Research

Quality and Reliability Problems from a Consumer's Perspective: an Increasing Problem Overlooked by Businesses?

Elke den Ouden[1,2,*,†], Lu Yuan[2], Peter J. M. Sonnemans[2] and Aarnout C. Brombacher[2]

[1] *Philips Applied Technologies—Industry Consulting, Building SFJ-767, P.O. Box 218, 5600 MD Eindhoven, The Netherlands*
[2] *Eindhoven University of Technology, Department of Technology Management, P.O. Box 513, 5600 MB Eindhoven, The Netherlands*

Currently, many businesses in the consumer electronics industry are facing an increasing number of consumer complaints, despite the application of quality tools that proved to be very powerful in the past. We assessed over 20 new product development projects, to understand the reasons behind the rising number of consumer complaints. We found that businesses are developing more innovative products that are brought to the market faster, with inherently higher uncertainties on the consumer expectations of these products. Current analyses of consumer complaints solely focus on checking if the product is functioning according to the technical specification, and these analyses show a rising number of consumer complaints where no failure could be established. When looking at product quality and reliability from a consumer's perspective, we found that consumers complain not only about technical product failures but also when the product does not satisfy their expectations. In this paper we will take the perspective of the consumer to analyse dissatisfaction with new products from various available sources, which were not set-up for quality and reliability purposes. We will show that analysing information from these sources gives better information, especially on the non-technical failures compared with the traditional quality and reliability sources. Copyright © 2006 John Wiley & Sons, Ltd.

*Correspondence to: Elke den Ouden, Philips Applied Technologies—Industry Consulting, Building SFJ-767, P.O. Box 218, 5600 MD Eindhoven, The Netherlands.
†E-mail: elke.den.ouden@philips.com

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1. INTRODUCTION

Many businesses in the consumer electronics industry are currently struggling to manage product quality and reliability. As earlier research has shown, the number of consumer complaints is currently rising (see Figure 1), despite the fact that organizations are rigorously applying available approaches to improve product quality[1].

To be able to control the number of consumer complaints in the future, we must first understand why a growing number of consumers are complaining. In many businesses, the product quality and reliability improvement focuses on technical issues: ensuring the function of the product according to the specifications. However, due to changes in the context of the business and in the business strategy, businesses have shifted their portfolio of products to include more innovative products. For these products, issues other than the classical technical product quality play an important role, such as the expectations the consumers or users have on the product functions and features or how the product will be used in daily life. Consumer complaints are currently showing a rise in non-technical complaints. The traditional (technical) way of looking at product quality and reliability is not suitable to handle those complaints.

The aim of our research is to analyse product quality and reliability from the consumer's perspective by exploring complaints in order to understand the background of the complaints. This is a first step towards capturing all consumer perceived failures instead of only the technical failures, and ultimately towards the prevention of similar complaints arising with future products.

Our research program was performed in close cooperation with the Consumer Electronics division of a multinational electronics company. First, in Section 2 we present an analysis of the changes in the business context and the impact these changes have on the scope of product quality and reliability. This analysis shows that for innovative products the scope needs to be widened to also include consumer complaints about products that are functioning well according to their technical specifications. The systems currently in use by the businesses in our research to monitor quality in the field do not cover those non-technical complaints, as we will see in Section 3. In particular, the lack of information on non-technical complaints for innovative products is hampering the ability to reduce and control the number of complaints. We will conclude that another view on product quality and reliability is needed from the businesses to match that of the consumers. A better understanding of the consumer's perspective, from the purchase of the product to its use, will help to identify potential problem areas that may cause dissatisfaction, possibly leading to complaints. A better understanding of the complaint behaviour is needed to understand the issues about which consumers complain, when they decide to complain and what channel they use to express their dissatisfaction. Insight into the consumer's perspective and the complaint behaviour, deduced from literature, will be presented in Sections 4 and 5. With these insights from literature we will analyse the information on consumer dissatisfaction that is available in the businesses. Although not set-up for the purpose of quality and reliability, various sources of information on consumer dissatisfaction appeared to be available and are presented in Section 6. In Section 7, a method will be presented for analysing consumer dissatisfaction on product quality and reliability (from a consumer's perspective). Two case studies, presented in Section 8, were performed to verify whether more information on consumer complaints, especially related to non-technical failures, could be obtained from readily available information. Finally, conclusions and recommendations for further research will be given and discussed in the last section.

2. CHANGING BUSINESS CONTEXT AND THE IMPACT ON THE SCOPE OF PRODUCT QUALITY AND RELIABILITY

In the past decades, the context of new product development, especially in the consumer electronics industry, has changed. A study has identified four major trends in the industry that may affect product quality[2]:

- increasingly complex products, due to new technology becoming more rapidly available at lower prices;
- strong pressure on time-to-market;
- increasingly global economy;
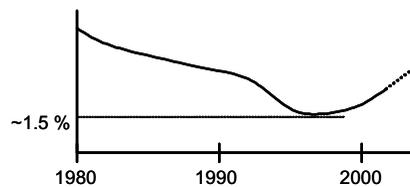- decreasing tolerance of end-users for quality and reliability problems.

Figure 1. Average percentage of consumers complaining about new products[1]

Table I. Characteristics in the business context of new product development

	Until mid 1990s	Now
Business strategy	Maintaining market share through production of high volumes and selling at competitive prices	Growth of turnover and profit through attractive, innovative products at higher price points
Product portfolio	Incremental innovations: existing technologies to existing markets[3]	New products: new technologies to existing markets or existing technologies to new markets[3]
Number of product generations to reach commodity	>10: enough time to learn consumer expectations and improve technical product quality and reliability	~3: no time to learn over product generations
Main uncertainty	Technology, in relation to cost effective mass production	Market, in relation to attractiveness of product and expectations of consumers on the product functions
Product complexity	Low: limited functions and connectivity options	High: multiple functions and connectivity options
Consumer expectations	Known, due to stable markets and incremental innovations	Unknown, due to dynamics in market and decision to introduce really new products
Role of specification	Fixed and complete at start, stable through the project	Evolving over time

These trends, together with the strategic decision of the businesses in our research to focus on more innovative products, put new challenges to product development and to the management of product quality and reliability.

