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# UTILIZATION OF OUTSIDE-IN INNOVATION INPUT FOR PRODUCT DEVELOPMENT

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## 1. Introduction

Chesbrough et al. define Open Innovation as *"(...) the **use of purposive inflows and outflows of knowledge to accelerate internal innovation**, and expand the markets for external use of innovation respectively"* [Chesbrough et. al. 2006]. In the following we focus on inflows of knowledge to the company that Chesbrough et al. call **outside-in innovation**. Research has elaborated several methods to carry out outside-in innovation in the context of product development. Research and industry experts are intensively discussing the application of these methods (see e.g. [Kogan 2011]). Methods of outside-in innovation do indeed support product development, but they also face obstructions and challenges, such as resistance within the organization and practical issues of application (for a summary see e.g. [Kirschner et al. 2011]).

In general, methods of outside-in innovation generate qualitative and non-representative input. Thus when they are applied, the need of operationalizing the results occurs. We refer to operationalization as processing the results so that they could be applied purposively to specific assignments, e.g. in product development in an industrial context. We demonstrated a first step towards utilizing outside-in innovation input by structuring it at the company's border (legal and organizational) (see [Kain et al. 2011]) in order to channel this inflow of knowledge to the company. In this article we focus the utilization of outside-in innovation input within product development.

### 1.1 Operationalization of qualitative input from outside-in innovation

In a simplified consideration operationalization for product development of outside-in innovation input could take place outside or inside product development. Outside specialized departments do perform market research. There is a detailed process for dealing with qualitative data available. In the case of questionnaires, these steps are (a) review and edit the questionnaires, (b) encode, (c) enter and validate data, (d) correct data, (e) create the data matrix [Altobelli 2007]. The data matrix columns depict the variables defined during encoding, and the rows show the different cases, e.g. interviewees. Raw data is collected and elaborated information (e.g. studies and reports result) results for supporting the management in general or in our focus, product development, the product managers.

In 2010 and 2011 we interviewed project managers and product developers concerning 34 different innovation projects in German manufacturing industry (some results reported in [Kirschner et al. 2011]) and we derive several issues: These above mentioned reports enable the product manager to comprehend the aggregated content and to monitor e.g. the fulfilment of strategic goals. From the perspective of a product developer, these studies and reports seem too abstract in order to put the recommendations into practice purposively. Additionally the raw data is often not representative and not operationalized to be applied in product development directly.

Inside product development methods of rating and weighting artifacts (see e.g. [Pahl et al. 2003]) that result during development, such as requirements, solution ideas, and concepts, are well applied. But if

applied on highly diverse and vast inflows of knowledge stimulated by outside-in innovation methods they would demand for tremendous amount of resources.
To conclude, the processes that exist in a company to potentially deal with input arising from outside-in innovation activities outside and inside product development do not completely satisfy the needs of product developers satisfactory.

### 1.2 Research Method

We identified a research gap for process-related support when operationalizing input from outside-in innovation activities for product development. The hypothesis results that auxiliary means derived systematically from outside-in innovation input could support effectively utilization of outside-in innovation input in product development.
According to [Blessing and Chakrabarti 2009] we identified the level of support in a descriptive study (DS-I). Then we composed support in a prescriptive study (PS) as depicted in Section 3 and in Section 4 and 5 we evaluate this support in a descriptive study (DS-II) in an industrial context.
In order to prove our process-related approach we conducted an empirical study together with industry. We applied the outside-in innovation method Immersive Product Improvement (for details see Section 2.2). The object of improvement was a common office telephone that 24 participants used in their daily business. We asked the participants to submit comments concerning the improvement of the telephone and provided a web interface for 7 days at the end of 2010. The website depicted photographs of the telephone from different perspectives, prompting the participants to submit comments. The participants were able to provide comments intuitively by clicking on the photograph and thus also locating their comments with respect to the product. All participants were able to access the website to review the collected comments, so comments could evolve.
In order to validate the effectiveness of our approach we collaborated with the manufacturer of the specific office telephone, a major German company. We organized a workshop with 10 of the engineers, which were in charge of developing the next generations of the office telephone that we analyzed. The project manager and his team, all experienced engineers, attended the workshop. We discussed our proceeding that was guided by our process-related approach and our results, which were the outside-in innovation input, its transformation into auxiliary means, and the applicability within product development.

