

# QFD application in different countries: a comparison of an exploratory study in Brazil with other surveys

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**Abstract:** this paper presents a comparison of QFD application among four surveys conducted in Brazil, Japan, Sweden, in the UK, and in the USA and Japan. It aims at providing a general understanding on how QFD is being used in those countries, including which experienced difficulties and benefits are common between them. The surveys have shown that QFD users are usually large companies. Although the experienced difficulties are dependent on each country, they are usually related with the lack of resources while the main benefits are those more difficult to measure such as better communications between departments and improvement of teamwork.

**Key words:** QFD, product development, quality planning, quality function deployment

## 1. Introduction

QFD (Quality Function Deployment) was developed in Japan during the 60's by Akao and Mizuno as a method for product development which aims at fulfilling customer demands. The primary objective of this method is to assure quality since the earlier stages of project development (AKAO, 1996). Moreover, QFD is a method which enables to deploy customer requirements into measurable quality characteristics in order to create products and services which satisfy those requirements. According to some authors (CHENG et al., 1995; OHFUJ et al., 1997), QFD benefits include: reduction of engineering changes, complaints, project lead time, and costs, increase of customer satisfaction, identification of engineering bottle neck, improvement of communication between departments, and possibility to transmit relevant quality information from the project to production.

In this sense, a number of cases can be found in the literature, such as improvement of car seat belts (EKDAHL & GUSTAFSSON, 1997), customer complaint reduction and increase of market share in a metal industry (CHENG et al., 1995), improvement of lorries and buses (FRAGOSO 1999), and software (SONDA, 2000), and enhancement of relationship between customers and vendors in shopping centers (CECIN et al., 2001) to name but a few.

Due to its benefits, QFD has started to be used in companies around the world besides Japan. In the USA, for instance, QFD began in the beginning of the 80's. In the same decade, some countries in Europe also initiated the use of the method. The dissemination of QFD in Brazil is more recent, in the 90's (MIGUEL & CHENG, 2001). From this increasingly usage, a number of surveys have been conducted in various nations in order to evaluate to which the method is applied as well as its main difficulties and benefits. This paper compares the results of four surveys conducted in different countries (Brazil, Sweden, UK, and the USA and Japan). It compares a preliminary survey carried out in Brazil (MIGUEL & CARPINETTI, 1999) with others reported by the literature (EKDAHL & GUSTAFSSON, 1997, in Sweden, MARTINS & ASPINWALL, 2000, in the United Kingdom, and CRISTIANO et al., 2001, in the USA and Japan).

## 2. Comparison of results

Firstly, it is presented the objectives of each survey, their methodology, and specific information of each one. Then, a comparison between them is done.

### 2.1. Objectives of each survey

When studying the objectives of each survey, it was verified that the surveys conducted in Sweden (EKDAHL & GUSTAFSSON, 1997), Brazil (CAUCHICK &

CARPINETTI, 1999) and in the UK (MARTINS & ASPINWALL, 2001) has similar aims, i.e. to identify which benefits and difficulties are consequence of QFD implementation. The American survey (CRISTIANO et al., 2000), however, aims at comparing how the American and Japanese companies apply QFD.

**2.1.1. The QFD experience in Sweden**

QFD is used in Sweden since 1988 (EKDAHL & GUSTAFSSON, 1997). In 1995, a Division of the Quality Technology and Management at Linköping University conducted a survey to verify the first eight years of QFD application in Sweden, its benefits and the experience of the companies with its usage. Additionally, this research also intended to identify and present some companies which could be considered as benchmarks on QFD, such as Volvo, Mölnlycke, and others.

**2.1.2. QFD in the USA and Japan**

QFD initiated in the USA from 1983, when an article was published and a four-days seminar was carried out in Chicago (AKAO, 1996). In 1992, a survey was conducted by GRIFFIN (1992) and, later on, in 1995, another one was carried out, this time comparing how companies in the USA and Japan used QFD. The full results of this survey were presented by Cristiano et al. (2000).

**2.1.3. Some QFD applications in Brazil**

QFD started to be used in Brazil in the beginning of 1990 (CHENG & SARANTOPOULOS, 1995; CAUCHICK MIGUEL & CHENG, 2001). After nearly ten years, an exploratory survey was conducted in 1999 which detailed results were presented elsewhere (CAUCHICK MIGUEL & CARPINETTI, 1999). The objectives of this survey were to verify companies which use QFD or have plans to apply it, the reasons for starting to use QFD, experienced difficulties with the method and its inherent benefits. This survey was based on a similar research conducted by EKDAHL & GUSTAFSSON (1997), regarding its objectives and analysis of results.

**2.1.4. Quality function deployment in the UK**

QFD began to be used in Europe and in the UK during the 80's. In 1999, a survey was performed aiming at reducing the lack of information about the method in the UK. Additionally, its objectives have included to identify the ben-

efits of the method, difficulties during implementation as well as its key points to do so. The results can be found in MARTINS & ASPINWALL (2001).

Table 1 summarises the objectives of all these surveys. Next section presents the sample and data collection techniques used by each research.

**Table 1 – Objectives of the surveys.**

Country	Main objectives
Sweden	Identify benefits and the experience with QFD
USA and Japan	Compare the QFD application between the two countries
Brazil	Identify main benefits and experienced difficulties
UK	Identify main benefits and experienced difficulties

**2.2. Sample characteristics and data collection of each survey**

According to OLIVEIRA (1997), the choice of the sample and the technique for gathering necessary data are dependent on the survey objectives and resources available. As a consequence, it is not a surprise that the surveys compared in this work used a non probabilistic sample, since the majority of them had similar objectives and they were investigating the application of the same method (QFD). Table 2 shows the types of the samples and techniques used for collecting the required information in the studied surveys.

**Table 2 – Sample type and chosen techniques used for data collection.**

Survey	Non random intentional sample	Questionnaire	Interview	Pre-test
Sweden	☐		☐	
USA and Japan	☐	☐	☐	
Brazil	☐	☐		☐
UK	☐	☐		☐

As can be seen in Table 2, most surveys used a questionnaire as the data collection technique. The American-Japanese research also used interviews with a smaller sample. In the Sweden survey is not clear which technique was used. However, since the response rate was nearly 100% and it used a small sample (see Table 3), it was supposed that the research applied interviews as a technique for gathering in-

formation. Two surveys stated they used pilot tests to improve the survey form (questionnaire). In the study conducted in Brazil it was sent three questionnaires while in the UK two questionnaires were posted to companies within the sample. According to MARCONI and LAKATOS (1991), the use of pre-tests is very important to enhance the instrument for data collection. It enables to evaluate if the questions are in accordance with the research objectives and if they are clear to the respondents. How the research defined the sample is presented below.

