26th CIRP Design Conference

Social media analysis of perceived product obsolescence

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Abstract

Customer satisfaction and customer loyalty are among the main goals for companies. In this context, the moment of and reason for obsolescence of a product is of particular importance for the customer satisfaction and repurchase decision. The reasons for obsolescence are manifold and usually unknown to the producing company. Besides product failures, a decrease in modern design, changing customer needs or new technologies available can cause obsolescence. This paper presents a study for investigating obsolescence from a customer perspective. To this end, social media reviews from Amazon have been extracted and analyzed in order to reveal the reasons of obsolescence with respect to product category.

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Peer-review under responsibility of the organizing committee of the 26th CIRP Design Conference

Keywords: obsolescence; customer satisfaction; social media

1. Introduction and Motivation

Numerous trends influence companies' product offers as well as customers' buying behavior. The rapid advancements in technology as well as the customer demands for the „latest" technology evoke shorter product use time. Furthermore, customers wish for highly individualized products and their buying decision is influenced by an increased ecological awareness. The latter induces companies to develop sustainably and aims at a thoughtful exploitation of resources.

From a company's perspective, multiple measures have been taken to intensify the customer focus. A trend towards a wider range of product varieties, or even customer-tailored products can be observed as well as shorter product life cycles. Services accompanying products serve to support the holistic solution of customer needs [1].

These measures aim at meeting the customer demands at most and increase customer satisfaction - not just at the moment of purchase, but throughout the whole time of use until the product becomes obsolete. For monitoring and assurance of customer satisfaction, its indicators as well as point in time of the survey need to be specified.

While specific definitions of customer satisfaction vary in literature, it can be stated that customer satisfaction is related to the experience a customer makes with a product or a service and the level to which it meets his expectations [2]. The conformation/dis-confirmation paradigm is the most-cited theory concerning the formation of satisfaction [3]. Indicators of customer satisfaction are the customer's recommendation or complaint behavior, the self-reported level of satisfaction (from tra-

ditional surveys) or - summed up in the term *customer loyalty* - the cross-buying or re-buying behavior [4] [5].

Customer satisfaction evolves through the whole utilization-phase; it is thus not sufficient to gather feedback only immediately after the purchase. Especially important for a highly satisfied customer over time is also the matter of obsolescence, i.e. the period in time towards the end of use phase. The reasons for obsolescence and its presumable effect on customer satisfaction or repurchase behavior have not yet been discussed broadly. Theories such as the „causal attribution" support the assumption that the reason for obsolescence, i.e. whether customers blame the producer for obsolescence, affects customer satisfaction. Thus, this subject will be outlined and analyzed henceforth. The paper is structured as follows: Firstly, the state of the art concerning product obsolescence will be illustrated in section 2, leading to the present research questions. In section 3, the current research methodology is outlined, followed by the results in section 4 and the discussion and outlook in section 5.

2. Product obsolescence

In the most common definition, obsolescence refers to the process of aging of a product [6]. An obsolete product is „out of use" or „out of date" [7], it is possibly sorted out and replaced. The subject of obsolescence has been focus of numerous research projects. On the one hand the theoretical construct of product obsolescence has been examined extensively - including a specification of the definition and the revelation of different reasons that lead to obsolescence [8] [9] [7]. On the other hand, the meaning of product obsolescence for companies or microeconomics has been discussed [10] [11] [12]. In this context, the so-called „planned obsolescence" has emerged. Planned obsolescence refers to the intentional diminution of products' life

span by the producer [13].
To understand the occurrence of obsolescence in the life span of a product, and especially the point in time when a product reaches the state of being obsolete, its definition will be specified.

2.1. Relative vs. absolute obsolescence

The state of obsolescence is referred to as „out of use" or „out of date". Since this definition provides a rather vague concept, researchers differentiate between the relative- and the absolute obsolescence [7]. Absolute obsolescence is viewed as the point in time, at which the product is technically worn out, whereas the relative obsolescence marks the point in time where the user sets the product out of order. Thus in general, relative obsolescence takes place before absolute obsolescence, see figure 1. That means that customers do not use a product until the technical end of the life span, as they perceive the product to be obsolete beforehand [7]. Given a certain product, of which have been sold many at time $t = t_{Purchase}$, figure 1 illustrates the distribution of physical product wear-outs - i.e. absolute obsolescence - and the „real" distribution of the discarding of products according to relative obsolescence. This leads to a timely gap of a product's technical life expectancy and the product's time of use $t_{Relative\ obsolescence} < t_{Absolute\ obsolescence}$. The diagrammed variance of the number of worn-out and number of discarded products is due to the statistical distribution of product failures and varying product obsolescence depending on individual perception respectively.
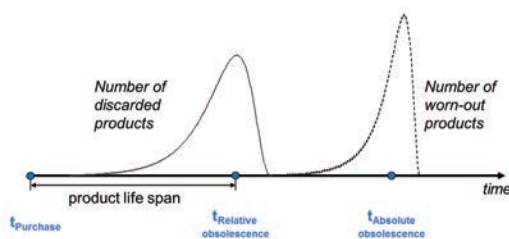