### 1.3 Focus of this article

This article aims to support product development utilize data collected by applying methods of outside-in innovation purposively. Thus we suggest a process-related approach for dealing with input resulting from outside-in innovation activities. In particular, we discuss the operationalization of this input from the perspective of product development using the example of the outside-in innovation Method Immersive Product Improvement (see section 2.2). Section 2 provides a brief overview of methodical support in product development and selected methods of outside-in innovation. In Section 3 we present our process-related approach to utilize outside-in Innovation input for product development. Section 4 depicts its application in an empirical case study in collaboration with industry. Section 5 discusses the results in detail, and section 6 concludes the article.

## 2. Background

This section presents a brief summary of the impact of methodical support in product development. Furthermore, it introduces two exemplary methods of outside-in innovation to illustrate the diverse character of resulting outside-in innovation input and to point out the need for operationalization due to the amount and diversity of input.

### 2.1 Methodical support in product development

The product development process ranges from strategic deliberations to checking the fulfilment of development goals; auxiliary means, such as methods or checklists, support specific tasks within the process. In Franke et al. we present the results of a survey of the measures and applied methods that characterize innovation success [Franke et al. 2009]. Based on 87 responses, we conclude that successful companies apply methods at least equally or more often than underperforming companies. This intends that method application itself improves product development. Considering the operationalization of outside-in innovation input methods in product development could help make input purposively applicable.

### 2.2 Methods of outside-in innovation

Diener and Piller identify three main approaches of outside-in innovation [Diener and Piller 2010]: (a) idea contest, (b) broadcast search, and (c) lead user approach. The lead user approach commonly involves workshops, in which lead users present and elaborate their ideas. An idea contest supports early phases and according to Diener and Piller a broadcast search supports late phases [Diener and Piller 2010]. In the following we especially focus on the idea contest in order to increase awareness of the need for operationalization input from the perspective of product development. Piller et al. discuss the customer idea contest from a methodological point of view, illustrate the application of this method in consumer goods and describe several steps (implementation, mode of operation, performance measurement) [Piller et al. 2006]. An idea contest produces product ideas within a specified solution space. We were recently able to support an idea contest that aimed to collect ideas for transforming semifinished materials into products. The semifinished materials supplier initiated the idea contest, with end users participating to provide product ideas containing the semifinished materials. Thus a very wide solution space emerged and additionally participants were not preselected (e.g. according to age, educational background, or profession). Participants articulated more than 500 ideas (ranging from colloquial to jargon) with different levels of concretization, which demanded a structured and systematic processing in order to make use of them.

The second example we briefly introduce is the method of Immersive Product Improvement (IPI), which we present in detail in [Kirschner et al. 2011] and [Kain et al. 2011]. IPI provides a product representation to users and collects their input based on their experiences. The aim is to improve existing products; thus IPI focuses on gathering user statements. It provides means to redesign products or components, and it reveals the user's perception of products. Thus IPI helps monitor the fulfilment of development goals and identify quality issues. Much of the resulting input refers to a specific product or even specific features of a product, but it is diverse, possibly contradictory and for the most part non-representative.

Related to outside-in innovation social scientists elaborated the netnography approach for market research applications. It originally stems from ethnography and "*provides information on the symbolism, meanings, and consumption patterns of online consumer groups*" [Kozinets 2002]. For instance, Sinkovics et al. apply netnography to qualitative analysis of online communities in game design in order to support software development [Sinkovics 2009]. They report how they took the textual content of a web forum as qualitative data as input for the netnography. They indeed derive results that are applicable for game development, but do not process their results for use within a company from the perspective of product development.

## 3. Process-related approach

The introduction illustrated a research gap for process-related support when operationalizing input from outside-in Innovation activities for product development. In this section we present an approach to utilize outside-in innovation input for product development and focus especially on operationalization.