**2.2.1. The Sweden survey**

In order to define the sample, it was carried out some contacts with consulting companies, universities and research groups. The authors (EKDAHL & GUSTAFSSON, 1997) asked to those institutions to point out organizations they knew QFD was applied. It was identified 35 companies in which QFD was used from which 31 of them were selected to participate in the survey.

**2.2.2. The survey in Japan and the USA**

In Japan, 400 members of JUSE (Union of Japanese Scientists and Engineers) were selected to answer the questionnaire. These companies attended QFD training courses promoted by JUSE or participated in the Annual Japanese QFD Symposium. The research had the support of Akao and Mizuno. In the USA, 417 companies were chosen, using data from the ASI (American Supplier Institute) and GOAL/QPC. The companies in the sample attended short courses or seminars in ASI and GOAL/QPC including companies which participated in six QFD symposiums. The sample did not include academic institutions or consulting companies.

In the case of the interviews, it was identified six companies in Japan which the researchers knew QFD was applied and participated in the initial studies conducted by Akao (Tokoyo Electric e Power Company – TEPCO, Fuji Univance, NEC, Toyoda Gosei e Aishin Seiki). In the USA, it was identified some companies in which QFD was extensively applied. Four of them were selected (General Motors, Chrysler, Richard Allen e Hayworth).

**2.2.3. The brazilian survey**

The sample was defined using a data base from the Federal Industry of the State of São Paulo – FIESP, published material about companies which experienced QFD and from

the indication of other academics (companies in which QFD was applied). The sample size resulted in 111 companies.

**2.2.4. The survey in Britain**

The sample in the British survey consisted of 246 organizations. It included: 100 top British companies (in terms of revenue), 120 companies within the automotive sector ISO 9000 certified (or a equivalent standard), 24 main universities according to The Times, and one research institute. Additionally, a consulting company was contracted to point out companies in which could be using QFD. This company indicated 11 more companies.

**2.3. Results from each survey**

Although most findings of the surveys are compared in this section, it was not possible to compare all of them due to the inherent differences in each survey. Table 3 summarises some results concerning the sample size, response rate and percentage of companies which apply QFD.

Table 3 – Sample results.

Survey	Sample size	Response rate (%)	Use QFD or it is implementing (%)
Sweden	31	100	100
USA	417	36,8	69
Japan	400	37,5	33
Brazil	111	28	28
UK	246	27,9	32,3

Table 3 shows that the response rate can be considered suitable for this kind of survey in all cases. Generally, the response rate for questionnaires is about 25% (MARCONI & LAKATOS, 1996). Only companies which QFD was used were selected to be in the sample in the Sweden survey. This did not occur with the others. This is the reason why 100% is QFD users. Differently from expected, more American companies apply QFD compared with Japan.

Regarding the profile of the companies, the majority of them which use QFD are large companies (according to the criteria of PNQ – Quality National Prize of Brazil, large companies are those with more than 500 employees). In Sweden, 27 from the 31 surveyed companies have more than 1000 employees. In the USA, the average number is 3000 while in Japan is less than that with an average of 564. However, it is still large organizations. In the UK, a bit more than 63% of companies has more than 300 em-

ployees. In the Brazilian survey the average is 2500, especially due to the participation of two big companies with more than 5000 employees.

The industrial sectors those companies belong are presented in Table 4. The different industrial classifications used by the surveys did not permit to have a better comparison among them. So, the American and Japanese results were omitted in Table 4.

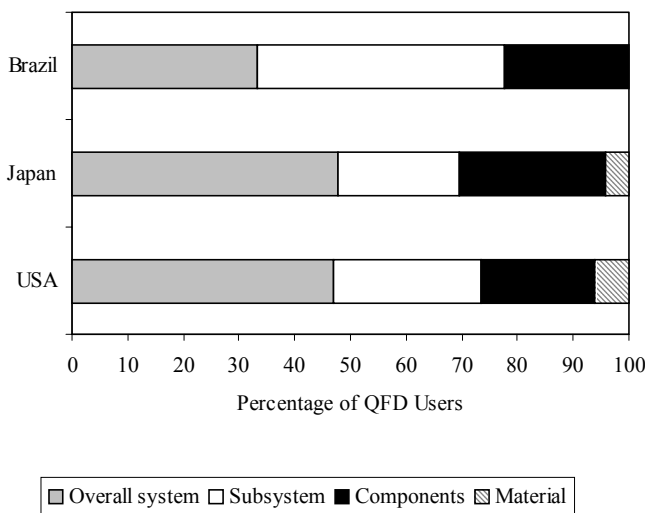
**Table 4 – Industrial sectors of the survey participants.**

Survey	Main industrial participants
Sweden	Manufacturing: 42%, Domestic Appliances: 13%, Automotive: 13%
Brazil	Automotive: 30%, Machine Tools: 6,5%, Other Machines: 6,5%, Plastic and Rubber: 6,5%
UK	Manufacturing: 69,6%, Education: 14,0%, Services: 18%

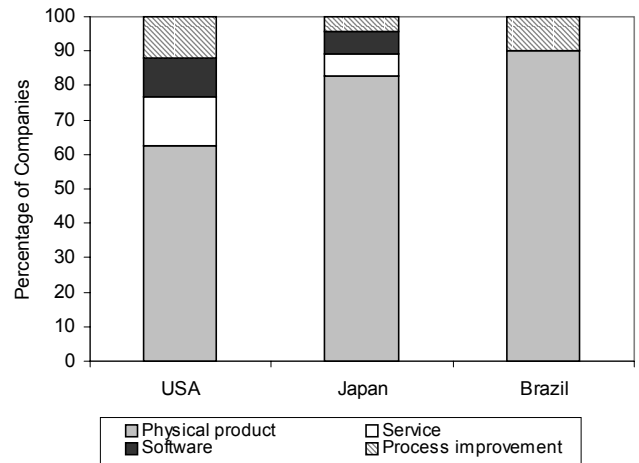
The American and Brazilian surveys allow to classify the companies as OME (Original Manufacturer Equipment) and Suppliers. In Japan and in the USA, more than half are suppliers (respectively 55.6 and 52.6%), similarly to the Brazilian survey (54.8%).

**2.3.1. Types of QFD projects**

Figures 1 and 2 present the types of projects in which QFD is used in the American, Japanese and Brazilian companies. The other surveys did not state such results.



**Figure 1 – Type of project.**



**Figure 2 – Type of product.**

As for project characteristics, a great amount of applications are devoted to the development of an overall system. In fact, the scope of QFD projects in terms of product complexity were comparable between the USA and Japan. Subsystem and component projects accounted for approximately one quarter of this study while this number is approximately 44% for Brazil. QFD application for product development (physical good) is the majority for all countries. Although the majority of the US projects were also directed at physical goods (63%), there is a broader use of QFD in the American sample for service (14%), process improvement (12%) and software development (11%) than in the Japanese cases. In fact, in Japan, a higher percentage (83%) of QFD projects was focussed on the development of a physical good. In Brazil, only 10% of QFD projects was not directed at physical goods development. Mostly of this 10% is devoted to process development. It was not found the development of either software or services in the Brazilian survey. The reason might be due to the chosen sample which did not consider such organizations.

