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Abstract: The purpose of this paper is to clarify the definition and several types of obsolescence and to introduce a decision tool in order to choose the appropriate type of obsolescence according to customer expectations. Our research is based on a literature review giving insight into existing definitions and types of obsolescence. Examples complete the research and show the practical application of obsolescence. The main findings are that although obsolescence is a widely-known concept comprising several definitions and types a decision tool for the selection of the appropriate type of obsolescence is missing. The paper offers an overview of existing definitions, types and examples for obsolescence. Moreover the paper offers an obsolescence matrix with two dimensions that can be applied as a decision tool.

Keywords: Obsolescence, Decision Tool, Product Life Cycle.

1 Introduction

Global markets face a dynamic change mainly reflected by saturation, higher transparency, higher competition and lower margins for products and services. The concept of obsolescence helps companies to differentiate from competition and to sell more products and services due to shorter life cycles. Obsolescence is described in several ways and considers mostly the disuse of a product or service (Cooper, 2010). Obsolescence has been discussed since the end of the 19th century but a clear definition (1), an overview of existing types of obsolescence (2) and the application of obsolescence according to customer expectations (3) are missing. Our contribution is important in order to clarify obsolescence within academia and to sketch how obsolescence can be applied within practice. Our paper is organized as follows. First the theoretical background with definitions and several types of obsolescence is given. Then the paper defines research questions and our research approach. Next, we develop structure several types of obsolescence and describe examples from practice. Then we develop the obsolescence matrix with two dimensions. In the contribution we describe our main findings and advantageous practical implications for companies. Finally, the description of limitations of our research defines options for further research.

2 Theoretical Background

Defining obsolescence

The term obsolescence is derived from Latin and means to wear out (1), to antique (2), to lose value (3) and lose prestige (4) (Pons, 2012). Within the literature we find several definitions for obsolescence which are listed in table 1; important passages are marked in italics.

Table 1 Obsolescence definitions

<i>Author</i>	<i>Definition</i>
Gregory, 1947	„Purposeful obsolescence exists (a) whenever manufacturers produce <i>goods</i> with a <i>shorted physical life</i> than the industry is capable of producing under existing technological and cost conditions; or (b) whenever manufacturers or sellers induce the public to <i>replace goods</i> which still retain substantial physical usefulness“
Hillman, 1977	Within obsolescence it is tried to <i>accelerate the replacement and renewal need</i> of consumers by a <i>planned reduction of the operating life</i> of consumer goods in order to support growth opportunities of a business.
Schmidt, 1971	The objective of planned obsolescence as a product strategy is to <i>reduce the time or number of applications</i> of a product in order to induce replacement purchases.
Tallman, 1963	“Planned obsolescence is a purposeful program of vendors to <i>shorten the time span</i> or number of performance over which a product (or service or even a way of life) continues to satisfy customers – thus presumably encouraging an early <i>purchase for replacement</i> .”
Zinn, 1972	Under obsolescence we understand the objective to <i>reduce the life cycle of long-term consumer goods</i> by <i>technical degradation</i> and/or a frequent model change combined with a conspicuous consumption based promotion.

Within the literature mentioned above we find similar aspects that describe obsolescence. Obsolescence is understood as a product strategy or a program (Schmidt, 1971; Tallman, 1963) of companies in order to utilize growth opportunities (Hillman, 1977). The fact that obsolescence is regarded as a product strategy illustrates the strong link of obsolescence to innovation management. Some companies apply obsolescence as a business model in order to obtain a recurring turnover.

The growth opportunities are carried out by the shortening of the life cycle, the operating life or the physical life of products (Gregory, 1947; Hillman, 1977; Zinn, 1972) and the resulting replacement purchases (Schmidt, 1971; Tallman, 1963). Hillman (1977) and Zinn (1972) specify products as long-term consumer goods and Tallman (1963) also includes services. Since obsolescence is also applied for industrial goods (e.g. expendable materials for manufacturing lines) we suggest not specifying a product type within the definition of obsolescence. The inclusion of services seems to be useful since the shortening of the life cycle of a service can influence the claiming of new services (e.g. market information).