### 3.1 Methodical support to utilize outside-in Innovation input for product development

We suggest an interdisciplinary engineering-oriented approach that provides auxiliary means to utilize outside-in innovation input during product development. Interactions with traditional processes allow the results to be fine-tuned and improved. We propose transforming outside-in innovation input into auxiliary means to support product development (see Background section). We narrowed down the situation to be supported as follows. Our support especially considers the so-called outside-in innovation (see [Chesbrough et al. 2006]), where input is collected outside the company and transferred into the company. We focus to provide support to the development process and we consider the purpose of method application as already well defined and also the method to perform as chosen. Thus we suggest a generic approach that is as specific as necessary in respect to the situation it is meant to support, but as independent to particular methods of outside-in innovation as possible. The approach comprises a procedure to utilize outside-in innovation input to product development consisting of three particular steps (see Fig. 1):

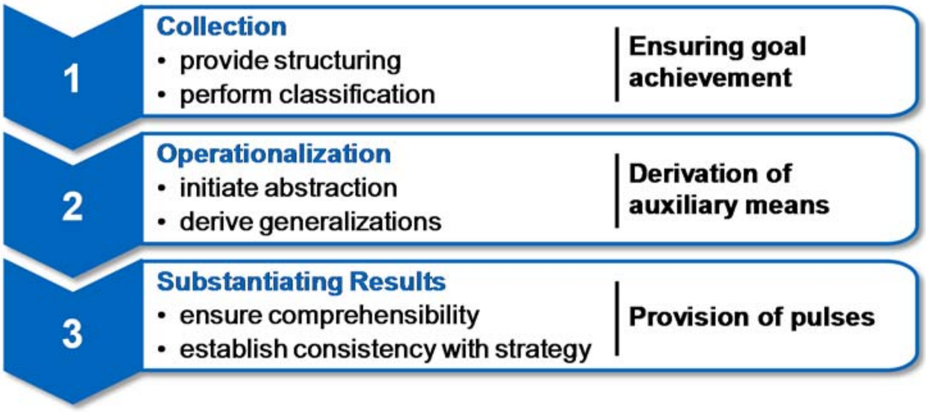


**Figure 1. Procedure to utilize outside-in innovation input for product development**

Step 1 comprises the *Collection* of outside-in innovation input, after setting a purpose and choosing an appropriate method according to the purpose was done. It comprises deriving criteria for structuring input, executing the method and classifying the input even during collection (discussed in detail in [Kain et al. 2011]). During input collection, this step makes it possible to ensure goal achievement, which means monitoring the application of the method. It results in structured input from a product development point of view and enables the product developer to gain an overview of the input collected.

Step 2 represents the *Operationalization* of the collected input. Based on the structured and classified input, it initiates abstractions and derives generalizations. Thereby it supports product development by derivation of auxiliary means, enabling the product developer to put input into practice.

Step 3, *Substantiating Results,* ensures the comprehensibility of the processed input and establishes its consistency with the company's strategy by analyzing the results in terms of other documents available within the company. Within this article, the authors discuss step 2, *Operationalization*, in detail.

### 3.2 Step 2: Operationalization

Content analysis drives step 2, *Operationalization*. Operationalization unlocks the participants' view that outside-in innovation activities focus to grasp. This view includes information about need and solution information, for instance, as well as experiences with product use and applications. Auxiliary means are created for operationalizing this external view during product development, such as checklists, external perception of the product, direct input on development methods and generalized statements.

**Input from step 1, *Collection***

In step 1, *Collection,* criteria from the company's perspective have been defined in order to cluster outside-in innovation input so that fulfilment of the previously defined objective (see system boundary of the process based approach) can be monitored. During method application, the participants build a structuring scheme from their perspective, which interlocks and expands the previously defined company's criteria (see for details [Kain et al. 2011]). It is not necessary to communicate the company's criteria explicitly to the participants. Thus the participants are able to structure their input without needing to be aware of (all) the criteria from the company's perspective.

The company benefits because goals and systems for evaluation are revealed from the participants' view. These need to overlap with the company's criteria in order to make the company's border more permeable for outside-in innovation input.