Regarding the number of projects concluded using QFD, 58% of the QFD users in Sweden finished 1 to 3 projects and about 42% of companies has more than 4 projects. In Brazil, 30% of QFD user companies is implementing QFD and they have not completed the first project. Fifty percent of companies has 1 to 3 finished QFD projects while 20% of users has 4 or more projects concluded. This information was not available in the other surveys.

**2.3.2. The commencement of QFD**

Figure 3 shows the main reasons of which each country initiated the use of QFD. In most cases, the reasons are: improvement of product development and increase of customer satisfaction. An interesting result in this figure is that 24% of companies which began to use QFD in the UK was driven to TQM implementation process. This was not identified in the other surveys.

There was no clear statement of the initial date of QFD in the companies in the American survey, but this information is provided by the other surveys. In nearly 79% of cases in the UK, about 58% of cases in Sweden, and in around 45% of cases in Brazil, companies began to apply QFD rather recently (in Sweden after 1992, in the UK after 1994, and in Brazil after 1996).

**2.3.3. Experienced difficulties**

Figure 4 shows the main difficulties the companies experienced when implementing QFD. The results of each survey present different levels of difficulties. In Sweden, the main problem was associated with the lack of managerial support. This can be considered a relevant concern, since it is one of the key points in order achieve implementation success, according to CHENG et al.(1995). In American companies, the main problem is relative to the lack of financial resources while in Japan is also the deficiency of resources but in this case human ones which, in fact, might mean financial. In Brazil, the principal problem was the difficulty to rate customer needs. In the UK, problems related with the voice of customer was also pointed out as well as the lack of commitment of the teamwork and top management.

**2.3.4. QFD meetings and teamwork**

The surveys in Sweden and Brazil revealed information regarding meeting frequency and duration. It was verified that the teamwork meetings are more frequent in companies from Sweden (about 47% of QFD users has weekly meetings and 30% every two weeks) rather than in Brazil (20% weekly meetings and 10% every two weeks). In most cases, the duration of the meetings is half day in Sweden (about 53% of companies) and two hours in Brazil (40% of QFD users).

The QFD teamwork usually consists of less than eleven people in the majority of companies (87% in Japan and Sweden, 82% in Brazil and 75% in the USA). The British survey does not provide such information.

**2.3.5. Matrices used**

The majority of companies which responded the survey in Sweden, in the UK, and in the USA use only the first matrix (the house of quality). This is of concern since the use of only one matrix does not assure that the company could deploy quality throughout its process. It was verified that the Japanese companies use more than one matrix in most cases, differently from companies in the USA. This is also true for the QFD users in the Brazilian survey. Table 5 shows which matrices the surveyed companies are using.

**Table 5 – Use of matrices.**

<b>Survey</b>	<b>Matrix</b>
Sweden	87% uses one matrix (house of quality)
USA	The majority uses one matrix (house of quality)
Japan	The majority uses one matrix
Brazil	70% uses other matrices
UK	63% uses one matrix (house of quality)

Note: In the survey of USA and Japan, the percentage of companies was not stated

**2.3.6. Customer requirements – usual number and data sources**

The ability to understand and address customer needs is key to the success of any product development effort, especially in an environment of time-based competition. The information used as input to the QFD process can be derived from a number of sources. American companies obtain customer requirements mainly through market research (customer visits, individual interviews, listening at shows, focus group discussions, etc.). In the UK, 58% of companies use interviews, customer visits and meeting with customers. On the other hand, Japanese companies use market research combined with internal data from warranty, complaints, sales information, etc. This was also found in the Brazilian survey. In 70% of cases, direct contact with customers is performed, most of them by interviews. According to OHFUJI et al. (1997), it is essential to directly listen the customers to identify its requirements and desires and not what the company thinks the customers want. The survey conducted in Sweden did not provide this kind of information. Figure 5 present the typical data sources found in the surveys.

The surveys conducted in Sweden and Brazil asked to the surveyed companies the average number customer require-

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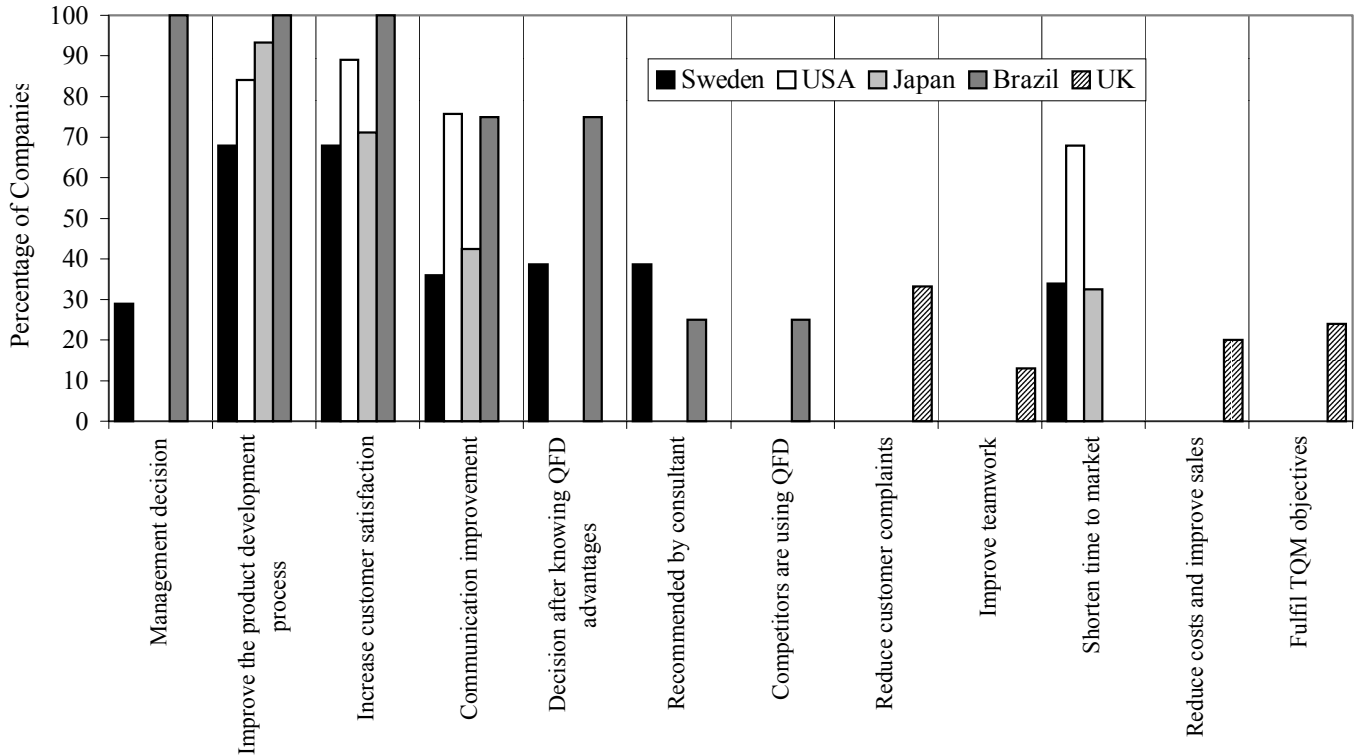


Figure 3 – Reasons to initiate QFD usage.