The shortening of the life cycle is carried out by the reduction of the time or number of applications (Schmidt, 1971; Tallman, 1963), by the technical degradation or by the frequent model change (Zinn, 1972). We see that the shortening of the life cycle can be realized in several ways which will be discussed further on the several types of obsolescence.

Based on the literature we propose the following definition of obsolescence for our research:

Obsolescence is a product, service or business strategy with the objective to utilize growth opportunities for companies by inducing replacement or renewal purchases. The method applied is to shorten the life cycle of products and/or services by reducing their number and/or time span of possible usages. Obsolescence is either influenced by the provider (product features e.g. technical changes, abrasion, new models) or by the customer (e.g. lower prestige).

We illustrate the proposed definition in figure 1.

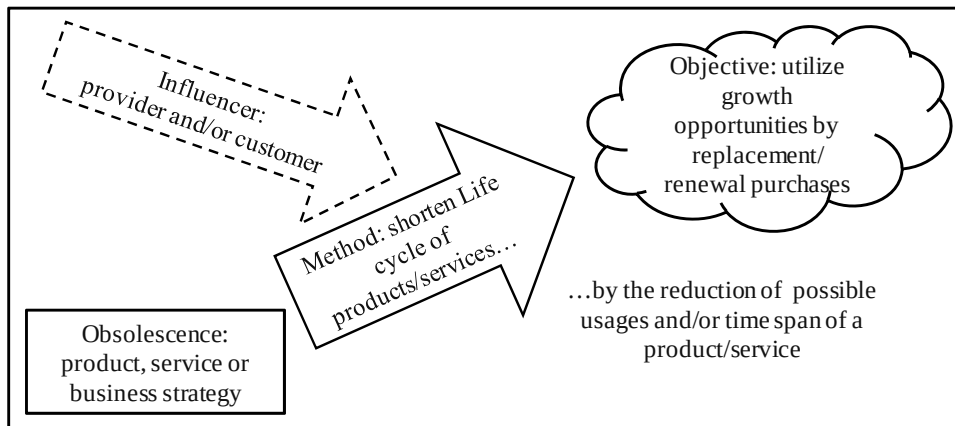


Figure 1 Definition of obsolescence

Types of obsolescence

Obsolescence can be regarded from two points of view. On the one hand obsolescence considers the use or life cycle of one specific product (absolute obsolescence) and, on the other hand, obsolescence considers the life cycle of a product category (relative obsolescence) (Cooper, 2010). In the following section we will define absolute and relative obsolescence with the corresponding subtypes.

Absolute obsolescence

Absolute obsolescence covers the product or service at the end of the erosion that can be natural or planned (Packard, 1964; Bodenstein et al., 1981). Natural erosion is caused by usage, neglected maintenance and downtime (Röper, 1976; Schmidt, 1971; Zalles-Reiber, 1996). Planned erosion (also: qualitative or planned obsolescence) is initiated by the producer and the life cycle of a product is held lower than technically possible (Packard, 1964; Bodenstein et al., 1981).

Relative obsolescence

Relative obsolescence occurs when products or services are usable but replaced by newer and/or fancier products and services. Relative obsolescence separates into the functional (Packard, 1964; Bodenstein et al., 1981) and the psychological obsolescence (Röper, 1976). The functional obsolescence is caused by the introduction of a new product that fulfils the function better than the existing product. So a product that functions is replaced by a product that is technically superior (Packard, 1964; Bodenstein et al., 1981). The following subtypes of the functional obsolescence exist:

- *Technical obsolescence*: products become technical obsolete from the engineering point of view (the product is not state-of-the-art anymore) and from the usability point of view (the product is not comfortable to use) (Zalles-Reiber, 1996).
- *Ecological obsolescence*: products become ecological obsolete when they pollute the environment according to the technical possibilities (Zalles-Reiber, 1996).

- *Economical obsolescence*: products become economical obsolete when their value for money is lower as compared to a new product (e.g. total cost of ownership including purchase, installation, operational, maintenance and disposal cost) (Burns, 2010; Zalles-Reiber, 1996).
- *Compatibility caused obsolescence*: products that are compatible to a basis product become obsolete when the basis product has been technically developed (Packard, 1964; Zalles-Reiber, 1996). Products also become obsolete when spare parts are no longer available (Brunn, 2012; COG, 2012).