As shown in Figure 1, around the mid 1990s product quality was at its all time high, resulting in a low number of consumer complaints on new products. Currently, the number of complaints is rising again. To understand the growth in complaints, one must realize the changing environment of the businesses as mentioned above. A comparison of the mid 1990s and present-day situations reveal major differences in the business context: Table I shows the main characteristics that are explored (this analysis is an extension of research on product development approaches[4]).

Managing product quality and reliability in the early 1990s meant ensuring that the product was technically functioning according to the specification. For improvement of the product quality and reliability, repair centres would provide information on products that failed to meet the specifications for technical reasons. Pareto analysis of these causes of product failures was the basis for improvement of the product design (component selection, Robust Design) or manufacturing process (statistical process control and testing). The classical approaches for reliability engineering (e.g. those mentioned in[5–9]) were previously successful in improving product quality and reliability in the business context.

Since the mid 1990s, the businesses in our research have changed their portfolio to include more innovative products. The main difference between developing the highly innovative products nowadays and the incremental products in the mid 1990s is that the consumer requirements are not yet fully known at the start of a development project. There are a number of reasons for this uncertainty in the consumer requirements.

Table II. Effect of changes in product portfolio on total number of consumer complaints—an example

Product	Year 1			Year 2		
	Sales	Hard failures	Soft failures	Sales	Hard failures	Soft failures
A (old)	90 000	2%	1%	40 000	2%	1%
B (new)	10 000	4%	8%	80 000	2%	4%
Total number of failures		2.2%	1.7%		2%	2.7%

- Consumers have different expectations of a product using a new technology than one based on the old technology (e.g. expecting a USB slot to connect a digital camera to a DVD recorder, which was not expected on a VHS recorder).
- New consumers or new applications of an existing technology have different requirements compared with expectations of the same technology in other applications (e.g. expecting shock resistance of a hard disk in a portable MP3 player, which is not an issue for a hard disk in a PC).
- A wider range of consumer types buy the product, due to the shorter time-span needed to reach commodity (i.e. a faster reduction of prices). For example, the second generation of a product is bought also by the early majority and late majority, instead of only the usual early adopters. Each consumer type has its own specific expectations or priorities in requirements[10,11] (e.g. an early adopter is more likely to own a DVD recorder that they wish to connect to their new LCD TV, whereas a consumer of the late majority category may want to connect their old VHS recorder to the same LCD TV).

Due to the uncertainties in consumer requirements, specifications are not clear at the start of the project and consequently they evolve over time. In addition, products are much more complex (more functions and connectivity options) and therefore it is much harder to ensure a complete specification, as well as to ensure correct performance of all the functions in all circumstances (e.g. connectivity to all kinds, brands and types of other products).

For businesses today, the main risk with respect to quality and reliability of new products is not just technical failures, but also failures of a non-technical nature, i.e. complaints due to the product not meeting the consumer's expectations. Therefore, the scope of product quality and reliability needs to be widened to cover these non-technical types of complaints. For this reason we make a distinction between hard reliability problems (i.e. complaints where the product does not meet the explicit, technical, product specifications) and soft reliability problems (i.e. complaints where, in spite of meeting with the explicit product specifications, a consumer still explicitly complains about the product)[12]. The traditional reliability engineering approaches only address the failure rate caused by technical reasons (hard failures), leaving the non-technical consumer-related issues (soft failures) unaddressed. The need to address soft failures becomes even more apparent if the shift in product portfolio is taken into account. Table II shows an example of the effect of changes in the product portfolio on the number of complaints. Even when the new product is dramatically improved to reduce hard and soft failures by 50%, the total percentage of failures grows (in this example from 3.9 to 4.7%) due to the changes in sales quantities of the old and new product. The percentage of soft failures of the total number of failures grows from 44 to 57%.

To be able to control the total number of consumer complaints on future new product developments within the changed business context, the scope of product quality and reliability will need to be widened. The introduction of innovative products on the market, which meet the consumer's expectations, requires prevention of both hard *and* soft failures.

3. FIELD QUALITY MONITORING SYSTEMS IN PRACTICE AND THEIR GAP

To understand the information that is gathered and analysed on product quality and reliability problems, an analysis is made of the field quality monitoring systems currently in use by the businesses in our research.
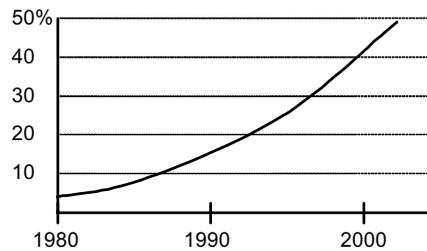
Figure 2. Percentage of 'failure not found' claims[12]

Table III. Reasons for product returns (October 2002)

Reason for return, mentioned by consumer	Percentage of total
Technical	**52%**
Product broken	52%
Non-technical ('failure not found')	**48%**
Didn't work as thought it would	28%
Don't know / no explanation	7%
No longer wanted	3%
Had already one	2%
Wanted a different one	2%
Spent too much money	1%
Other	5%

The businesses mainly rely on information from service centres (i.e. repairs) to gather information on problems in the field. This was a very effective system until the mid 1990s, and it has not changed much since. With the growing number of consumer complaints it became clear that this system would no longer suffice. Earlier research has already revealed problems in the field information available from the service centres, such as it being incomplete, not suitable for root cause analysis and/or too late to act as a guide for improvements[13].

The main driver in the service process is to ensure a highly effective and efficient repair process. Typical performance indicators are the turnaround time—the time needed to find and solve a problem and return the product to the consumer (which is obviously important for the consumer as well)—and costs. Gathering more information from the consumer, for example on the circumstances in which the problem occurs, takes time, adds costs and is adverse to the direct interest of the service centre. Products where no failure can be identified end up in the category 'failure not found', and no further analysis is performed to discover the consumer's reason for complaining or even returning the product. The percentage of 'failure not found' claims has grown over the past decades, as can be seen in Figure 2[12].