**Operationalization - Task Abstraction**

Abstraction focuses on identifying elements to reduce detailed information [Pahl et al. 2003]. Here abstraction processes the structuring scheme that has been generated, consisting of company and participant-specific criteria, and utilizes it as a key for the collected outside-in innovation input. Access to the data based on the company-specific criteria enables a company-driven evaluation of the data. Customer perceptions are revealed, enabling an evaluation of the participants' view (of the product) and providing methodological support for product development.

**Operationalization - Task Generalization**

Given the criteria from the company's perspective that must be defined based on the objectives of method application in step 1, *Collection,* additional criteria from the company's perspective will strengthen the meaningfulness and applicability of the collected outside-in innovation input (see Fig. 2). The motivation is to be able to refine the collected outside-in innovation input for a specific purpose once the collection phase is complete. This helps the collected input be utilized for different purposes and increases acceptance for utilizing the input within the company. Additional criteria from the company's perspective complement the first set of criteria and add extra structuring elements to the input in order to operationalize it for development. A mapping of these criteria allows the input to be generalized.

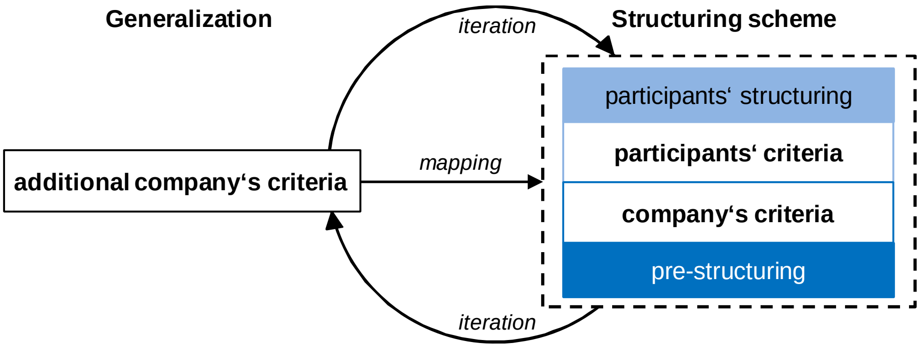


**Figure 2. Generalization by means of additional criteria**

## 4. Application

We conducted an empirical study applying the method Immersive Product Improvement (IPI) in order to evaluate the suggested process-related approach. The IPI method results in user feedback for existing products (see Background section). This article is based on the data already presented in [Kain et al. 2011] for proving step 1, *Collection,* of our suggested approach. Here we focus on the subsequent step 2, *Operationalization*. The following subsection briefly describes the data collection process and then presents the derivation of auxiliary means for operationalizing outside-in innovation input during product development.

### 4.1 Input data from step 1, *Collection*

In [Kain et al. 2011] we discussed structuring Outside-in Innovation input in such a way that both the participants and the company are able to access it from their viewpoint during the collection process. We also showed how to further classify the collected input, e.g. according to the level of concretization.

In this case, the physical product structure provided the structure for the company's outside-in innovation input. The photograph in the web tool applied to collect data was coded, which means that sections had been generated that referred to the product structure. When clicking on the photograph, participants unknowingly chose a section. Participants structured their comments by assigning them to objects and attributing them by categories. The participants were not aware of the product structure as an underlying pre-structuring criterion and thus were not meant to know all the details of the product structure or to name it properly. The participants submitted more than 50 comments.

### 4.2 Operationalization - Task Abstraction

This subsection presents the auxiliary means derived systematically in step 2, *Operationalization*. We applied the IPI method to an office telephone and derived auxiliary means from this specific Outside-in Innovation input.

#### *4.2.1 Checklist*

A checklist summarizes all of the categories that participants generated in order to structure their comments (see Table 1).

**Table 1. Categories generated by participants**

| Category | | | |
|---|---|---|---|
| Acoustics | Ergonomics | Mechanics | Stability |
| Amount | Function | Menu | Surface |
| Arrangement | Geometry | Operation | Wishes |
| Cleanability | Look | Programming | |
| Colour | Material | Size | |

#### *4.2.2 External product perception*

A list illustrates participants' perceptions of the product (see Table 2). The criterion *physical product structure* structures the table and shows the referring sections and objects generated by participants. The number of categories that further describe an object and the number of comments placed in a category referring to the object denote the amount of input provided per object.

