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VERIFICATION OF QUALITY CRITERIA BY CUSTOMER INTEGRATION

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1. Introduction

In today's competitive business environment it is important for companies to grow through developing new products and expanding to new market segments. When doing so, companies cannot draw from previous experiences and have to cope with totally unknown market segments. A further challenge related to market expansion is a huge uncertainty concerning customer needs as well as desired product functionalities and design. To develop successful innovations companies need to know about product features that are highly valued in the marketplace and that determine the product quality as perceived by the customer. This quality demand of customers has to be clarified early in the innovation process and allows target/actual comparisons (e.g. product verification) in later innovation process stages. To this end, *product quality* and *quality criteria* have to be defined.

According to ISO 9000 [2005], *product quality* refers to the degree to which a product meets existing requirements (length, width, weight, and material specifications). Regius [2006] and Meffert et al. [2011] further distinguished product quality in objective and subjective quality. Objective or technical quality is related to product manufacturing and compliance to technical specifications. In contrast, subjective respectively perceived quality depends on the customer. Hence, customers' expectations in regard of quality have to be clarified and implemented in the product. According to [Regius 2006], the manufacturer should aim at covering as many customer desires and needs as possible. As basis for the paper at hand, we define product quality as the extent to which requirements are met by the product. Thus, product quality is highly related to customer satisfaction and results from the comparison of customer requirements and actual product design.

Quality criteria can be defined as product features used to evaluate product quality. Product features are assigned with target values (e.g. durability of a car should be at least 300000 km) [Schenkl et al. 2013b]. However, customers' quality demands are not equal for each market segment or product. Corresponding to the price segment and the product's application purpose, customers assign different values to different product features. Quality criteria allow the comparison of different product variants. Garvin's [1987] eight dimensions of quality (aesthetics, conformance, reliability, durability, performance, serviceability, features and perceived quality) are a basis for the definition of quality criteria [Schenkl et al. 2013a].

To gather customers' preferences and knowledge in order to develop new products in line with customer needs, many companies nowadays open up their innovation processes and integrate their current and potential customers. As customers possess huge product-related knowledge due to product usage, they are seen as one of the key resources for new product development [Reichwald et al. 2004]. Therefore, in this context customer integration is a valuable approach to answer questions such as, which product features are highly valued by customers? What is the optimal product design?

The paper is structured as follows. Section 2 presents the state of the art in customer integration into innovation processes. We introduce a methodology for evaluating quality criteria by customer integration in Section 3 and illustrate the application of the developed methodology with a single case study in the automobile industry (Section 4). We conclude the paper by discussing some theoretical and practical implications of the research at hand.

2. Theoretical Background on Customer Integration

In an increasingly competitive market environment accompanied with shortened product life cycles as well as increasing innovation and cost pressure, many companies change their innovation strategies from innovating for customers to innovating with customers [Desouza et al. 2008], [Gassmann and Enkel 2006]. External stakeholders such as customers, suppliers, or universities have product-related knowledge relevant for companies that can be gathered and integrated into the innovation process. This opening up of the innovation process is also defined as the open innovation approach coined by Chesbrough [Chesbrough 2003], [Gassmann and Enkel 2006].

Customer integration into innovation processes can be viewed as a sub-process of the innovation process. As Figure 1 shows, the sub-process of customer integration is triggered by the need for customer input. Customer input can be defined as contributions that customers can make to the different stages of the innovation process. Customers can give input to the innovation process in form of ideas, needs, preferences, solutions, evaluations, and concepts or prototypes for new products [Kohler et al. 2011], [Reichwald et al. 2004] (see Figure 1). In the first stage of the customer integration process, the most appropriate customer integration method(s) is (are) selected to gather the required customer input. In the next two stages, the customer integration method is prepared and executed. Finally, the obtained customer input needs to be validated and then delivered to the innovation process [Fähling et al. 2011].

