traditionally been seen as a tool to provide a reliable method of addressing customer needs in product development and manufacturing while promoting and structuring cross-functional communication and information sharing. The increasing awareness of the importance of meeting customer needs has led to the use of QFD in a variety of other areas. QFD remains an important part of the development processes used for many manufactured goods, but it is also being successfully applied to the development of services, software systems, support systems, organisational structure and strategy. The current set of *IJQRM* Special Issues aims to illustrate "Best Practice" QFD implementations and to highlight the great variety of areas where QFD is being successfully applied.

The core goal of QFD is to ensure that organisational actions and decisions are directly linked to adding perceived value to customers and other stakeholders. The well-recognised "traditional" QFD approaches involve a series of matrices and techniques that are designed around this core goal, and are well documented in Akao (1990), King (1989), Mazur (1999) and Terninko (1997). However, each time QFD is applied to a new situation, a slightly different approach is required to provide the best results. For example, QFD is increasingly used alongside other tools and techniques and often only certain portions of QFD are used. In addition, different QFD enhancements or versions may be employed.

As individual as each application of QFD is, it is reassuring to know that the core philosophy and methods do not change. Current training courses, such as the QFD Institute's Green, Black and Master Red Belt certifications, impart a comprehensive understanding of the complete approach to practitioners and researchers. With this base understanding, practitioners can achieve "Best Practice" by applying the elements

International Journal of Quality & Reliability Management
Vol. 22 No. 1, 2005
pp. 6-9

0265-671X

of QFD that are useful in their particular situation and combining them with other tools and methods as appropriate.

Theoretical and leading-edge contributions to QFD use were highlighted in a Special Issue of the *International Journal of Quality & Reliability Management* in 2003 That Special Issue focused on the newest advances in QFD use and theory, and was titled "The Leading Edge in QFD" (Hunt, 2003).

In recognition of the continued developments in the practice of QFD, the *International Journal of Quality & Reliability Management* is dedicating two Special Issues to exploring current "Best Practice" in QFD. These Special Issues will illustrate how current use of QFD continues to stretch the bounds of applications and techniques. The "Best Practice" elements of each of the highlighted QFD applications are the elements that contribute to the flexibility and success of this tool. In essence, "Best Practice" could be defined as "what works best in this situation". "Best Practice" will vary depending on the application and the context – there is no "one size fits all" in QFD.

This is the second of the two *IJQRM* Special Issues in this series. The first issue, "Best Practice QFD I: Cases", focused primarily on case study examples that illustrate "Best Practice" applications or extensions to QFD. This second Special Issue, "Best Practice QFD II: Strategy and regional QFD", highlights QFD as a strategy development tool and presents a series of papers exploring regional QFD usage through multiple case studies or surveys. Through these two Special Issues, QFD has been shown to be a dynamic, versatile and relevant tool.

The editors would particularly like to thank the members of the International Expert Editorial Board who gave up their time to review the papers submitted. Authors of both published and unpublished papers have benefited from the generous feedback and advice provided by the International Expert Editorial Board.

Newcomers to QFD may find the introductory and background information in the first three papers of the first Special Issue particularly useful. For more complete introductory QFD material, the editors recommend the previously mentioned references of Akao, King, Mazur and Terninko. Readers will also find current information on the web sites of the various QFD associations such as the American QFD Institute, the QFD Institut Deutschland (Germany), and The Latin American QFD Association. Editor Robert Hunt's Centre for Management Innovation and Technology at Macquarie University contains a link to a popular on-line QFD tutorial. In addition, the American QFD Institute has online searchable abstracts of all the papers presented at the US QFD Annual Symposia since 1989.

The first of the seven "Best Practice" QFD applications presented in this journal begin with an invited paper jointly authored by James LeProvost and QFD Master Red Belt instructor Glenn Mazur, Executive Director of the US QFD Institute. Their paper on "Quality infrastructure improvement" demonstrates the application of QFD to the development of an open project portfolio management system to help prioritise projects in the IT department of a major US corporation. The system uses internal and external customer needs and project complexity as criteria, and reduces the tendency for resources to be allocated to "pet" projects that are sponsored by powerful departments. Instead, the system will identify and favour the resourcing of projects that promise to deliver superior customer value.

The second invited paper is a joint work between the editors and Mike Walker, the CEO of Customer Driven Strategies. Mike is a leading QFD practitioner, especially in the area of strategic planning. This paper shows how, by focusing on time-stable and concept non-specific customer outcomes, organisations can systematically work through the iterative "fuzzy front end" of the strategy process to determine which natural segments of customers to target, and what specific areas of value to focus on. A modified version of the Pugh concept selection principles (Pugh, 1981) can then be utilised to determine the best portfolio of strategies to achieve the desired aims. Three cases from Australia, New Zealand and the USA are outlined to illustrate some real-life examples of the use of QFD principles in strategic planning.

Every organisation receives complaints from customers at times, and most apologise to customers sometimes – but not many organisations exploit these complaints for their benefit. Verónica González Bosch and Francisco Tamayo Enríquez show how customer complaint data can be used to improve products and services. The Customer Complaint Management System (CCMS) proposed by González Bosch and Tamayo Enríquez incorporates elements of QFD along with other tools to leverage the existing customer complaint data in a Latin American transport company as a learning opportunity. The CCMS provides a formal method for translating customer complaints into customer needs. Problem analysis, the development of solutions, and incorporation of these solutions are also structured in the CCMS. QFD philosophy is shown to provide an important theme during the CCMS, ensuring a strong focus on learning and customer satisfaction.

Ginn and Zairi's paper surveys QFD practices and perceptions of 164 QFD practitioners in Ford Motor Company and from 27 QFD consulting organisations across Europe and the USA. The paper illustrates clearly the need for a non-dogmatic, flexible approach to QFD application as a methodology. Blindly applying the full methodology as a one-size-fits-all is a recipe for creating a slow moving bureaucracy that is both frustrating to use and wasteful of time and resources. QFD is a means to an end rather than an end in itself. The survey found that initial training is critical. The study also underlines the findings of a prior study of the critical importance of senior management in championing and sponsoring the use of QFD (Pandey and Clausing, 1991). These results align well with those found by Hunt (1997).

The relationship between the factors conducive to QFD and organisational productivity and creativity is the subject of a paper by John Politis. It uses previously validated survey instruments from Politis (2003) and Amabile *et al.* (1996) and establishes stronger positive correlation between QFD and productivity than between QFD and creativity. The analysis was carried out in Dubai in the Middle East and is the first study to attempt examination of these important relationships. Some limitations to the research are explained by the author, and it is suggested that other researchers may want to examine more closely the relationships between organisational creativity and productivity and QFD adoption.

Paulo Cauchick Miguel presents a field research study on the use of QFD in seven companies operating in Brazil. The study includes local divisions of multinational organisations as well as Brazilian organisations. The mature implementations of QFD in these organisations are well summarised, and their experiences provide a useful source of information for QFD practitioners or those considering applying QFD. This

multiple case study paper highlights the elements of "QFD Best Practice" in each application, and summarises the common themes across all applications.

While QFD is fundamentally a practical methodology grounded in common sense, the last paper by Akao Prize winner Dr Thomas Fehlmann presents a theoretically based analysis. Fehlmann looks at QFD's basic matrix approach from the point of view of combinatory mathematics. He concludes that the traditional approach can lead to erroneous weighting of the technical characteristics. Characterising QFD matrices as "many to many" cause and effect diagrams, where the technical characteristics deliver the customer outcomes, Fehlmann shows that further steps are necessary to calculate the optimum technical characteristic weightings that will deliver the customer outcome weightings. The paper explains the mathematics and process behind the calculations and is bound to raise debate in QFD practitioner circles. The fact that QFD continues to evolve and yield new insights more than 30 years after its initial development highlights it as a dynamic and active methodology.

In total, 14 papers have been presented in the *IJQRM* Special Issue series on "Best Practice QFD". QFD has been shown to be a flexible, robust and innovative approach that can be applied in a variety of situations. To best address the needs of these different applications, many different QFD-based methods are in use, and the methods continue to evolve. However, core QFD principles underlie all applications to ensure that customer needs are central to decision making, and that organisational efforts are focused on what is most important to customers and stakeholders. The common theme is that "Best Practice" for QFD is finding the methods that work best in each situation.

Robert Hunt and Catherine Killen
Guest Editors

References

Akao, Y. (1990), *Quality Function Deployment: Integrating Customer Requirements into Product Design* (translated by Mazur, G.), Productivity Press, Cambridge, MA.

Amabile, T.M., Conti, R., Coon, H., Lazenby, J. and Herron, M. (1996), "Assessing the work environment for creativity", *Academy of Management Journal*, Vol. 39, pp. 1154-84.

Hunt, R.A. (1997), "QFD applied to innovation and strategic transformation in the South West Pacific Rim", *Transactions from the 3rd International Symposium on Quality Function Deployment, Linköping*, Vol. 1, pp. 281-93.

Hunt, R.A. (Ed.) (2003), "The leading edge in quality function deployment", *International Journal of Quality & Reliability Management*, Vol. 20 No. 1, Special Issue.

King, B. (1989), *Better Designs in Half the Time: Implementing QFD Quality Function Deployment in America*, GOAL/QPC and Methuen & Co., New York, NY.

Mazur, G.H. (1999), "Comprehensive quality function deployment", *Version 2000*, 25 June.

Pandey, A. and Clausing, D.P. (1991), *Manufacturing and Productivity*, MIT Press, Cambridge, MA.

Politis, J.D. (2003), "QFD: the role of various leadership styles", *The Leadership & Organizational Development Journal*, Vol. 24 No. 4, pp. 181-92.

Pugh, S. (1981), "Concept selection – a method that works", International Conference on Engineering Design, Rome.

Terninko, J. (1997), *Step by Step QFD: Customer-Driven Product Design*, St Lucie Press, Boca Raton, FL.

IJQRM
22,1

10

Quality infrastructure improvement: using QFD to manage project priorities and project management resources

James LePrevost
National City Corporation, Cleveland, Ohio, USA, and
Glenn Mazur
Japan Business Consultants Ltd, Ann Arbor, Michigan, USA

Abstract

Purpose – A common difficulty for an information technology (IT) department is to focus resources (people) where they can deliver the greatest benefit for the efforts made. It sometimes happens that a bias develops where some departments insist that their projects are more critical than others and they demand not only that their projects be attended to immediately, but also that the most senior people be assigned to them. To better utilize resources, it makes sense to prioritize projects on their benefit contribution to internal and external customers, as well as to assign skill-appropriate people to work on them. National City has applied QFD to help them in identifying and prioritizing the needs of their customers and then using these to evaluate each project for its benefit contribution and for its degree of complexity, which will help assign appropriate resources to the project.

Design/methodology/approach – This paper will show how we customized the QFD process through the QFD Green Belt® training of the QFD Institute. It is shown how the list of internal customer needs, which became the criteria for determining project benefit, and then developed another set of criteria to judge the project complexity and the required technical skill level to work on the project, were developed. The paper includes charts and matrices defining the process.

Findings – National City can now prioritize its internal IT projects and assign the most appropriate people to them in order to deliver the greatest value to National City's customers.

Originality/value – QFD helped National City to manage internal initiatives by prioritizing them according to the benefits they had. Project management and technical resources can now schedule their time according to priority, which reduces non-effective multitasking and will allow for more initiatives to be completed in the long run.

Keywords Quality function deployment, Project management, Communication technologies

Paper type Case study

International Journal of Quality & Reliability Management
Vol. 22 No. 1, 2005
pp. 10-16

0265-671X
DOI 10.1108/02656710510572959

Introduction

National City Corporation (NYSE: NCC), headquartered in Cleveland, Ohio, is one of the nation's largest financial holding companies, operating through an extensive distribution network in Ohio, Illinois, Indiana, Kentucky, Michigan, and Pennsylvania, and in selected markets nationally. National City's primary businesses include commercial and retail banking, consumer finance, asset management, mortgage financing and servicing, and payment processing. National City employs more than 33,000 individuals.

Enterprise Production Services (EPS) is responsible for the availability, integrity and performance of National City's production systems across the enterprise. We are first and foremost a service organization that measures success in meeting or

exceeding agreed-upon service level commitments with our lines of business. The Process and Control department within EPS is responsible for managing internal IT improvement and remediation projects. Unlike most projects that deliver a new product or application at the end of the lifecycle, our internal IT projects deliver improvements or will remediate an existing condition in the production environment. Our challenge is to deliver the projects that have the greatest benefit to our internal and external clients while at the same time utilizing similar resources that perform day-to-day production support activities.

Quality function deployment (QFD) is a total quality management tool developed in the 1960s by Drs Yoji Akao and Shigeru Mizuno to assure the quality of new products and services. Its first principles include a "design" approach, which means to begin at the highest-order requirements and to systematically "deploy" downstream to critical details in the design, build, and delivery of the product. This method has been proved effective in software and IT project management applications as an empirical process for defining and prioritizing engineering activities (Gorham and McDonald, 1997).

QFD process for project selection

With the lack of standardized prioritization across departments, projects were all too often handed out without consideration of other project initiatives or the project workload that was placed on strategic resources. Repeatedly, the resources became overloaded with projects from different managers that all seemed to carry a high priority or no perceived benefit. This allowed the technical resources to determine their own priority and work on project initiatives that enhanced their technical ability and not necessarily that which had the most benefit to EPS, and in turn the external NCC customer. The QFD Green Belt® course (QFD Institute, 2000) provided the basis for adapting the process to the needs of our IT department. By selecting criteria that aligned project benefits with the strategic direction of EPS we are able to manage projects that helped to meet or exceed our service level commitments with our lines of business.

Defining and prioritizing benefits

Our internal customers are EPS managers, team leads, and the technical resources that support the various platforms across NCC, each having their own goals and priorities for maintaining production systems. External customers represent end users of system applications, both internal and external to NCC.

Because of the need to determine what criteria made some projects more important than others, we went to the *gemba* and interviewed technical personnel and managers. The feedback from the technical personnel revealed that they wanted to know the priority for each project so that they could focus their time accordingly. Understanding of priorities would keep them from jumping from task to task, depending on which manager was asking for project tasks that week. On the other hand, management wanted to know that projects were being completed that added benefit to NCC.

Our next step was to form a stakeholders' committee comprised of internal customers, which would maintain ownership of the project portfolio, prioritization, and status reporting for the initiatives. The team also had the responsibility for canceling projects, resource management, and placing projects on hold when another initiative of higher priority was in contention with a strategic resource. A new process called "Quality Infrastructure Improvements" (QII) was created to manage the data

gathering, reporting, and prioritization for these projects. The committee's first task was to determine what benefits internal improvements and remediation initiatives had to the internal and external customers.

Since not all benefits have an equal impact on the company, the analytic hierarchy process (AHP) was used to prioritize the benefits. This method has the internal customer comparing the benefits two at a time using a verbal scale from equal to extremely more important. This takes advantage of how people best make judgments – in pairs using a natural language ordinal scale. AHP then converts these into numerical ratio scale priorities that accurately represent what matters most and by how much (see Figure 1).

This ranking signifies that project initiatives that maintain the existing production environment should be considered before other initiatives, whereas improvement and proactive initiatives would place lower on the prioritization list and only become active when resources were available or if they also had a production issue or an information protection (IP) security, regulatory, or audit requirement. Table I explains the characteristics of the two highest ranking project benefits.

Defining and prioritizing complexity

The next obstacle was to understand what resource should own an initiative to see it through the project lifecycle. After much discussion and brainstorming, the stakeholder committee determined three criteria that influenced the effectiveness of a project owner to successfully complete an initiative. The three criteria are characteristics of complexity within the production environment and often play a

Criteria	IP Security, Regulatory, or Audit Requirement	Cost savings or cost avoidance	Replacing product end of life or support	Another project is dependant upon this initiative	Production issue	ZBD – Potential for production impact if not addressed timely	total	avg.
IP Security, Regulatory, or Audit Requirement	1	3	7	4	1/9	4	1.140	**0.190**
Cost savings or cost avoidance	1/3	1	7	1/5	1/9	1	0.435	**0.072**
Replacing product end of life or support	1/7	0.142857	1	1/7	1/9	1/3	0.150	**0.025**
Another project is dependant upon this initiative	1/4	5	7	1	1/5	3	0.887	**0.148**
Production issue	9	9	9	5	1	7	3.048	**0.508**
timely	1/4	1	3	0.3333	1/7	1	0.341	**0.057**
	10.976	19.143	34.000	10.676	1.676	16.333	6.000	1.000

Figure 1.
Project benefits prioritized using AHP

Criteria	Characteristics
IP security, regulatory or audit requirements	0 = N/A or none 2 = requirement >6 months 5 = requirement >3 months and < 6 months 9 = urgent requirement <3 months
Production issues	0 = N/A or none 2 = production issue (sev. 5) 5 = production issue (sev. 3 or 4) 9 = production issue (sev. 1 or 2)

Table I.
Project benefits criteria and characteristics

major role in the success of a project, as shown in Table II. Similar to the benefits, the relative degree of complexity was quantified using the AHP, as shown in Figure 2.

Benefits versus complexity

The allocation of a project owner is based both on how important the project is (benefits to the company) as well the complexity of the problem. To better understand these relationships, Figure 3 was constructed.

Strategic resource allocation guidelines

Next, we set guidelines for assigning a project owner resource to projects, as follows.

(1) *Project management*:

- characterized by medium-high benefits and medium-high complexity;
- these projects may be regarded as essential to EPS;
- these projects mandate project management methodologies be followed to ensure on-time and on-budget completion; and
- the high-benefit and high-complexity nature of these projects require project management focus.