Figure 1. Relative Obsolescence

The occurrence of relative obsolescence implies that there are other reasons for customers to reject a product than mere technical failures. These will be presented henceforth.

2.2. Reasons for relative obsolescence

Several approaches concerning the reasons for relative obsolescence have been promoted in literature [14] [15] [16]. The model of Cooper, however, is the most accepted, taking into account the other researchers' preliminarily work. The author identifies 3 categories of relative obsolescence, namely *technological*, *psychological* and *economic obsolescence* [7]. According to Cooper, technological obsolescence occurs due to the fact that the functional quality of a product in use is of minor value compared to newer models appearing on the market. Psychological obsolescence arises when the product's attractiveness has decreased or the customer is no longer satisfied. Finally, the financial disadvantage of keeping an existing product instead of discarding it or replacing it by a different product is referred to as economic obsolescence.

The definition of psychological obsolescence leaves the largest room for interpretation. A loss of attractiveness or satisfaction is clearly subjective depending on the individual customer and can also owe to changing customer needs. Furthermore, it implies a comparison of the obsolete to the initial state of attractiveness or satisfaction, which would need to be known for an accurate assignment.

Experimental research has been carried out regarding specific questions related to obsolescence to underline the theoretical construct. In the work mentioned above, Cooper examined attitudes and customer behavior towards product life spans and the level of satisfaction with current life spans of different product categories [7]. Grewal focused on the timing of the repeat purchase and how it is affected by different dimensions of the customers' attitude [9]. A third example of research to date is Park's study who investigated the likelihood of a replacement of a still functioning product by a customer depending on the offering of a trade-in, the customer's usage goal (hedonic vs. utilitarian) and the willingness to pay.

Before leading over to the current study a brief overview of the meaning of obsolescence for companies is presented.

2.3. Implications of obsolescence for companies

The effects of obsolescence - and especially planned obsolescence - have been studied on a microeconomic level as with regard to companies [17] [18]. London first investigated planned obsolescence as a measure to overcome the Depression in 1932 [19]. A more recent project focused on the effect of variety of goods and product redesign - as an inducement of perceived obsolescence - on welfare: according the Blonigen et al, welfare can be increased by redesigning products [20]. In the same research project it was shown that the above mentioned influencing variables had likewise a positive effect on companies' profit. A similar result was yielded by Hua et al who found a positive correlation between the product change intensity (frequency of replacement products) and the companies' performance, measured in sales and market share [21]. Fishman goes even further by stating that planned obsolescence is a necessary condition for technological progress and innovation within a company [11]. He argues that innovators lack incentives to invent new technologies or products if the ones current on the market are too durable.

Besides these favorable effects, possible disadvantages or negative side-effects might be evoked by (planned) obsolescence. That is, the disapproval of customers can lead to a decrease in sales in the long run and even affect the company's brand image negatively. Cooper discovered that customers are dissatisfied if a product wears out too fast, as measured by a „reasonable" life span depending on the product category [7]. Additionally, Billen states that customers who are facing a repurchase, base their decision on the experience they have made with the product in use [22]. An undesirable experience could be caused by a rapidly worn-out product, but could be also arising from the reason of obsolescence, if it is viewed as unfavorable by the customer. It is important for the customer satisfaction whether the customer ascribes the reason of obsolescence to the company or to other influences, e.g. self-inflicted, reasonable life-span etc. In this context it is referred to as „causal attribution" [4]. The question if the failing of a product feature is

acceptable depends on the product category and the customers' preferences concerning relevant product features. Since the relevance of product features has been shown to be changing over time [23], the identification and strict conservation of attributes relevant to the (initial) purchase is not necessarily expedient. In other words, the reasons for obsolescence need to be examined at the point in time it occurs and cannot be extrapolated from information at the time of purchase or the time of use.