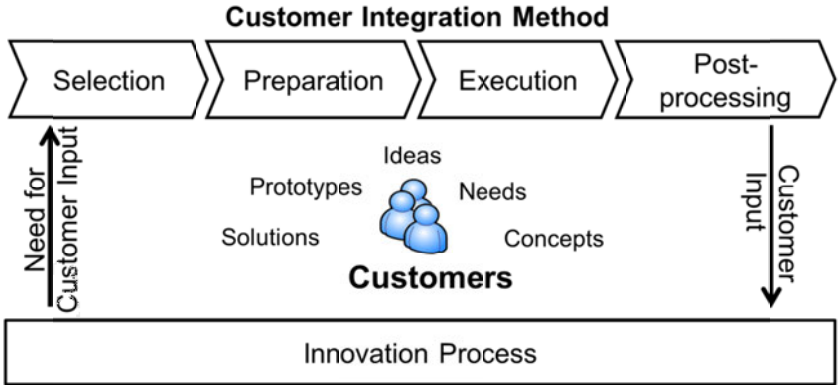

Figure 1. Customer integration process (based on [Fähling et al. 2011])

There are a lot of different customer integration methods available to collect customer input. For instance, companies conduct lead user workshops, focus groups, idea competitions, surveys, or customer interviews to integrate their customers into the new product development process [Zogaj and Bretschneider 2012]. The selection of the most appropriate customer integration method(s) in a certain context depends on the type of customer input required, the distribution of the target customer in time and space, customer expertise as well as organizational constraint such as time, budget, or personnel [Fähling et al. 2011].

Customer integration methods can be assigned on a continuum between *passive* and *active* customer integration [Alam 2002], [Schultze et al. 2007] based on the responsibilities taken by the customer in the innovation process [Cavaye 1995]. Examples for passive customer integration are surveys or complaint analysis. On the other end of the continuum, active customer integration methods such as lead user workshops, focus groups, and innovation communities reside. These customer integration methods enable customers to actively execute tasks such as idea generation and product design previously done by employees of the integrating company [Zogaj and Bretschneider 2012].

In this paper, we select and apply customer integration methods to collect customer input in form of the verification of quality criteria. In our single case study of a manufacturer in the automobile industry, the goal of customer integration is to answer open questions such as which features are highly valued and determine product quality as perceived by customers? What features are expected by customers? What does the optimal design of the new product for the new market segment look like? These issues have to be clarified in order to develop high quality products that meet customer needs.

3. Methodology

In the following we introduce a methodology for verifying quality criteria by customer integration. Our approach specifies the phase "Selection" of the customer integration process according to Fähling et al. [2011] and is detailed for the verification of quality criteria. The methodology consists of four steps (cp. Figure 2). First, the needed customer input respectively quality criteria that have to be verified by customer integration are defined. Second, the defined quality criteria are prioritized. Third, the most applicable customer integration methods are selected. Finally, the needed customer input is assigned to one of the selected customer integration methods with which the needed customer input is aimed to be collected.

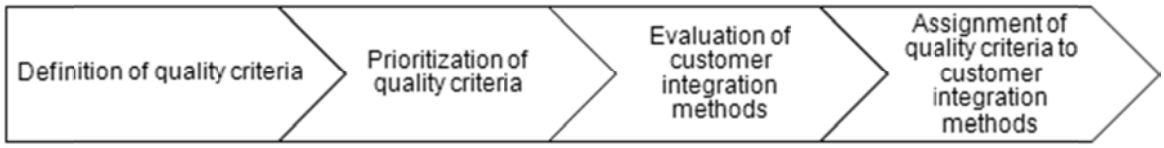

Figure 2. Methodology for verifying quality criteria by customer integration

3.1 Definition of quality criteria

In the first step of the methodology, the needed customer input has to be defined and translated in questions to be answered by customers. Quality criteria allow the comparison of different product variants. As explained in Section 1, quality criteria consist of product features and assigned specifications/target values. The product features either concern the whole product or a specific component. There are four types of questions through which quality criteria may be verified (cp. Figure 3). Based on these four generic questions, specific questions to be answered by customer integration can be formulated.