A review of the reasons for product returns, covering returns in the month of October 2002 in the United States and Europe of 20 consumer electronics products from different businesses, shows that technical failures only account for half of the complaints, the other half being complaints of a non-technical nature (see Table III). The table also shows that the information available on the non-technical returns is not detailed enough to give insight into the cause of the dissatisfaction of the consumer.

From discussions with business managers about the need for valuable information on all product quality and reliability problems in the field (both technical and non-technical), three factors were identified that hinder a modification of the system to gather more information, especially on the non-technical problems from the field.

- *Governance model*. Responsibilities in organizations have changed and are now clearly split; the service organizations are 'only' responsible for a fast and cost-effective repair of products. Providing quality information is not their responsibility, unless specifically asked and paid for by the business. The separation in responsibility requires additional effort to (re-)install the required quality information flow, which is crucial to reduce the number of complaints.

- *Focus on costs*. Costs have a very high priority in the business balanced score cards of the businesses. In line with the quality management principles[6], the costs of poor quality are measured in the businesses, and there is a continuous drive for cost reduction. The focus on costs leads to solutions that are not supporting reduction of the number of consumer complaints; for example, a repair is much more costly than handling a call at the helpdesk, so it is more cost effective to avoid one single repair than avoiding a higher number of consumers calling the helpdesk. The focus on costs is hampering information flows that are very valuable for product quality improvement, but do not directly bring cost savings.
- *Metric/key performance indicator*. A common metric used to measure product quality and reliability is the Warranty Call Rate (WCR). This metric has very limited practical value as a metric for reduction of the number of consumer complaints, as it assumes a constant failure rate and is very sensitive to sales volumes[13]. However, more importantly, this metric only includes technical repairs and ignores other consumer complaints.

In summary, the current field quality monitoring system, based on data from service centres, does not provide the information that is required to understand the reasons for consumer complaints on both hard and soft failures; it lacks information on complaints other than those caused by technical failures.

4. CONSUMER'S PERSPECTIVE

Consumers complain for various reasons, not only if the product is broken (see also Table III). Some of these reasons are related to the buying decision ('had already one', 'wanted a different one', 'spent too much money'), others are more related to the use of the product ('product broken', 'didn't work as thought it would'). A better understanding of the consumer experiences in all phases of their interaction with the product is required, to be able to capture all (potential) reasons for dissatisfaction and product returns. We will use the 'consumer process' as a framework to position these experiences. Various researchers have published on the consumer process, from both the marketing and the product development point of view. The overall consumer process is not described as such, but literature is available on four major parts: the buying process, the out-of-the-box experience, extended use and end-of-use. At the end of this section the overall consumer process will be derived from the literature.

4.1. The buying process

Most literature on 'consumer behaviour' splits the buying process into two phases, the pre-sales phase and the point-of-sales phase, to describe the consumer characteristics and their effect on the buying process[14–18].

The pre-sales phase starts with the consumer recognizing a problem or a need. Even though a consumer recognizes a need, they may not decide to buy the product, as they may be considering the need not being sufficiently important or they might not be able to satisfy the need[16]. After recognizing the need, the information search starts. This can be either an internal search (own memory of experiences and information) or an external search. Particulary experienced consumers may base their buying decisions on an internal search only[14]. If consumers do not have direct experience related to a product, they may turn to some form of external search. The source of information plays an important role in their decision; some frequently used sources are as follows.

- *Salesperson*. Satisfaction with the salesperson correlates with product satisfaction[19], but product familiarity prior to purchase correlates with lower trust in the salesperson[20].
- *Friends and family*. This is the most frequently consulted external source, but the information usually does not have professional value.
- *Consumer reports (from a non-commercial, impersonal source)*. Consumers consider these as reliable and of high value, and these can have a strong impact on the selection and decision making, especially with regard to negative information and warnings about products[14].
- *Advertising information*. Although this information has professional value, it is not considered reliable by consumers as it is supposedly meant to increase sales.
- *Displays and packaging*. This includes information given in a store by displays or informative labelling on the package[14].

Regardless of the amount of information consumers collect, there is always a risk in the decision. Brand loyalty has proven to be the most popular strategy to reduce the risks, as a strong brand reputation helps consumers to simplify their choice and is a safe shortcut in their decision making[21]. In general, consumers trust a decision more after they have collected a lot of information, but more information does not necessarily lead to a better decision[14]. The information gathered in this phase influences the expectations that a consumer has of the product.

The pre-sales phase ends with the evaluation of alternatives. During the information search the consumer becomes familiar with the different alternatives to fulfil their need. To decide between alternatives, consumers use different criteria. Three categories of criteria are defined: *must be*—the basic criteria that need to be fulfilled; *one-dimensional*—on which the comparison of alternatives will take place; and *attractive requirements*—which are not used to select alternatives, but can make an alternative even more attractive[22]. Furthermore, different consumers have different requirements depending on the level of experience with a (similar) product; an experienced consumer has more specific criteria than an inexperienced customer.

The second phase of the buying process is the point-of-sales phase in which the purchase actually takes place[18]. The factors influencing the buying decision and the expectations of the consumer on the product are as follows.

- The shop. A consumer selects a specific shop, based on location, layout, merchandising and service[16]. Shops that offer the desired product change over time, as distribution channels change over the technology lifecycle; dealer channels, national distributors, value-added dealers, retailers and mass merchants each serve in covering the market, from the new market entry stage, through growth, to the mature stage[21]. More recently the Internet can be added as well.
- The quality of information available in the shop. Mass merchants and the Internet do not provide assistance to consumers in the shop, while retailers and especially value-added dealers have qualified personnel to assist.
- The product's looks[17], including the size, colour, complexity and shape.
- The post-sale factors, such as warranty, service, parts availability and maintenance.