Criteria	Characteristics
Technology exists in the environment	0 = tuning/analysis 2 = minor upgrade/maintenance 5 = major upgrade or new feature added to current technology 9 = new technology in environment
Technical success factors (resource constraints)	0 = wide range of NCC resources can complete 2 = several NCC resources can complete 5 = limited NCC resources, resource constraints, or involvement by one team/group 9 = outside vendor will be engaged
Other IS involvement	0 = only EPS internal resources required 2 = incidental involvement by other groups 5 = multiple outside resources required (IP or STS) 9 = multiple outside resources required (IP, STS, AIS, or Project Services) or extensive involvement by one group

Table II.
Project complexity criteria and characteristics

Criteria	Technology exists in current environment	Technical success factors/Resource Constraints	Initiative is driven by EPS personnel	1	2	3	total	avg.
Technology exists in current environment	**1.00**	**0.33**	**0.50**	0.167	0.182	0.143	0.491	**0.164**
Technical success factors/Resource Contraints	**3.00**	**1.00**	**2.00**	0.500	0.545	0.571	1.617	**0.539**
Initiative is driven by EPS personnel	**2.00**	**0.50**	**1.00**	0.333	0.273	0.286	0.892	**0.297**
	6.000	1.833	3.500	1.000	1.000	1.000	3.000	0.164

Figure 2.
Project complexity quantified using AHP

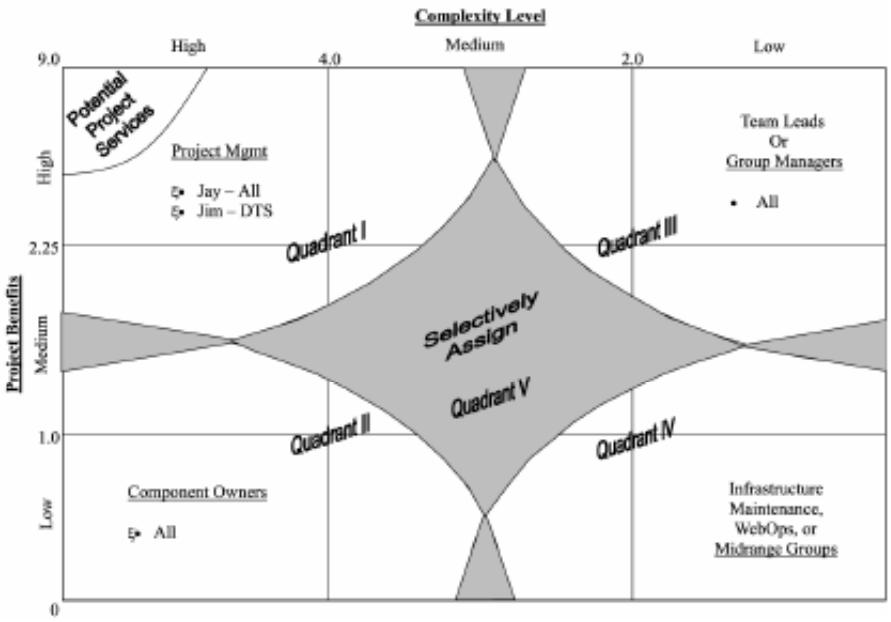


Figure 3.
Project benefits versus complexity

(2) *Component owners*:

- characterized by low-medium benefits and medium-high complexity;
- normally small, short-term projects that require strong technical skills;
- component owners will function as technical team leads since minimal integration is required; and
- minimal project management knowledge is needed.

(3) *Team leads or group managers*:

- characterized by medium-high benefits and medium-low complexity;
- these projects are usually process improvement efforts to support production;
- minimum integration across functional lines is necessary, which allows team leads and group managers to function as project managers; and
- short time frames also characterize these projects.

(4) *Infrastructure maintenance, WebOps, or midrange groups*:

- characterized by low-medium benefits and low-medium complexity;
- these projects are usually identified by technical experts but executed by technical project coordinators; and
- one project coordinator may end up managing multiple small projects.

(5) *Selectively assign*:

- these projects are potentially on the boundary between multiple quadrants;
- they require a better understanding of the project benefits, complexity, and resource constraints in effect at the time to properly assign the necessary resources; and
- these initiatives will need to be selectively assigned because of their benefits, complexity, and resource constraints.

Project Definition Form (PDF) and scoring projects across departments

To manage the information gathered during initial project definition, a web form was created to simplify entry and tracking of new initiatives. The Project Definition Form (PDF) allows users internal to EPS as well as those from other divisions to enter pre-defined criteria. The requestor completes a high level description of the project along with information that relates to the characteristics of the project's benefits and complexity. The PDF is then reviewed by all members of the QII committee for general understanding of the project and how it may impact their department and NCC. Each member then responds to an electronic survey that records scores for each benefit and complexity based on a nine-point scale. This information is tallied and reviewed at the weekly QII meeting to facilitate discussion and score each benefit and complexity on a nine-point scale as a collaborative effort.

Prioritization of projects based on benefit and complexity using a matrix

The prioritized benefits and complexity were entered into the columns of a matrix and the projects were entered in the rows. The degree of benefit and complexity of each project were rated in the intersections using a nine-point scale. These rates were then multiplied by the priorities of each benefit and complexity, and separately added across to yield the absolute weights, which were then classified as high, medium, or low depending on their scores. A portion of the matrix is shown in Figure 4.

Next steps

Projects are added into the QII process as the need arises. Currently we are adding 5-6 projects monthly. The QII team reviews all projects through the electronic PDF and

Project Owner Assigned	EPS Initiatives	Platform	IP Security, Regulatory, or Audit Requirement	Cost savings or cost avoidance	Replacing product end of life or support	Another project is dependant upon this initiative	Production issue	ZBD - Potential for production impact if not adressed timely	Absolute Weight	Priority	Technology exists in current environment	Technical success factors/ Resource Constraints	Initiative is driven by EPS personnel	Absolute Weight	Complexity
	Benefit Weight		19%	7%	2%	15%	51%	6%			16%	54%	30%		
X	UPGRADE KAL-MAIN31 – SERVER HAS POOR RELIANCE	D	0	2	5	0	9	9	5.35	H	5	2	0	1.90	L
X	HIS MIGRATION	D	5	2	5	0	5	5	4.04	H	9	5	5	5.66	H
X	NOVELL FILE SHARING IMPROVEMENTS	D	0	2	9	0	5	9	3.42	H	2	5	5	4.51	H
X	HARDWARE/DASD CHALLENGED NETWARE SERVERS	D	0	5	9	0	5	5	3.41	H	2	2	2	2.00	L
X	WEBTRENDS SERVER UPGRADE	E	0	2	0	0	5	9	3.20	H	2	2	0	1.41	L
x	TSM ON NOVELL	D	0	2	0	0	5	5	2.97	H	5	5	2	4.11	H
X	UPGRADE NOVELL SERVER BLO-MAIN11 W/COMPAQ	D	0	2	0	0	5	5	2.97	H	2	2	0	1.41	L
x	DOWN FOR MAINTENANCE SERVER	E	0	2	0	0	5	2	2.80	H	5	2	0	1.90	L

Figure 4.
Matrix used to prioritize projects based on level of benefit and complexity (partial)

then they are ranked prior to the weekly meeting. During the meeting we review new initiatives and rank them according to benefits and complexity, and assign a project owner accordingly. We also review active projects that submit a biweekly status report which reviews milestone completions, budget, resource, and timeline constraints.

To keep the project prioritization matrix up to date with the strategic direction of NCC, the benefits and complexity will be reviewed annually and re-weighted accordingly. This will allow for some projects to be re-prioritized to meet the new goals and objectives of EPS and NCC.

The QII team also plans to measure the success of the completed initiatives and tie back the value added by completing them within the desired time frame. We also have an opportunity to look at the initiatives that are not being completed and determine the strategic resource that limits the number of initiatives that could be managed by that resource. We then can make recommendations to management for additional resources to accomplish the lower priority initiatives or find other internal or external resources to fill the capacity need.

We have also used the QFD process in a project risk initiation assessment. The assessment used QFD to gather risk factors for larger IT projects across NCC. Departments from Project Services, Engineering, Client Services, and Business Consulting gathered hundreds of risk factors which were analyzed and grouped into five categories, and then used the AHP process to weight each characteristic of the five categories. Next, each category was ranked to assign an overall project initiation risk score which will be used in conjunction with the cost benefit analysis to help determine project portfolio selection. The risk assessment will also be used as a foundation for a risk mitigation plan when the project becomes active.

Conclusion

QFD helped us to manage internal initiatives by prioritizing them by the benefits they had to EPS. We are now able to distinguish between pet projects and those that have the highest payback to NCC and assign appropriate resources to complete the initiatives within an acceptable time frame. This allows for both project management and technical resources to schedule their time according to priority (Kerzner, 2001; Kendal and Rollins, 2003), which reduces non-effective multitasking and will allow for more internal initiatives to be completed in the long run.

References

Gorham, T. and McDonald, M.P. (1997), "Deploying software QFD within large organizations", *Transactions of the 9th Symposium on QFD*, QFD Institute, Ann Arbor, MI.

Kendal, G.I. and Rollins, S.C. (2003), *Advanced Project Portfolio Management and the PMO: Multiplying ROI at Warp Speed*, J. Ross Publishing, Boca Raton, FL.

Kerzner, H. (2001), *Project Management: A Systems Approach to Planning, Scheduling, and Controlling*, 7th ed., Wiley, New York, NY.

QFD Institute (2000), *Quality Function Deployment Green Belt® Workshop*, QFD Institute, Ann Arbor, MI.

Strategic planning using QFD

Catherine P. Killen
Centre for Management Innovation and Technology, Management Policy and Practice Group, University of Technology, Sydney, Australia
Mike Walker
Customer-Driven Strategies Pty Ltd, Brisbane, Australia, and
Robert A. Hunt
Centre for Management Innovation and Technology, Graduate School of Management, Macquarie University, Sydney, Australia

Abstract

Purpose – This paper outlines the use of quality function deployment (QFD) for strategic planning. QFD provides a comprehensive process for defining the issues facing an organisation in terms of customer and stakeholder outcomes, natural segments and key strategic opportunities.

Design/methodology/approach – An explanation and overview of the two core stages of strategic planning using QFD are followed by three case examples.

Findings – Strategic QFD avoids complex matrix analysis and instead moves directly to concept generation and evaluation. One of the main benefits of strategic QFD is the level of commitment and support for the resulting strategy throughout the organisation. This paper also shows how strategic QFD can be used to identify and optimise internal capabilities and to find and address specific customer opportunities.

Practical implications – Strategic planners will find that QFD-based philosophy and methods are useful tools for the creation of a customer-driven strategy.

Originality/value – This paper provides insight for practitioners and academics into how strategic QFD systematically translates vision into action, targeting opportunities and creating innovative strategies that are stable even in fast-changing environments.

Keywords Quality function deployment, Strategic planning, Innovation, Quality concepts

Paper type General review

1. Introduction

Quality function deployment (QFD) offers a rigorous analysis methodology for understanding customer outcomes and developing comprehensive product specifications. QFD tools and principles are traditionally used for product development, but they are just as appropriate for the development of business strategy (Walker, 2002). QFD strategic planning involves two key steps:

(1) the development of customer strategies; and

(2) the development of enabling strategies.

This paper provides an explanation and overview of the two core stages of strategic planning using QFD followed by some case examples. Section 2 outlines the first stage, the development of the customer strategy, and section 3 summarises the second stage, the generation and selection of enabling strategies. Case studies illustrating best-practice use of QFD for strategic planning are included in section 4.

International Journal of Quality & Reliability Management
Vol. 22 No. 1, 2005
pp. 17-29

0265-671X
DOI 10.1108/02656710510572968

2. The development of customer strategies

QFD principles insist that business strategy must be firmly based on an effective customer strategy. Experts in strategic planning agree that "current and future customer requirements are the driving force behind the creation of strategic direction for best-in-class organisations" (US Federal Benchmarking Consortium, 1997). Accurate, timely and complete information is required for strategic planning, and these high-performing organisations use "aggressive and varied ways to locate and listen to the Voice of the Customer" (US Federal Benchmarking Consortium, 1997).

Corporate strategy is sometimes simplistically viewed as a top-down process where visioning leads directly to decisions on products, processes and operations, and where customer strategy is just an afterthought. QFD-based methods start with customer and stakeholder outcomes. These outcomes lead to a strategy for each business and then to the corporate strategy to manage the business portfolio. The same processes apply to public sector organisations – their businesses or major activities must also deliver customer outcomes.

Translating corporate goals into action plans is an iterative process that involves upwards as well as downwards information flow, as shown in Figure 1.

The development of a "customer strategy" is a vital step in the strategy process. A major problem in planning, whether it is for products, organisations or any project, is not establishing a customer strategy that properly resolves the "fuzzy front end" before latching on to the strategic direction (Killen and Hunt, 2004). Failure is inevitable if plans are developed before the key deliverables are understood.

Often, organisations that are striving for innovation and improved performance realise that they should be customer-driven, but do not know how to gather and analyse the market research data, or how to use it to determine an effective customer strategy. The QFD approach to solving the fuzzy front end in strategy projects involves answering essentially the same questions as in product and service development projects. Who are the different types of customers that are impacted? What are their desired outcomes? Why do some of these represent bigger opportunities? How much improvement do we need to make to achieve our goals?

Figure 1.
Strategy development and deployment

These questions must be answered for all the different customer types: end customers, distributors, strategic partners, shareholders and other stakeholders such as staff, the environment and the local community.

The development of the customer strategy requires a methodical process, as outlined in Figure 2. Rigorous and comprehensive qualitative research is used to uncover customer outcomes that are stable over time. The customer outcomes are used to design statistically valid quantitative research, which provides the hard data for "natural market segmentation" and "opportunity analysis", which in turn allow customer positioning strategies to be determined.

2.1 Outcomes and customer input to the strategy process

A common mistake is for organisations to jump too quickly and rush through (or even skip completely) the vital in-depth qualitative customer research stage. Without realising it, these organisations are starting with invalid assumptions and undermining their entire planning process.

QFD utilises qualitative research interviewing techniques to listen to the voice of the customer and hear "what customers mean rather than what they say". While it is important for customer research to consider the known needs of current customers and other stakeholders, it is also important that the customer research looks to the future. The diagram in Figure 3 shows that a large area of potential opportunity is based on future customers and on needs that are not yet known or well understood.

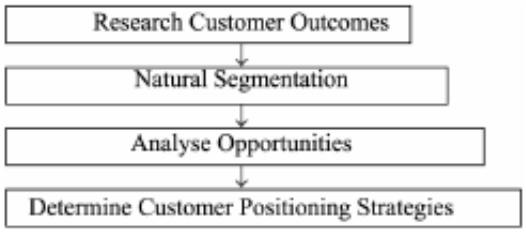
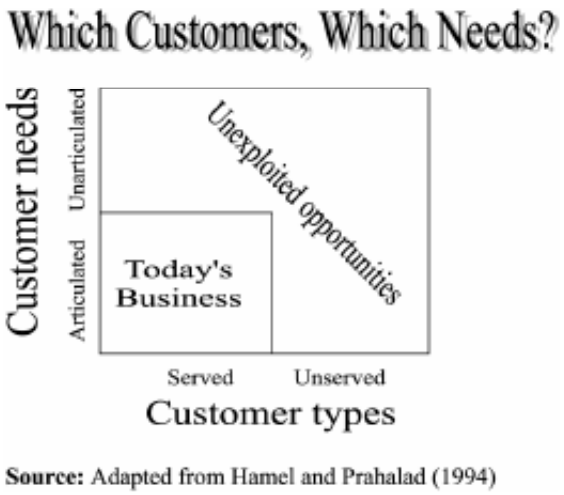


Figure 2.
Translating customer outcomes into customer strategy



Source: Adapted from Hamel and Prahalad (1994)

Figure 3.
Customer needs and types

The qualitative research sample must consider all potential customers as well as the current customers, and the research must uncover any previously unidentified needs. The sample does not need to be large – research shows that more than 95 per cent of customer outcomes can be identified with around 30 interviews for each major customer type, providing the respondents are carefully selected (Ulwick, 1999; Griffin and Hauser, 1993).

The aim of qualitative research is to uncover the full range of customer outcomes and probe each outcome deeply enough to fully understand the "what", "how" and "why" of the desired benefits. QFD methodology includes many tools to aid in this research process. These include:

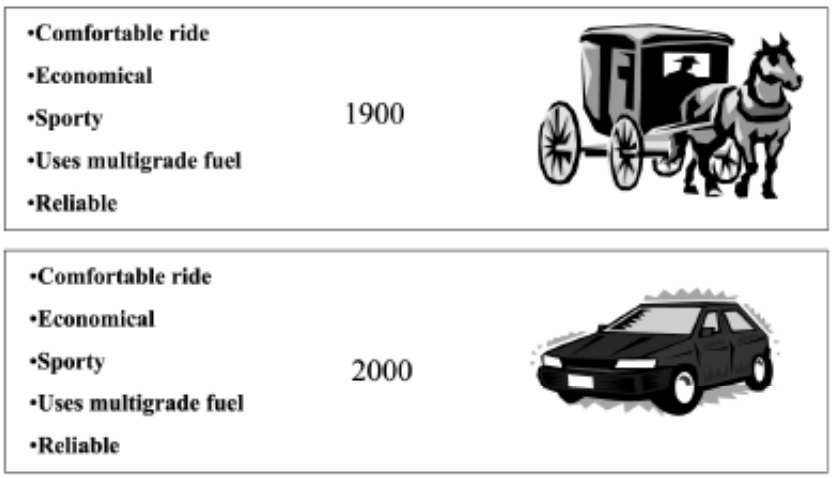
- the Kano model of customer satisfaction, which differentiates between basic, spoken and excitement outcomes (Kano *et al.*, 1985);
- the lead-user method, which provides a mechanism to seek input from advanced or early users (Herstatt and Von Hippel, 1992); and
- neurolinguistics, which was initially developed for psychology and now provides a general theory of communication used in many fields (Bandler and Grinder, 1979).