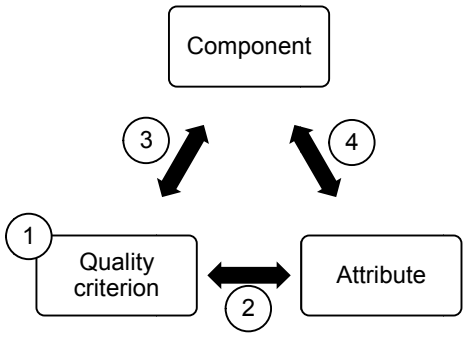

Figure 3. Information about quality criteria

1. *How relevant are quality criteria?*
   The importance of a quality criterion is unclear. For instance, in an entry level segment, economy is more important than in upmarket segments.
2. *What is the desired specification of a quality criterion*?
   The product features desired and highly valued by the customer are unclear.

3. *How relevant is a quality criterion for a specific component?*
   Similarly to (1), the importance of a quality criterion in the context of a specific component is unclear. Examples are the importance of clearances of a component directly visible for the car driver (e.g. around the instrument panel) compared to clearances outside of direct visibility (e.g. the interior of the luggage compartment).
4. *What is the desired specification of a quality criterion for a certain component?*
   Similarly to (2), the demanded value of a quality criterion for a specific component is unclear. Examples are the optical appearance of the instrument panel of a car or the durability of wear parts.

(3) and (4) are listed separately because quality criteria for a specific component may differ compared from those of the whole product. Three types of components are of particular interest:

- Components that have a high customer relevance
- Components that are of substandard quality in the existing product portfolio
- Components based on new technologies or solutions and/or components where customer needs
- regarding specific design is unclear.

3.2 Prioritization of quality criteria

After defining the quality criteria, their criticality has to be evaluated. For focusing the effort (expenditures related to the preparation, execution and post-processing of customer integration) only critical criteria respectively quality criteria of high priority should be verified. The priority/criticality of a quality criterion depends on both importance and uncertainty:

- *Importance:*
  Significance of the information for the development project
- *Uncertainty*:
  Doubts concerning the information, e.g. regarding quality attributes desired by customers

The quality criteria are evaluated regarding these two aspects and are depicted in a portfolio. Thereby they are categorized in customer input of low, medium, or high priority (see Figure 4).

3.3 Evaluation of customer integration methods

After defining and evaluating the required customer input, suitable customer integration methods to verify the quality criteria have to be selected. To this end, there are several evaluation criteria such as the customer input needed, internal and external resources required, duration, divisibility, or cyclicality of the customer integration method. For instance, Fähling et al. [2011] propose a framework consisting of 30 criteria. In the following we introduce a set of five criteria for the evaluation and selection of customer integration methods in order to reduce the complexity and time effort of the selection process (see Table 1). Since time is a limited resource in daily business, a set of evaluation criteria covering five industry-oriented aspects of customer integration (e.g. expenditures, confidentiality) is sufficient. First of all, the goal of customer integration respectively the outcome of customer integration has to be clearly defined, which is covered by the criterion *type of input*. Second, the type and amount of *customers* to give the input has to be defined. Depending on the customer type different types of input can be expected and different customer integration methods are applicable. Further, the company has to decide whether *physical items* can or have to be provided to the customer in order to acquire the needed type of customer input. When integrating customers into the innovation process, *confidentiality* is always a crucial issue that needs to be considered. Finally, customer integration requires *extensive investments of time, financial or human resources*. This set of evaluation criteria also serves as a basis for assigning quality criteria to suitable customer integration methods in the next step (Section 3.4).

3.4 Assignment of quality criteria to customer integration methods

Based on the compatibility of the customer integration method with the required customer input (here: quality criteria to be verified), quality criteria are assigned to one of the selected customer integration

methods. To this end, for each quality criterion a separate compatibility matrix is set up. Within that matrix, the customer integration methods are rated for each criterion if they are suitable for verifying this specific quality criterion. A customer integration method is suitable for the verification of a quality criterion if all evaluation criteria are compatible (cp. Tables 3 and 4). The application of the introduced methodology is illustrated by a case study in the next Section.