Dissatisfaction in the buying phase usually does not lead to a complaint, but to a decision not to buy the product ('missed sales' for the company). Although the buying process does not lead to a high number of complaints directly, it is a very important cause of soft failures. If a consumer decides to buy the product with too high expectations (e.g. because the information collected on the product is incorrect or incomplete), this problem will surface later on, when the product does not meet these expectations.

4.2. The out-of-the-box experience

Literature on the consumer process *after* the buying decision is scarce. The most relevant research for this paper is conducted by IBM on the aspects of 'installation' and 'first use' of products, also called the 'out-of-the-box' experience[23]. Three user types are distinguished in installing products: *novice users*—new to the product and its functions; *familiar or occasional users*—familiar with the type of product, knowing what it can do, but still new to specific functions; and *experienced users*—knowing how to use the product and functions, for example through having used the previous version[24]. Typically, novice users have high expectations based on advertisements, and have little interest in or appreciation for the underlying technology, while experienced users understand the capabilities and limitations of the product much better[25]. This implies that the type of problems a consumer will encounter, and may complain about during installation and first use, are dependent on the user type. It is important to realize that many consumer electronics products are used by more than one person; for example, a family consisting of persons with a major difference in prior knowledge and experience with similar products. Understanding a complaint in this phase requires insight into the type of consumers that use the product and the (mis-)fit with their familiarity or knowledge.

4.3. Extended use

After the out-of-the-box phase, the consumer enters the extended use phase. Again literature is scarce; the most relevant articles discuss the subject 'usability', mostly from the domain of software user interfaces.
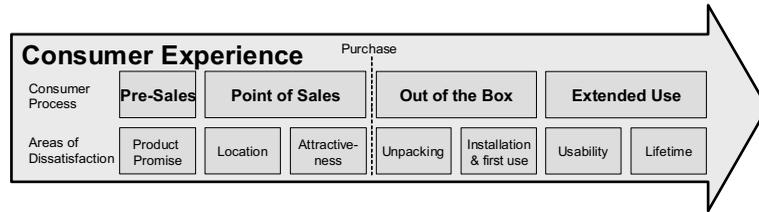
Figure 3. Consumer process and (potential) areas of dissatisfaction

Usability for human–machine interaction is defined as 'the ease of use of the functionality and features a consumer experiences during use of a product in a certain environment'[26]. Factors influencing the usability of a system are *effectiveness*—accomplishment of tasks in terms of speed and errors, *flexibility*—allowing adaptation to variations in tasks and environments, *attitude*—acceptable levels of human costs in terms of discomfort, frustration and personal effort and *learnability*—time to learn and retention. For consumer electronics products it is not only the performance that is relevant (how efficient and effective it is to achieve intended goals by using a product), but also the experience with using the product (i.e. on a metaphysical level, how the consumer 'feels' about the product)[27,28]. Consumers may complain in any of these areas, should the product not meet their expectations. Insight into which functions or features are frequently used and the ease of use of those functions or features is required to understand consumer complaints on usability.

4.4. End-of-use

A consumer may decide to no longer use the product for various reasons. The product will most likely be discarded when the 'must-be' requirements of the Kano model[22] are no longer satisfied[29]. The time when a consumer replaces the product by a new one differs: an innovator will more likely replace a still functioning product by the newest innovation, while a laggard on the other hand may only adopt an innovation if the old product type is no longer available[10]. Replacement motives include[30]: *expected defects*—consumers may expect aging products not to perform for much longer, and may already consider replacement prior to real product failure; *satisfactory product age*—consumers may have a period of time in mind that the product should last, after which the product has done its job and is mentally written off; and *deserving a new product*—buying a new product to reward or treat oneself. In the scope of our research the consumer process is considered to end once the decision has been taken by the consumer to no longer use the product and from then on dissatisfaction is no longer an issue. Consumers may complain if their expectations are not met at any time before they have decided to no longer use the product.

4.5. The overall consumer process

Based on the aspects of the consumer experience found in the literature, we derive the consumer process as shown in Figure 3.

The consumer's experience with the product starts when they become aware of their need and consider the product to fulfil this need in the pre-sales phase. The subsequent point-of-sales phase may end in a decision to purchase the product. After the purchase, the consumer process continues with the out-of-the-box experience, through to extended use and ends when the product is no longer used. The potential areas of dissatisfaction from the consumer perspective are also mentioned in Figure 3. These areas are further explained in Table IV, including some examples.

A consumer dissatisfied by any of the areas given in Table IV will complain immediately. In the phases prior to the purchase decision a consumer may be dissatisfied with the product immediately and then will most likely

Table IV. Potential areas of dissatisfaction

Area of dissatisfaction	Example
Product promise Consumer's perception of what the product should be able to do (functions, features, performance), based on information gathered, for example advertisements, brand reputation, sales info or 'hearsay'	Consumer expects that 'wireless speakers' come without any wires, while a power cable is still required
Location In which shops the product is available and the service provided in these shops	Consumer finds a typical product model not to be available in a nearby shop
Attractiveness Look and feel of the product or demo-version	Consumer finds a demo of the product too complicated
Unpacking Ease of unpacking and completeness of 'product' (accessories, manuals, etc.)	Consumer expected accessories to be included, but needs to buy them separately
Installation and first use Connecting, configuring, installing the product and using the main functions for the first time	Consumer cannot get this new product working together with products they already owned
Usability Ease of use of functions and features that are frequently used and intuitivity of user interface for rarely used functions	Consumer dislikes amount of steps needed to perform a function they need frequently
Lifetime Technical lifetime of the product or compatibility with future products	Consumer cannot get a new product working with this old product, for example required connection is not available

decide not to buy the product ('missed sales' for the company). In some cases consumers may call the company for additional information, for example on product specifications or availability in certain shops. If a consumer becomes dissatisfied with the product after the purchase decision, it may still be due to (inflated) expectations that are not met by the product (e.g. a misinterpretation of what a certain function will do). The roots of this type of dissatisfaction are in the pre-purchase phase, where the consumer is gathering information on the product and, based on this information, decides to buy the product. Misinterpretation or false information leads to a consumer making a wrong decision, and discovering this only after the product has been purchased.