**Table 2. External product perception**

| Physical product structure | Section | Objects | No. of categories | No. of comments |
|---|---|---|---|---|
| Housing | Housing_top | Display support | 1 | 1 |
| | | Housing | 1 | 1 |
| | | Handset storage | 1 | 3 |
| | | Logo | 1 | 1 |
| | Housing_base | Rubber | 1 | 1 |
| | | Integrated telephone support retainer | 1 | 2 |
| | | Cable support | 1 | 1 |
| | | Telephone cable | 1 | 1 |
| Cable | Cable | Interface cable – Handset | 2 | 2 |
| | | Helix cable | 3 | 4 |
| | | Plug | 1 | 1 |
| Handset | Handset | Handset | 5 | 8 |
| Keypad | Keypad | Key panel | 1 | 1 |
| Feature list | Feature list | Answering machine | 1 | 7 |
| Feature keys | Feature keys | Speed calling keys | 3 | 3 |
| Guidance keys | Guidance keys | Dialogue keys | 2 | 4 |
| Speaker | Speaker | Speaker | 1 | 2 |
| Display | Display | Screen | 4 | 11 |
| Keys for telephone settings | Keys for telephone settings | - | - | - |

#### *4.2.3 Direct input on development methods*

Analysis of the level of concretization for the collected input (see [Kain et al. 2011]) revealed several comments on the function level (see Table 3).

**Table 3. Direct input to development methods**

| Derived function | Character |
|---|---|
| **Provide integrated retainer to connect to a telephone support lever**<br>[Housing_base→ integrated telephone support retainer →Function] | Additional |
| **Provide means to end a call manually**<br>[Housing_top→Handset storage→ Function] | Additional |
| **Provide phone number after the call has been ended for some time**<br>[Display→ Screen →Function] | Additional |
| **Show options in additional display**<br>[Display → Screen → Function] | Additional |
| **Save last dialed number in last number redial**<br>[Display → Screen → Function] | Additional |
| **Illuminate display**<br>[Display → Screen → Function] | Additional |
| **Turn display support** [Housing_top→Display→ Mechanics] | Negated |

### 4.3 Operationalization - Generalization

Adding material as another company-specific criterion allows for generalizations about the collected input (see Table 4). In this case, refining the collected outside-in innovation allows the significance of the comments to be explained.

**Table 4. Generalization by adding material as additional criteria**

| Material | Physical product structure | Section | Object | Category | Comment |
|---|---|---|---|---|---|
| Material 1 | Housing | 1 Housing_top | Display support | Stability | 15.12.10, 18:41 the display support of my first phone was broken. Thus you couldn't turn it down anymore |
| Material 1 | Housing | 1 Housing_top | Housing | Surface | 07.12.10, 11:07 soils too quickly |
| Material 1 | Housing | 1 Housing_top | Logo | Look | 07.12.10, 16:58 the petrol colored logo does not conform to corporate identity anymore. Rookie mistake - please correct. |
| Material 1 | Handset | 4 Handset | Handset | Cleanability | 07.12.10, 12:10 A 0.5mm slit in the hand grip area of course quickly becomes soiled and unsightly. Either design the handset without a slit or with a wider slit that is easy to clean. |
| Material 1 | Handset | 4 Handset | Handset | Colour | 07.12.10, 12:11 it's ok. |

## 5. Discussion and interpretation

In this section we discuss the auxiliary means derived in the empirical study (in Sections 4.2 and 4.3) of the office phone. We analyze the suggested auxiliary means in regard to whether they could support utilization of the collected outside-in innovation input in product development.

### 5.1 Operationalization - Task Abstraction

In the following subsections we discuss the different means derived in the task *Abstraction* based on the collected data.

#### *5.1.1 Checklist*

The generated checklist (Table 1) contains categories that participants generated in order to structure their comments. 18 different categories were used to attribute the submitted comments. Except for the category of *wishes,* they relate to categories used in structuring a list of specifications during product development, e.g. Geometry or Material. The major difference from a list of specifications, however, is that there are no target values assigned to these categories. Thus this checklist lacks direct input from participants that may even be contradictory. It represents information that describes how participants attribute the product, without depicting solutions.