As mentioned in the introduction, fast obsolescence of products may furthermore have negative impacts on the producer in terms of brand image. On the one hand, an unacceptable decrease of functionality or a product failure can be associated with a lack of quality; on the other hand, the customers' favor for ecologically aware companies which develop sustainably will not be met. Besides the customers' attitude towards ecological factors, social or ethical aspects of planned obsolescence have often been discussed as well [1] [12].

Taking sections 2.2 and 2.3 into consideration, the current research question can be formulated as follows:

1. From a customer's perspective: which reason for obsolescence is predominant depending on the product category?
2. Does the reason of obsolescence influence the customers' satisfaction in terms of product rating and repurchase decision?

3. Current research methodology

To investigate the identified research questions, an analysis of customer reviews is conducted. Customer reviews as basis of information are advantageous in many respects. Customers share experiences with products over the whole time of use, including the moment of obsolescence. They give information voluntarily and unbiased, which makes the data particularly valuable.

The platform selected for this study is *Amazon.de*. AMAZON is one of the largest internet-based retailers for a great variety of products - and it has also become a popular platform for customers to rate products and share their experiences and opinions.

To account for possible product and brand specific effects, two different product categories - namely vacuum cleaners and mobile phones - as well as two different brands have been chosen for this study. For the sake of discretion, brands will simply be referred to as „Brand 1" and „Brand 2". In each brand and product category 250 customer reviews have been randomly extracted, resulting in a total number of 1000 reviews. See table 1 for the distribution of star ratings in each group.

Table 1. Number of product reviews extracted

product category	vacuum cleaner					mobile phone				
star-rating	1	2	3	4	5	1	2	3	4	5
Brand 1	9	9	8	28	196	41	13	15	29	152
Brand 2	24	23	27	47	129	32	15	20	53	130

The average customer ratings were noted as 4.6 (brand 1) and 4.2 (brand 2) for vacuum cleaners and 3.9 (brand 1 and 2) for mobile phones respectively. The analysis was conducted on a textual basis according to the scheme described in section 3.1.

3.1. Text analysis

In step 1, the reviews that contained information about the occurrence and reason for obsolescence were selected. The mention could either relate to the currently bought product or to its preceding one, i.e. the one that was found to be obsolete beforehand and led to the current purchase. The occurrence and reason for obsolescence had to be mentioned distinctly in the text. Since the word „obsolescence" is however not common in the vocabulary rut of most people, selection rules had been defined for an objective judgment.

Selection rules for the identification of obsolescence:

– Mention that a product had been taken out of order by the user/thrown away
– Mention of the definitive intention that it will not be used anymore/will be replaced by a different product.

Besides, only those reviews have been selected for further research, where a distinct reason as to *why* the product has become obsolete was mentioned.

In a second step, the mentions of obsolescence have been categorized according to type of obsolescence and reason given by the writer. Thus, it was recorded if the product had been indicated as absolutely or relatively obsolete by the customer or, if the process of obsolescence had been portrayed. For the categorization of reason, a pre-study was conducted examining reviews of similar products. The following categories, which covered the possible reasoning scope for obsolescence could be identified: 1. decrease in ergonomics, 2. decreasing in sensory quality 3. changing customer needs 4. decrease in functions 5. high working costs, 6. wear-out. The identified categories are similar to the ones introduced by COOPER [7], although psychological obsolescence has been subdivided into more detailed categories, see figure 2. As stated in section 2.2, psychological obsolescence arises from a decrease in either attractiveness or satisfaction. Concerning the chosen products, attractiveness and satisfaction are hence measured in three dimensions, namely the physical appearance of the product (sensory quality), ergonomics when handling the product in use (ergonomics) and the customer's usage goal (changing customer needs) which is highly relevant for the overall satisfaction. Although it was found in the pre-study that working costs play a minor role, this reason has been kept for the main study for the sake of completeness.
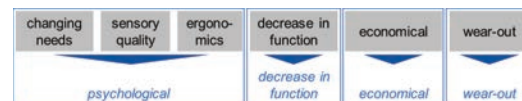

Figure 2. Mapping of identified categories to COOPER's theory

Examples for each reason for obsolescence is given with regard to product category in figure 3, for mobile phones and va-

cuum cleaners respectively. If multiple reasons were given by the writer leading to obsolescence, each reason is recorded.