The key to accurate qualitative research is to focus on customer outcomes rather than the requested features, complaints, or other comments that customers usually offer. Neurolinguistics is particularly useful for understanding and probing customer outcomes (Laborde, 1983). An outcome is "the result you want, defined in terms of the way you would like to see things happen, the way you want to feel, and what you want to hear when you have your outcome" (Laborde, 1983, p. 7). The difference between outcomes and solutions may appear rather subtle, but is in fact very significant. Customer outcomes are the benefits the customer desires, whereas product features are solutions that deliver those benefits[1]. The danger in focusing on solutions too early is that it prevents proper consideration of other solutions and inhibits innovation.

Customer outcomes offer a solid basis for forward planning. When properly defined, outcomes are remarkably stable over time, even in turbulent high-tech markets, whereas solutions can age very quickly as new technologies and processes are developed. For example, the desire to "communicate across long distances" is a customer outcome that is fairly stable. However, the solutions have changed dramatically over the years, from knotted ropes and stone tablets to postal mail, telegraph, two-way radio, telephone, fax, mobile telephones, SMS messaging and e-mail.

Transportation provides another example of stable outcomes, as illustrated in Figure 4. While the technological solution has changed over the century from a horse-drawn carriage to a sporty car, the underlying benefits or outcomes have remained the same. Customers still want the means of transport to provide a comfortable ride, be economical, sporty, use multigrade fuel and be reliable.

It is important that the qualitative research report sets out the verbatim comments of participants, rather than the views of researchers. Often this report amounts to 80-100 close-typed pages and requires careful analysis to clearly identify the required customer benefits in terms of stable outcomes. The time-stable characteristic of outcomes is crucial for the formulation of a strategy that will "project a clear and compelling future for all stakeholders [. . .] Strategies can and should evolve over time, but should not bob around in the water and be buffeted by the waves" (Xavier and Hunt, 2002, p. 59).



Source: Terninko (1997, p. 7)

Figure 4.
Outcomes versus solutions over time

In terms of statistical validity, qualitative research is really only "hearsay". However, comprehensive and thorough qualitative research is vital for the design of the quantitative research sample framework and survey instrument that will provide the hard data on which important decisions must be based. The number of participants included in quantitative research sample framework varies depending on the type of project and the number of expected market segments. The primary aim is to provide hard data on customer priorities and satisfaction perceptions, although often other information is gathered, such as demographics, preferred communications media, and attitudes. Customer research often results in a large number of customer outcomes – even basic commodity industries such as steel and paper may involve 60-80 outcomes. The challenge is to obtain as much information as possible without making the survey so time-consuming or difficult that response rates decline.

2.2 Outcome-based "natural" segmentation

Market segmentation is an important step in analysing research data, but it is too often overlooked. If organisations do not understand their customers and the differences between different types of customers, they have little chance of making the right decisions. Often there are significant market segments with their own unique priorities: rather than providing a "one size fits all" product or service, organisations may gain significant competitive advantage by customising products and services for particular customer segments.

Conventional market segmentation is usually based on standard industry classifications or demographics. These divisions are convenient for organisational reporting, but are artificial because they often include customers with widely differing outcome perceptions. Conventional segmentation often obscures the existence of important customer groups and does not provide a useful framework for customer outcome analysis.

Natural segmentation is based on grouping customers into segments where they share the same outcome priority and satisfaction perceptions. Natural segments are not

always immediately obvious and may need to be revealed by analysing outcome-based data. A statistical technique called "cluster analysis" is used for revealing natural segments. The main advantage of these natural segments is that products and services that are developed to meet these customers' outcomes are likely to be successful. The size of the segments is also useful in predicting market share.

2.3 Opportunity analysis

Often there are a large number of possible customer outcome and market segment combinations, but it is impossible to successfully address all of these areas at the same time. There is a need to focus on the few vital opportunity areas, otherwise across-the-board funding results in important areas being under-resourced while other areas consume too many resources.

Opportunity analysis focuses attention on the handful of opportunities that will maximise the leverage from the limited resources available. These key opportunity areas are identified by desired customer outcomes that are both highly important and poorly satisfied. The "opportunity algorithm" is a simple yet effective heuristic measure that combines these two aspects in a single metric (Ulwick, 2002b):

$$\text{Opportunity} = \text{Importance} + (\text{Importance} - \text{Satisfaction}).$$

The opportunity algorithm data is also used in the market segmentation to focus the clustering analysis on the small number of natural segments that can generate and sustain competitive advantage (Ulwick, 2002a). Further analysis of the natural customer segments and the most significant opportunity areas highlights the customer outcomes that represent the greatest overall opportunities from the relatively large initial set of outcomes.

2.4 Customer-positioning strategies

Identifying the market segmentation highlights the unique opportunities to serve new or existing customer groups and pinpoints innovation targets. It also helps new entrants to markets to identify possible profitable entry points for disruptive technologies, or helps incumbent organisations with established market share to plan their response to potential disruptive technologies (Christensen, 1997).

According to Porter (1996), the essence of strategy is the creation of a unique and valuable position that leads to sustainable competitive advantage. The challenge is to realign the company's activities based on the market position and to carefully position the organisation to achieve the corporate vision. A successful positioning strategy or "value proposition" must differentiate the organisation's products and services from those of the competition. Table I illustrates how each customer outcome strategy can be analysed in terms of relative importance and outcome satisfaction to determine the value proposition.

The value proposition identifies the planned organisational response for each of the high opportunity customer outcomes. The value proposition may apply across the board or may be different for different segments. The use of stable outcomes helps identify a product platform that will provide a sustainable competitive position and will be robust in the face of technological change.

Outcomes can conflict with each other, so that delivering one outcome makes delivering another more difficult, particularly in public sector organisations. The aim

	Satisfaction of the outcome in the competitive market			
Customer outcome importance level	All poor	We better	Competition better	All good
High importance	Breakthrough innovation opportunity	Maintain and promote	Imitate or leapfrog	Investigate disruptive technologies
Low importance	Monitor	Reduce costs	Improve but do not invest	Monitor

Note: Outcome opportunity matrix developed and applied in QFD consulting projects by Mike Walker, Customer-Driven Strategies

Table I. Outcome opportunity matrix

of the value proposition is to provide more value than competitors, enough to keep or win over target customers, but not to add extra cost through unwanted features. For example, if an organisation is better than the competition in satisfying an outcome that is unimportant to customers, there may be an opportunity to reduce costs on that dimension. In this instance the organisation could consider reducing the level of satisfaction provided for an unimportant outcome in order to reduce prices.

3. Developing enabling strategies

The second major step in strategic planning is developing enabling strategies that will match the organisational capabilities with the target opportunity areas. QFD relationship matrix analysis is often dispensed with in strategic QFD because the customer positioning results in a focus on a small number of opportunity areas. The concept selection technique (Pugh, 1981), which is commonly used with QFD, has been adapted for generating and evaluating alternative strategic concepts.

"Strategy concepts" are sets of enabling strategies and strategic initiatives that are coherent and mutually supportive. In most organisations there are numerous solutions, ideas and suggestions to be considered – ranging from improvements in the utilisation of existing resources to innovative new technologies. Strategic concepts are built up by considering each outcome opportunity and identifying the possible solutions that address the key opportunities.

Each idea is scored on its effectiveness in meeting customer outcomes using the market research data. Sometimes other criteria are also evaluated, such as cost, effort required, risk of failure and vulnerability to competitive replication. The concept selection technique allows the alternative solutions to be modified and improved during the process. In contrast, conjoint analysis requires the alternatives to be defined up front before the research is conducted, which largely precludes innovation.

The technique starts with base strategic concepts that are automatically generated from all the proposed solutions for each high opportunity outcome. For example, one base strategic concept will include the ideas that are most effective in satisfying opportunities, while another will include the least cost ideas (or least effort to implement, or lowest risk, etc.). These base strategy sets provide a basis for discussion, but need to be reviewed carefully as they may contain ideas that are impractical or in conflict with each other. Often these trade-offs highlight breakthrough opportunities to use new technology or old technology in a new way.

Evaluating strategic concepts using clearly identified and prioritised criteria removes subjectivity and clarifies the interactions between opportunities and strategic initiatives. It also ensures strategic decisions are not technology-driven. New strategy sets are usually created by mixing and matching features from the different concepts, and this often leads to new insights and breakthrough ideas. The technique is iterative, and in each cycle the best strategic concept is examined to find new ideas. The focus on key opportunity areas means that usually only a few iterations are needed before the final set of strategies is determined.

3.1 Implementation issues

Managers, staff and technology experts must participate in strategic planning teams for each major activity using QFD. Strategy consultants can facilitate the process, but the strategic directions must come from the team. Team members are particularly important in determining the customer strategy and identifying strategic innovations that will deliver breakthroughs on the target opportunities, yet are practical in terms of the organisation's capabilities. Policy deployment (PD) is commonly used to manage strategic change and monitor implementation. It is critical that the people charged with implementation understand and agree with the strategy. PD involves communicating strategies throughout the organisation – so that each person understands their role – and making performance highly visible. One of the main benefits of PD is the improvement in staff morale from improved communication (Walker, 1992, 1993).

Each element of the proposed strategy is evaluated by performance measures. Predictive metrics are used to measure process capabilities (Ulwick, 1999), output measures track the end results, and ongoing outcome research tracks customer satisfaction. Some of these measures are used during the planning process and others are important during implementation. To avoid losing focus, the number of measures should be kept to a minimum and should be monitored on a regular basis along with goals, timelines and responsibilities.

Computer software is used in strategic QFD to record information on the marketplace, customer outcomes, segments, opportunity areas, technologies, ideas and strategies. This "organisational knowledge base" provides an important resource for future projects. Software is also useful for analysing the customer data, natural segments and opportunity areas, and for generating and selecting alternative strategic concepts. The aim is to streamline the planning process so the team can focus on innovation and strategy. Computer systems using intranet technology are also being used at Brisbane City Council to manage policy deployment, providing ready access to strategies and performance measures at each level and function in the organisation (Ryan, 2004)[2].

Continual customer research is required to track changes in the industry. Although outcomes do not tend to change very much, products often move through a lifecycle, and the basis of differentiation between customer priorities changes from basic functionality to more sophisticated features and finally to price. Performance perceptions also change as technologies evolve and competitors adopt different strategies. In-depth customer research may be needed when customer priorities and performance perceptions are thought to have changed significantly.

4. Best-practice QFD for strategy: case examples

Strategic QFD has been used in a wide range of projects from improving profits at a lift manufacturer (Hunt and Xavier, 1996) to launching a council-owned business (Shellshear, 1998). The following three case examples illustrate the application of best-practice strategic QFD in different organisations:

(1) Energex strategy development;

(2) Meat and Livestock Australia (MLA) development of R&D strategies; and

(3) Health care delivery strategies using outcome-based segmentation.

4.1 Energex strategy development

Energex used the strategic QFD approach to plan its entry into the New Zealand market. The customer research and analysis highlighted critical segment opportunities, helped Energex design its business proposals, and optimised its strengths in network technology and management.

Energex is an energy network capability provider that was created through the corporatisation of the public energy company SEQEB in Queensland, Australia. With experience and expertise in the design and operation of energy supply networks, but no marketing experience, Energex needed to develop a strategy for competing in the international market. This would provide a major challenge to the organisation and required a change in culture and the development of new capabilities.

It was decided that a radical change in methodology was required in order for Energex to break out of their public service culture and to develop the ability to generate success in an internationally competitive market. The first international business opportunity Energex targeted was the provision of electricity network management in Auckland, New Zealand. QFD was chosen for this project and proved to be a successful tool on many counts. QFD's most acknowledged benefit is to provide a process to sharpen the focus on the customer. This was doubly beneficial in the Energex case, as the company was able to learn first how to identify the customers and understand their needs as well as to benefit from QFD's ability to provide the focus on the most important needs. In addition, QFD was instrumental in garnering the support of the managers and staff in the new organisation. At first, they were not accepting of the privatisation of the workplace and were apprehensive about the changes it would bring. QFD increased support by providing a logical process that everyone could understand and participate in. Energex management did not know whether they would win the Auckland contract, but they could see that QFD would provide measurable outcomes that would identify areas for improvement even if they did not win.

The QFD qualitative and quantitative customer research process took about three months to complete. Even before the Auckland tender was released, Energex was actively learning about the New Zealand market and talking to the customers, the network owners and board members. The process identified the concerns of these customers, who were largely non-technical members of the community. For example, safety was identified as a very important customer outcome – it was particularly important due to increasing concerns about public liability at the time. QFD then helped Energex create its proposal with an enhanced safety element. The process was drilled down many levels to specific operating proposals and procedures to meet safety requirements. For example, the research identified that certain local safety operations

were important for customers, and that the customers had confidence in the local safety practices. Therefore, Energex developed a strategy to not only meet the international standards, but also to offer compliance with local safety practices. Energex understood that although the additional local practices might not improve safety, customers' perceptions can be strong strategic drivers.

Energex won the Auckland contract, and now successfully supplies network management services there. The customer-driven strategies developed through the QFD process have been directly credited with the success. John Wedgwood, the Marketing Manager of Energex at the time, believes that "We would not have had a chance at all without QFD". He feels that QFD provided three main benefits: "QFD told us about the New Zealand market, brought the employees on board, and showed Energex how to identify and optimise our capabilities. This was the first time we really had to go through our organisation and find out what we could do. QFD gave us the confidence that Energex had the internal capabilities to get the job done."

4.2 Development of R&D strategies for Meat and Livestock Australia (MLA)

Strategic QFD has proven to be a useful tool for developing customer-driven strategy at Meat and Livestock Australia (MLA). Before using QFD, MLA had already recognised the importance of meeting customer needs and had tried to ensure that their strategic directions were customer-driven. For example, they had a practice of including prominent graziers in their planning teams, with the expectation that this was providing the customers' perspective. However, once they became familiar with QFD, MLA realised that the graziers' input was not adequate for the development of a truly customer-driven strategy because they did not constitute a statistically valid sample that was representative of the industry.

MLA's first strategic QFD project was charged with developing the strategy for beef research and information delivery in Northern Australia. The beef industry is a very significant contributor to Australia's gross domestic product, export income and employment levels. MLA aims to foster innovation in beef production at the farm level. Their research, development and information extension programs are designed to "initiate and coordinate research within universities, the CSIRO (Commonwealth Scientific Research Organisation) and other research organisations and to develop and promote effective extension and training within the industry" (Walker, 2002, p. 11). The project team included representatives from MLA, research centres and the state government departments who participated in six two-day workshops over about five months. Extensive qualitative and quantitative research was conducted with beef producers, researchers, information deliverers, MLA staff and external stakeholders. Customer outcomes were developed and prioritised based on end-user priorities and satisfaction perceptions. New strategies were developed and structured according to these end-user outcomes rather than the traditional approach based on science disciplines. The selected strategies involved four initiatives:

(1) communication to stakeholders and the community;

(2) produce access and uptake;

(3) generating solutions; and

(4) building capacity in research and skills development (Walker, 2002).

MLA felt that the structured research and analysis process in QFD offered considerable advantages, and have subsequently used QFD on several projects. One of the main benefits of QFD was the high level of ownership from MLA personnel and the industry, which increased confidence that selected strategic directions were optimal for customers and stakeholders.

4.3 Health-care delivery strategies using outcome-based segmentation

Outcomes-based thinking requires a radical mind set change. While outcomes may not be new to practised QFD practitioners, mainstream management – and particularly senior management – involved in strategy formulation is largely ignorant of the concept. For example, in a recent Harvard Business School research project sponsored by the Harvard/Kennedy School Health Care Delivery Project (Ulwick *et al.*, 2003), 72 unique consumer outcomes were identified and prioritised. Some of the most important and least satisfied were:

- I want to know with certainty that my body is free from disease, infection and tumours;
- I want to maintain concentration and focus; and
- I want to be able to determine what dosage of vitamins and supplements should be taken to achieve desired health objectives.

Interestingly, when these results were presented to the senior managements of a group of major traditional health care providers, insurers and regulators, they were unaware of these outcomes.

The Harvard/Kennedy School Health Care Delivery project used the opportunity algorithm to focus on the consumer outcomes with the most significant opportunities for improvement (see Table II). The base "importance" and "satisfaction" ratings in Table II indicate the percentage of individuals who rate the respective outcomes with a four or five on a five-point Likert scale (Ulwick, 1999). For instance, the importance rating of 9.3 indicates that 93 per cent of people rate the outcome "Know with certainty that body is free from disease, infection, tumours" as very important or critically important, and that only 51 per cent are satisfied or highly satisfied with the situation. This technique avoids the poor discrimination problems associated with using the traditional average Likert rating. It also avoids the issues of limiting choices that occur when applying the pairwise comparison analytic hierarchy process, another popular method of representing the relative importance of customer needs or outcomes. In

Desired outcome	Importance of solving (I)	Satisfaction with current solution (S)	Opportunity $[I + (I - S)]$
Know with certainty that body is free from disease, infection, tumours	9.3	5.1	13.5
Maintain concentration and focus	8.7	5.1	12.3
Determine what dosage of vitamins and supplements should be taken to achieve desired health objectives	6.3	4.0	8.6

Source: Ulwick *et al.*, 2003

Table II. Opportunity algorithm applied to health-care delivery outcomes

combination with the opportunity algorithm, this method of rating is an excellent technique for obtaining strong discrimination and focusing on the small number of outcomes with highest opportunity; one of the core principles of QFD.