Regarding obsolescence we have to consider environmental aspects. On the one hand obsolescence can support saving energy/water consumption (see ecological obsolescence) and on the other hand obsolescence leads to a higher use of resources and more waste by shortening the life cycle of products.

The psychological (also: social) obsolescence is caused by the introduction of a new product that is more modern (Bodenstein, 1981; Burns, 2010; Packard, 1964; Schmidt, 1971). The following subtypes of the psychological obsolescence exist:

- *Aesthetic obsolescence*: products become aesthetic obsolete when their appearance is not acceptable anymore (Park, 2010; Zalles-Reiber, 1996).
- *Stylistic obsolescence*: products become stylistic obsolete when new styles appear and the consumer has the wish or is forced to be trendy (Heine, 1968).
- *Social obsolescence*: products become social obsolete when there is change of the social perception (Burns, 2010; Zalles-Reiber, 1996).
- *Legal obsolescence*: products become legal obsolete when legal requirements do not allow applying the product (Röper, 1976).

The authors and introduced types of obsolescence are summarized in table 2.

Table 2 Authors and types of obsolescence

<i>Author</i>	Absolute Obsolescence	Natural Obsolescence	Planned Obsolescence	Relative Obsolescence	Functional Obsolescence	Technical Obsolescence	Ecological Obsolescence	Economical Obsolescence	Compatibility caused Obsolescence	Psychological Obsolescence	Aesthetic Obsolescence	Stylistic Obsolescence	Social Obsolescence	Legal Obsolescence
Bodenstein et. al., 1977		x	x		x	x			x	x		x		
Burns, 2010						x	x				x	x	x	
COG, 2012									x					
Cooper, 2010	x			x										
Gregory, 1947			x							x				
Heine, 1968		x	x							x	x	x	x	
Packard, 1960			x		x					x				
Park, 2010											x			
Röper, 1976			x		x					x		x		x
Schmidt, 1971			x		x				x					
Zalles-Reiber, 1996		x	x		x	x	x	x	x		x	x	x	

The existing approaches illustrate the variety that exists within obsolescence. The existing approaches do not cover obsolescence completely; they also do not show the application of obsolescence according to customer expectations.

3 Research Questions and Design

Research Questions

The literature mentioned above reports definitions and types of obsolescence. The existing approaches to obsolescence do not cover the term obsolescence completely. A decision tool for the application of obsolescence according to internal and external circumstances is missing. Within our contribution we clarify the several types of obsolescence and develop an obsolescence matrix that enables companies to choose the appropriate type of obsolescence. Based on the problem described and current understanding we answer the following main research questions:

- How can the several types of obsolescence be structured and which examples exist for each type?
- What are the customer's expectations and how do these influence the type of obsolescence?
- How can these expectations be integrated into a decision tool in order to choose the appropriate type of obsolescence?

Research Design

In our research we applied literature review combined with case study research. Case study research (Benbasat et al., 1987; Eisenhardt, 1989; Yin, 1994; Stake, 1995) analyses interesting cases, describes them and develops empirically founded concepts (Kromrey, 2007). We analysed several examples of obsolescence and assigned them to the several types of obsolescence. We applied literature review in order to gain insight into the state of the art of obsolescence and developed an obsolescence matrix in order to classify the several types of obsolescence.

4 Structure and examples of the several types of obsolescence

In figure 2 we structure the existing types of obsolescence based on the literature mentioned above.