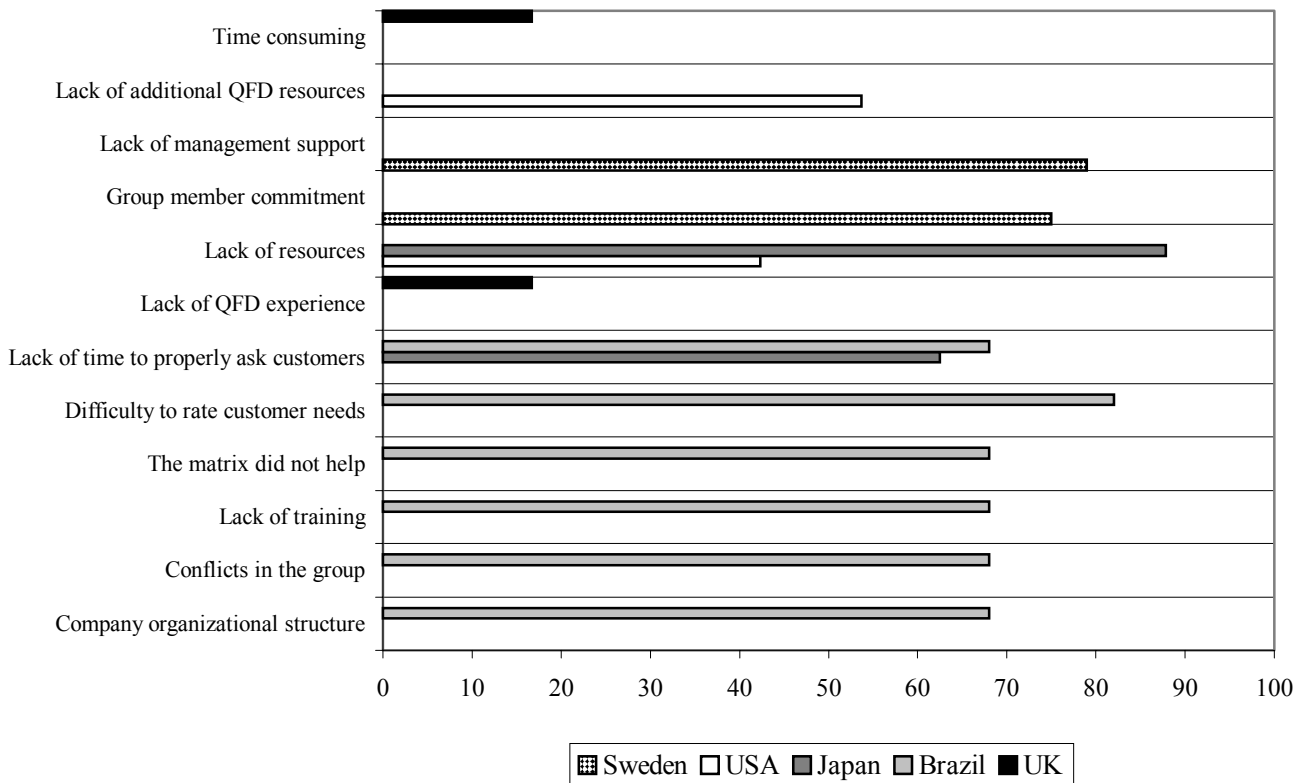


Figure 4 – QFD main difficulties.

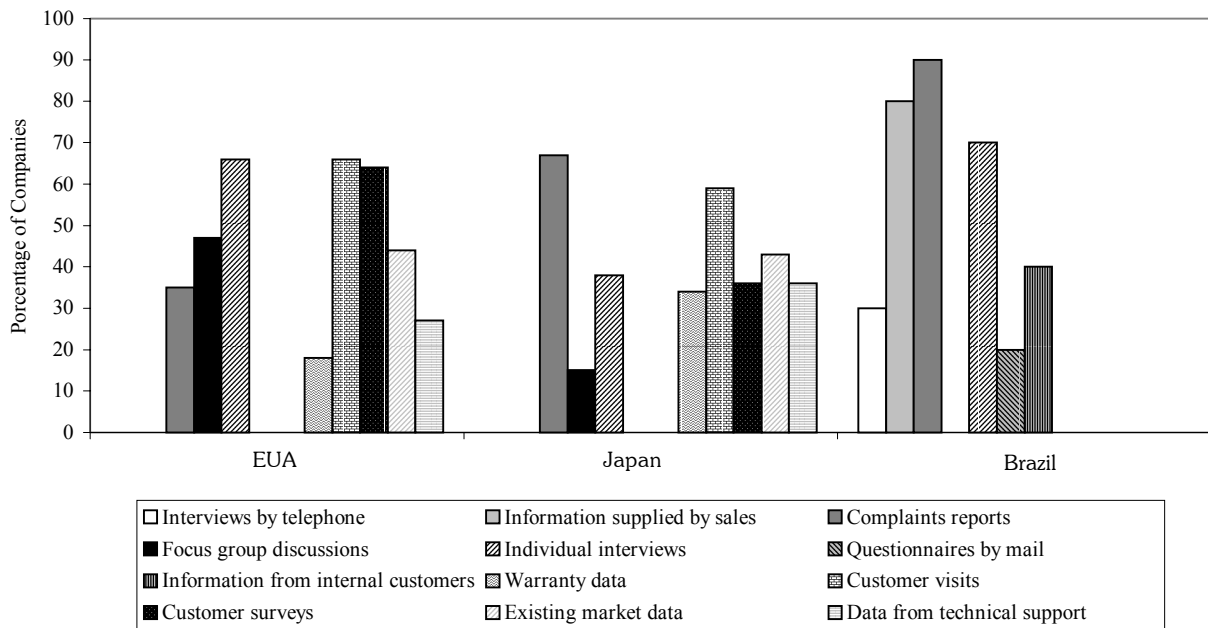


Figure 5 – Data source used in QFD studies.

ments and quality characteristics. The findings were quite similar. The number of customer requirements was, in average, 27 in Brazil and 30 in Sweden while the number quality characteristics was 40 and 41, respectively in Brazil and in Sweden.