The Harvard/Kennedy School Project identified four natural market segments. People in one of these segments (food-centric people – containing approximately 55 million Americans) want to determine if toxins are present in their bodies. People in this segment also want to know if there are vitamin or nutrition imbalances in their bodies. These outcomes are only currently being met by time-consuming multiple doctor visits and expensive tests. The opportunity algorithm indicated that a strategy to develop inexpensive home tests to answer these questions could be very attractive (Ulwick *et al.*, 2003).

5. Summary

This paper illustrates how quality function deployment has been developed as a "best practice" strategy process, and illustrates its application in a variety of organisations. Strategic QFD systematically translates vision into action in a series of logical steps: researching customer outcomes, analysing segments, targeting opportunities and creating innovative strategies that are stable in fast-changing environments. It provides a deep understanding of the different customers and stakeholders, identifies previously unknown segments, and targets the critical opportunities. Strategic QFD also generates innovative strategies to achieve the organisation's vision and leads directly to policy deployment for implementation and performance management.

Notes

1. Andrew Tiede, CEO, The Positioning Group, pioneered the use of outcome research for strategic planning when consulting to major corporations during the 1990s.
2. Peter Ryan is the Corporate Strategy and Performance Planner for the City of Brisbane. His approach is to be featured shortly in *Harvard Business Review*.

References

Bandler, R. and Grinder, J. (1979), *Frogs into Princes: Neuro Linguistic Programming*, NLP Comprehensive, Evergreen, CO.

Christensen, C. (1997), *The Innovator's Dilemma*, Harvard Business School Press, Boston, MA.

Griffin, A. and Hauser, J. (1993), "The voice of the customer", *Marketing Science*, Vol. 12 No. 1, pp. 1-27.

Hamel, G. and Prahalad, C.K. (1994), *Competing for the Future*, Harvard Business School Press, Boston, MA, p. 112.

Herstatt, C. and von Hippel, E. (1992), "From experience: developing new product concepts via the lead user method: a case study in a 'low-tech field'", *Journal of Product Innovation Management*, Vol. 9, pp. 213-21.

Hunt, R.A. and Xavier, F. (1996), "Building and sustaining an industry leader with QFD: Deve Hydraulic Lifts Australia Pty Ltd", *Transactions of the 8th US Symposium and 2nd World Symposium on Quality Function Deployment*, QFD Institute, Novi, MI.

Kano, N., Seraku, F., Takahashi, F. and Tsuji, S. (1985), "Attractive quality and must be quality", *Quality*, Vol. 14 No. 2, pp. 39-45.

Killen, C.P. and Hunt, R.A. (2004), "Strategy: solving the fuzzy front end", Management Challenge in the New Millennium, Quality Management and Organizational Development (QMOD) Conference, Monterrey, August 4-6.

Laborde, G. (1983), *Influencing with Integrity: Management Skills for Communication and Negotiation*, Syntony Publishing, Palo Alto, CA.

Porter, M. (1996), "What is strategy?", *Harvard Business Review*, Vol. 74 No. 6, pp. 61-78.

Pugh, S. (1981), "Concept selection – a method that works", International Conference on Engineering Design, Rome.

Ryan, P. (2004), "Developments in strategic performance management issues", CIMA Seminar, Brisbane.

Shellshear, D. (1998), "Commercialising city drains using the CD-MAP® process", *Proceedings of the World Innovation and Strategy Conference 1998, incorporating 4th International Symposium on Quality Function Deployment*, Sydney, 2-5 August.

Terninko, J. (1997), *Step by Step QFD: Customer Driven Product Development*, CRC Press/St Lucie Press, Boca Raton, FL.

Ulwick, A.W. (1999), *Business Strategy Formulation: Theory, Process and the Intellectual Revolution*, Quorum Books, Westport, CT.

Ulwick, A.W. (2002a), "Outcome-based segmentation", available at: www.strategyn.com (accessed March 5, 2004).

Ulwick, A.W. (2002b), "Turn customer input into innovation", *Harvard Business Review*, Vol. 80 No. 1, pp. 91-7.

Ulwick, A.W., Christensen, C. and Grossman, J. (2003), "A prescription for health care reform", *Strategy and Innovation*, (web journal).

US Federal Benchmarking Consortium (1997), *Best Practices in Customer-Driven Strategic Planning, Study Report*, US Federal Benchmarking Consortium.

Walker, M.N. (1992), "Policy deployment", *Quality Australia*, Vol. 9 No. 3, pp. 28-32.

Walker, M.N. (1993), "Policy deployment – the key ingredient in making TQM effective", *The Quality Magazine*, Vol. 2 No. 4, pp. 70-4.

Walker, M.N. (2002), "Customer driven breakthroughs using QFD and policy deployment", *Management Decision*, Vol. 40 No. 3, pp. 248-56.

Xavier, F. and Hunt, R.A. (2002), "Strategy in turbulent times", *Managerial Auditing Journal*, Vol. 17 No. 1, pp. 55-9.

IJQRM
22,1

30

TQM and QFD: exploiting a customer complaint management system

Verónica González Bosch
Product Design and Innovation Center, Monterrey Tech (ITESM), Monterrey, Mexico, and
Francisco Tamayo Enríquez
Arnecom, San Nicolás de los Garza, Mexico

Abstract

Purpose – To present a simple yet comprehensive customer complaint management system (CCMS) which includes tools and concepts from total quality management (TQM) and quality function deployment (QFD) proposed by the authors.

Design/methodology/approach – A comprehensive CCMS model based on the Deming cycle that integrates practice-tested methodologies such as QFD, problem solving and failure mode effect analysis (FMEA) was developed. In order to provide an example of the application, possibilities and limitations of our proposed CCMS model, a project developed for a major Latin American transportation company is presented.

Findings – Excellent service can only be achieved with a profound knowledge of evolving customer needs. Functional CCMS should be implemented in every company, regardless of its size, structure or products. QFD, FMEA and problem-solving tools are very useful but, rather than the tools themselves, the fundamental element to develop a successful CCMS is the spirit of improvement towards total customer satisfaction energized by top management's leadership and commitment. A successfully implemented CCMS can change the perspective of complaint management and transform the process of answering complaints from a trivial activity to a more exciting process-design and learning experience, renovating the spirit of continuous improvement towards service excellence.

Research limitations/implications – The model may not be useful to some major companies that already have their own database systems for storing and analyzing customer complaints in real time. The results were only validated in a single project with its particular characteristics.

Practical implications – In a service economy, comprehensive systems for capturing, analyzing and translating customer complaints into adequate actions for focused improvement are required for competitiveness. Simple CCMS can be implemented without significant investment, in order to exploit customer complaints.

Originality/value – This paper presents a simple, yet comprehensive CCMS based on practice-tested methodologies successfully implemented in an improvement project. Companies that do not have formal CCMS can find efficiency in the model because of its simplicity.

Keywords Quality function deployment, Complaints, Customer services quality, Failure modes and effects analysis

Paper type Research paper

International Journal of Quality & Reliability Management
Vol. 22 No. 1, 2005
pp. 30-37

0265-671X
DOI 10.1108/02656710510572977

Introduction

A decade ago, even before the "internet boom", Zeithaml *et al.* (1990 p. 1) reported that "executives ranked the improvement of service and tangible product quality as the single most critical challenge facing U.S. business". In addition, services accounted for approximately 75 percent of the US gross national product (GNP), and 90 percent of the

new jobs the economy created. This transition towards a service economy has represented a global trend and is a major competitive issue. Nevertheless, service worldwide does not appear to have improved as much as customers require. Furthermore, in many service industries, current customer complaints are the same as were received ten years ago.

Deming (1986) believed that failures in service, and therefore complaints, are inevitable due to the number of variables and perceptions involved in service transactions. He also showed us, with his Deming cycle, that feedback and learning from mistakes were both key ingredients for achieving true TQM and sustained profitability. As Zeithaml *et al.* (1990 p. 3) wondered, "How do we explain the incongruity that service excellence pays off and yet it is in such short supply?" If service companies frequently get information from the customer about what is going wrong, why are so many service companies not changing fast enough?

Complaints are expensive, both as direct and indirect costs. But for this price, companies can extract priceless knowledge, because complaints contain the direct voice of the customer (VOC). One of the main steps of quality function deployment (QFD) is "going to the *gemba*". Akao and Mazur (2003 p. 23) define *gemba* as "a Japanese term that refers to the place where source information can be learned". This confirmation at the place where actions for the customer are taking place is one of the strengths of QFD. Therefore, *gemba* visits should be carefully planned to obtain the "real" voice of the customer. When a complaint arises, however, there has been such a large gap between expected and perceived basic needs that the *gemba* has taken the initiative by contacting the company to make sure that its voice is completely understood!

If complaints are transformed into knowledge about customers, they can provide a valuable amount of capital for enterprises (González Bosch, 2001). To exploit this capital, companies must design, build, operate and continuously upgrade systems for managing complaints. These systems are called customer complaint management systems (CCMS).

Considering the value that customer complaints have, it could be expected that robust CCMS are being used successfully at many service companies. However, Tax *et al.* (1998) state that in general, firms are not well informed on how to deal with either service failures or with the impact of CCMS.

Berry (1996) describes three main factors that hinder the proliferation of CCMS:

(1) CCMS costs are visible and immediate, while their benefits are long-term and indirect;

(2) managers doubt customer honesty when voicing a complaint; and

(3) many unsatisfied customers do not complain: according to Stephens and Gwinner (1998 p. 172), up to two-thirds of unsatisfied customers do not complain.

In addition, we find that in many organizational cultures a complaint stands for failure and blame, so employees try to minimize or hide the occurrence of complaints.

Customer complaint management system model

Although important research has been conducted around CCMS (e.g. Technical Assistance Research Program, 1979), most models are not comprehensive enough, and understate the importance of some steps that have been demonstrated to be crucial to

the process through experience with TQM and QFD methodologies. Therefore, a model for CCMS that integrates practice-tested methodologies such as QFD, problem solving and failure mode effect analysis (FMEA) was developed.

The seven steps of the CCMS model, based on the Deming cycle, are all traceable to a TQM methodology (QFD, FMEA or 8Ds). These steps are:

- document the voice of the customer (VOC);
- translate VOC into customer needs and problems;
- analyze and solve the problem;
- exploit customer needs;
- update FMEA to avoid recurrence;
- share solutions with affected customer; and
- update system performance measurements (Figure 1).

Three important indicators for measuring the CCMS success are proposed:

(1) time to respond to a customer complaint, from receiving it to giving an answer to the affected customer;

(2) percentage of closed cases out of complaints received; and

(3) evaluation of service level.

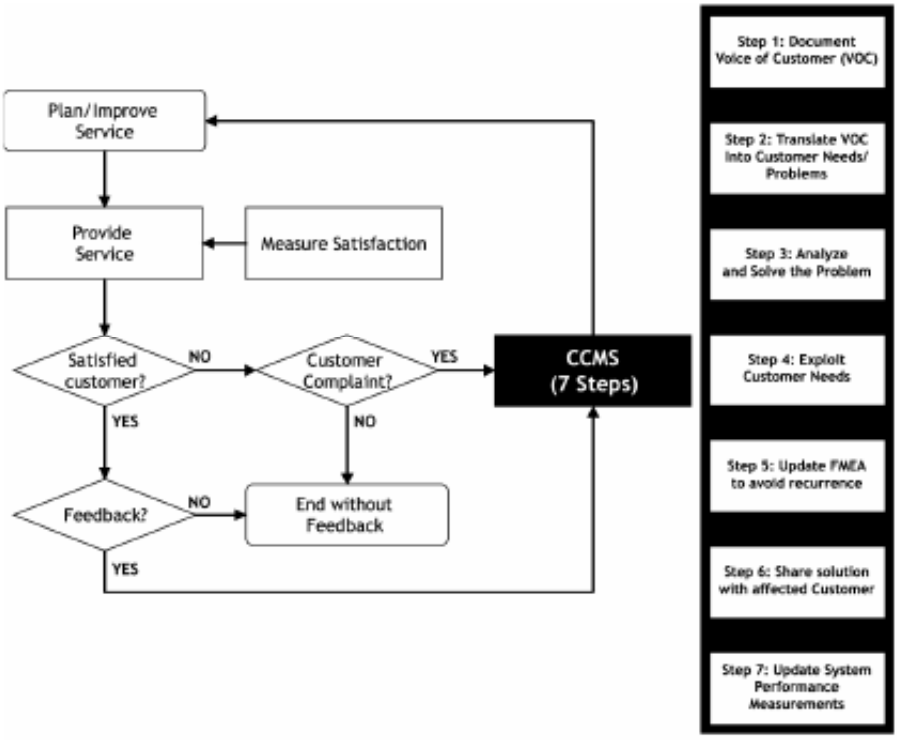


Figure 1.
CCMS model

Although service level is affected by many variables other than CCMS, it can provide a reference for the general improvement status of the company through its service strategies.

Case study: LatinAir

In order to provide an example of the application, possibilities and limitations of our proposed CCMS model, we present a project developed for a major Latin American transportation company. In order to keep things confidential, we will refer to it as "LatinAir". Numbers, figures, dates and exact verbalizations have also been modified slightly for the same purpose. The improvement team assigned to this project, and integrated by LatinAir personnel and the authors, will be referred as "LA Team".

With the intention of making this process easier to understand for LatinAir personnel, a Microscoft Excel document was developed with five linked worksheets. Worksheet 1 includes voice and customer needs (CNs), as well as the problem definition and its causes. Worksheet 2 is an FMEA format. Worksheet 3 is a matrix that relates CNs with processes. Worksheet 4 is an automatically generated apology letter for the customer. Finally, Worksheet 5 is a diagram that shows unmet needs. These worksheets simplified the work and served as a useful validation tool. They also allowed LatinAir personnel to easily modify and adopt the tool to their needs and language as they mastered the process.

Step 1: document VOC

The first step was to document the VOC into the worksheet. Although there is a format to document complaints at LatinAir, every complaint has been managed as a single issue. In a complaint, there may be more than one useful verbalization, so we divided each complaint in all the verbalizations to be analyzed (Table I).

Step 2: translate VOC into customer needs and problems

For each verbalization, the LA Team identified the customer need (CN) behind the verbalizations. For some verbalizations, more than one CN was identified. In order to achieve consistency, the team wrote each CN to complete the sentence "I need to ..." (Table II). The QFD concepts and tools were very useful in this part of the process, since the LA Team had already studied how to translate the VOC into expected benefits, filtering process features.

The LA Team also clearly defined the problem that most probably caused the CN not to be satisfied, specifying all available dimensions of the problem (Table III). Using

Complaint number	Flight	Route	Voice of customer (verbalization)
10.1	44	A-C	"At the counter, we were informed that we would be boarding at Gate 2. After a while, we noticed a lot of movement in Gate 3 [...] Gate 3 was the correct boarding gate, not Gate 2 [...]"
10.2	44	A-C	"[...] the agent rudely commented to us that we were not eligible for hotel and dinner like the rest of the passengers, because we had arrived late (because of the boarding gate issue) [...]"

Table I.
Voice of customer example (partial view of Worksheet 1)

the CONCATENATE Function of Excel, the problem was automatically described as "8 passengers with service response mistaken at boarding gate on Mar-15-01".

Step 3: analyze and solve the problem

After defining the problem, the affected processes were analyzed and the causes were determined (Table IV). Previously, causes were not completely validated, so there were no real solutions, only contingency and non-permanent countermeasures. When looking for root causes, LatinAir executives obtained very useful information about their systems. This strongly motivated their interest in participating actively in this learning process, providing both ideas and resources. This step also allowed the LA Team to establish corrective countermeasures that were more customer-oriented, since they considered the CNs behind the complaints. Nevertheless, a problem-solving methodology (e.g. 8Ds) is not enough for orienting the service processes to CNs, because the scope of problem-solving methodologies is problem correction and QFD's scope is understanding and satisfying customer needs: therefore, the next steps were followed.

Step 4: exploit customer needs

Exploiting customer needs means maximizing the value to the company. Complaints are a first-rate source for identifying Kano's expected and basic requirements (CNs) to be satisfied. Exciting requirements can be extracted from congratulations and positive comments. When a comprehensive QFD house of quality (HoQ) or CN-weighted priority list exists, the CNs extracted from the complaints could be useful for improving or updating those planning tools. When there is no information available on CN priority, these needs could serve as an initial reference for customer-oriented improvement.

There was no prioritized list of CNs at LatinAir. In this project, the team stratified the CNs and then prepared a basic list of equivalent-level CNs with the frequency that the needs were not met (Figure 2). This will allow LatinAir to continue focusing its

Table II.
Customer need example (partial view of Worksheet 1)

Complaint number	Need (I need to ...)
10.2	... receive a friendly and respectful service

Table III.
Problem definition example (partial view of Worksheet 1)

	What is the problem?					
Complaint number	Identity (what: object) noun	Identity (what: defect) negative adjective	Where?	When?	Magnitude (how much)	Magnitude (concept)
10.2	Service response	Mistaken	Boarding gate	Mar-15-01	8	Passengers

Table IV.
Process affected and causes analysis (partial view of Worksheet 1)

Complaint number	Cause of process failure	Affected process
10.2	Protocol rules for answering passengers were not followed	Passenger service

efforts on these needs and as a reference point for subsequent comprehensive QFD projects to be developed. The LA Team strongly recommended a project for identifying and prioritizing CNs directly from the customer. The LA Team concurred to assume at this point that all CNs had relatively the same importance, so focus for service process redesign should be assigned to the CNs that were generating higher number of reports.

A matrix was developed (Figure 3) to identify which processes were related to which CNs. This allowed LatinAir to identify interesting patterns and processes that needed to be redesigned or drastically improved.