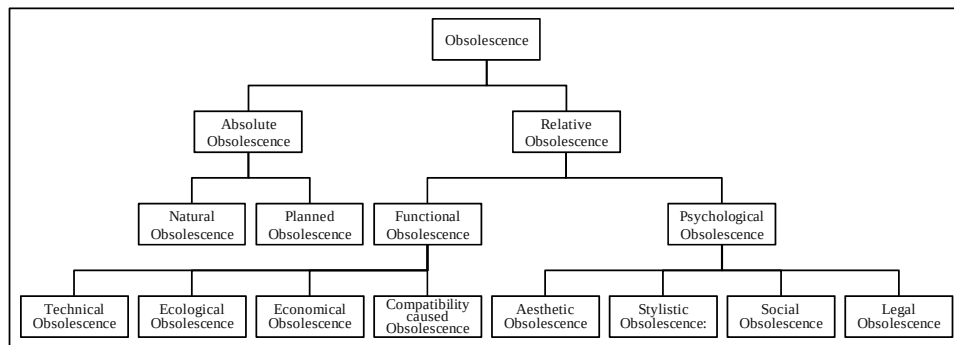


Figure 2 Overview over types of obsolescence

Figure 2 shows ten subtypes of obsolescence. In table 3 we included examples for the ten subtypes.

Table 3 Examples for obsolescence

Type of obsolescence	Example
1. Natural	Oxidation of a product via environmental influence (e.g. a ski edge).
2. Planned	Shorter life cycle of a notebook battery (12 months) instead of other components (24 months) (Asus, 2009); shorter life cycle of an electric bulb (1.000 hours) instead of possible 2.500 hours (Röper, 1976; Wortmann, 1983); printers and printer cartridges (Heise, 2010).
3. Technical	New computer processor with technical adaptations; iPhone 5 with additional technical features (Apple, 2012).
4. Ecological	Electronic devices such as washing machines, dishwashers, refrigerators with lower water/energy consumption (Zalles-Reiber, 1996).
5. Economical	Passenger cars with a lower fuel consumption which leads to lower fuel costs (ADAC, 2012).
6. Compatibility caused	VHS player and VHS cassette (Packard, 1964); floppy disc that is not compatible to new pc models.

- | | |
|--------------|---|
| 7. Aesthetic | Scratches on mobile phone covers (Park, 2010) |
| 8. Stylistic | Collections of fashion chains like Zara or H&M (Brickau et al., 2011); new models of passenger cars. |
| 9. Social | Shift of social value: today corsets are not worn anymore (Burns, 2010); switch of the social position: from student to employee. |
| 10. Legal | New legal requirements regarding max. emissions of passenger cars (TÜV Süd, 2008) |

Besides these types of obsolescence there exist mixed forms that lead to an initial purchase (van Nes, 2010). An ecological obsolescence that supports consumers to protect the environment by less water/energy consumption also affects the economical obsolescence. In this paper, however, we do not consider these mixed forms of obsolescence; we rather focus on the pure types of obsolescence.

5 Development of the Obsolescence Matrix

Regarding the two main types of obsolescence (absolute and relative) the value to the customer is important in order to initiate replacement or renewal purchases. The value to the customer has been discussed in several scientific publications (Zeithaml, 1988; Monroe, 1990; Anderson et al., 1993; Gale, 1994; Butz and Goodstein, 1996; Woodruff, 1997; Kotler et al. 2009; Schallmo and Salarvand, 2011). Based on Schallmo and Salarvand (2011) we define the value to the customer as follows:

Value to the customer is the difference between what customers receive (=benefit) and the price they pay. This difference is the perceived value for the customer while using a product or service; it represents the sum of economic, time, quality and image benefits. Since customer preferences differ, the perceived value also differs; that implies that the value for each customer may vary individually. A company creates and provides value for its customers.

In order to operationalise the value to the customer it is possible to apply two extremes: functional (e.g. quality) and aesthetic/social (e.g. image) value to the customer.

Apart from the value to customers, we also consider the importance of actuality of the product/service for the customer. The importance of actuality expresses the reactions of customers to external changes (e.g. new product generations). The following four motives influence the importance of actuality to customers (van Nes, 2010):

- *Abrasion*: this motive is caused by the partial/complete defect of a product which has to be substituted.
- *Higher efficiency*: this motive combines “abrasion” with the need for higher performance (e.g. savings, safety, quality, usability).
- *Nice appearance*: this motive combines abrasion with the need for an improved aesthetic appearance (e.g. design, quality, and image).
- *New requirements*: this motive is caused by one or more new product features (social value, scalability).