Table 1. Evaluation criteria of customer integration methods

Type of input: Depending on the customer input needed the customer integration method has to be selected. Some customer integration methods ask the customer to create and submit ideas (e.g. idea competitions) [Leimeister et al. 2009] others aim at identifying customer needs and preferences (e.g. survey) [Enkel et al. 2005b].
Customer type: The different customer integration methods allow access to different types and amount of customers. Hence, depending on the type of customer selected to give the required external input different customer integration methods are applicable. For instance, virtual customer integration methods such as online idea competitions allow to integrate a relatively high number of geographically dispersed customers [Fähling et al. 2011].
Physical items: To get certain customer input it is necessary to provide physical items respectively a physical interaction of the customer with the product/prototype. For instance, customer integration in person (not virtually) is essential to gather customer input on surface feel, smell, or taste (cp. [Fähling et al. 2011])
Confidentiality: A risk related to customer integration is the loss of know-how. When integrating customers into innovation processes, they unavoidably acquire knowledge which they might use for their own proposes or trade to competitors [Enkel et al. 2005a]. Some customer integration methods allow the customer to get more confidential insights than others. More general tasks and topics are less dangerous than more concrete and sensitive innovation topics. Thus, confidentiality is an important criteria to be taken into account by practitioners when selecting customer integration methods [Hemetsberger and Godula 2007].
Expenditures/Effort: This criterion refers to the expenditures required for preparation, execution, and post-processing of the customer integration method. Some methods such as interviews are less expensive and time-consuming than other methods (e.g. interviews less expensive and time-consuming than focus groups) [Alam 2002]. Since, resources are always limited in companies, managers aim at selecting customer integration methods that allow the collection of the needed customer input with a minimum level of effort.

4. Case study

The above introduced methodology was applied in a case study within a new product development project in the automotive industry. The company planned to enter a new market segment, where customers' quality demand was unclear and needed to be clarified. Due to confidentially reasons the results are shown exemplarily with distorted values.

4.1 Definition of quality criteria

Based on the company's experience on the automotive market, an initial set of quality criteria to be verified by customer integration was defined. Examples for the defined quality criteria are:

1. Surface feel: What type of surfaces is perceived as high-value?
2. Economy: How important is economy for the customer?
3. Features: How important are features for the customer?
4. Acoustics drivetrain: What acoustics are perceived as high-value?
5. Clearances: Do clearances influence the product quality as perceived by the customer?
6. Durability components: Which durability is demanded by customers?
7. Visual appearance instrument panel: Which design of the product is highly valued by customers?
8. Functionality instrument panel: Which features are perceived as of high quality by the customer (e.g. analogue vs. digital speedometer)?

4.2 Prioritization of quality criteria

These quality criteria were evaluated by experienced product designers of the development team in terms of their importance and uncertainty as the portfolio in Figure 4 illustrates. As a result of this

second step, the quality criteria are evaluated and prioritized. For the next steps of the introduced methodology only 'critical' quality criteria meaning those with a high score either in importance or uncertainty were considered and those with a medium score in both uncertainty and importance (marked grey in Figure 4).

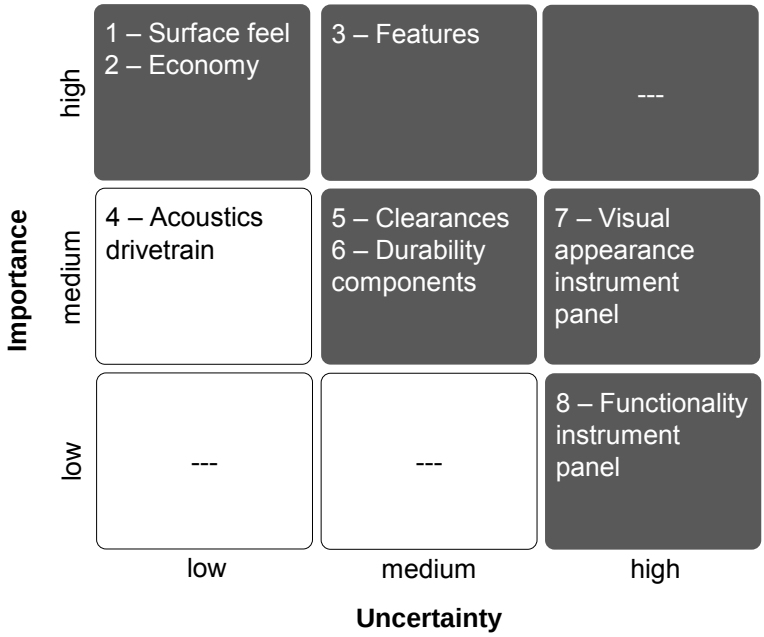

Figure 4. Priority of quality criteria

4.3 Evaluation of customer integration methods

Applying the set of five evaluation criteria (see 3.3.), three customer integration methods were evaluated as applicable in the underlying context. All of the five evaluation criteria were weighted equally. Additionally, these customer integration methods are in particular suitable since they are known in the company and have been applied in previous projects. In the following the three selected customer integration methods are described.

