A Typology of Quality Problems: Lessons from the Automotive Industry

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Abstract. The purpose of this paper is to explore new approaches in the practice of quality management, beyond the existing and well-documented quality approaches of cure and prevention. In-depth case studies at three European automotive manufacturers and their suppliers have shown that a new generation of complicated quality problems has emerged. These problems are neither preventable nor curable at an acceptable cost because their basis is more emotional than technical. It is concluded that traditional expertise in matters technical are no longer sufficient for success. It has become essential to develop skills in the less structured areas of understanding and managing customer relationships. In: Shebani K (ed). Proceedings of the 1st International Conference on Applied Operational Research – ICAOR (2008), pp 120–128. Lecture Notes in Management Science Vol. 1. ISSN 2008-0050.

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1 Introduction

Some decades ago, the aim of quality procedures in manufacturing was to cure what had gone wrong. This was done via inspection and then re-working faulty products. Over time, many manufactured products became more complex because of the growing number of (high-tech) components. This made inspection activities increasingly labor intensive, which meant that in many industries the inspection approach became too expensive. The emphasis then switched to assuring the quality of the finished product through preventing mistakes from occurring. From a managerial perspective this was a far more complex operation because it meant
tracing faults back to their original causes which could be in a supplier’s operations or even in the product’s design.

Now, increasing product complexity combines with the growth of global sourcing and long supply chains to ensure that prevention becomes more difficult (Van Iwaarden et al., 2006). At the same time customer pressures for innovation and unwillingness to wait for delivery, mean there is often little time for cure. So some mistakes are almost bound to happen, which would mean that quick and effective reactions are essential for modern manufacturing organizations.

The purpose of this paper is to explore new approaches in the practice of quality management, beyond the existing and well-documented quality approaches of cure and prevention. In the next section the historical developments in quality management are reviewed. Thereafter, the methodology of the empirical research is explained. Finally, the findings are presented and conclusions are drawn.

2 Evolution of Quality Management

The way quality management is practiced by organizations has developed over time. In recent history, four fairly discrete stages in the evolution of quality management can be identified (Dale et al., 2007):

1. Inspection
2. Quality control
3. Quality assurance
4. Total quality management

The first two stages are based on detection of quality problems (i.e. cure), while the last two are based on prevention of quality problems. The hierarchical progression in the four stages of quality management is graphically displayed in Figure 1.

![Figure 1](image_url)

**Fig. 1.** The four stages in the evolution of quality management (Dale et al., 2007)
2.1 Inspection

Quality inspection means that one or more characteristics of a product, service or activity are examined, measured, tested, or assessed and compared with specified requirements to assess conformity against a specification or performance standard (Dale et al., 2007). Inspection can take place in both manufacturing and service environments. Manufacturing organizations can inspect incoming goods, sub-assemblies during the production process, and final products before they are delivered to the customers. In service organizations inspection can take place at key points, sometimes called appraisal points, in the production and delivery process. Inspections can be done by specialized staff (Kanji, 1990) or, in the form of self-inspection, by employees who are responsible for a certain product or process. The system is a detection-based quality system that does not by itself prevent quality problems from reoccurring (Ross and Shetty, 1985).

2.2 Quality control

The stage of quality control is more advanced than the inspection stage, although it is still based on detection of quality problems (Dale et al., 2007). A system of quality control will typically have detailed product and performance specifications, fixed inspection points in the process, and feedback of process information to relevant stakeholders. So, while inspection systems are strongly focused on the product, quality control systems are more focused on the processes from which these products originate. A drawback of quality control systems is that they may lead employees to believe that they can rely on their work to be checked. Consequently, these employees may not feel stimulated to prevent quality problems or improve the processes for which they are responsible (Van der Wiele, 1998).

2.3 Quality assurance

Solving quality problems after they occur is not very efficient and therefore the next quality stage (i.e. quality assurance) aims to prevent quality problems from occurring (Dale et al., 2007). So, this is a prevention-based quality system. A quality assurance system is focused on providing confidence that an organization will comply with quality requirements. Quality assurance systems have a wider focus than quality control systems because they move from a process focus towards a system focus, which means that they encompass multiple processes to increase uniformity and conformity.
2.4 Total quality management

The fourth stage in the quality management development hierarchy is total quality management (TQM). TQM involves the application of quality management principles at every level in an organization and to all aspects of an organization (Dale et al., 2007). TQM is a company-wide approach to quality with a balance between technical, managerial, and people issues. The individual quality tools and techniques in the TQM stage may be the same as in the quality assurance stage but in the TQM stage they affect every person, activity and function of an organization.

2.5 A new stage?

The four stages discussed above show a clear hierarchy from a narrow focus (e.g. product or process) to a broad focus (i.e. company-wide), as well as from ex-post (i.e. inspection) to ex-ante (i.e. prevention). The term total quality management seems to suggest that it is the top of the pyramid, above which no higher hierarchical level exists. However, as argued in the introduction, quality has moved into the supply chain, which has become longer because of global outsourcing. These developments mean that companies need to look outside their organization for the roots of quality problems, and at the same time it means that prevention is increasingly difficult.