**2.3.7. The benefits achieved after QFD implementation**

Table 6 shows the main benefits achieved using QFD in each survey. Subjective issues such as communication improvement and involvement of employees in the decision-making process were stated as benefits gained from applying the method, respectively, in the surveys carried out in Sweden and in the UK. The survey in the USA stated the main benefit of product acceptance was an increased customer satisfaction (nearly 83% QFD users) while in Japan was decreased problems with initial quality and increased product visibility (both indicated by around 53% of users). The impact that QFD had on product improvement was significantly pointed out by the surveyed companies in the USA (a bit more than 85% of companies) and Japan (about 73% of QFD users). Differently from the other surveys, the Brazilian used a assign-rate question to this issue. Some companies considered as ‘excellent’ the strengthen of concurrent engineering practice (40% of QFD users) and as ‘satisfactory’ (72% of companies) the increased product quality and reliability.

Other issues evaluated in the surveys in Sweden and Brazil were the effects that the use of QFD generates in the project itself and in the overall results. Table 7 summarises these results. In the Brazilian survey, many respondents did not answered this question. This high level of blank questions (40%) is due to the fact that most of these companies was implementing QFD so that they did not have results to answer the question yet. Additionally, 40% of QFD users considered as ‘neutral’ the effect of QFD in the overall results. This can be explained by the fact that QFD is rather recent and more positive assessment will come later when the method reaches a more mature degree in the country (MIGUEL & CARPINETTI, 1999).

In the Sweden survey, the findings were not much better that those in the Brazilian one. Approximately one third of QFD users considered that the use of the method had ‘good’ results and a bit more than 14% as ‘considerable’ results. The other surveys did not explore this issue.

Table 7 presents the effects the use of QFD has in the projects. It is worth mentioning that the results in American companies were better that the Japanese. In Sweden, 67% of QFD users considered as ‘good’ or ‘a success’ while in Brazil 30% considered as ‘good’ or ‘a success’.

**Table 6 – QFD benefits.**

<b>Benefits</b>	<b>Sweden</b>	<b>USA</b>	<b>Japan</b>	<b>Brazil</b>	<b>UK</b>
Increased quality and reliability	-	-	-	72%*	39%+
Increased customer satisfaction	33%	82,7%	42,9%	42%*	-
Increased employee satisfaction	-	-	-	42%*	-
Teamwork improvement	-	57,6%	26,2%	42%*	20%
Strengthen of concurrent engineering practice	-	-	-	42%**	-
Cost reduction	19%	23,8%	14,3%	42%*	39%+
Better communications between departments	65%	51,2%	34,1%	42%*	15%++
Reduced time to market	28%	24,7%	9,3%	29%**	39%+
Facilitating rational decisions	41%	76%	53,3%	-	-
Knowledge documentation	52%	73,7%	54,6%	-	-
Creating unity among team members	52%	67%	47,7%	-	-
Increased number of design alternatives	30%	46,7%	40,5%	-	-
Improved communication between marketing and design	-	62,1	37,2	-	15%++
Better designs	41%	66,7%	56,5%	-	-
Increased ability to innovate	40%	44,9%	36,6%	-	-
Increased customer loyalty	-	-	-	-	39%+
Reduction of customer complaints	-	-	-	-	39%+
Increased involvement of employees in the decision-making process	-	-	-	-	24%
Increased sales	25%	30,5%	19,5%	-	-
Increased product visibility	-	52,6%	36,8%	-	-

Notes: In the brazilian survey – \*: satisfactory; \*\*: excellent in the UK survey – +: increased quality and reliability plus reduction of costs and time to market plus increased customer loyalty plus reduction of complaints = 39%; ++: improved communication between departments plus between marketing and design = 15%.

Next topic is devoted to present some exclusive results of each survey, which cannot be compared.

**3.Exclusive survey results results**

Some of the survey results were specifically designed for each study. This section summarises these results.

**3.1 QFD in Sweden**

An interesting result of the Swedish survey (EKDAHL & GUSTAFSSON, 1997) was the comparison between the reasons that the companies decided to apply QFD and the achieved results. Table 8 presents such results (it is shown the percentage of companies which ‘agree’). Since the literature points out tangible QFD benefits, many companies began to use the method seeking for these benefits in the first place. However, in the results of Table 8, the intangible benefits “better communication” and “improvement of the product development process” were more evident in terms of positive result.

The work of EKDAHL and GUSTAFSSON (1997) also presents three cases of companies considered as models in terms of QFD application, summarised next.

**3.1.1. QFD at volvo**

QFD was introduced at Volvo Care Corporation in 1988 and since then they have carried out more than 50 projects.

**Table 7 – Effects of QFD use in the projects.**

<b>Effect</b>	<b>Sweden (%)</b>	<b>USA (%)</b>	<b>Japan (%)</b>	<b>Brazil (%)</b>
Poor	6,7	n.a	n.a	0
Bad	9,7	n.a	n.a	0
Neutral	17	n.a	n.a	30
Good	32	85,4%**	72,7%*	10
a Success	35	85,4%**	72,7%*	20
Positive impact in the end of the project	n.a	65.7	45.7	n.a
In blank questions	n.a	n.a	n.a	40

Notes: \*\*: “good” plus “a success” = 85,4%; \*: “good” plus “a success” = 72,7%; n.a. – not available



**Table 8 – Reasons for implementing QFD and achieved results.**

<b>Benefit</b>	<b>Reason</b>	<b>Positive result</b>
Improvement of the product development process	68,2%	41,8%
Shorter time to market	31,8%	16,4%
Better communication	35,5%	64,5%
Increased customer satisfaction	68,2%	31,8%

Volvo projects are classified in three categories: product improvement, minor innovation, and innovative (EKDAHL & GUSTAFSSON, 1997).

Most of the QFD projects at Volvo belong to the product improvement category. The objective of these projects is generally to improve an existing product or, since a car is such a large and complex product, a subsystem or a component. One example of the use of QFD for product improvement at Volvo was the enhancement of the transmission system on the 1993 Volvo 850. The QFD project resulted in several changes being introduced in the 1996 Volvo 850 and the effect on customer satisfaction was almost immediate. The number of customer complaints related to the manual gearbox was reduced by more than 50%. Another example is the improvement of seat belts. An example of a minor innovation project was the introduction of a three point belt in the middle, instead of the traditional belt around the waist. A innovative project was the example of the environmental concept car. The mission of the project was to develop a vehicle that would fulfil California's strictest environmental laws while meeting Volvo's corporate and customer requirements and expectation. The result of the project was the development of a four-seated vehicle with two different power suppliers, one electrical and one hybrid.

According to Volvo, QFD has played an important role in Volvo's improvement efforts to be presently among the top three brands in the USA. The benefits that Volvo experiences from using QFD are an improved product development process resulting in better products, better and more extensive customer involvement, and the development of inter-disciplinary competence. The main drawback of QFD is the relatively large amount of time necessary, for instance, to complete the house of quality. Initial projects also tend to be more time-consuming than subsequent projects, mainly due to increased experience in applying the method.