#### *5.1.2 External product perception*

The external product perception (Table 2) contains issues emphasized by the participants. Here a (1) large number of objects per element of the product structure primarily represents a need for discussion.

Within an object, a (2) large number of comments per object equals high emphasis. Additionally, the authors consider (3) long threads (large number of comments within a category) to express a high emphasis on specific categories of specific objects.
The physical product structure elements *housing* and *cable* include the most objects. Many issues were been pointed out here that could support redesigning the product, such as the mechanics of the *display support* on the *housing*.
But here again the pre-definition of the product structure highly influences the number of objects per element (see 1), which may be the case for *housing*. *Screen*, *handset*, and *answering machine* each produce a large number of comments per object (see 2). The length of threads (see 3) further indicates the attention of the participants, such as *feature list→answering machine→menu navigation*, *display→display→function*, *guidance keys→dialogue keys→arrangement*. This quantitative analysis of the collected data should not be misunderstood as identifying issues that must be solved in order to gain maximum satisfaction for the user in general. But it does point out issues that received many comments (e.g. *feature list→answering machine→menu navigation*) or issues that have been specified (e.g. *display→display→function*) or even further evolved during the process of commenting.
Table 2 in particular depicts how the participants perceive the product. For example, the participants discuss the answering machine and locate it in the section *feature list* of the product structure. It is quite obvious that the participants located the answering machine in this part of the telephone because the pushbuttons to operate it are placed there.
The responsible product managers at the telephone manufacturing company told us that from their point of view the answering machine is not a part of the telephone itself, because the functionality is provided by an external service provider on a special server. They could not understand why the participants of the study were not able to distinguish between the telephone itself and the additional answering machine. A fruitful discussion arose. The provided checklist communicates external product perceptions and thus enables the developer to rethink issues that are clouded by professional blinkers.
These considerations embody the external product perception and support development by alerting the developers and suggesting actions to take.

#### *5.1.3 Direct input on development methods*

The depicted functions (Table 3) provide direct input on product development. Analyzing the collected input with regard to the level of concretization reveals functions formulated by the participants. The first case depicted leads to functions that have not yet been considered for the product (*Illuminate display*); the second leads to functions that are integrated in the product but are not considered necessary from an external viewpoint (*Turn display support*). It is not easy to derive functions from the collected input, but various helpful tools are available, such as a model of product concretization. These functions directly contribute to methodologies in product development, such as functional modeling or Failure Mode and Effects Analysis (FMEA). Thus existing engineering documents may be reconsidered, supplemented or, in the case of negating a function, revised. Here the collected input directly applies to methodologies of product development.

### 5.2 Operationalization - Task Generalization

Additional company-specific criteria support generalization. The materials used in the various components of the telephone make up an additional criterion that expresses a company's view of the collected data. This is useful for refining the collected input so that it can be used, but additional criteria need to be connected to the existing criteria. Otherwise all of the collected input will need to be "coded" according to the new criteria, which opposes the suggested procedure of structuring the input during collection to reduce the effort required for utilization. Fig. 3 shows the mapping between the material and the product structure. Two types of materials are mainly used in realizing the physical appearance of the telephone. Each element of the product structure is made of a specific material. It is now possible to list all categories of objects that are assigned to specific elements of the product structure and are made of a specific material. Appropriate categories are selected in order to derive a useful statement for the criterion *material*. This makes it possible to correlate outside-in innovation input in a holistic sense.

Material 1 is meaningfully related to the categories *stability*, *surface*, *look*, *cleanability* and *color*. The categories *acoustics*, *arrangement*, *ergonomics*, *functions* do not fit properly. *Wishes* may fit, but is considered not to contribute directly, because participants were not directly prompted to comment on the criterion of material.
The comment provided in the category *look* is not related to the material of the housing, because it discusses the logo printed on the housing. But the comment provided on the handset, for instance, regarding the issue of *cleanability,* refers to the rapid soiling of the housing.
In particular, it is crucial to choose the appropriate set of categories (that have been established by the participants) for additional structuring characteristics (from a company's point of view).
Thus generalization is a means to widen the base of provided comments and thus to generalize the statements and suggest further actions.