1. **Customer interview** with a *driving instructor*
   Since the driving school only uses vehicles from the company the driving instructor possesses *huge use experience* on the company's existing product portfolio as well as *customer demands*. Since *physical items* could not be shown in the interview, *customer input* regarding surface feel could not be gathered with this customer integration method. Due to *confidentiality* issues, no specific questions which allow interferences to the new market segment or product could be asked.
2. **Survey** on a trade fair
   A trade fair allows access to a *wide range of customer types* with *different needs* and *levels of use experience*. Further, the *effort* for a simple survey [Hemetsberger and Godula 2007] was assessed as rather low, since an external company was assigned with preparation and post-processing of the survey. Again, no *physical items* were available at that time and therefore customer input regarding surface feel could not be gathered. The survey was conducted at the booth of the manufacturer. Thus, due to *confidentiality* issues too detailed questions that ease interferences have been avoided.
3. **Product test** with *target customer* of the new product
   For the survey all visitors of the trade fair were considered. This approach includes customers which do not match with the targeted customer type of the new product. In contrast to the survey, a product test enables the manufacturer to intentionally select participants corresponding to the target customer. Additionally, this customer integration method allowed more detailed questions, since *physical items* were present. Due to *confidentiality* issues only

employees corresponding to the type of customer targeted with the new product have been selected as participants of the product test. However, the preparation (e. g. location, physical items, inviting and motivating employees to participate), execution, and post processing of a product test take a lot of time.

The results of the evaluation of the three customer integration methods are summarized in Table 2.

Table 2. Evaluation of customer integration methods

	Type of input	Customer type	Physical items	Confidentiality	Expenditures
Customer interview	deep insight into customer needs	n=1	not available	not confidential	medium
Survey	superficial insight into customer needs	broad spectrum	not available	not confidential	low
Product test	deep insight into customer needs	n<30	available	confidential	high

When comparing the customer integration methods with each other, the survey was found to be the least resource-consuming method since the preparation and post-processing was conducted by an external company. Therefore, customer input required and evaluated as of highest priority was assigned to this customer integration method. Preparation, execution, and post-processing of the interview with the driving instructor take some more effort and resources than the survey. However, the input collected through the interview with the driving instructor had to be evaluated critically since the input is determined by the driving instructor's subjective opinion. For this reason the validity and usage of the input was limited. Therefore, the allocated customer input had to be further verified with the product test.

4.4 Assignment of quality criteria to customer integration methods

Based on the compatibility of the customer integration method with the required customer input (here: quality criteria to be verified), quality criteria are assigned to one of the selected customer integration methods. For each quality criterion a separate compatibility matrix is set up. Table 3 and 4 exemplarily show the compatibility check for the quality criteria "features" and "visual appearance instrument panel". Thereby '+' means "compatible" and '-' stands for "incompatible", meaning that a quality criterion can be verified by the customer integration method or not. From the compatibility check was found that the customer integration method survey is most suitable to verify the quality criterion "features" (see Table 3).

Table 3. Compatibility matrix for quality criterion "features"

	Type of input	Customer type	Physical items	Confidentiality	Expenditures	Overall
Customer interview	+	-	+	+	+	-
Survey	+	+	+	+	+	+
Product test	+	-	+	+	+	-

For verifying the criterion "features" a broad customer base has to be asked regarding their preferences. Since a survey at the trade fair allows the integration of more customers than an interview or product test, the survey is the only compatible customer integration method regarding "customer type". Further, only a superficial insight on customer needs is required to verify "features". This can be achieved by all integration methods, thus all of three are compatible. To ask about the importance of different product features for customers, physical items are not necessarily required. Confidentiality

is not an issue as the quality criterion “features” may be verified without revealing sensitive information. Thus, all three customer integration methods are compatible with the evaluation criteria “physical items” and “confidentially”. Altogether the quality criterion “features” is verified by a survey on a trade fair. In these examples only one customer integration method was suitable regarding all criteria.