3 Methodology

Three case studies at European automotive manufacturers have been undertaken. Some basic information about the case companies is presented in Table 1. The second row in the table describes the type of production that takes place at each of the case companies. Heavy Truck Co has brand responsibility for the trucks it assembles, which means that it not only assembles the trucks but it also develops and sells them. Small Car Co does contract manufacturing, which means that it is only responsible for assembling the cars, and not for development and marketing activities. Premium Car Co is a production location, which has a similar profile as Small Car Co, however, it is part of a larger hierarchical organization. Small Car Co needs to make a profit on its assembly activities in order to survive, while Premium Car Co is not judged on profit because it is a cost center within the larger organization to which it belongs.
Table 1. Characteristics of the studied case companies

<table>
<thead>
<tr>
<th></th>
<th>Case company 1 Heavy Truck Co</th>
<th>Case company 2 Small Car Co</th>
<th>Case company 3 Premium Car Co</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market segment</td>
<td>Heavy trucks</td>
<td>Small cars</td>
<td>Lower premium cars</td>
</tr>
<tr>
<td>Type of production</td>
<td>Brand responsibility</td>
<td>Contract manufacturing</td>
<td>Production location</td>
</tr>
<tr>
<td>Annual production volume</td>
<td>45,000</td>
<td>210,000</td>
<td>80,000</td>
</tr>
<tr>
<td>Number of different models assembled</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Number of employees</td>
<td>3,500</td>
<td>4,300</td>
<td>2,000</td>
</tr>
<tr>
<td>Factory location</td>
<td>Western Europe</td>
<td>Western Europe</td>
<td>Western Europe</td>
</tr>
<tr>
<td>Number of first tier suppliers</td>
<td>440</td>
<td>250</td>
<td>220</td>
</tr>
<tr>
<td>Major suppliers on-site in supplier park</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

These case studies are meant to provide a better understanding of the factors that are important in this research. The case studies focus on the ‘how’ and ‘why’ of changes in the quality management approach of the studied companies. According to Yin (2003), case studies are particularly suitable for answering ‘how’ and ‘why’ questions.

In all three case companies, interviews have been held with the quality manager, supply chain manager, production manager, and human resources manager (for Small Car Co, the logistics manager has been interviewed as well). In addition, three relevant first tier suppliers have been selected by the quality managers of each of the case companies (for Premium Car Co, only two suppliers could be interviewed). The quality managers selected suppliers that are important in terms of the components they supply, and in terms of the influence these components have on the final product. At each of the suppliers, interviews have been held with the quality manager (sometimes together with the account manager for the case company). The reason for interviewing supplier firms is the significant increase in outsourcing and the resulting influence that suppliers have on the final product. In 2006, supplies accounted for about 65 percent of the costs of a car and this is expected to rise to about 75 percent in the near future (De Saint-Seine, 2006). Therefore, the views of suppliers on the outsourcing practices and supply chain management of each of the case companies are an important contribution to the case research.

All interviews have been conducted by two interviewers and each interview has taken between one and a half and three hours. The interviews inside the case company have all focused on the changes in management systems that have taken place over the last ten years in the field of responsibility of the interviewee. Where possible, expectations for the future were discussed as well. The interviews at the
suppliers have been focused on the changes that have taken place in the way the relationship between the supplier and the case company is managed by the case company.

Six stages have been involved in the interviewing process:

1. The interview itself. Both interviewers have, individually, written down each interview.
2. Discussion between the two interviewers. Any discrepancies between the two write-ups were resolved through discussions. Based on the two write-ups and the discussions, an accurate write-up of the interview has been produced.
3. Request for comments from interviewee. The write-up of the interview was sent to the interviewee with a request to comment on it and correct any errors. All feedback from the interviewees has been incorporated in the final write-ups.
4. Discussions with quality experts. Out of the final write-ups the most important quality management issues and developments have been derived by means of discussions between the two interviewers and two academic quality experts.
5. Feedback sessions. The derived quality management issues and developments have been presented to the interviewees in a discussion meeting during which these managers could express their perceptions and opinions.
6. Final version of quality management issues and developments. The feedback from the interviewees has been incorporated in the final overview of derived quality management issues and developments.

In addition to the interviews at the case companies and their suppliers, information has been collected by means of plant tours and by studying minutes of relevant meetings and quality management procedures and policies.

4 Findings

The case studies at the three European automotive manufacturers have shown that there are four major categories of challenging quality problems. There are problems:

1. whose causes might be technically simple, but whose traceability is complicated and costly
2. that are technically difficult
3. that do not relate to technical solutions
4. arising from the tension between standardization and differentiation

Each of these categories of quality problems will be discussed below.
Category 1: Technically simple but difficult to trace
The combination of increased outsourcing, modular design and long supply chains mean that traceability of quality problems is complicated and costly, even though the causes of these quality problems might be technically simple. All three automotive manufacturers have consistently increased the extent to which they outsource production. In the past they would procure a large number of individual parts and assemble, for example, the instrument panel themselves. Currently, the instrument panel is bought as a completed module, including satellite navigation, air-conditioning, etc. The complete module is then installed in a matter of seconds.