In our research, we include these types of complaints as they are part of the total number of complaints, as was shown in Figure 1.

The relation between the areas of dissatisfaction and complaints is not straightforward. Consumers will not always complain on all the problems they find, but accept certain problems or express their dissatisfaction in other ways than by a formal complaint. A better understanding of the complaint behaviour is needed to understand the relation between dissatisfaction and complaints.

5.   CONSUMER COMPLAINT BEHAVIOUR

Consumers experience problems with the product in any of the phases as depicted in Figure 3. Not all problems or reasons for dissatisfaction will be expressed in a complaint. A deeper understanding of the complaint behaviour is necessary (e.g. for which reasons do they complain, when do they decide to complain—and when not—and through which channel will the complaints be filed), to understand the relation between consumer dissatisfaction and complaints. Literature on consumer dissatisfaction and complaint behaviour is scarce. First, we introduce the available concepts on (dis-)satisfaction, expectations and actions consumers take when they are dissatisfied. The section ends with a discussion on the influence of complaint behaviour on the availability of feedback in businesses.

5.1.   Consumer (dis-)satisfaction

Satisfaction is defined as a match between what consumers expect from a product and the actual perceived performance. If the product (in a wide context, i.e. including accessories, service, manuals, etc.) is falling short of its promise, consumers are dissatisfied[31].

5.2.   Expectations of consumers

The expectations are created mainly in the pre-sales and point-of-sales phases[32]. A consumer's first evaluation on the product is based on the retail marketing mix, such as product characteristics, price considerations, customer service, store location, facilities, customer communication, institutional profile/image and design and in-store ambience. All these aspects influence the expectations of the consumer regarding the product, including quality, price, variety of choice, uniqueness, convenience, reliability, service, performance and information and excitement[33].

Consumers from different adopter categories (innovators, early adopters, early majority, late majority and laggards[11]) are expected to have different expectations and needs regarding the product[34]. During the buying decision, consumers evaluate the so-called 'relative advantage' of a product compared with existing (already owned) products[11], i.e. the new product is bought when the consumer believes it will provide sufficient advantages to ensure that its benefits are greater than the adoption effort (costs, learning time, etc.). The adoption effort may vary between different user types (novice, familiar or occasional users[23]), and as a consequence the expectations on relative advantage may vary. Furthermore, knowledge of alternatives leads to more accurate expectations[14].

5.3.   Actions of dissatisfied consumers

If consumers are faced with problems, i.e. the product does not match their expectations, they respond in different ways, based on a number of factors[35]:

- the degree of dissatisfaction;
- the importance of the purchase;
- personal characteristics;
- the expected response time to get an answer.

Consumers can also be classified according to the action they take if they are dissatisfied with the product. The following categories are distinguished[36]: *passives*—who take no action, for example by not using the product again; *voicers*—who complain directly to the manufacturer; *irates*—who tell friends, negative word-of-mouth, dissuade others; and *activists*—who involve a third party, for example by going to court. The actions are also dependent on the level of dissatisfaction: 50% of the people that are slightly dissatisfied will complain, as will 75% who are extremely annoyed and 90% of those who are absolutely furious[37]. This also makes clear that not all dissatisfied consumers take action. Possible causes for this 'lack of action' are[14]: that complaining requires to much effort or the expectation of success is low; experiencing a communication threshold, for example due to education or earlier experiences with complaining; not reaching the 'action threshold' due to a lack of assertiveness or uncertainty about the justifiability of the complaint; experiencing barriers, for example unwilling retailers or high fees for services; and restriction due to personal and social norms, who feeling that complaining or making trouble is not appropriate behaviour. The threshold to complain can be lowered by[38] offering a multi-channel contact centre—allowing the consumers to choose the right channel for them, for example calling a helpdesk or writing an e-mail, conducting a customer survey and providing an on-line forum.

For our research it is important to understand the existence of thresholds for consumers to complain, as it influences the availability of information on the actual consumer's experience. From the above discussion it becomes clear that the traditional feedback channel that businesses use to collect information on complaints, i.e. the service centres, is a channel with relative high thresholds. Consumers will have to physically take

their product to the service centres or retailer—who will then forward it to the service centres—and they will have to explain the reason for the return (although in the United States this is often easier as many retailers have a 'no questions asked' return policy). Due to the relatively high threshold, the available complaint records from service centres are only the 'tip of the iceberg'; many more consumers will have problems that are not reported. This emphasizes the importance to look for multiple sources of information on consumer dissatisfaction.

The starting point of our research is the complaint rate (as shown in Figure 1). Information on consumer dissatisfaction that is collected in other sources than service centres is not included in this complaint rate. The complaint rate is only addressing the 'tip of the iceberg' with respect to consumer dissatisfaction, and a widening of the metric is necessary if the reduction of consumer dissatisfaction is to be taken seriously, but this is outside the scope of our research.

To reduce the complaint rate there is no direct reason to look for other sources of information on consumer dissatisfaction other than the service centres, but it is expected that sources with a lower threshold for consumers to complain will contain more information on problems that consumers experience with their product. We will not be able to prove a correlation between the type of non-technical problems reported in service centres and the type of problems collected through other sources because the service centres only categorize them as 'fault not found' and information required to prove a correlation is not available. Taking into account the complaint behaviour of consumers, it can be expected that sources with a lower threshold will contain very relevant information on problems that consumer experience and a strong correlation with the service centre data is expected.

The next step in our research is to analyse which sources of information on consumer dissatisfaction are available, and check if this information is suitable for a case study to verify if analysis of this information will provide more insight into the non-technical consumer complaints.

6. SOURCES OF INFORMATION ON CONSUMER DISSATISFACTION

For our research we have analysed sources of information regarding consumer dissatisfaction that were available in four business groups in consumer electronics, in addition to the traditional sources of product quality and reliability problems. The regular information sources are those described in Section 3: service centres with a focus solely on technical product failures and on the components/modules that cause these failures. Information on soft failures is not covered in these sources.