Table 4. Compatibility matrix for quality criterion “visual appearance instrument panel”

	Type of input	Customer type	Physical items	Confidentiality	Expenditures	Overall
Customer interview	+	-	-	-	+	-
Survey	+	+	-	-	+	-
Product test	+	+	+	+	+	+

For verifying the quality criterion “visual appearance instrument panel” a medium broad customer spectrum has to be asked. Thus both survey and product test are compatible. ” As for the verification of the quality criterion “features” to verify “visual appearances instrument panel” only a superficial understanding of customer needs has to be acquired. This can be attained by all integration methods. Therefore, all of them are compatible. Supporting the customer integration with physical items (prototypes of an instrument panel) is recommended. Since the application of prototypes reveals sensitive information, the product test with employees is the only compatible customer integration method. Altogether the quality criterion “visual appearance instrument panel” is verified within the product test.

5. Conclusions

This paper presents a methodology for the verification of quality criteria by customer integration. Quality criteria are product features used for assessing product quality from the customer perspective. For instance, quality criteria can be applied for comparing and evaluating different product variants in the innovation process. Customer integration allows the clarification of uncertainties regarding the customers’ quality demand when entering new market segments. The methodology consists of a procedure/steps and assigned methods for the prioritization of required customer input as well as the evaluation and selection of suitable customer integration methods.

The introduced methodology has been applied within a case study in the automotive industry. Based on this single case study, we can draw the following conclusions on the verification of quality criteria by customer integration. In general, our case of a manufacturer in the automotive industry has shown successful application of the introduced methodology. The methodology provides comprehensible steps and tools such as matrixes and evaluation criteria for the prioritization of customer input or the selection of customer integration methods. These tools allow structured decision making and documentation of results. The results of the methodology are delivered in the form of customers’ quality demand and product features highly valued. Thereby, the delivered results are the basis for quality-related decisions in development projects, e.g. the selection of concepts to be pursued and put forward in the marketplace.

In our case study, customer integration for the verification of quality criteria yielded valuable insights into customers’ quality demand in the targeted new market segment. Thus, customer integration leads to less market uncertainty and a higher preference fit since the newly developed product is adapted to customer needs.

Within the case study, the participants of the product test were not very technophile and therefore could not answer detailed questions about technical product features. This influences both the results on demanded product features, the applicability of customer integration methods. The needed customer input has to be translated in clear, simple, and comprehensible questions. Detailed questions on sophisticated technical details may overstrain the customer. Also, the company has to decide between posing more open or closed questions. Open questions allow for a broader and unbiased

insight into customer needs. However, this type of questioning may be less comprehensible for the customer and may lead to less goal-oriented or useful answers. A possible solution is the application of analogies and pictographic descriptions which support a better understanding of questions [Dahl and Moreau 2002]. Additionally the number of questions needs to be considered. The number of questions to be answered by the customer has to be limited in order to keep the customer's effort at a minimum. This issue is addressed by the introduced methodology through prioritizing quality criteria in step 2.

A major challenge in our case study was the confidentiality issue. Many customer integration methods require the company to brief the customer about the new market segment and product concepts/prototypes. Questions have to be formulated accordingly and physical items cannot be provided. This strongly limits the opportunities in customer integration and the type and quality of collected customer input.

To conclude, in the single case study the application of the presented methodology delivered valuable results for the new product development project. The methodical approach fostered a more goal-oriented and focused approach. Goal-orientation and focusing effort is necessary since customer integration methods require extensive efforts for preparation and post-processing. The presented approach was worked out for the purpose of verifying quality criteria by customer integration. The selected customer integration methods are applicable and suitable to the specific context. With adequate modifications, the introduced methodology can be applied for other purposes, such as collecting and verifying customer requirements. One adaption may be in terms of the evaluation criteria. For companies in other industries, other evaluation criteria might be more applicable. Also, in a different context the weight of the criteria might be adjusted. For instance, a company might consider the criterion expenses/effort as most important and therefore weight it with a higher factor.

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