Reason for obsolescence	vacuum cleaner	mobile phone
ergonomics	hindered dragging	unergonomic size of phone
sensory quality	increase in loudness	scratches on display
changing needs	wish for easy cleaning	wish for water-prove phone
functional	decrease in suction power	decrease in battery run-time
working costs	vacuum cleaner bags	-
wear-out	motor stops working	phone terminally not responding

Figure 3. Examples for reasons for obsolescence

For subsequent analysis, it has been further noted if the occurrence of obsolescence was related to the current or preceding product. If it was related to the current product it has been noted if the writer distinctly indicated that he had no intention of buying this brand again in the future. In the latter case it has been evaluated whether the same or a different product/brand was chosen in the current purchase. Lastly, the time of use until obsolescence has been - if explicitly stated by the customer - noted.
Results of the text analysis are presented in the subsequent section 4.

4. Results

The number of reviews containing information about the occurrence of obsolescence per product category as defined in section 3.1 are given in table 2.

Table 2. Number of reviews containing mention of obsolescence

Product category	vacuum cleaner	mobile phone
Brand 1	62	52
Brand 2	60	68

Approximately 24.8% (brand 1) and 24% (brand 2) of reviews concerning vacuum cleaners inclose information about occurrence and reason of obsolescence, in comparison to approximately 20.8% (brand 1) and 27.2% (brand 2) of reviews concerning mobile phones. That is, approximately every fourth customer provides information in the review about why something has become obsolete.
The in-depth analysis and categorization disclosed the distribution of reasons for obsolescence. The results are illustrated in figure 4 per product category, answering research question one.
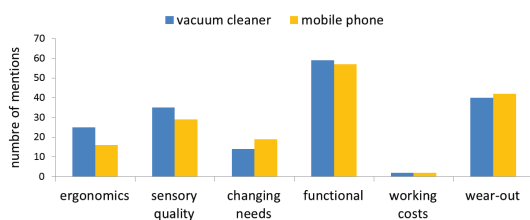

Figure 4. Distribution of reasons of obsolescence by product category

The distributions appear similar between the two product categories. Decreasing or insufficient functions are mentioned

most frequently, followed by physical wear-out and a decrease in sensory quality. When accumulating the reasons according to COOPER (see figure 2), perceived obsolescence is mostly due to psychological factors, i.e. a decrease in attractiveness or satisfaction. As anticipated and stated above, the matter of working costs is of low relevance. However, working costs for the user of vacuum cleaners arise in form of cleaner bags; working costs for mobile phones are mostly connected to the contract and not the product itself. Therefore, this factor might play a minor role simply owing to the choice of product.

Approaching research question two, it has been analyzed whether the reasons for obsolescence correlate with the indicators of customer satisfaction and loyalty. To this end, three specific relations have been examined, which will be outlined below:

1. reason for obsolescence of preceding product/ repurchase of the same brand or other brand
2. reason for obsolescence of current product/ no repurchase of the same brand intended
3. reason for obsolescence of current product/ star-rating of current product

To examine relation 1, i.e the relation between the preceding product and repurchase decision (same brand/other brand), only those reviews, which held information about the brand of the previous product, were considered. This is due to the fact that customers name the reason for obsolescence but not necessarily the brand of the preceding product.
In total, 122 customers specified the brand of the preceding product; in 89 cases the customer chose a different brand and in 33 cases he remained loyal. See below for the results in table 3.

Table 3. Reason for obsolescence and repurchase decision

Product category	vacuum cleaner		mobile phone	
	same brand	other brand	same brand	other brand
ergonomics	0	8	1	1
sensory quality	0	6	1	1
changing needs	0	13	7	10
functional	2	18	4	9
working costs	0	2	0	0
wear-out	11	14	7	7
sum	13	61	20	28

A 2-sample proportion test regarding the sum in each product category yielded a significant difference ($z = -5.00, p = 0.000$) at a level of significance of $\alpha = 5\%$. Clearly, the customers of vacuum cleaners tend to change the brand when their preceding product has become obsolete. This does not apply, however, when the reason for obsolescence was a physical wear-out.
Taking a closer look at this data revealed a possible dependency of the brand choice on the time of use until obsolescence, see figure 5. This suggests that if the durability of a vacuum cleaner exceeds a certain age, customers value the long-lasting product rather than that they disapprove the occurred obsolescence. The data supports COOPER's survey: in average, the „reasonable" durability of vacuum cleaners

was numbered as 9 years by interviewed householders [7]. A close-up look at the reviews from mobile phones show similar tendencies, however customers rarely mentioned the time until wear-out.
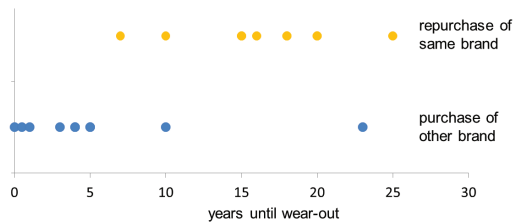