Volvo provides the following recommendations: the importance of networking between different QFD teams within the organization, have a QFD facilitator with the expressed purpose of training and guiding the teams greatly improved the efficiency and effectiveness of the projects, and chose initial projects with care. Moreover, the practitioners at Volvo learned that collecting the voice of customer in through and well planned manner is vital.

**3.1.2. QFD at whirlpool**

Whirlpool Sweden started to apply QFD in the end of the 1980's with ten full scale QFD projects completed. Only the house of quality matrix is used at Whirlpool. After experienced a few products conducted on a subsystem level, a large project was developed. The largest project was the development of the VIP 34 microwave oven. Whirlpool wanted to develop a completely new microwave oven with large oven capacity and small outer dimensions. The project was divided into 10 subprojects. Each subproject team was responsible for developing a house of quality for a specific attribute of the oven such as safety, microwave system or oven door. Later on, the results from the different teams were combined into one large house of quality with about 30 customer needs and over 70 quality characteristics. Due to the extent and complexity of the application, a number of difficulties have emerged from the VIP 34 project. So, the company decided to use QFD for smaller projects.

The main advantages of QFD at Whirlpool were the systematisation and structure in the product development process. Another aspect, important to the users, was the improved documentation of the development projects which follows from using the method. Further, the practitioners at Whirlpool emphasised that the results benefit from having a constant focus on the customer during product development. The drawbacks were related to the amount of time needed to complete the house of quality. Other problem experienced at the company regards communication of results to people who were not familiar with the QFD method and how the information should be interpreted.

Whirlpool considered as key points to have well defined and suitably limited projects, measure the engineering quality characteristics, and manage to select relevant customer issues from an abundance of data with the greatest leverage for improvement. Finally, Whirlpool pointed out some peda-

gical aspects concerning implementation of the method. One such aspect is how to make potential users realise that the seemingly excessive time spent in the beginning of a QFD project really pays off in the end.

### **3.1.3. QFD at Mölnlycke**

Mölnlycke introduced the method within product development process in 1990. The primary purpose at the company was to create a common platform for understanding the customer throughout the entire company. The method has been used for several different products in a wide range of markets. Some examples of products where Mölnlycke used QFD in the development activities are baby diapers and feminine towels. The company has only used the house of quality. For Mölnlycke, the most important benefit of QFD has been the possibility of creating a shared understanding in the entire company of who the customer are and what their expectations will be. Another important advantage of QFD experienced at Mölnlycke is the possibility of reusing results from prior projects in the early phases of new product development projects. One of the difficulties is related with obstacle of reaching beyond the first matrix. The company considered as the main reason for this the lack of suitable methods for evaluating the engineering characteristics specific for Mölnlycke different products. Although the company frequently stated the reuse of results from early projects, it should take care when using the house of quality for many years since customer requirements are not constants and they vary with time as pointed out by AKAO (1996).

Finally, the company has also come to realise that even though QFD can contribute substantially to the product development process, other tools are also necessary to be truly successful.

### **3.2. QFD in the USA and Japan**

In this research, one of the QFD differences between the companies in Japan and in the USA was that the American companies were more apt to use the phases of quality deployment popularised by the American Supplier Institute (ASI). Comprehensive QFD that originated with AKAO (1996) was more often used by Japanese companies.

Another issue is concerning the QFD teamwork. In 83% of American QFD users use cross functional teams which involve, in about 55% of companies, members from more than five different company functional areas. Surprisingly,

Japanese companies which have tradition of working in teams, have lower levels of using cross functional teams (in a bit more than 53% of users) compared with the American companies. Additionally, more than five members were present in the teams in nearly 30% of users.

As presented earlier in Table 5, the majority of American companies uses only the house of quality. Cases when more than one matrix are used are shown in Figure 6 indicating other deployments.

Regarding how the American companies analyse information gathered from customers, they mainly use the voice of customer tables and relationship diagrams while the Japanese companies not only use voice of customer tables but also affinity diagrams.

#### **3.2.1. Case study presented at the USA-Japan survey**

A case study was conducted in the USA and Japan in 1993 before carrying out the survey. This was performed so the researchers could have an overall view of QFD in both countries. The starting point for the design of the survey was a series of interviews that were conducted in six companies in the USA and four in Japan. These discussions were centred on the breadth, depth and effectiveness of QFD usage and served as the foundation for the development of the written survey. Due to the wide variety of known applications of QFD and to understand the uses of QFD, the sample population was not limited to companies manufacturing physical goods, but also included companies using QFD for other purposes such as software development, service and process improvement.

The results of the interviews have shown that companies in each country employed various methods for institutionalising QFD, including internal champions, cross-functional teams, and a centralised functional group. In both countries the main factor in the success of the method was in the support of top management. Changing corporate culture in the USA to embrace a method like QFD is often more difficult because of the many “fads” that companies have pursued as quick fix to complex problems (CRISTIANO et al., 2000). In the Japanese cases, QFD was viewed and used much more as a tool for organization learning. Another difference observed in the usage of QFD between the USA and Japan was the manner in which the QFD decision making

## QFD application in different countries: a comparison of an exploratory study in Brazil with other surveys

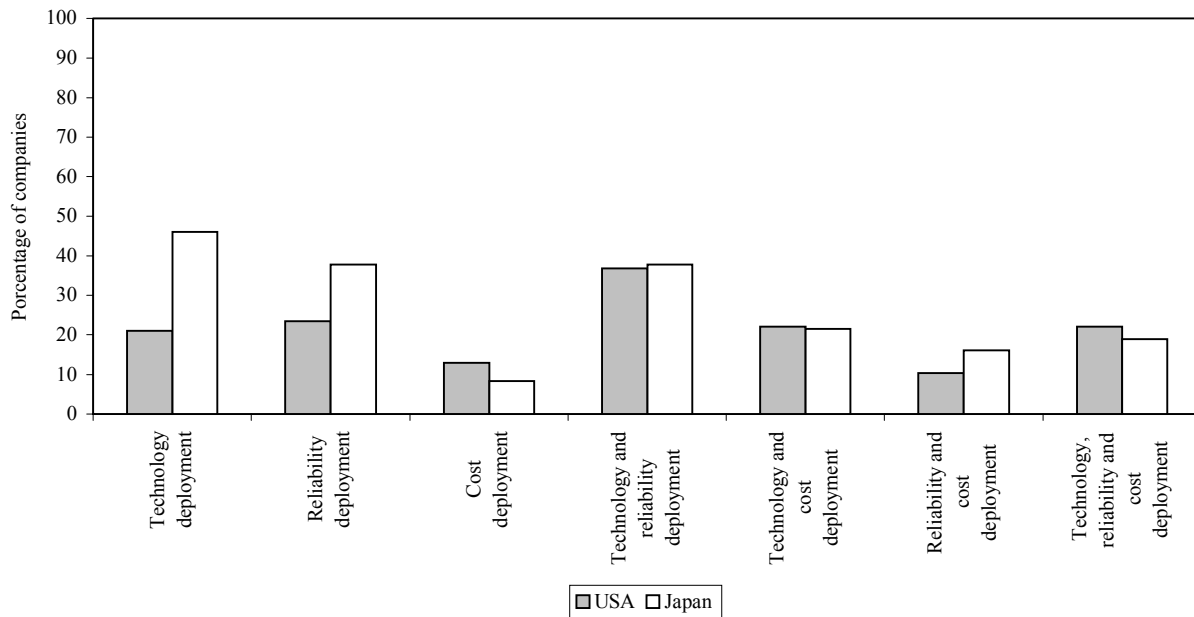


Figure 6 – Other deployments.