Step 5: update FMEA to avoid recurrence

There was no service FMEA at LatinAir. With the documentation of the first group of complaints, an initial FMEA was developed (Tables V and VI). This FMEA has been serving as a basis for detecting failure modes and developing an initial preventive system. Many more preventive actions were added to this FMEA later. Steps 4 and 5 allowed the LA Team to establish some relevant preventive actions to be taken that

Customer Need	Number of reported times need was not satisfied
Receive a friendly and respectful service	15
Get all the services I paid for with my ticket	14
Trouble-free connections	5
Confidence that requested services will be effectively carried on	4
Have a secure service when buying tickets	4

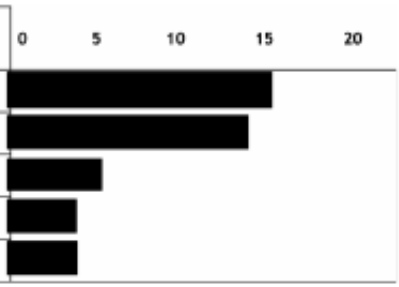


Figure 2.
Example of some critical customer needs (partial view of Worksheet 5)

Needs vs. Processes	Passenger service	Tickets purchasing	Boarding
Receive a friendly and respectful service	15		
Get all the services I paid for with my ticket	7		7
Guarantee that there will not be problems with the flight connections		5	
Confidence that requested services will be effectively carried on		9	

Figure 3.
Matrix of customer needs versus processes (partial view of Worksheet 3)

Complaint number	Process description: what is done?	Potential failure mode: how it fails?	Potential failure effect: consequence (need not satisfied)
10.2	Passenger service	Service response mistaken	Receive a friendly and respectful service

Table V.
FMEA (partial view of Worksheet 2)

were useful to prevent detected failure modes and/or to protect identified important CNs. The LA Team agreed that this generated a more customer-oriented service process.

Step 6: share solutions with the affected customer

When a customer has a problem with a company, but the problem is properly managed, it is highly probable that the customer will remain loyal to the company. Moreover, it is also very likely that the customer will make comments to others about the excellence of the response (Barlow and Moller, 1996). Customers like to be listened to and considered, because this makes them feel respected and important. Therefore, it is essential to give the customer a sincere apology and to respond to their complaint as soon as possible. Our Excel document automatically generates an "apology letter" that includes the identified need, the problem definition and its causes, the corrective and preventive actions to be taken, and the e-mail address of the employee responsible for the implementation. We included this letter as a validation for the analysis done, because it should sound coherent when all of the elements are put together. LatinAir is using these letters as a reference for responding to their customers.

Step 7: update system performance measurements

When the process is finished, two metrics should be updated at LatinAir:

(1) the percentage of customer complaints closed; and

(2) the total closing time.

In this project, we found that a time-effective complaint closing process is a key element for achieving a high percentage of closed cases. Therefore, closing time is a critical variable to be controlled.

Conclusion

Excellent service is a genuine key for a better future, for both customers and suppliers (Zeithaml *et al.*, 1990). However, this can only be achieved with a profound knowledge of evolving customer needs. A functional customer complaint management system will generate this knowledge, and such a system should be implemented in every company regardless of its size, structure or products. QFD, FMEA and problem-solving tools are very useful: nevertheless, during the implementation process, the LA Team determined that rather than the tools themselves, the fundamental element to develop a successful CCMS is the spirit of improvement towards total customer satisfaction energized by top management's leadership and commitment. QFD concepts and tools were especially valuable because they did not just provide an answer to the problems detected. They allowed for a better understanding of the customer needs behind the

Causes of potential failure	PRN	Recommended actions: what do you do to prevent failure?	Responsible
Protocol rules for answering passengers were not followed	125	Review everyday protocol and their importance rules with all service personnel, to avoid lack of observance	J. Smith, Manager e-mail: jsmith@latinair.com

Table VI.
FMEA (partial view of Worksheet 2)

verbalizations and they freed the LA Team to focus on learning and achieving higher customer satisfaction. This change in the perspective of complaint management at LatinAir transformed the process of answering complaints from a trivial activity to a more exciting process design and learning experience. Complaints are no longer seen as a source of blame but as a unique learning opportunity. There is a renewed spirit of continuous improvement toward service excellence. Procedures, service rules and training in TQM and QFD tools and systems are being developed. Before the implementation of the CCMS at LatinAir, the total closing time for answering a complaint would usually be measured in weeks – now it is only a matter of days. The percentage of closed cases has increased as well. Although enthusiasm at LatinAir is contagious and their culture has evolved, there is still much work to do. LatinAir employees say that they want to be the best customer-service team in the market, and they mean it. The smiles on their faces and the pride and energy their leaders are conveying through their example and actions are strong indicators that their continual improvement will lead to world-class customer-service success.

References

Akao, Y. and Mazur, G. (2003), "The leading edge in QFD: past, present and future", *International Journal of Quality and & Reliability Management*, Vol. 20 No. 1, pp. 20-35.

Barlow, J. and Moller, C. (1996), *A Complaint is a Gift*, Berrett-Koehler, San Francisco, CA.

Berry, L. (1996), *On Great Service: A Framework for Action*, Free Press, New York, NY.

Deming, W.E. (1986), *Out of the Crisis*, MIT Centre for Advanced Engineering Studies, Cambridge, MA.

González Bosch, V. (2001), *La Administración de las Quejas como Capital de las Empresas* (in Spanish), ITESM, Monterrey.

Stephens, N. and Gwinner, K. (1998), "Why don't some people complain? A cognitive-emotive process model of consumer complaint behavior", *Journal of the Academy of Marketing Science*, Vol. 26 No. 3, pp. 172-89.

Tax, S., Brown, S. and Chandrashekaran, M. (1998), "Customer evaluation of service complaint experiences: implications for relationship marketing", *Journal of Marketing*, Vol. 68, pp. 60-76.

Technical Assistance Research Programme (1979), *Consumer Complaints Handling in America: An Update Study*, Office of Consumer Affairs, Washington, DC.

Zeithaml, V.A., Parasuraman, A. and Berry, L.L. (1990), *Delivering Quality Service*, Free Press, New York, NY.

Further reading

Terninko, J. (1997), *QFD: Step-by-Step Customer-Driven Product Design*, St Lucie Press, Boca Raton, FL.

IJQRM
22,1

38

Best practice QFD application: an internal/external benchmarking approach based on Ford Motors' experience

David Ginn and Mohamed Zairi
School of Management, University of Bradford, Bradford, UK

Abstract

Purpose – This paper is based on a benchmarking exercise involving some 164 QFD practitioners within Ford Motor Company and 27 selected external QFD companies. The predominant response "cell" was from Vehicle Centre 1, Power-Train Systems Engineering, although there was both a US and non-power-train response content. The benchmarking focused on four parts: (1) criteria of success; (2) learning experience; (3) teamwork; and (4) future of QFD.

Design/methodology/approach – Quality function deployment (QFD) is a bridge between the customer and the product (process/service) development community. The QFD technique translates customer requirements obtained from market research into product measurables using matrix diagrams and product development teamwork. Ideally this process continues throughout the product development cycle, from design to production, using a series of QFD phases, prioritising and trading off the key measurables at each step. The ideal result should be both perceived and actual improvements to quality, functional performance and reduced cost on key attributes to prompt higher customer satisfaction. Use of QFD is therefore seen as both a strategic and a tactical tool within a competitive market. The problem facing many QFD practitioners, including Ford Motor Company, is that the cost, complexity and commitment required to deliver effective QFD-driven targets in a timely manner either exceed available resources or represent a cultural anathema.

Findings – Following a discussion of the major findings from the Ford survey on usage pattern, the results were then benchmarked with a 1991 QFD usage survey conducted by MIT with 100 US companies.

Research limitations/implications – The concept of QFD was developed in the mid-1960s in Japan, with many Japanese companies now automatically incorporating QFD as an integral part of company-wide quality practice. In contrast, many Western companies, having used QFD only since the mid-1980s, either have already abandoned QFD in frustration or are in the process of radically rethinking its practice within their own changing quality improvement environments.

Originality/value – Senior and middle management support, including the release of resources, remains a critical component of successful QFD implementation. There is also a need to integrate a more flexible and timely QFD process within the requirements of the established product development process. All this depends on well-trained, cross-functional and multi-disciplined teams with unified goals and focus.

Keywords Quality function deployment, House of quality, Customer satisfaction, Team working, Performance management, Quality

Paper type Research paper

International Journal of Quality & Reliability Management
Vol. 22 No. 1, 2005
pp. 38-58

0265-671X
DOI 10.1108/02656710510572986

1. Some working definitions and descriptions of quality function deployment

In the Ford *Quality Function Deployment Executive Briefing* (Ford Motor Company, 1987) it was stated that there was no single definition for quality function deployment, but the following definition was proposed as a starting point:

> A system for translating customer requirements into appropriate company requirements at each stage (of the product development cycle) from research and product development to engineering and manufacturing to marketing/sales and distribution.

Despite there being revisions to this definition within Ford Motor Company, the essence of the definition remains the same, although more recent QFD definitions within Ford Motor Company have added breadth by including key words such as "quality", "value", "target setting process", "planning tool", "customer driven product development process", "customer focused engineering" and "customer satisfaction". A selection of excerpts over time includes:

- "A planning tool for translating customer needs and expectations into appropriate company requirements" and "Customer Driven Product Development" (Ford Motor Company, 1989); and
- "A planning tool that identifies the significant few items on which to focus time, product improvement efforts and other resources" (Ford Motor Company, 1992).

Other descriptions and definitions of QFD, include amongst others, the following. Kathawala and Motwani (1994) simply state: "QFD can reduce the risk of misinterpreting customer requirements". Kathawala and Motwani (1994) further quote from the work of Maddux *et al.* (1991), that "QFD's objectives are to: identify the customer, determine what the customer wants, and provide a way to meet the customer's desires". Asaka and Ozeki (1988) place great emphasis on the word "planning" in their descriptions of QFD, as do Sullivan (1988), McElroy (1989), and Ford Motor Company (1983). Asaka and Ozeki (1988), however, prefer to shorten the term "quality function deployment" to just "quality deployment", and state that quality deployment (or QFD) "defines the functions of planning, development, design and manufacturing of a product to satisfy the quality requirements of customers". This shortening of QFD to just "quality deployment" is consistent with Akao (1990). Quality deployment refers to the charts, tables and descriptive matrices used to design in the quality (or "goodness") required by the customer in the product. Akao (1990) has two definitions for QFD, one narrow, and one broad:

(1) narrow QFD definition: "The business or task functions responsible for quality (design, manufacturing, production)"; and

(2) broad QFD definition: "A combination of these business or task functions responsible for quality (design, manufacturing, production etc.) and the quality deployment charts".

Akao (1988) adds that "function deployment is often a later step in QFD where the basic functions of the product or service are identified by experienced people at the production company". Akao (1990) likens function deployment to the "voice of the engineer" who has the task of identifying the "must be" attributes of the product, where Akao (1990) gives the example of "must be" as an unspoken customer requirement, an attribute that must be there, otherwise it is a source of dissatisfaction to the customer (such as a bed and a bathroom in a hotel, which the customer must have). However, Akao (1990) asserts that to have these "must be" attributes, or functions, does not guarantee customer satisfaction: it only ensures no strong dissatisfaction. Akao (1990) summarises this argument by stating that when a customer's spoken quality demand opposes these "must be" attributes or functions, then the producer of the product or service must

balance the spoken demands with practical functional requirements of the product or service. Akao (1990) ties in the purpose of the quality charts or quality tables (which have already been referred to as "houses of quality" or "QFD matrices" by the previously referenced authors) as a "means to" and not "an end in themselves", that is to say they are there to provide insight into the nature of the product or service and what is necessary to improve it with relation to the spoken quality demands of the customer.

Slinger (1992) neatly proposes that "Quality Function Deployment is a design tool which is a powerful support to "encouraging" engineering design teams to take a structured, thorough approach to product design". Slinger (1992) and Metherell (1991) further describe a four-stage (phase) QFD process as part of an integrated engineering process, which they illustrate as linked into simultaneous engineering using teamwork, training and planning. Metherell (1991) adds to the setting of QFD and simultaneous engineering in context with integrated engineering by emphasising the focus for team effort. Metherell (1991) also intimates that QFD as part of this integrated engineering process is consistent with the highest "opportunity for change" at the concept levels, and offers traceability throughout the product cycle.

Consistent with the previous two authors, Hauser and Clausing (1988) propose a definition of QFD through reference to its classic house of quality matrix, which reads: "the house of quality is a kind of conceptual map that provides the means for interfunctional planning and communications". They further suggest that people with different problems and responsibilities can thrash out design priorities by referring to patterns of evidence from the house of quality. This interpretation adds to argument for QFD being more than just a planning tool scenario, but also a tool for interdisciplinary communications within any company. Hauser and Clausing's (1988) definition proposes that QFD is both a planning and communications tool that helps focus and coordinate skills within an organisation from design to manufacture into a product customers want and will continue to buy.

Sullivan (1988) corroborates this view that QFD is a both a planning tool and an aid to communication, and observes that several US companies (notably Ford) show case studies being very successful in applying the QFD matrix charts, which in turn has helped integrate the various diverse activities within that company. Sullivan develops this argument, however, by suggesting that QFD can be used as the "hardware" through which "policy management", which he refers to as the "software", can be integrated. The difference with policy management to "objective management", the more typical style of management, is that the latter is based on measuring performance by results, while the former focuses on developing the means of achieving results through methods, systems, or resources. Sullivan (1988) suggests that the foundation of policy management is "business planning". Business planning in turn is based on employee ownership or entrepreneurship to set goals through a comprehensive planning process across the whole organization, by reducing the void between departments. The results from this level of detail then become the results of the policy means and a measure of policy management success. In summary, Sullivan (1988) proposes that "soft technologies" such as policy management are important to achieve the business plan, and that this must be integrated through congruent objectives with the use of "hard technologies" such as QFD, Taguchi methods and SPC to deploy product requirements. All these elements combined deliver the key goal of meeting customer expectations. This argument for QFD is an integral part of business planning

and is corroborated by Barlow (1995), who refers to "policy deployment" in the same context. Greenall (1995) describes policy deployment as process-focused, rather than management by objectives.

The idea of using QFD within an organization as an aid to business planning becomes clear when placed in the context of its numerous and varied benefits, which will now be discussed. Zairi (1993) summaries four key benefits as being:

(1) higher quality;

(2) lower cost;

(3) shorter timing; and

(4) marketing advantage.

Akao's (1990) survey of QFD benefits within Japanese industry quotes five key process benefits:

(1) decreased start-up problems;

(2) competitive analysis becomes possible;

(3) control points clarified;

(4) effective communications between divisions; and

(5) design intent carried through to manufacturing.

Aoki *et al.* (1990) relate the benefits of QFD as being in conjunction with "quality charts, related procedures of new product development and quality assurance activities", and summarises these into two broad benefits that lead to:

(1) the development of new products that both meet customers' demands and wins their trust as well as being developed in a timely manner to lead the market; and

(2) the improvement of interdepartmental communication on product development by identifying problems from early pre-design stage to ensure development and process time reductions.

It would appear, however, that QFD is only one of many techniques available to companies wishing to improve product development times. Reinertsen (1991) reviews how companies can overcome 15 common barriers to timing product-development cycles, and refers to QFD and CE (concurrent engineering) as valuable in trimming development cycles down, but from the 15 common barriers, QFD is only completely successful in just two areas while CE is successful in only five areas. These are:

- "hitting moving targets" (QFD);
- "lack of concurrency" (CE);
- "moving *locus* of control" (CE);
- "phased development systems" (CE); and
- "focus on communication" (QFD/CE).

The Reinertsen (1991) list of remaining barriers (which are largely self-explanatory) that QFD specifically does not adequately address include:

- taking giant steps;
- ignoring market clocks;

- overloading capacity;
- ignoring queue time;
- burn rate management;
- lack of concurrency;
- inattention to architecture;
- moving locus of control;
- phased development systems;
- inappropriate testing strategies;
- failure to quantify the problem;
- make/buy decisions; and
- when efforts pay off.

Reinertsen (1991) does, however, acknowledge the crucial role of communications in developing products rapidly.

Finally, a description of QFD is given by Reynolds (1992), who proposes that the planning process of quality function deployment is the major development in the quality sector of business. Reynolds (1992) describes QFD as a tool that uses "a sophisticated subjective analysis to design an "optimal" product with maximum customer satisfaction assured". This definition places emphasis on the subjective approach QFD offers, and that optimisation of the product is the route to maximum customer satisfaction. Miguel (2003), on the other hand, further emphasizes the importance of establishing a customer-centric approach, using the magic of QFD.

2. The background, method and intention of the QFD practitioner survey

The purpose of the benchmarking survey on QFD usage patterns was to check the importance of having consistently well trained and well maintained cross-functional teams with multi-disciplinary skills supported by senior management, all of which are factors highlighted in previous studies.

The research was based on a questionnaire which was sent out to 283 internal Ford employees, including core team, support team and ex-team members worldwide, as well as some 80 external QFD practitioners, representing some 27 companies. The areas of the study covered include aspects related to QFD project management, QFD training and experience, QFD teamwork, and finally the future of QFD.

Part of the analysis is to benchmark the internal QFD practices within Ford with external QFD practices where applicable. Like the internal responses, the external responses include a cross-section of experience and application expertise that ranges from the complete beginner to long-established team members who are at the forefront of QFD development within their respective companies.