Figure 5. Wear-out time of vacuum cleaners and brand loyalty

Comparing the data concerning vacuum cleaners and mobiles phones it also becomes apparent that customers of mobile phones do not change brands as often, when a change in needs has made the preceding product obsolete. This might be due to little technological difference between mobile phones on the market. That is, the wish for a bigger screen or water-prove case can be satisfied by the same producer, whereas a change in need regarding vacuum cleaners (easy cleaning/quiet in use) might be attributed to a specific brand.

The second relation to be examined focuses on the reason for obsolescence of the current product and intention of the customer not to buy the same brand again. For the sake of objectivity, the latter attribute has only been assigned to the review if the customer mentions explicitly that he is not going to repurchase this brand. Table 4 illustrates the results by product category. The number in brackets indicates the total number of occurrences in obsolescence of the current product. In order to discover if one reason for obsolescence prevents significantly more or less customer from repurchasing the same brand again, a 2-sample proportion test was conducted (level of significance $\alpha = 5\%$).

Table 4. Repurchase of current brand not intended by reason for obsolescence

Product category	vacuum cleaner		mobile phone	
ergonomics	4	(16)	3	(14)
sensory quality	6	(25)	9	(26)
changing needs	0	(0)	1	(1)
functional	6	(34)	14	(43)
working costs	0	(0)	1	(2)
wear-out	0	(10)	3	(28)

Comparing each reason's proportion to the rest of the data as a reference showed that for vacuum cleaners, only the proportion of wear-out is significantly lower. Pairwise comparison of reason's proportions yielded also significant differences between ergonomics and wear-out ($z = 2.31, p = 0.021$), sensory quality and wear-out ($z = 2.8, p = 0.005$) as well as functional and wear-out ($z = 2.7, = 0.007$).
The proportion of one reason was also tested against the remaining reasons combined. In the case of mobile phones, a significant deviation could only be found for the wear-out ($z = -0.28, p = 0.005$). That is, a wear-out induces customers

under-proportionally to change the brand. Pairwise comparisons further indicated that a decrease in sensory quality leads significantly more often to a change in brand than wear-out ($z = 2.17, p = 0.03$) as well as functional obsolescence compared to wear-out ($z = 2.37, p = 0.018$).

Thus, similar to the results to relation 1, customers react significantly rarely with a change of brand if wear-out is the reason for obsolescence. Yet, especially occurrences of obsolescence owing to a decrease in sensory quality or function prevent customers from buying the same brand again. Overall, it is remarkable that 27.2% of mobile phone customers and 18.8% of vacuum cleaner customers whose product became obsolete refuse to buy the same brand again. The necessity for products that satisfy customers throughout the whole time of use cannot be dismissed.

The third relation addresses the reason for obsolescence of the current product and its star rating. The star rating serves here as a general indicator of satisfaction and numerical judgment of the product by the customer. Obviously the rating of products which have become obsolete is lower than the overall rating, compare table 1.
Of interest is though whether the ratings are influenced by the reason for obsolescence. To this end, a Mann-Whitney U test was conducted comparing each the rating of a reason of obsolescence to the accumulated rest. The medians of the distribution are examined regarding significant differences. However, no significant difference could be found allowing a level of significance of $\alpha = 5\%$. Hence, no reason of obsolescence has a stronger impact on the (low) rating than the others.

5. Summary and outlook

This paper addresses the matter of product obsolescence and its relevance for customer satisfaction and customer loyalty. The distribution of reasons for obsolescence were examined through an in-depth analysis of customer reviews from AMAZON. It was found that obsolescence is often perceived by a decrease in function or sensory quality, a physical wear-out of the product or is due to changing customer needs. It was further discovered that customer loyalty - in terms of repurchase of the same brand - is dependent on the specific reason of obsolescence as well as on the time span the customer used the product until obsolescence. Thus, the durability of relevant product features is an indispensable factor for customer satisfaction and retention. Further research will need to study the possibility of maintenance and repair and its effect on the perception of obsolescence. Additionally, the affect of product obsolescence for the judgment of a new product in the repurchase decision is of interest.

Empirical observation within this study suggest that the occurrence of obsolescence induces customers to rate the new, substituting product higher. The arithmetic means of the ratings of products whose preceding product has become obsolete and the remaining ratings are shown in table 5.