This strategy means that the suppliers have had to switch from parts suppliers to module suppliers, which greatly increased their responsibilities and the necessary competences. As a result these first tier suppliers have started to outsource parts of the modules they assemble. By doing so, the supply chain has become longer and less transparent for the automotive manufacturers. The need for cost reductions has meant that supply chains have also literally become longer: more parts are procured from low-cost countries, which are located far from Western Europe.

Under such conditions it is very complicated and costly to trace back quality problems. Many parties are involved from many different countries and cultures, speaking different languages.

Category 2: Technically difficult
In the premium vehicle segments, the amount of software installed in the car has expanded fast with the proliferation of the number and type of gadgets and gizmos on offer. Yet, even in more mass market cars, the amount of software in vehicles is also increasing rapidly. The interviewees told that software quality problems are often very difficult to solve. They often show up in interaction with other software and electronics, which means that they are often limited to few cars which have a certain combination of accessories.

Given the enormous increase in the number of car variants and options, the dealerships may fail to spot a structural software problem because only one car in the dealership’s fleet may be affected. Only when dealerships report the problem to the car manufacturer will it be identified as a structural software problem because several dealerships may report the same problem.

Even when a software problem has been adequately identified, they remain very difficult to solve since the cars contain many systems with different software architectures. Suppliers of these systems will not accept the blame if their systems are functioning properly in a car of a competing manufacturer.

Category 3: Unrelated to technical solutions
Thirdly, there are problems arising which do not clearly relate to technical solutions. Customers now are buying cars with much clearer ideas about the kinds of feelings they should experience after purchase. Should such desired feelings not be aroused then companies naturally receive far more complaints whose background is more emotional than technical.
The problem with such complaints is that they cannot be fixed by means of some technical solution. A solution to an individual problem could be to adapt the design of the vehicle. However, this would not solve the whole issue because the design changes may dissatisfy buyers who were perfectly happy with the initial design.

The quality function must ensure the design team is aware of the types of customer they do not desire and take active steps to move such customers onto more suitable products. It now pays organizations not just to identify who their target group is but also to identify the type of customer they do not want and to actively take steps to select such individuals out. Such approach will work best in markets where distinct customer groups can be distinguished. However, in many Western car markets, customers have developed such individual tastes that this is very difficult to do.

Category 4: Standardization vs. differentiation
Because of the trend to produce a global vehicle which must serve many different markets, the likelihood of one cultural group of customers being dissatisfied whilst others are quite happy, has increased.

The drive to lower costs had resulted in platform and component sharing among different types and brands of cars. Using the same platform for a car type sold in the USA and another car type sold in Europe, means that a compromise has to be found in ride quality and handling. Striking a balance may not always be possible, resulting in dissatisfaction in one or more markets.

Allowing customers to differentiate their cars by means of option packages can alleviate the problem. However, it will also increase the price of the car and thereby cancel out the financial advantages of platform sharing.

Possibilities of prevention and cure
Quality has always in the past regarded bad quality as being solvable; and even being free (Crosby 1979). Tools and techniques have been developed to solve and then to prevent bad quality from occurring.

Now, with the aforementioned series of nearly intractable problems being thrown up by both technological and market changes, quality has to face the fact that maybe some of the problems are neither preventable nor curable at an acceptable cost. Risk management or the comparison between the costs of allowing a vehicle to be produced with the possibility of a fault and subsequent recall compared to the cost of fixing it now, has raised its ugly head.

As always it will be more straightforward to solve the harder technically based quality issues. If rapid introduction of totally new models using long complicated supply chains will involve teething troubles; if increasing software in cars is bound to lead to some glitches sooner or later; then quality needs to devise methods of ensuring that, despite all this, the customer remains satisfied and loyal. All car manufacturers either are already or soon will be hit by these issues. So such problems will soon be – and must be – seen by customers as normal.
Conclusions

The quality movement used to be technically based to solve technical problems. Now most quality technical problems are caused by others within the supply chain. So the quality manager has to understand people and cooperative relationships as much as he does machines and statistics.

The growing number of issues ending up with the quality manager as complaints but whose basis is more emotional than technical means again that the quality manager has to use his understanding of people and how to treat them so that they end up feeling positive toward the product and the company despite their initial complaint.

In a world of a growing number of errors and mistakes, and of multiplying sources of information, the power of word of mouth recommendation is becoming all important. It is the responsibility of sales and marketing to increase the numbers who are positive about the brand/company with their praise. It is the quality function’s responsibility to limit the damage which can be caused by customers who are not happy with their purchase.

The quality manager must play a key role in this. No longer is his traditional expertise in matters technical sufficient for success. Now he also must develop skills in the less structured areas of understanding and managing customer relationships.

References