3. Response profile for the QFD practitioners survey

From within Ford Motor Company responses were polled from current core and support team member distribution lists to active QFD efforts within the company worldwide. These distribution lists were based on the authors' own e-mail QFD distribution lists and were customised into three key lists of "core", "support" and "ex-QFD" team members. These three lists, although given "pigeon-holed" titles of

core, support and ex-team members, in reality represented a more complex distribution of interest. The areas represented within Ford, although extensive and comprehensive in many cases, still had a strong Power-Train Systems Engineering bias. Details of QFD usage questionnaires sent, returned and lost are given in Table I.

From the external responses, as already noted some 27 companies or QFD user groups were represented. The companies which agreed to participate in the questionnaire included:

- ASI QFD User Group;
- Jaguar Car Company;
- Martin Smith & Partners;
- University of Derby;
- Sporting Body Mind;
- British Sugar;
- MIL Research;
- Lever Brothers Ltd;
- Unilever plc;
- ICL;
- Cabot Leiden TC;
- ITI (UK) Ltd;
- Birds Eye Walls Ltd;
- Abbey National;
- Van den Bergh Foods;
- Elida Gibbs;
- TSB plc;
- Mars plc;
- IBM International;
- The CIM Institute;
- Lucas Engineering;
- MDI (UK) Ltd;

Questionnaire groups	Number sent out	Number returned	Number lost
Internal			
Core team members (VCI-Europe)	94	64	
Support team members (VCI-Europe)	88	36	+2
Ex-team members (VCI-Europe)	45	18	
Core team members (VC2-5 – USA)	56	9	
Internal totals	283	127 (45)	+2
External totals	80	37 (46)	+11
Combined totals	363	164 (45)	+13

Note: Numbers in parentheses are percentages

Table I. QFD usage questionnaires sent, returned and lost in post

- Ward Dutton Partnership;
- Edwards High Vacuum International;
- Four Square Drinks; and
- University of Bradford Management Centre.

4. Analysis of the QFD questionnaire findings

The key findings will be discussed from the five main parts, which include:

(1) respondent details;

(2) criteria for effective QFD application;

(3) the learning experience;

(4) the QFD team; and

(5) the future of QFD.

A comparison within the 1991 QFD implementation survey conducted by Pandey and Clausing (1991) at MIT, with some 79 companies in the USA with 203 responses, will take place at the end of this paper. The results from the internal and external responses have not been separated for two reasons. The first reason is that the original draft of results did not show a great difference across the complete response range between the internal and external responses. The second reason was that with the constraint of time, it was considered more important to get the fullest content analysed question by question. The focus on a detailed question-by-question breakdown of results broadly showed a greater contrast of results than would have been seen by focusing on splitting the two key response groups of internal and external.

The following five sections mirror Parts A to D of the questionnaire, as well as the initial "Respondent details" that all respondents completed before talking all or part of the questionnaire: Section 1 – Respondent details; Section 2 – Part A: Criteria for effective application; Section 3 – Part B: Learning experience; Section 4 – Part C: The QFD team; and Section 5 – Part D: The future of QFD.

The first level of detail is the respondent details, which all 164 respondents completed. From this profile of the respondents was set. The total of 127 internal (Ford Motor Company) respondents compared to just 37 external respondents must be put into context of a 45 and a 46 per cent response level to the total number of questionnaires sent out to internal and external respondents, respectively.

Partly due to the bias of the source of the internal distribution lists, and partly due to the historic bias for QFD application within Ford Motor Company, the power-train versus non-power-train respondent level internally is 3 to 1 (94 to 33 absolute counts). The respondent levels externally are the opposite, with non power-train responses outnumbering power-train responses five to one. Overall, however, power-train respondents outnumber non-power-train respondents by almost two to one.

By far the most overwhelming fact in the personal respondent profile is the 92 per cent versus 8 percent male to female overall response levels. This ratio is higher internally within Ford than externally (96 to 4 per cent and 77 to 23 per cent, respectively).

All respondents were asked to identify where in their respective company's product development cycle they saw their job function role. This question framed the terms as

"upstream versus downstream ratios" (such as 80/20, upstream/downstream). With this came the finding that three-quarters (75 per cent) of the respondents saw themselves spread evenly within the 70/30 to 100/0 upstream/downstream band of the product development cycle, with barely upwards of 3 per cent in the remaining mid- to downstream area of the product development cycle. There was one "population" of 12 per cent in the 50/50 band.

The split between management role and general safety role (GSR) internally within Ford Motor Company was largely even, 54 to 46 per cent respectively. However, externally it was very much management-role biased (81 to 19 per cent, respectively). Overall this places the bias towards management role at 59 per cent to 41 per cent GSR.

The penultimate aspect of the respondent details was the years that respondents had spent in the (their) company. The response profile looked at the bands as follows: 0-1 +, 2-5 + and then in five-year bands, from 6-10 + finishing at 36-40. Although this produced a broad spread for both internal and external respondents, there was a combined peak within the 2-5 + band of 24 per cent that flattened off to 17 and 18 per cent (6-10 + and 11-15 +), and tailed off to 12 per cent and below from 16-20 + years.

The overall results for the current interests in QFD practice produced a fairly even spread of interest across all the five areas, with option d, "A potential new QFD Team member" receiving the least (10 per cent), but the main option was option e, "An interested party to QFD efforts", with 37 per cent response levels (although this was with the highest multiple count of 23, or 14 per cent). The second and third options were very close, with 30 and 26 per cent for option a, "QFD Core Team member/leader" and option c, "Past QFD Team member", respectively.

5. Criteria for effective QFD application

In this section, a series of questions were asked to establish both the "forced" and "unforced" responses to criteria critical to the successful implementation of QFD. The questions and responses covered a range of criteria across both the technical (hard) and human (soft) aspects considered important when progressing a QFD project.

5.1 Issues critical to the success of QFD

Overall, all six criteria proposed in the questionnaire received good response levels, with "Training" (87 per cent) the highest, followed by "Team selection" (81 per cent) and "Senior management role" (79 per cent). The key to the question asked how critical each of the criteria were to the success of QFD, with "3" being the most critical and "1" the least. The results broadly showed that all six of the criteria were heavily weighted towards the "2" and "3" ratings, indicating that respondents considered all the criteria had a moderate to critical influence on the success of QFD. However, three criteria in particular had all four key response cells ratings between 60 and 90 per cent in the "3" critical to QFD success. These were "Training", "Team selection" and "Project targets and deliverables". "Senior management role" came a close fourth in importance. Overall, it can be said that two criteria held consistently high responses levels and ratings, being criteria 1 and 2 of "Training" and "Team selection", respectively.

The second part of this process was to identify the most important issues supporting the criteria of success. The top seven keywords for "Training and team selection" can be seen in Table II.

From the results, it can be seen there is an even spread of the top four issues for "Training", while for "Team selection" it is more specifically cross-functional technical expertise that is most important.

5.2 QFD project type experience and usefulness in support of task activity

This question simply aimed at understanding the profile of experience in QFD projects. In summary of the four project types given, i.e. "(a) New product development", "(b) Current product improvement", "(c) New process development" and "(d) Current process improvement", there was clearly an emphasis on "New product development" in particular, followed by "Current product development". The ratings show that QFD was seen as largely critical (36 per cent) followed by moderate (29 per cent) to the success of "New product development", while for "Current product development" it was seen largely as moderate (27 per cent) to success.

5.3 Key benefits experienced as a direct result of using QFD

A total of 76 per cent of the respondents identified 16 areas of benefits (with response levels of 3 per cent and above) plus a group of others/miscellaneous as a direct result of using QFD. The top seven benefits out of the total of 16 are summarised below as keywords with their response level percentages shown in Table III. As can be seen in Table III, "Understanding the customer" received nearly a 50 per cent response level, with "Teamwork" a strong second.

5.4 Key problems experienced as a direct result of using QFD

Respondents were also asked to identify all the key problems experienced as a direct result of using QFD. This prompted a 71 per cent response level, just slightly lower then the benefits response level of 76 per cent. However, unlike the benefits which descended in order fairly evenly from a response of 47 per cent to 31 per cent to 26 per

Top seven keywords for "Training and team selection"	Percentage
"Train together in team"	27
"More adequate training"	22
"Team/technical skills (required, i.e. EQUIP)"	21
"Timing of training (i.e. just in time)"	21
"Team selection (cross-functional)"	41
"Technical expertise"	40
"Commitment"	28

Table II.
Training

Benefit	Response level (per cent)
"Understanding the customer"	47
"Teamwork and team focus"	31
"Supports quality improvement"	26
"Prioritisation of (customer) wants and resources (to support QFD)"	22
"Assists engineering and product knowledge"	21
"Structured, systematic and data-driven approach"	18
"Corporate knowledge and documentation"	18

Table III.
Top seven benefits from direct QFD application

cent down to 18 per cent for eights, the problems identified with an equivalent 18 per cent response level (or above), number only four, almost half the number of the benefits. The difference this time is that the top problem of "Slow/time consuming/lengthy process", with a response level of 45 per cent, similar to the top benefit, is double the count for the second problem response of only 23 per cent. One of the notable differences, however, is the total number of problems (with counts of 3 per cent and above) reaches a total of 27, compared to a total of only 16 benefits. This finding illustrates a general frustration with the QFD process that perhaps outweighs its benefits. The top eight problems are shown in Table IV.

5.5 Effectiveness of QFD to support technical and human criteria of success

Overall this question received a high response level for both "Technical criteria of success" and "Human criteria of success" (87 and 85 per cent, respectively). Both headings had four criteria given with an opportunity for respondents to identify any other criteria of success within both headings. The aim was to establish the effectiveness of QFD to support these criteria. All criteria under both headings received around 130-140 responses each. However, the ratings of 1, 2 and 3 (for QFD being marginal, moderate or critical to criteria of success) varied. The "Technical criteria of success" that QFD was considered of greatest benefit was "Quality improvement", which corroborates the findings of key QFD benefits, where "Supports quality improvement" was third most important (26 per cent). The other three technical criteria of "Innovation", "Cost reduction" and "Speed of delivery" all displayed a reasonable to strong response in the rating "1" (marginal) to "2" (moderate), with a range of 28-44 per cent. All the "Human criteria of success" had high response levels for both ratings "2" (moderate) and "3" (critical) of between 41 and 49 per cent and 35 and 41 per cent, respectively. This strongly suggests that perhaps the key measure of QFD benefits are less tangible "human" aspects.

6. Learning experience

The overall combined responses levels for Part B, the "Learning experience" was very good, with the lowest at 75 per cent ("Format of QFD believed to hold the greatest benefit to the company") to 93 and 94 per cent ("Initial contact with QFD" and "QFD software skills"). Most were around 85-90 per cent. Part B covers some 13 questions covering initial contact and learning experiences of QFD through to post-training experience and observations, as well as QFD software application knowledge. The last two questions include experience of other supporting quality tools and processes used in place of or in conjunction with QFD.

Problem	Response level (per cent)
"Slow/time-consuming/lengthy process"	45
"Inability of team to stay together"	23
"Poor understanding/poor image of QFD"	22
"Lack of funding/high cost of surveys"	20
"Bureaucratic/too complex/too much detail"	16
"Inappropriate/poor training of QFD"	16
"Poor understanding of the customer"	15
"Lacks focus/poor direction"	15

Table IV.
Top eight problems from direct application of QFD

6.1 Initial contact with QFD

"In a QFD team" was by far the most important initial contact for 43 per cent of the respondents, in particular internally within Ford Motor Company. The second most important form of initial contact with QFD was through "Training" (28 per cent), closely followed by "Colleagues" (21 per cent). These second two formats, however, equally represented the most important initial contact to QFD externally (40 per cent and 35 per cent of all external responses). "Literature" represented only a very small proportion of initial contacts (11 per cent), with "Other" contacts even less (4 per cent).

6.2 Poor image of QFD

After "Training", QFD appears to be equally as likely to be spread by word of mouth by "Colleagues". Any current poor images of QFD within Motor Ford Company may get an even poorer image, especially if the "colleagues" in question are untrained or poorly informed in the first place. Certainly from the perspective of a large company like Ford, where effective communications will be tested to the limits of efficiency, quality tools such as QFD, which are simple in principle but difficult in effective application, are susceptible to distortion or misuse, which does nothing for its long-term credibility.

6.3 Formal training experiences (B.2)

The results from the "Formal training" experience question provided a three-level response for each of the four response cells. This meant many respondents with formal training experience will have given a multi-response answer. That is to say an internal (or external) respondent may have experienced training from ASI Quality Systems (American Suppliers Institute), as well as with internal formal training modules in QFD, such as Ford EQUIP or Quick QFD.

6.4 Format of QFD thought to offer the greatest benefit to the company

These results suggests that there is an opportunity to develop and offer a QFD process that is not constrained by an specific number of phases, formats or rigid rules, while still retaining the option to deliver customer-generated targets down through the PDC. Such an opportunity has been tackled with limited success by the Ease of Start QFD.

The key conclusion here is that most QFD practitioners, although keen to retain the option of deploying QFD through as many phases as possible — depending on resources, timing, and task required – do not want too many constraints before either starting a QFD or whilst conducting a QFD. This supports the need to teach a flexible QFD approach, and has an impact on how teams are trained. A summary of the four QFD formats in order of preference is shown in Table V.

Table V.
Order of importance for QFD format considered most beneficial

Rank	Percentage	Format
1	77	Customised (flexible to task)
2	17	Single phase (phase 0 or phase 1 only)
3	12	Four-phase (traditional ASI taught)
4	9	Multiphase (four-phase plus sub-system phases 1A and 1B)

6.5 Initial impressions of QFD before training or current experience

The respondents were asked to give three keywords that expressed their initial impressions of QFD "before" training or current experience. The top five initial impressions before training are:

(1) "Unknown/unheard of/unaware";
(2) "Time consuming/lengthy/slow";
(3) "Vague/sceptical/suspicion";
(4) "Gimmick/fashionable/management jargon"; and
(5) "Logical/structured/systematic".

The top six impressions after training are:

(1) "Worthwhile/helpful/useful";
(2) "Valuable/powerful/important";
(3) "Time consuming/lengthy/slow";
(4) "Logical/structured/systematic";
(5) "Laborious/demanding/work"; and
(6) "Complex/difficult/complicated".

6.6.The issue of "customer" understanding

The first observation is that after training/current experience, "Worthwhile/helpful/useful" remains as the consistent top (positive) keyword group/impression. This result, coupled with the drop from second place at 34 per cent before training/experience to sixth place with 10 per cent for "Complex/difficult/complicated", and the fact that there are an equal number of positive impressions in the top six places in the "after" training experience section, strongly supports the benefits that training provides to QFD by way of a positive impression. This argument for training to support not only better understanding of the QFD process but to act as a vehicle for improving the image of QFD is an important lesson to learn. Of all the positive impressions within the original list of 22, a total of 11, virtually all except two, of the positive keyword group/impressions either show an increase in response levels or appear for the first time. Of the two that do not, "Simple" remains the same (3 per cent) and "Customer focused/driven product" disappears completely. It does seem strange that this key positive impression using the key word "customer" appears so low before and not at all after.

6.7 Teamwork issues

One surprising finding was that the positive keyword group of "Team building/teamwork/empowerment" showed such a low response count both before and after (2 and 6 per cent, respectively) training and/or current experience. The low response may be explained by the fact that respondents perceive teamwork as a derivative of QFD rather than an active ingredient or prerequisite.

6.8 Negative and positive impressions and a possible measure for success

It is of critical importance to review the few negative keyword groups/impressions that remain after training and current experience (see Table VI). These negative impressions will result in an ongoing poor image of QFD for those who do not actively

Negative keyword groups/impressions	Before (per cent)	After (per cent)
"Time-consuming/lengthy/slow"	21	25 (down)
"Laborious/demanding/work"	1	14 (up)
"Complex/difficult/complicated"	34	10 (down)
"Misunderstood/misused/underdeveloped"	N/A	9 (new)
"Inefficient/ineffective/indecisive"	7	7 (same)
"Frustrating/disappointed/results not accepted"	N/A	6 (new)
"Lack of expertise/specialists/facilitators"	N/A	3 (new)
"Team too big/untrained/lost momentum"	N/A	3 (new)
"Inflexible/cumbersome"	5	2 (up)
"Waste of time/not much help/not applicable"	N/A	2 (new)
"Not supported by senior management"	N/A	1 (new)
"Bureaucratic (prescriptive/mechanistic)"	5	1 (down)
"Vague/sceptical/suspicion"	15	N/A (lost)
"Gimmick/fashionable/management jargon"	13	N/A (lost)
"Optimistic/theoretical/academic"	3	N/A (lost)
"Expensive/costly"	3	N/A (lost)
"Does not fit into Ford culture"	3	N/A (lost)
"Advanced and research only/selective"	2	N/A (lost)

Table VI.
Eighteen negative impressions of QFD before and after training

participate in QFD. It is negative impressions that will most likely be remembered rather than the benefits, which as described already, tend to be less tangible or visible to those not involved with QFD, or embarking on a QFD for the first time.

6.9 Key elements still missing from training

All of the top four elements still missing from respondents' understanding of the QFD process are linked very closely to each other. A statement summarising the findings would read: "Respondents require 'more training' on how, when and with what to 'apply QFD', including a greater 'understanding of customer wants' and the opportunity to 'practice QFD within a Team'" (see Table VII). This finding emphasises the importance to respondents of four key elements of training of QFD, integration of QFD with other tools, the customer and practical application.

6.10 QFD software application skills and expertise

This section of the questionnaire response had a high response level. However, the total number of respondents who had used or had training on QFD software applications was very small, with only 33 (21 per cent) out of 154 responses. By default most practitioners using QFD software used the current Ford QFDNET (48 per cent) or the old Ford QFDplus (36 per cent), with the rest (including mostly external respondents) using ASI AFD Designer (36 per cent). The other QFD software packages used

Rank	Element	Percentage
1	"Complete/general/more training on QFD"	17
2	"Global coordination/alignment/integration of QFD"	14
3	"Reach/getting/understanding customer wants"	10
4	"Work/involve/practise/do it/train with a team"	10

Table VII.
Top four key elements still missing from QFD training

included examples from the companies participating, including ITI QFD Capture, Lucas Teamset, and IBM Strategic Pointer 2000.