A further analysis of potential sources for information on both soft and hard failures has revealed three different sources that contain information on consumer dissatisfaction, namely, helpdesks, Internet and trade. Although these sources are not set up for the purpose of providing product quality and reliability information, they do provide useful information regarding the consumer's perspective. Each of those sources will be described briefly, with an indication of the information that is available and the way that this information is currently used in the business.

6.1. Helpdesks

Many consumers do not directly return the product to a service centre or the store if they experience a problem, but they first call a helpdesk. The data logged at the helpdesk provide additional information regarding problems consumers experience that have not (yet) led to the decision to return the product. As people also contact a helpdesk if they are not able to install or operate the product or have questions about its function, it is also a much better source of data on a wider range of failures (not just technical malfunction).

The businesses in our research see the helpdesks as an aftersales service to the consumers and not as a valuable source of information on quality and reliability. The information gathered at the helpdesks is currently only used to improve the efficiency of the service process, for example modifying the failure tree used by the call centre agents when helping a consumer.

6.2. Internet

Recently, through its widespread use, the Internet is also becoming a very useful source of information. Forums, Web sites and surveys through the Internet contain information on problems that consumers experienced with the product.

In Internet forums, consumers inform each other on the products they have bought and on the problems and solutions they have found. The data in these forums give a more in-depth view on how consumers experience their products. Many forums also give options for consumers to indicate their appreciation of the product on a number of aspects, such as performance, quality, price and user-friendliness. Although the data are very rich in content (e.g. including specific information on problem situations), they provide no statistical information, since they might not be representative of the total group of consumers that bought the product.

Many businesses have a Web site with information for consumers (product information as well as 'frequently asked questions'), and an option for consumers to ask questions through e-mail. The information collected here is similar to that collected by the helpdesks.

In some cases the Internet is used more actively, for example in clubs where consumers are asked to register their products to stay informed on relevant information, such as firmware updates or related new products. In this way the business has more direct contact with the consumers and gets information on the various products a consumer owns.

Another more active approach is conducting a customer survey through the Internet. Consumers who bought a certain product are asked to complete a survey in which their satisfaction with the product is reviewed and in which they can also indicate the problems and issues found with the product. These surveys are not a standard activity after launching a new product, but are only done occasionally.

In general, businesses have a rather scattered approach regarding the use of the Internet. It is not used structurally, but occasionally a business unit is aware of its potential and uses an approach (e.g. through a survey or by setting up a forum) to gather specific quality and reliability related information.

6.3. Trade

The third source of information is the trade. As retailers or shop-keepers do have direct contact with consumers they can provide useful information on the consumer experience. Currently there is a shift from buying consumer electronics products in specialized electronics shops towards buying them in large warehouses or supermarkets as well as on the Internet, in which case this source provides less information. In the United States, getting information from retailers is often a problem as many stores have a 'no questions asked' return policy, in which consumers do not have to indicate why they return the product. In such cases it is hard to find good information on the consumer experience and on the reasons for dissatisfaction.

In the businesses in our research this source is not regularly used, mainly as the sales volume through channels that could provide high-quality feedback is limited, and therefore statistically not representative. Although there is regular contact with the trade, it is focused on explaining the new product range and on sales promotions. Concepts under development are also discussed with trade representatives, and although experiences with earlier products are often mentioned during such sessions there is no specific effort to collect this information on a regular basis.

In summary, we discovered that there is much more information readily available on consumer dissatisfaction with products and related complaints than is currently actively being used. Although this information is not collected and analysed structurally, there is sufficient information available for case studies to verify if the analysis of this information will provide better insight into the non-technical consumer complaints.

7. METHOD OF ANALYSIS

As mentioned earlier, the aim of our research is to understand the reasons for consumer complaints, especially the soft failures for which no information is currently available. With the information gathered on the consumer
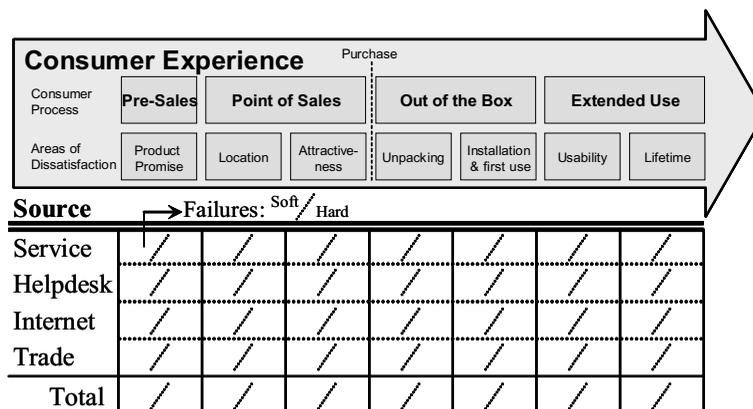
Figure 4. Analysis method for consumer dissatisfaction

process, the potential areas of dissatisfaction and the available sources of information, we were able to design a method to analyse the information on consumer dissatisfaction.

The main requirement for the method is that it covers all potential areas for dissatisfaction, and therefore we have used the consumer process as a starting point. We are mainly interested in the problems that arise after the purchase decision has been made (as these complaints contribute to the increasing number of consumer complaints as was shown in Figure 1), but the method also easily allows the capture of the problems that are reported prior to purchase. Although it is outside the scope of our research, understanding these problems will give further insight into consumer expectations that are currently not met, and potential reasons for 'missed sales'.

All available data from the various sources will be analysed to understand in which phase of the consumer process the problem occurred, and if it is a hard failure—the product is not meeting the explicit product specifications—or a soft failure—the explicit product specifications are met, but a consumer still complains about the product (including accessories, instructions manual, etc.)[12]. Figure 4 gives an overview of this method.

With the help of this analysis method the main problem areas from the consumer's perspective (i.e. areas of dissatisfaction) will be revealed. At the same time the method can also show whether the different sources of data are covering all potential problem areas.