process was structured. In Japan, most of the ground work was done by the engineers in functional areas, but the decision making and the cross-functional component of the process was accomplished at the management level, with the managers participating at various points in the process. In contrast, in the USA, the ground-work, decision making and cross-functional component of QFD process were typically performed by working engineers representing a variety of functional areas. According to CRISTIANO et al. (2000), this is generally more consistent with the contemporary American model of cross-functional decision making that is based on team autonomy. Finally, QFD appeared to be a core element in the overall company TQC (Total Quality Control) efforts more in Japan than in the USA.

### 3.3. The survey in Brazil

In this research some information was related to the operational aspects of QFD usage such as team work, used matrices, and QFD results.

The cross-functional teams were usually from the following areas: product engineering (20%), manufacturing engineering (18%), production and sales (both with 18%), quality (15%), and tool shop, laboratories and services with 5% each.

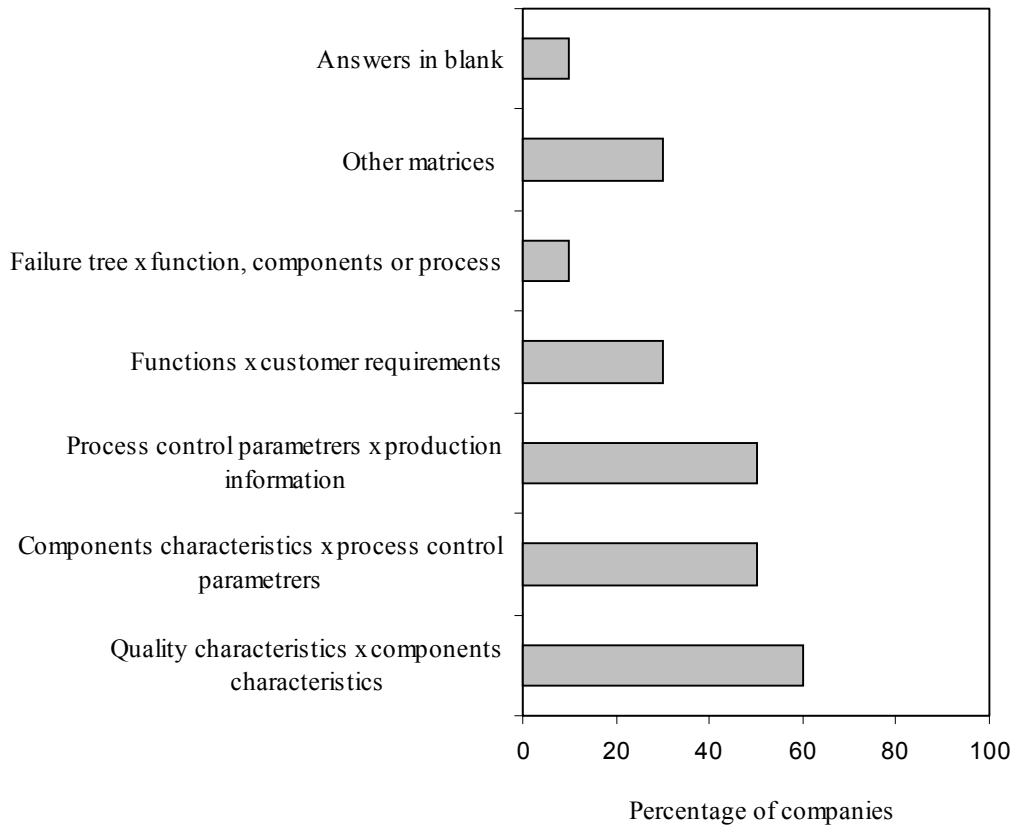
The Brazilian survey provided some detailed information regarding other QFD matrices which are done after concluding the house of quality, as shown in Figure 7. As can be seen, the quality characteristics x components characteris-

tics is the most used, pointed out by 60% of QFD users. This matrix is usually used when the components of the products are related directly with the project quality so identifying the components which are critical to achieve such quality. Obviously, this kind of matrices are used by companies of which products are assembled (automotive and autoparts, domestic appliances, computers, etc.) and it reflects the sample used in this study.

Concerning QFD overall results, the majority of the Brazilian QFD users (60%) had a 'partial success' in QFD implementation. The reason could be related with the lack of QFD experience (MIGUEL & CARPINETTI, 1999). Generally speaking, the use of QFD is rather recent in the country since most companies started to use it from the second half of the 90's. Only 13% of the QFD users finished its QFD implementation process.

### 3.4. The british survey

It is presented in this survey how QFD results are usually published. Only 13% of the user respondents released or published their studies externally (e.g. in the literature, to customer, to suppliers). However, 50% of them released the results within the company on a need-to-know basis. Ideally, the results should be released to all sectors involved with product development, since the knowledge could be transferred so the employees could be aware of the real customer demands. Another important information is that some com-



**Figure 7 – Other matrices used besides the house of quality.**

panies ceased QFD usage. Of the 19 user respondents, 7 said that they were not using the method any more. Six of them stopped because of the problems they experienced in its implementation. Behavioural management problems such as flaws in the teamwork and lack of commitment rather than completing the QFD matrices were certainly considered to be the major cause. Additionally, none of the respondents mentioned problems with the training or planning stages, and cost was not considered a problem (MARTINS & ASPINWALL, 2001).

**4. Synthesis of the studies**

This section presents a conclusive synthesis of each research, concerning QFD implementation and results in the countries.

**4.1. Sweden**

According to EKDAHL and GUSTAFSSON (1997), the application of QFD is growing in Sweden. The authors considered QFD introduction rather recent in the country (although it should be taken into account the year that publication). They also mentioned that there were companies which are evaluating how QFD can fulfil its needs. Companies such as Whirlpool and Mölnlycke had problems of developing qual-

ity characteristics and Volvo had some difficulties in obtaining customer requirements. Nevertheless, these difficulties can be considered as expected when using QFD. The Swedish research identified that intangible QFD benefits are more prominent than the tangible ones. This is not in accordance with most QFD literature which usually indicate quantitative benefits in order to illustrate the importance of QFD application

**4.2. Japan and the USA**

Generally, the obtained survey results are differently from the expected, since in most cases the results from the American companies are usually better than the Japanese ones. This could be explained by the greater expectation the American companies might have with QFD application. Conversely, Japanese companies have probably achieved its objectives since they have already implemented QFD for a long time. Overall, American companies are prioritising QFD application to develop new products while the priority for the Japanese ones is product improvement.