When asked to identify the key improvements to the QFD software package respondents currently used, there was consistency across the response cells and packages used. The three most important improvements are shown in Table VIII.

6.11 Other quality tools and processes used in conjunction with QFD

Of the "top" nine tools and processes, there was some variation to the response levels between "used" and "essential" with each tool or process considered. All the tools or processes drew between 17 and 50 per cent for either the "used" or "essential" category. A list of the top nine quality tools and processes in order of being "essential" to QFD success support are shown in Table IX.

7. The QFD team

The respondents who answered Part C, "The QFD team", answered either from their current teamwork experience or from the perspective of their past QFD teamwork experience. The teamwork "experience" covered a broad baseline from active core team members or support team members to occasional participants, such as from the perspective of facilitators, trainers or consultants. The overall response level to this section in Part C was 70 per cent of the total respondents.

7.1 QFD team's objectives, goals and aims (C.1)

The respondents were asked to identify whether or not their QFD team's objectives, goals and aims were clearly defined and understood by:

- their management;
- by the team itself; and
- by the team's next "internal" customer.

Table VIII.
Top three improvements required for QFD software

Rank	Improvement	Percentage
1	"Easier/better printing/plotting capability"	30
2	"Transferability into standard applications" (e.g. Word, Excel, FMEAplus)	27
3	"Improved layout/display of graphics"	24

Table IX.
Top nine quality tools/processes essential to QFD success

Rank	Quality tool or process	"Essential" response (per cent)	"Used" response (per cent)
1	Experimentation	47	40
2	Systems engineering	43	25
3	Taguchi (robustness)	39	34
4	FMEA		35
5	Quality engineering	32	18
6	Systems design specifications	27	20
7	Process management	25	23
8	Concurrent engineering	24	17
9	TOPS 8D	21	43

Overall, only option b, "By the team" showed a strong 75 per cent "yes" response, followed by option a, "their management" at 47 per cent, and lastly by option c, "by the team's next internal customer". This finding first raises the issue as to the viability of gaining adequate management support in the first place, a constant criticism throughout the questionnaire. Second, it raises a concern that communication, particularly downstream from the QFD team, is lacking, which will seriously affect the chance of the QFD team effectively deploying its targets.

7.2 The cross-functionality of the team

Overall respondents were happy that their teams were suitably cross-functional to meet the QFD objectives set. This response level was a yes to no ratio of two to one (60 to 30 per cent). This result so clearly illustrates the awareness respondents have of the need for cross-functional teamwork when conducting QFD projects.

7.3 QFD team members' roles and tasks

To the question "Are the QFD team members' roles and tasks sufficiently identified to meet the team's objectives?", the split becomes skewed when looking at internal and external responses. The external response is four to one "yes", while the internal response is almost two to one "no". This shows a weakness in the internal (Ford Motor Company) QFD team structures. Despite there being people skills and teambuilding exercises internally within the EQUIP training process (before full "globalisation" of the Ford Engineering Techniques Programme) within Ford Motor Company, it was either too late, never completed, or there was little to put it into practice.

7.4 The level of QFD process knowledge within the QFD team

This question was intended to determine the current level of understanding of the process knowledge within respondents' QFD teams. Not surprisingly, judging by the responses already received in Part A and Part B, only 28 per cent of the respondents considered their teams to be comprised of teams with most of the members up to speed with QFD process knowledge. The biggest response of 35 per cent focused on "Only a few of the team area up to speed with QFD (process knowledge)". The findings from this simply reinforce previous findings that training in the QFD process is still incomplete for most people actively involved within QFD teams.

7.5 The regular QFD team meeting schedule

This question was simply intended to identify where geographically QFD team meetings were typically being held. There were three options:

(1) on-site at place of work;

(2) 50/50 on-site at/off-site from place of work; and

(3) off-site from place of work.

Although the order by response levels was off site (45 per cent), on-site (30 per cent) and 50/50 on-site/off-site (18 per cent), the split was 80 per cent on-site for external respondents, while internal respondents confirmed off-site as a preference by 48 per cent (almost half), with the other two options split with about 25 per cent each.

7.6 The eight criteria of success for QFD team meetings

Respondents were asked to review eight criteria of success for their QFD team meetings, and rate one of three options for each criterion. The three options were:

(1) "criterion is never met";

(2) "criterion is only partly met", and

(3) "criterion is successfully met".

In common with most of Part C, the responses show an overall bias to option 2, which identifies the criteria of success being only partly met. This is the case for seven of the eight criteria and displays a response level range of between 42 and 60 per cent. The only criterion that shows option 3 as top (with a response level of 43 per cent), indicating that the criterion is successfully met, is "Tasks are clearly defined and assigned". This is marginal, however, as option 2, "criterion is only partly met" still drew a 38 per cent response level. The criteria of success that display the most predominant bias towards option 2 and the three strongest response levels for option 3 of "criterion is only partly met" and "criterion is successfully met", respectively, are shown in Table X.

8. The future of QFD

8.1 The future challenges of QFD implementation within the company

There were a total of 16 keyword groups identified, with the top six drawing between 10 and 19 per cent response levels. The response levels to the keyword groups showed differences between the internal and external respondents to the point where although 16 keyword groups still remained for internal respondents, with the same top six, only ten keyword groups were identified by external respondents, with only three drawing response levels above 10 per cent (see Table XI).

Overall, apart from the third external response above, all of the top six are consistent for both internal and external responses. All of the above seven challenges are consistent throughout the questionnaire. These seven combined can be summarised into four key categories of challenges in relative order of importance, are shown in Table XII.

	Criterion of success	
		"Criterion is only partly met" (per cent)
1	"Tasks are completed on time"	60
2	"Agenda are completed in time allocated"	57
3	"Optimum meeting frequency for progress"	51
4	"Optimum meeting attendance for progress"	51
5	"QFD process checks are regularly scheduled"	50
6	"Optimum meeting length for tasks/agenda"	42
7	"Schedule/agenda posted well in advance"	42
		"Criterion is successfully met" (per cent)
7	"Tasks are clearly defined and assigned"	43
7	"Schedule/agenda is posted well in advance"	40
6	"Optimum meeting length for tasks/agenda"	34

Table X.
Eight criteria of QFD team meeting success

		Response levels (per cent)
Top six internal keyword groups		
1	"Resources identified and applied"	22
2	"Integration of/standardisation of QFD practice"	19
3	"Senior management buy-in/support/champions"	15
4	"Time management/faster/flexible QFD"	13
5	"Prioritisation/discipline/goals/aims/objectives"	13
6	"Better understanding of QFD/effective training"	10
Top three external keyword groups		
1	"Better understanding of QFD/effective training"	30
2	"Senior management buy-in/support/champions"	18
3	"Link product success with use of QFD"	12

Table XI.
Future of internal and external challenges for QFD use

	Challenges to future of QFD	Relative response level (per cent)
1	Management support for QFD process and resources	35
2	A more flexible, speedier standard process	25
3	More effective training/communicate success stories	19
4	Discipline and prioritisation of goals/aims/objectives	11

Table XII.
Four key challenges to the future of QFD use

8.2 Best chance for QFD being adopted by most people within the company

Broadly, the top five "best chances" of QFD being adopted by most people within the company followed a consistent descent in order for all the four key response cells, with only the fifth "chance" keyword group being heavily weighted by the external response, which would have made it the second most important external best "chance" (see Table XIII).

8.3 QFD becoming a company standard to meet high customer satisfaction

Respondents were simply asked if they thought QFD would become the company standard for meeting high customer satisfaction. Although, there was no intention to just obtain a "yes/no" answer, this was how most respondents replied. The response levels were consistent with the sample sizes across the four key response cells, with a cautious overall answer given, with only 39 per cent saying "yes", 33 per cent saying "maybe/only if" and 23 per cent saying "no".

	Best chance for QFD adoption by most people	Response level (per cent)
1	"Benefits need to be seen/success stories"	33
2	"More training/information on QFD process"	20
3	"Integrate/institutionalise QFD with PD process"	15
4	"Simplify/rationalise/speed up QFD process"	13
5	"Driven by senior management/champions/sponsors"	13

Table XIII.
Five best chances for QFD adoption by most people

8.4 QFD use bringing strategic benefits to the company
To this question the response in D.4 was "yes" with a 70 per cent response level, followed by "maybe/only if" at 13 per cent and "no" at 9 per cent. This finding contrasts dramatically with the many negative or highly critical findings within the questionnaire. This finding perhaps more clearly demonstrates how the image of QFD, although poor in practice, does have a good or positive image in theory.

8.5 Advances most liked to see within QFD
The overall top five "advances" are shown in Table XIV.

8.6 Other statements on the topic of QFD and a preliminary conclusion
Two key responses arose from this last question from a total of seven:

(1) "Senior and middle management vision is required" (17 per cent); and
(2) "Keep pushing/promoting QFD (through training)" (9 per cent).

Although the overall response levels are low, these two responses reflect two of the broad themes discovered in the questionnaire findings, which are critical to the future success of QFD use within both internal and external environments. The first is that support for all areas of resources, from time given to the process to allow it to run, headcount allocation to teams and funding of market research through to benchmarking, are all critical to QFD. This support for resources can only be sanctioned by senior and middle management. Without it the QFD process may exist within a company by name, but not by action.

9. Benchmark comparison between the Ford results and the 1991 QFD usage survey results

To assist the conclusion and validation of the Ford benchmarking survey on QFD practice, a comparison was made with a similar QFD implementation survey run by Pandey and Clausing (1991) in the summer of 1991. The MIT QFD Implementation Survey had a similar large response level of 203 (compared with 164) and a broad response profile, with some 79 companies from the consumer goods to aerospace industries represented. Although the response range of the current survey was smaller with only 27 companies represented, there was still a broad range of responsibilities represented within the internal Ford responses. Within the internal Ford response profile, approximately ten organisations from Power-Train to Programme Office were represented. Even within Power-Train itself, there were many disciplines represented. A key focus of both surveys included establishing the extent of use of QFD within the companies and factors of the perceived success of QFD.

	Advances most liked to see in QFD	Response level (per cent)
1	"Streamlined/speedier/more flexible process"	25
2	"Improved QFD/market research techniques/links"	11
3	"Improve communication of QFD results"	10
4	"Link QFD with other quality tools/processes"	9
5	"More practical/product/programme application"	7

Table XIV.
Top five advances most liked to see in QFD

Both the 1991 survey results and the Ford survey results showed that the majority of companies used QFD mainly in the pre-production phase. In the 1991 survey, 63 per cent of QFDs were at the advanced, planning or design end of the product cycle, which compares to 78 per cent within the Ford survey. This also needs to be balanced with "East versus West" cultural usage of QFD, and in fact reinforces the fact that the West uses QFD mainly as up-front planning tool rather than a downstream deployment tool with regard to product development. Although the findings of the 1991 survey showed that most companies had only applied ten or fewer QFD projects, this question was not directly asked in the study. However, this correlates well with the literature search findings. Certainly within Ford Europe, and particularly within the organisation of Power-Train only 10-14 QFD projects had even been attempted. Of these, less than ten had been successfully completed.

Of the top factors related to successful implementation in the 1991 survey, there were a number of differences with the forced ranking of the top criteria for successful implementation within Part A of the Ford survey. In Part A of the Ford survey, both "senior management role" and "team selection" were in the top three key criteria of success, which was comparable with the 1991 results. Also in common with the Ford survey, the 1991 survey reported that 40 per cent of respondents did not feel QFD was "catching on" and that their team was "incomplete". This matches very closely the Ford survey results on teamwork in Part C. Also when considering all four parts of the Ford survey, there are many parallels with the top five factors for successful implementation in the 1991 survey.

The Ford survey also produced a response that reinforces the top two factors of success in the 1991 survey, i.e. that "Senior and middle management vision is required".

A comparison of the 1991 top five factors related to successful implementation and the Ford top five future "challenges" of QFD implementation is given in Table XV.

The main limitations of this research study are related to the fact that a standardized QFD methodology was not used. This is further exacerbated by the fact that we are often dealing with dynamic customer needs, which require dynamic usage of QFD. The need to standardize the QFD methodology is acknowledged by Akao (2003) who argues that:

> QFD will also be positioned as an effective tool for quality assurance systems in the information age. For these goals, QFD methodology needs to be standardized.

In conclusion, it can be stated that senior and middle management support, including the release of resources, remains a critical component of successful QFD implementation. There is also a need to integrate a more flexible and timely QFD process within the requirements of the established product development process. All

Table XV.
1991 versus Ford QFD survey top five factors of success

1991 top five factors	Ford top five challenges
Top management support	Resources identified and applied
Middle management support	Integration/standardisation of QFD with PD
Completeness of multi-functional teams	Senior management buy-in-support/teams champions
Integration of QFD into PD process	Time management/faster/flexible QFD
Flexibility in adapting QFD	Prioritisation/discipline/goals/aims/methodology objectives

this depends on well-trained, cross-functional and multi-disciplined teams with unified goals and focus.

References

Akao, Y. (Ed.) (1990), *Quality Function Deployment: Integrating Customer Requirements into Product Design* (originally published as *Hinshitutenkai katsuyo no jissai*, Japan Standards Association, Tokyo), Productivity Press, Cambridge, MA.

Aoki, H., Kawasaki, Y. and Taniguchi, T. (1990), "Using quality deployment charts: subsystems, parts deployment, quality assurance charts", in Akao, Y. (Ed.), *Quality Function Deployment: Integrating Customer Requirements into Product Design* (originally published as *Hinshitutenkai katsuyo no jissai*, Japan Standards Association, Tokyo), Productivity Press, Cambridge, MA, pp. 83-111.

Asaka, T. and Ozeki, K. (1988), *Handbook of Quality Tools: The Japanese Approach* (originally published as *Genbacho no tameno QC Hikkei*, Japanese Standards Association, Tokyo), Productivity Press, Cambridge, MA.

Barlow, K. (1995), "Policy deployment in action at Kawneer", ASI Quality Systems 6th European Symposium for Taguchi Methods & QFD, Kenilworth, May 16-18.

Ford Motor Company (1983), *Module 7, Customer Focused Engineering, Level 1, QFD Manual*, Engineering Quality Improvement Programme, EQUIP Centre, Ford Motor Company, Boreham Airfield.

Ford Motor Company (1987), *Quality Function Deployment, Executive Briefing*, QFD00250, ASI Press, Dearborn, MI.

Ford Motor Company (1989), *QFD Awareness Seminar*, Quality Education and Training Centre, Ford Motor Company, Dearborn, MI.

Ford Motor Company (1992), *QFD Reference Manual: Car Product Development*, Technical Training and Educational Planning, Ford Motor Company, Dearborn, MI.

Greenall, R. (1995), "Policy deployment", ASI Quality Systems 6th European Symposium for Taguchi Methods & QFD, May 16-18, Kenilworth.

Hauser, J.R. and Clausing, D. (1988), "The house of quality", *Harvard Business Review*, pp. 63-73.

Kathawala, Y. and Motwani, J. (1994), "Implementing quality function deployment: a systems approach", *The TQM Magazine*, Vol. 6 No. 6, pp. 31-7.

McElroy, J. (1989), "QFD: building the house of quality", *Automotive Industries*, January, pp. 30-2.

Maddux, G.A., Amos, R.W. and Wyskidcy, A.R. (1991), "Organisations can apply quality function deployment as a strategic planning tool", *Industrial Engineering*, Vol. 23, September, pp. 33-7.

Metherell, S.M. (1991), "Quality function deployment, less firefighting and more forward planning", IFS Conference Proceedings.

Miguel, P.A.C. (2003), "The state-of-the-art of the Brazilian QFD applications at the top 500 companies", *International Journal of Quality & Reliability Management*, Vol. 20 No. 1, pp. 74-89.

Pandey, A. and Clausing, D.P. (1991), "QFD implementation survey report", working paper, Laboratory for Manufacturing and Productivity, MIT, Cambridge, MA.

Reinertsen, D. (1991), "Outrunning the pack in faster product development", *Electronic Design*, January, pp. 111-24.

Reynolds, M. (1992), "Quality assertive companies to benefit from recovery", *Elatometrics*, February, p. 19.

Slinger, M. (1992), *To Practise QFD with Success Requires a New Approach to Product Design*, Kontinuert Forbedring, Copenhagen.

Sullivan, L.P. (1988), "Policy management through quality function deployment", *Quality Progress*, May, pp. 18-20.

Zairi, M. (1993), *Quality Function Deployment: A Modern Competitive Tool, TQM Practitioner Series*, European Foundation for Quality Management/Technical Communications (Publishing), Eindhoven.

The Emerald Research Register for this journal is available at
www.emeraldinsight.com/researchregister

The current issue and full text archive of this journal is available at
www.emeraldinsight.com/0265-671X.htm

QFD, organisational creativity and productivity

John D. Politis
Pioneering Faculty of Business Programs, Higher Colleges of Technology, Dubai, United Arab Emirates

Abstract

Purpose – This paper examines the relationship between organisational creativity, productivity and the underlying dimensions that foster quality function deployment (QFD).

Methodology – A total of 359 usable questionnaires were received from employees who are engaged in quality management programmes from nine companies in the United Arab Emirates (UAE). These were subjected to a series of correlational and regression analyses.

Findings – There are three major findings in this research. First, the relationship between the QFD variables and organisational creativity is positive and significant. Second, the relationship between the QFD variables and productivity is stronger compared with the relationship between the QFD variables and organisational creativity.