8. CASE STUDIES AND FINDINGS

To verify whether sources other than the traditional service centres will contain more information on consumer complaints, especially on non-technical failures, the analysis method has been applied in two projects in the consumer electronics industry.

Selection criteria for the projects were as follows.

- New products (technology new to an existing market or existing technology to new markets[3]).
- Dataset(s) on consumer problems covering:
  - hard and soft failures;
  - problems from various phases in the consumer process.

The classification of the problems recorded in the dataset along the consumer process and in the categories soft/hard was done with an expert from the business, with knowledge of the product and the specifications.
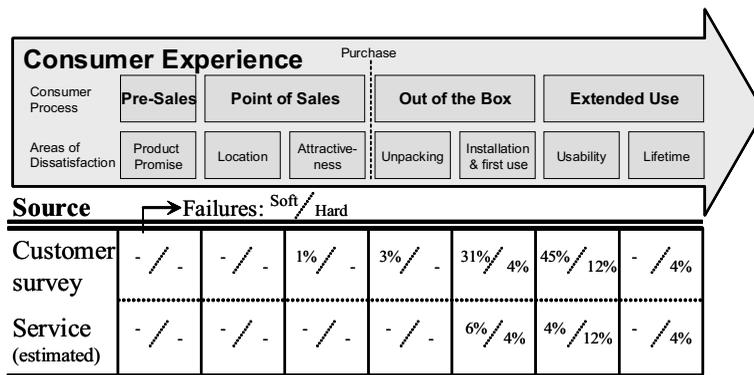
Figure 5. Consumer dissatisfaction analysis for case 1

Table V. Examples of soft problems. Bold type indicates problems that would be classified as 'fault not found' in a service centre

Unpacking	Installation and first use	Useability
No manual in Dutch language	Installation too complex	**Product too noisy in standby mode**
Quality feel of the remote control	**Problem with, connection to other product**	Consumer wants software updates
Manual too difficult	Cannot find certain buttons	**Reaction of remote control too slow**
	Not clear how to switch off demo	Option not available in this product
	Manual too difficult	Product cannot be used without a remote

8.1. Case 1

The first case study concerns the analysis of complaints on a product that was available on the market for only three months. The product contained new technologies and provided some real new features. Data from a Web survey on customer satisfaction with the product were available, covering Germany, France and the Netherlands. In total, over 1000 consumers who had actually bought and used the product had completed the survey, which also involved questions on the ease of use, performance and quality and reliability of the product. The survey collected a total of 1479 records with feedback from consumers, varying from 'minor issues' such as the look of the remote control to 'serious problems' with important new features. Obviously, as this data were collected actively from the consumers, it is not expected that all consumers would have complained about the problem they encountered and it is therefore not expected that all these problems would have been included in a complaint rate from a service centre. The data were analysed with experts from the business to: (1) identify the area of dissatisfaction for each problem; and (2) to check which part of the survey information would have also been captured by consumers reporting their problems through the usual channels, i.e. a service centre.

Figure 5 shows the distribution of the number of problems (the total of the first 'Source' row equals 100%) over the different areas of dissatisfaction. The second 'Source' row represents the similar distribution for the number of problems that would have been captured in service centres (the total of the second 'Source' row equals 30%).

Although the survey does not cover the entire problem spectrum, as the product was only on the market for three months and the number of lifetime problems therefore might not yet be stable, still a number of observations can be made from these results.

First of all it can be seen that the customer survey covers many more problems, compared with the traditional channel, i.e. the service centre (100% versus 30%). Usually, the 'soft problems' found in the service centre are classified as 'failure not found' as those are, for example, connectivity problems that cannot be reproduced at the service centre as the service engineer does not know with which other product these problems appear. The other 70% of the problems would not be reported to the service centre at all. Table V shows some examples of soft problems.

Consumer Experience — Purchase

Consumer Process	Pre-Sales	Point of Sales		Out of the Box		Extended Use	
Areas of Dissatisfaction	Product Promise	Location	Attractive-ness	Unpacking	Installation & 1st Use	Usability	Lifetime

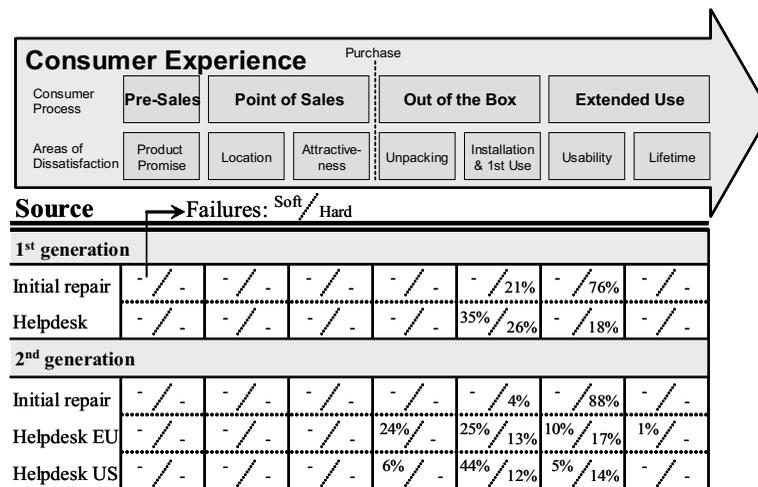| Source → Failures: Soft/Hard	Product Promise	Location	Attractiveness	Unpacking	Installation & 1st Use	Usability	Lifetime
1st generation							
Initial repair	- / -	- / -	- / -	- / -	- / 21%	- / 76%	- / -
Helpdesk	- / -	- / -	- / -	- / -	35% / 26%	- / 18%	- / -
2nd generation							
Initial repair	- / -	- / -	- / -	- / -	- / 4%	- / 88%	- / -
Helpdesk EU	- / -	- / -	- / -	24% / -	25% / 13%	10% / 17%	1% / -
Helpdesk US	- / -	- / -	- / -	6% / -	44% / 12%	5% / 14%	- / -

Figure 6. Consumer dissatisfaction analysis for case 2

Second, from the distribution it can be seen that there are many more problems experienced in the earlier phases of the consumer process than the service centre would identify. Moreover, the survey information proved to contain much more information regarding quality and reliability as experienced by the consumers compared with the service centre, for example the number and types of other products owned by the consumers (relevant for connectivity issues) and information about the customer's experience with other products with similar functions. This context information is not available through service centres. Although we do not analyse this information further here, it will become useful when looking for improvement of the product quality and reliability (which is outside the scope of this paper).