**4.3. UK**

The difficulties of using QFD identified by the empirical study were most associated with working in teams, while the

complexity of the tool played a second role. Moreover, time consuming issues and difficulties in attaining the voice of customer were also indicated. With the reference to the benefits gained from applying QFD, a new set of aspects emerged. These were subjective issues such as involvement of employees, ability to work in teams and communication internally (within the company) and externally (with the customer). Finally, most companies did not go beyond the first matrix, i.e. the house of quality.

#### **4.4. Brazil**

The research pointed out that QFD introduction is rather recent in the country and most QFD users did not have consolidate experiences with the method. The main benefits were associated not only with tangible benefits like product quality and reliability improvement, but also included intangible ones such as teamwork improvement and enhancement of concurrent engineering practice. The main difficulties were relative to the problems of understand and rate customer needs, conflicts in the teams and lack of training. The main drawback of this survey was the small size of the sample, which should consider this study as an exploratory one.

#### **5. Conclusions**

By comparing the four surveys, it was verified that, in most cases, their objectives were to identify the extent QFD has being applied in the countries and its main benefits and experienced difficulties. In order to fulfil those aims, the studies used non probabilistic and intentional samples mostly using a questionnaire send by surface mail to collect the data.

Regarding the results of the surveys, it was identified that companies started to apply QFD aiming at increasing customer satisfaction and improving their product development process. The majority of QFD users are large companies, mainly to develop physical products. In countries like Sweden and Brazil, the use of QFD is rather recent. Nevertheless, it should be taken into account that the Swedish survey was developed a couple of years before the Brazilian one. Concerning the matrices used in the QFD process, companies in the USA, Sweden and in the UK customarily use the house of quality (first matrix). Conversely, in Japan and in Brazil other matrices are used as well.

Concerning the main experienced difficulties when applying QFD, the results varied from country to country but in most cases they were relative to the lack of resources. The

principal benefits also varied among the studies. They were associated with subjective issues such as communication improvement between company functional areas.

This work focussed on comparing published survey results in some countries when applying QFD. Although this comparison is still valid, the survey performed in Brazil had some limitations, mainly related to the sample (definition and size) and the questionnaire (contents and form). The subsequent work was to conduct a more extensive survey. Some of the preliminary results can be found elsewhere (CARNEVALLI & MIGUEL, 2001 & CARNEVALLI et al., 2001). The full results of this more extensive survey will be published in the future. Then, the next stage is to make a detailed study of the QFD implementation process and to have a better understanding of it within the product development process.

#### **6. References**

- AKAO, Y. **Introdução ao desdobramento da qualidade**. Belo Horizonte: Fundação Christiano Ottoni, 1996.
- CARNEVALLI, J.A. and MIGUEL, P.A.C. Desenvolvimento da pesquisa de campo, amostra e questionário para a realização de um estudo tipo survey sobre a aplicação do QFD no Brasil. In: XXI, ENEGEP Salvador. **Anais...** Salvador, 2001, CD-ROM.
- CARNEVALLI, J.A., SASSI, A. and MIGUEL, P.A.C. Implantação do QFD no Brasil: Base Metodológica e Resultado do Piloto. In: 3º Congresso Brasileiro de Gestão de Desenvolvimento de Produto, Florianópolis. **Anais...** Florianópolis, 2001, CD-ROM.
- MIGUEL, P.A.C. and CARPINETTI, L.R. Some Brazilian experiences on QFD application. In: 5th International Symposium on Quality Function Deployment, Belo Horizonte. **Anais...** Belo Horizonte, 1999. pp. 229–239.
- MIGUEL, P.A.C. and CHENG, L.C. QFD in Brazil: present status and future perspectives. In: 7th International Symposium on Quality Function Deployment, Tóquio. **Anais...** Tóquio, 2001. pp. 147–152.
- CECIN, S.R. et al. Desdobramento da qualidade em serviços: uma aplicação no setor de shopping centers. In: 3º Congresso Brasileiro de Gestão de Desenvolvimento de Produto, Florianópolis. **Anais...** Florianópolis, 2001, CD-ROM.

CHENG, L.C. et al. **QFD: planejamento da qualidade**. Belo Horizonte: Fundação Christiano Ottoni, 1995.

CHENG, L.C. and SARANTOPOULOS, I.A. QFD in Brazil: a successful diffusion process into organizations. In: 1st International Symposium on Quality Function Deployment, Tóquio. **Anais...** Tóquio, 1995.

CRISTIANO, J.J., LIKER, J.K. and III WHITE, C.C. **Customer-driven product development through quality function deployment in the U.S. and Japan**. Elsevier Science, v.17, 2000.

EKDAHL, F. and GUSTAFSSON, A. QFD: the swedish experience. In: **The ninth symposium on quality function deployment**, 9, 1997, Novi, Michigan, 1997.

FRAGOSO, H.R. O ciclo de desenvolvimento do produto da Volkswagen caminhões e ônibus. In: Congresso brasileiro de gestão de desenvolvimento de produtos, 1, 1999, Belo Horizonte. **Anais...** Belo Horizonte, 1999, CD.

GRIFFIN, A. Evaluating QFD's use in US firms as a process for developing products. **Journal of production innovation magazine**, no. 9, 1992.

MARCONI, M.D.A. and LAKATOS, E.M. **Técnicas de pesquisa: planejamento e execução de pesquisas, amostragens e técnicas de pesquisas, elaboração, análise e interpretação de dados**. 3.ed. São Paulo: Atlas, 1996.

MARCONI, M.D.A. and LAKATOS, E.M. **Fundamentos de metodologia científica**. 3.ed. São Paulo: Atlas, 1991.

MARTINS, A. and ASPINWALL, E.M. **Quality function deployment: an empirical study in the UK**, Total Quality Management, v.12, n.5, 2001.

OHFUJI, T., ONO, M. and AKAO, Y. **Métodos de desdobramento da qualidade** (1). Belo Horizonte: Fundação Christiano Ottoni, 1997.

OLIVEIRA, S.L. Tratado de metodologia científica: PROJETOS DE PESQUISAS, TGI, TCC, **monografias, dissertações e teses**. São Paulo: Pioneira, 1997.

SONDA, F.A., RIBEIRO, J.L.D. and ECHEVESTRE, M.E. **A aplicação do QFD no desenvolvimento de software: um estudo de caso**. Produção, v.10 n. 1, 2000.

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