Practical implications – Finally, the study suggests that top management commitment, worker-supervisor collaboration in QFD efforts, internal processes and strategies for QFD, the effectiveness of use of information and data to support QFD actions, and building relationships with customers, are essential in creating an organisational climate conducive to QFD implementation. The study shows that the real challenge for organisations in the UAE is to create a working environment that facilitates the process of QFD.

Keywords Creative thinking, Quality function deployment, Productivity rate, Innovation, United Arab Emirates

Paper type Research paper

1. Introduction

The competitiveness of an organisation depends on its ability to continuously adapt to new environments, develop new products, and create innovative ideas (Kay, 1993; Martensen and Dahlgaard, 1999). But how? Many organisations have reached the conclusion that total quality management (TQM) is essential in the process of achieving sustained organisational competitive advantage in the new economy. It is reported that TQM is a paradigm and a philosophy (Haag *et al.*, 1996) that comprises three primary activities, namely:

(1) *hoshin* planning;

(2) quality function deployment (QFD); and

(3) statistical process control (SPC).

Yet, QFD appears to be the key tool in every conceptual TQM model proposed today (Besterfield *et al.*, 1999).

According to Akao (1990), QFD is:

> ... a method for developing a design quality aimed at satisfying the consumer and then translating the consumer's demands into design targets and major quality assurance points to be used throughout the production phase.

International Journal of Quality & Reliability Management
Vol. 22 No. 1, 2005
pp. 59-71

0265-671X
DOI 10.1108/02656710510572996

In other words, QFD is a pointed way of listening to customers to learn exactly what they want, and then using a logical system (i.e. vehicle) to determine how best to fulfil those needs with available resources. It is a team builder – it ensures that everyone works together to give customers what they want (Guinta and Praizler, 1993). It gives everyone in the organisation a road map showing every step, from design through to delivery, and interacts to fulfil customer requirements.

Moreover, it is widely recognised that QFD has enabled a variety of organisations to deliver dramatic performance improvements through transforming customer requirements into appropriate products or services (Mitra, 1998; Sullivan, 1986). Although the literature suggests that QFD is cited as the most widespread implementation of TQM (Sage, 1992), and ultimately reduces development time and increases market share and profitability (Menon *et al.*, 1994; Prasad, 1996), there are no studies that have examined empirically the relationship between the underlying dimensions conducive to QFD implementation and performance improvements.

Current research lacks empirical evidence supporting the role played by the work environment in the course of QFD, as applied under the continuous improvement process (i.e. *kaizen* philosophy). Specifically, there is no empirical evidence assessing the effect of worker-supervisor collaboration in QFD efforts and top management's support of and commitment to TQM. After all, QFD is the implementation vehicle for TQM, and its power and success lies in top management's commitment and support, the availability of human resources, and the use of information and data to support QFD actions. Thus, there is an interest from academics and practitioners in addressing the underlying variables that facilitate QFD implementation.

The goal of this study is to examine empirically the relationship between creativity, productivity and the specific determinants conducive to the QFD process. The study involves a questionnaire-based survey of employees who are engaged in quality management programs from large organisations in the United Arab Emirates.

2. Work outcomes

Work outcome or organisational performance is of considerable importance for quality of life, for national economies and for increasing organisational competitiveness in the rapidly changing global economy. Due to its importance, the concept of measuring performance has received a great deal of scientific attention in the last 20 years (Cohen and Bailey, 1997). Over the years, organisational performance has been used to evaluate and compare:

- different leadership styles (Stogdill, 1974; Misumi, 1985; Cohen *et al.*, 1996);
- different types of organisational structures (Farris, 1969; Barefield and Young, 1988);
- different types of manufacturing practices (Hiromoto, 1988; Kaplan, 1990; Young, 1992);
- different training and modelling techniques (Bandura, 1977; Manz, 1986; Manz and Sims, 1981, 1986); and
- different theories of motivation, creativity, the contributions of individual or organisational groups and a myriad other social phenomena.

With so many different approaches to work performance to pin down, what is important to measure in an organisation is difficult to determine. It is even more difficult to measure performance in organisations with active QFD and continuous improvement programs. In these organisations, performance measures should be able to gauge the outcomes of creative individuals. Amabile *et al.* (1996) have established two dimensions of work outcome – creativity and productivity – which fit into the broader framework of TQM, *kaizen*, and QFD. "Creativity" refers to "a creative organisation or unit, where a great deal of creativity is called for and where people believe they actually produce creative work", while "productivity" refers to "an efficient, effective and productive organisation or unit" (Amabile *et al.*, 1996, p. 1166).

Amabile *et al.* (1996) have drawn on the literature of creativity and developed an instrument which assesses organisational creativity, productivity and the dimensions of the work environment that were found in empirical research and theory as essential for organisational creativity. This research instrument is referred to in the literature as "KEYS": it contains 78 items, and can be found in Amabile's KEYS User's Manual (Amabile, 1995). Of the 78 items, 12 gauge the respondents' perceptions of work performance (i.e. organisational creativity and productivity) of the work being carried out in their teams, and the remaining 66 describe the work environment. All items for creativity and productivity are written as simple descriptive statements of the work. In order to avoid response bias, some items were worded positively and some were worded negatively. A typical item for creativity was "a great deal of creativity is called for in my daily work", while an item for productivity was "my area of this organisation is effective". Amabile *et al.*'s scales of organisational creativity and productivity were included in the research model of this study.

3. Determinants of quality function deployment

Quality function deployment (QFD) is a literal translation of the Japanese words *hinshitsu kino tenkai* (Akao *et al.*, 1983). QFD was developed by Akao and Mizuno in Japan in 1966. By 1972 the power of the approach had been well demonstrated at the Mitsubishi Heavy Industries Kobe Shipyard (Sullivan, 1986), and in 1978 the first book on the subject was published in Japanese, and was later translated into English in 1994 (Mizuno and Akao, 1994).

In Akao's words:

> . . . QFD is a way to assure the design quality while the product is still in the design stage.

As a very important side benefit, he points out that when appropriately applied, QFD has demonstrated the reduction of development time by one-half to one-third (Akao, 1990). Due to its superb performance improvements, QFD has been successfully used in a wide variety of organisations (Menon *et al.*, 1994), and it is deeply integrated into our commercial industry culture (Wollover, 1997). While QFD is by far the most highly developed form of integrated product and process development in existence (Zaim and Sevkli, 2002), it is difficult to understand what stimulates or hinders the success of QFD implementation (Day, 1993). Yet, there is a general consensus that organisations with employees acquiring customer focused thinking will be able to accomplish future challenges (Akao, 1995), and QFD will serve as a *tool* for achieving these challenges through aligning company-wide activities to customer focus.

A review of the literature indicates that it is rather difficult to identify a *quality tool* that has the ability to both determine what will satisfy the customer, and translate those

customer desires into the target product or service (Mizuno, 1988; Mazur, 1992). As a result, where should organisations begin? What are the environmental variables that facilitate QFD practices? How do organisations assess those underlying dimensions that advance QFD implementation? Politis (2003) has drawn on the literature of TQM and QFD and developed scales which assess that dimensions of the work environment that have been suggested in theory and practice as being essential to QFD implementation. These scales are referred to in the literature as the "QFD methodologies or determinants".

Seven determinants conducive to QFD implementation are measured by Politis's QFD instrument. Their definitions have been adopted from Politis (2003 pp. 181-2):

- *QFD strategic planning*, so that the company sets strategic directions and action plans to support QFD methodologies;
- *customer and market focus*, so that the company determines customer requirements, expectations and builds customer relationships for their satisfaction;
- *QFD information and analysis*, so that the company selects information systems that support strategic planning;
- *human resources focus on QFD*, so that the company enables employees to develop and utilise their full potential to effectively deliver value to the customer;
- *top management commitment to QFD*, so that management demonstrates its commitment to QFD by providing human and capital resources;
- *QFD training to supervisors*, so that there is a breakdown of barriers between ranks, and participation exists between supervisors and other levels to enhance the quality of training and quality efforts; and
- *worker-supervisor collaboration in QFD efforts*, so that there is a collaboration between workers and supervisors to solve quality problems.

The various items of the above constructs are listed in Politis's (2003 pp. 191-2) study.

Although there is no direct evidence suggesting a relationship between the above QFD constructs and the dimensions of creativity and productivity, it is suggested that organisations need to create a supportive working environment that encourages employees' creative thinking and idea generation (Amabile, 1998; Eyton, 1996; Goldsmith, 1996). In other words, for employees to be creative and innovative, there must be a work environment that supports QFD implementation. Moreover, there is extensive literature that indicates that organisations using QFD practices exhibit cost reductions, project time reductions (Guinta and Praizler, 1993), reductions in new model development costs and reductions in development time (Menon *et al.*, 1994; Prasad, 1996). Moreover, in a number of real life case studies it was found that QFD inspires commitment and creativity in its delivery. For example, Smith and Nephew Group Research Centre (2003) claim that QFD enabled them to develop the metaprocesses to stimulate an increase in creativity and innovation. It is thus reasonable to assume that the factors of QFD, as established by Politis (2003), will be positively correlated with the factors of creativity and productivity. The assumed connectedness between the determinants fostering QFD and the dimensions of creativity and productivity is expressed in the following hypotheses:

H1. Correlations between each of the QFD constructs (i.e. QFD strategic planning, customer and market focus, QFD information and analysis, human resources

focus on QFD, top management commitment to QFD, QFD training to supervisors, and worker-supervisor collaboration in QFD efforts) will be positively related to creativity.

H2. Correlations between each of the QFD constructs (i.e. QFD strategic planning, customer and market focus, QFD information and analysis, human resources focus on QFD, top management commitment to QFD, QFD training to supervisors, and worker-supervisor collaboration in QFD efforts) will be positively related to productivity.

4. Subjects and procedure

4.1 Sample

The study focused on organisations operating in the United Arab Emirates (UAE). The Department of Economic Development in Dubai offers Quality Awards as a means of improving the standards of business operating in Dubai, thus boosting external and internal trade. The Department has a list of companies that have embarked on a wide range of quality management programs such as ISO 9000, TQM and *kaizen*. Questionnaires were sent to companies throughout Dubai randomly chosen from those listed with the Department of Economic Development. In order to reduce variability, questionnaires were sent only to companies that have received the Dubai Quality Award. A total of nine companies from the communications, public works, electricity and water, petroleum, cement products, and aluminium products industries participated in the study. Confidentiality and anonymity was assured to these companies. Despite their diversity, these companies have trained employees to reflect leading contemporary practices in the field of TQM (see www.dqg.org/2004/awards). Thus, the work environment in which the employees operated provided opportunities for meaningful TQM to occur. Interviews with both management and employees revealed that these organisations experienced some changes in both their internal and external environments following the implementation of their TQM program, which then led to increases in productivity, quality, and customer and employee satisfaction.

All respondents were full-time employees of the participating companies and volunteered to participate in the study. Questionnaires, written in English, containing the name and address of the business unit as a company or division, the items measuring creativity, productivity, and the QFD determinants were distributed to 410 employees in the nine companies. Three hundred and fifty nine useful questionnaires were received from the survey; yielding an 88 percent response rate. The proportion of distribution of responses received by industry category is shown in Table I.

The majority of the respondents were within the 21-30 age group (78 percent). Given the relatively young age of the sample, the level of work experience is accordingly low. Eighty-four (84) percent of the respondents have had four years of work experience or less. The respondents were 7 percent female and 93 percent male, and all had attained some sort of technical or university qualification taught in English.

4.2 Analytical procedure

An inferential statistical technique (ANOVA) was used to determine whether the sample data came from the same population or different populations. Confirmatory factor analyses (CFAs) were performed using the analysis of moment structures

Table I.
Distribution of responses received by industry

Industry	Number of questionnaires sent	Distribution (%)	Number of responses received	Distribution (%)
Communications	73	17.81	60	16.72
Public works	28	6.83	19	5.29
Electricity and water	70	17.07	64	17.83
Petroleum	87	21.22	81	22.56
Cement	60	14.63	53	14.76
Aluminium	92	22.44	82	22.84
Total	410	100.00	359	100.00

(AMOS, version 5) software (Arbuckle, 2003) for the factor analysis of the measurement models. Using CFAs, we assessed the validity of the measurement models of the variables used in the paper. A mixture of fit-indices was employed to assess the overall fit of the measurement models. The ratio of chi-square to degrees of freedom (χ^2/df) was computed, with ratios of less than 2.0 indicating a good fit. However, since absolute indices can be adversely effected by sample size (Loehlin, 1992), four other relative indices, i.e. the goodness-of-fit index (GFI), the adjusted goodness-of-fit index (AGFI), the comparative fit index (CFI), and the Tucker and Lewis index (TLI), were computed to provide a more robust evaluation of model fit (Tanaka, 1987; Tucker and Lewis, 1973). For GFI, AGFI, CFI and TLI, coefficients closer to unity indicate a good fit, with acceptable levels of fit being above 0.90 (Marsh *et al.*, 1988). For root mean square residual (RMR) and root mean square error approximation (RMSEA), evidence of good fit is considered to be values less than 0.05. Values from 0.05 to 0.10 are indicative of moderate fit and values greater than 0.10 are taken to be evidence of a poorly fitting model (Browne and Cudeck, 1993).

If the CFAs of the measurement models indicate that the values of the fit indices are equal to or greater than the recommended values described earlier (i.e. demonstrate adequate validity and reliability), we accepted these models as the best fitting models. Subsequently, we created a composite scale for each latent variable (Politis, 2001). For example, we created the composite latent variable of creativity using equation (1):

$$\text{Composite latent variable of creativity} = 0.16\text{OV}_1 + 0.12\text{OV}_2 + 0.14\text{OV}_3 + 0.17\text{OV}_4 + 0.22\text{OV}_5 + 0.19\text{OV}_6, \quad (1)$$

where OV_1 is observed variable 1, and 0.16 is the standardised factor score regression weight of OV_1, given in the AMOS outcome, etc. These composite factors were then subjected to a series of correlational and regression analyses.

5. Results

5.1 Detecting organisational differences

The null hypothesis (H_0) that the population value for the average of the QFD and work outcome variables is the same for employees in the nine companies was tested using between- and within-company analysis. The results indicate that the between-company variance is greater than the within-company variance, and thus the greater the likelihood of significant difference. Moreover, the observed F ratios for

QFD strategic planning ($F = 6.33$, $p < 0.001$), customer and market focus ($F = 6.73$, $p < 0.001$), QFD information and analysis ($F = 7.95$, $p < 0.001$), human resources focus on QFD ($F = 10.75$, $p < 0.001$), top management commitment to QFD ($F = 8.72$, $p < 0.001$), QFD training to supervisors ($F = 6.67$, $p < 0.001$), worker-supervisor collaboration in QFD efforts ($F = 9.69$, $p < 0.001$), creativity ($F = 5.65$, $p < 0.01$),and productivity ($F = 7.43$, $p < 0.001$) exceeded the critical F ($F_{crit} = 2.61$, with $\alpha = 0.01$). On the basis of the calculated F values, H_0 is rejected, and it was therefore concluded that there is a significant difference among the means of the variables tested in this study. In other words, it is unlikely that the means of the QFD, creativity, and productivity variables are the same for the nine companies in the population. Thus, the relationship between the variables in this study may be more attributable to individual employees (and not companies), i.e. individual effects.

5.2 Measurement models

As noted earlier, the variables measured in the survey are QFD strategic planning, customer and market focus, QFD information and analysis, human resources focus on QFD, top management commitment to QFD, QFD training to supervisors, and worker-supervisor collaboration in QFD efforts and the outcome measures of creativity and productivity, as rated by the employees, of the participating organisations.

5.2.1 Independent variables. Quality function deployment constructs were assessed using Politis's (2003) 45-item instrument for measuring the underlying dimensions conducive to QFD. Responses to the 45 items were made on a seven-point Likert scale with response options from "strongly agree" to "strongly disagree". We conducted CFA of all QFD items in order to check for construct independence. We first fitted a seven-factor model to the data, corresponding to that proposed by Politis (2003). The fit indices of GFI, AGFI, CFI, TLI, RMR, and RMSEA were 0.97, 0.94, 0.95, 0.93, 0.04, and 0.07, respectively, suggesting that this model provides a good fit. Thus, the data supported the independence of the seven factors, namely, QFD strategic planning (four items, mean = 4.58, $\alpha = 0.82$), customer and market focus (ten items, mean=5.37, $\alpha = 0.89$), QFD information and analysis (four items, mean = 5.22, $\alpha = 0.79$), human resources focus on QFD (six items, mean = 5.07, $\alpha = 0.87$), top management commitment to QFD (five items, mean = 4.56, $\alpha = 0.85$), QFD training to supervisors (five items, mean = 4.54, $\alpha = 0.71$), and worker-supervisor collaboration in QFD efforts (four items, mean = 5.47, $\alpha = 0.73$). It should be noted that seven items were dropped due to cross loading and/or poor loading, these being of the order of or less than 0.09.

5.2.2 Dependent variables. The outcome of work was assessed using Amabile *et al.*'s (1996) two work performance criteria, namely creativity (six items) and productivity (six items). Responses to the 12 items were made on a four-point Likert scale with response options from "never" to "always". We conducted CFA of all 12 items in order to check for construct independence. The fit indices of GFI, AGFI, CFI, TLI, RMR, and RMSEA were 0.97/0.95, 0.94/0.93, 0.94/0.95, 0.92/0.91, 0.04/0.06, and 0.08/0.09, for creativity and productivity, respectively, suggesting that it is appropriate to create two separate constructs. These are creativity (five items, mean = 2.76, $\alpha = 0.76$), and productivity (six items, mean = 2.88, $\alpha = 0.79$). One item from creativity was dropped due to poor loading, being of the order of 0.11.