8.2. Case 2

The second case study concerns the feedback of the first and second generations of a new product, using a very new technology, targeted at a relative low price level in the market and expected to be sold in large quantities to a wide target group.

The following sources were used to gather the feedback information on consumer experiences.

- *Initial repair factory*. The first 200 sets that were returned by consumers, and that showed a defect, were sent directly to the initial repair factory where a thorough investigation on the root cause of the failure was performed. For the first generation all 200 sets were analysed. For the second generation only the first 38 sets were available.
- *Helpdesks*. Data from call centres in the United States and Europe were available for both the first and second generation. For the second generation, the datasets of the two continents were kept apart, enabling comparison between Europe and the United States.

Figure 6 shows the distribution of the consumer complaints over the areas of dissatisfaction. The total of the rows does not equal 100%. In the initial repair centres these are the 'failure not found' problems, which could not be classified along the consumer process. Also, some of the data entries of the helpdesks were too vaguely described for classification, and were left out as well.

This case study shows that there is a clear difference in the coverage of the different types of problems (indicated by the area of dissatisfaction) between the initial repair factory and the call centres. The initial repair factory mainly encounters the technical malfunctioning of products (included as 'usability' issues), where the call centres mainly encounter problems with connectivity and installation of products (included as issues

concerning 'installation and first use'). The study also shows differences in the type of problems found in Europe and the United States: Europe shows more cases of dissatisfaction with unpacking, while in the United States more problems with installation and first use are found. These problems would not be revealed with the traditional feedback from the service centres.

As already mentioned, the initial repair centres cater for real root cause analysis of technical problems, and will find causes for problems that could have been classified as 'failure not found' in the regular service centres (e.g. due to the lack of time or unavailability of different products to connect to check connectivity problems). On the other hand, only products that showed a defect will be send to the initial repair centres, so soft failures are already filtered out.

From this case it becomes clear that multiple sources will give a much better insight into the areas of dissatisfaction that lead to consumer complaints compared with a single source such as the initial repair centre.

9. CONCLUSIONS

The aim of this paper was to analyse product quality and reliability from the consumer's perspective in order to understand the background of the increasing number of consumer complaints. For consumers, not only are the technical, hard failures (products malfunctioning or not according to the specification) causing dissatisfaction and leading to complaints, but non-technical, soft failures (products functioning according to the specification, but not according to the consumer's expectation) are also doing so. In particular, the soft failures need attention, as the number of those failures is already high and still growing, and they are not addressed in existing approaches for product quality and reliability.

The case studies, in which consumer dissatisfaction information was analysed from a wide range of sources to verify if this would reveal information on the non-technical failures, showed the following points.

- The traditional sources of field information (service data on repairs) only cover information on hard failures. Soft failures are not addressed specifically but are classified as 'failure not found'.
- Existing sources of information, which were not set up to provide product quality and reliability information, proved to contain much more information on reasons for consumer dissatisfaction, especially on soft failures, than traditional sources. Also, relevant context information on the specific problem consumers encounter is available (such as other products they own, or in which circumstances they experienced the problem).
- The classification of problems along the consumer process reveals that consumers experience the most quality and reliability problems, including soft problems, in the 'installation and first use' phase.

Business managers and experts in the businesses are convinced that there is a strong correlation between the problems found in those sources and the non-technical complaints (in service centres classified as 'failure not found') and the non-technical problems found in other sources. From this analysis, we cannot prove the existence of such a correlation. Further research will be needed to identify and prove such a correlation.

For businesses the next step will be to understand the root causes of the problems that consumers experience. These causes will be of a different nature than the causes of the technical failures. All kinds of decisions made in the business process may cause a soft failure, such as a service policy or a decision in the definition of the product. Further research is needed to develop an effective approach for analysing root causes of soft failures in the business processes, to ultimately be able to install an adequate feedback system and improve on non-technical failures.

This study involved only readily available data on consumer dissatisfaction. Businesses should reconsider using their existing feedback systems to collect information on both hard and soft failures, to avoid the scenario that soft failures stay in the category 'failure not found' and cannot be reduced or controlled. It is expected that soft failures will remain an increasingly growing problem if overlooked by companies, especially for new products.

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Authors' biographies

Elke den Ouden is a managing consultant at Philips Applied Technologies, where she heads a group of over 30 consultants active in the field of product innovation, supporting various businesses world-wide. She also holds a part-time position at the Faculty of Technology Management at the Eindhoven University of Technology. Her research interest is in improving product quality from the consumers' perspective.

Lu Yuan obtained her joint PhD in engineering science at both the Eindhoven University of Technology and the National University of Singapore. She is currently working as an assistant professor at the Faculty of Technology Management at the Eindhoven University of Technology. Her research interests include reliability analysis and management of highly innovative product development processes.

Peter J. M. Sonnemans holds a Masters degree in Science and a PhD from the Eindhoven University of Technology. After his assignment in applied research in industry as a research scientist he became responsible for improvement of quality of business processes as an operational project leader and later as a consultant in industry. He is currently leading a research programme at the faculty of Technology Management at the Eindhoven University of Technology on prediction of product quality early in the product development phase, in close collaboration with industrial partners.

Aarnout C. Brombacher is a professor in Quality and Reliability Engineering at the Eindhoven University of Technology. He is responsible for research in the fields of quality and reliability of (high volume) consumer products and reliability and safety in process industry. He has authored and co-authored over 40 papers on these subjects and has written a book with the title 'Reliability by Design'. He is a fellow of the research school BETA and a distinguished visiting professor at the National University of Singapore.