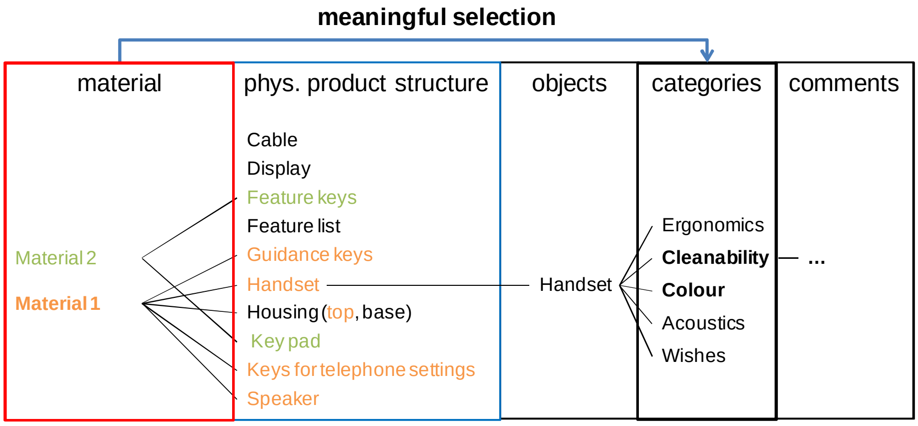


**Figure 3. Applying material as additional criteria**

### 5.3 Validation

As described in Section 1.2 we discussed our proceeding that was guided by our process-related approach and our results, which were the outside-in innovation input, its transformation into auxiliary means, and the applicability within product development together with 10 of the engineers of a major German company. They were in charge of developing the next generations of the office telephone that we analyzed. In addition to the successful validation of step 1 Collection of our approach that we reported in [Kain et al. 2011] we also discussed the validation of step 2 Operationalization.
The practitioners agreed that it was feasible to integrate the processed data into the development process efficiently. In particular, they were surprised about the users' product perception concerning the answering machine, as reported in Section 5.1.2. We had the impression that an hour of intense discussion the real value of the table 2 "external product perception" became clear, and all agreed on its usefulness.

## 6. Conclusion and future work

The authors presented a procedure to purposively utilize outside-in innovation input for product development, consisting of the steps (1) *Collection*, (2) *Operationalization* and (3) *Substantiating Results*. This article focuses on step 2 *Operationalization* and reports an empirical study in collaboration with industry to illustrate the suggested approach.
We showed the application of our approach with the example of the outside-in innovation method Immersive Product Improvement applied to an office telephone. Industry experts proved that the approach supports transforming outside-in innovation input collected by the chosen method into auxiliary means to utilize it in product development efficiently. Contrary to approaches from social sciences as reported in for instance in Section 1.1 data was not prepared according to a coding scheme, which eventually could be derived from the data itself or in beforehand. Contrary the data itself has been collected in a structured way according to company specific criteria, so that developers could make use of it for their specific tasks in product development. The participants of our study were able

to prepare the data themselves (see Section 4.1) and thus we reduced the risk of misinterpretation. The operationalization considers the structuring performed by the participants, triggers abstraction and generalization. Consolidating (even contradicting) statements and interpretation from a subjective point of view do not occur. Nevertheless developers can access particular statements if specific tasks during product development demand for it. Developers could then reflect specific statements and apply methods for rating and weighting they are used to for further evaluation. When developers understand these statements they are also able to further evolve and elaborate the idea behind.

This article contributes to research and industry an approach to utilize outside-in innovation input (inflows if knowledge) for product development. The process view of the approach narrows down the utilization of outside-in innovation input to particular distinguishable tasks and thus eases the comparison of outside-in innovation methods and supports their purposive application in industry.

The suggested procedure also supports utilizing input resulting from methods of outside-in innovation other than the method Immersive Product Improvement that we applied in this empirical study.

We will apply the approach to another method of outside-in innovation to illustrate its generic character. In particular, we will emphasize the differences in applying the approach by looking at various methods of outside-in innovation. Subsequently, we will further refine the approach.

We would also like to acknowledge the reviewers who provided very useful feedback which helped us to improve the quality of this paper.

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