To search for significant differences, a Chi-Square test was conducted for the data pair of vacuum cleaners and mobile phones respectively. Customers rated vacuum cleaners significantly

higher when the preceding one was mentioned to have become obsolete ($\chi^2 = 12.5862$, $p = 0.013$). This customer behavior was likewise observed for mobile phones ($\chi^2 = 9.7498$, $p = 0.045$).

Table 5. Arithmetic mean of ratings

Product category	vacuum cleaner	mobile phone	all products
Mean rating of products whose preceding product has become obsolete	4.626	4.490	4.577
Mean rating of all others	4.173	3.879	4.023

The results suggest that when a customer is conscious about the reason for obsolescence of the preceding product he perceives the new product over-proportionally good. Yet, further research needs to be conducted to thoroughly investigate this topic.

References

[1] Guiltinan J. Creative Destruction and Destructive Creations: Environmental Ethics and Planned Obsolescence. Journal of Business Ethics; 89; 2009; p. 1928.

[2] Sanchez-Fernandez R. Consumer Perception of Value: Literature Review and a new conceptual framework. Journal of Consumer Satisfaction, Dissatisfaction and Complaining Behavior; Volume 19; 2006; p. 40-58.

[3] Homburg C, Giering A, Hentschel F. Der Zusammenhang zwischen Kundenzufriedenheit und Kundenbindung. Die Betriebswirtschaft; 59; 1999; p. 174-195.

[4] Matzler K. Kundenzufriedenheit und Involvement. Wiesbaden: Gabler, Deutscher Universitätsverlag; 1997.

[5] Nufer G, Prell K. Operationalisierung und Messung von Kundenzufriedenheit. Reutlinger Diskussionbeiträge zu Marketing & Management; Nr. 4; 2011.

[6] Stevenson A. Oxford Dictionary of English; 2010.

[7] Cooper T. Inadequate Life? Evidence of Consumer Attitudes to Product Obsolescence. Journal of Consumer Policy; 27; 2004 p. 421-449.

[8] Guiltinan J. Consumer durables replacement decision-making: An overview and research agenda. Market Lett; 21; 2010; p. 163-174.

[9] Grewal R, Mehta R, Kardes FR. The Timing of Repeat Purchases of Consumer Durable Goods: The Role of Functional Bases of Consumer Attitudes. Journal of Marketing Research; Vol XLI; 2004; p. 101-115.

[10] Waldman M. Planned Obsolescence and the R&D Decision. The RAND Journal of Economics; Vol. 27, No. 3; 1996; p. 583-595.

[11] Fishman A, Gandal N, Shy O. Planned Obsolescence as an Engine of Technological Progress. Journal of Industrial Economics; Vol. 41; No. 4; 1993; p. 361-370.

[12] Hübner R. Geplante Obsoleszenz - zwischen Wunsch und Ärgernis. Soziale Technik; 2; 2014

[13] Packard V. The waste makers. Harmondsworth: Pelican; 1960.

[14] Heiskanen E. Conditions for product life extension. Helsinki: National Consumer Research CentreM; Working Paper 23; 1996

[15] Granberg B. The quality re-evaluation process: Product obsolescence in a consumer- producer interaction framework. Stockholm: University of Stockholm, Department of Economic History; 1997.

[16] Kostecki M (Ed.). The durable use of consumer products. Dordrecht: Kluwer; 1998.

[17] Bayus BL. Accelerating the Durable Replacement Cycle with Marketing Mix Variables. Journal of Product Innovation Management; 1988; p. 216-226.

[18] Utaka A. Planned obsolescence and Social Welfare. Journal of Business; Vol. 79; 2006; p. 137-148.

[19] London B. Ending the Depression Through Planned Obsolescence; 1932.

[20] Blonigen BA, Knittel CR, Soderbery A. Keeping it Fresh: Strategic Product Redesigns and Welfare. NBER Working Paper Series; 2013.

[21] Hua SY, Wemmerlöv U. Product Change Intensity, Product Advantage, and Market Performance: An Empirical Investigation of the PC Industry. Journal of Product Innovation Management; 23; 2006; p. 316329.

[22] Billen P. Unsicherheit des Nachfragers bei Wiederholungskufen. Gabler, Deutscher Universittsverlag; 2002.

[23] Amini P, Falk B, Schmitt R. Quantitative Analysis of the Consumer Perceived Value Deviation. 24th CIRP Design Conference; 2014.