In accordance to the valuation of these motives it is possible to define the two extremes: high and low importance of actuality of the product/service.

Based on the two dimensions value to customers and importance of actuality to customers we develop the obsolescence matrix which is illustrated in figure 3.

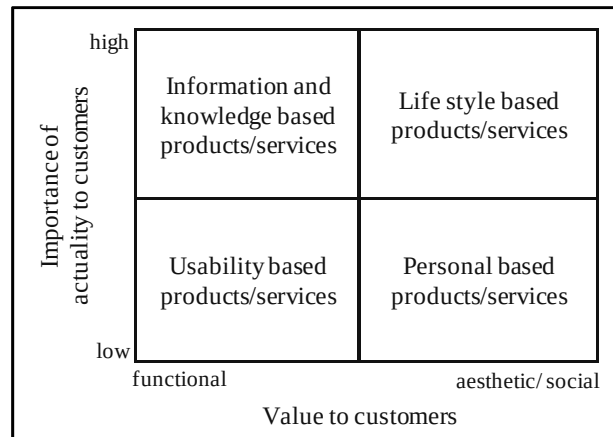


Figure 3 The obsolescence matrix

Depending on the classification of the two dimensions the obsolescence matrix provides a set of four different product and service types:

- Usability based products and services
- Personal based products and services
- Information and knowledge based products and services
- Life style based products and services.

These products and services can be sold either in Business-to-Consumer or in Business-to-Business-Markets. In the following section we will explain these four product and service types.

Usability based products and services

Usability based products and services provide a functional value to customers and have a low importance of actuality to customers. These products/services are simple and problem oriented (e.g. printer cartridges, razor blades, light bulbs). We recommend applying the natural and planned obsolescence.

Personal based products and services

Personal based products and services have an aesthetic/social value and a low importance of actuality to customers. These products/services are replaced due to aesthetic abrasion (e.g. furniture). We recommend applying the aesthetic and social obsolescence.

Information and knowledge based products and services

Information and knowledge based products and services have a functional value and a high importance of actuality to customers. These products/services are developed technically and rapidly (e.g. digital cameras, mobile phones). We recommend applying the technical, ecological, economical, compatibility caused and legal obsolescence.

Life style based products and services.

Life style based products and services have an aesthetic/social value and a high importance of actuality to customers. These products and services are replaced caused by new designs (e.g. cars, fashion). We recommend applying the aesthetic, stylistic and social obsolescence.

Due to their characteristics some types of obsolescence are recommended twice. Also the previous mentioned combination of several types of obsolescence is possible.

6 Contributions

The contribution of our research is a clarification of the term obsolescence including an overview of existing definitions, types and examples. Based on this we develop an obsolescence matrix that is applied as a decision tool in order to select the appropriate type of obsolescence in accordance to customer expectations. This closes an existing gap of the current research regarding obsolescence and its application.

7 Practical Implications

Managers and business developers will gain insights from the findings by having an overview on different types of obsolescence with examples. These types of obsolescence are included into an obsolescence matrix with the two dimensions: value to customers and importance of actuality to customers. The overview of the different types of obsolescence and the obsolescence matrix will enable companies to adjust their product, service or business strategy regarding obsolescence of products and services according to internal and external drivers. By applying obsolescence in a proper way companies are enabled to optimize their current and future revenues.

8 Limitations

This paper reports the results of our research regarding obsolescence. Although we applied literature review and included examples the research design challenges generalizability. Furthermore some aspects (e.g. the integration of obsolescence within innovation management) have not been considered deeply. Therefore interviews with practitioners and a broad study should be conducted in order to gain further information.

9 Further Researches

Several issues await further research. Firstly, antecedents and consequences of obsolescence including the historical background and the critical evaluation (e.g. the ecologic aspects) of obsolescence. Secondly, the role of obsolescence within innovation management, especially within business model innovation, applying obsolescence as a business model. And thirdly, the quantification of the several types of obsolescence regarding their potential.

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Areas for Feedback and Development

Is the structure of obsolescence complete?

Do you have any ideas for additional types of obsolescence?

Do you have any additional examples for obsolescence (esp. B2B)?

Do you know a tool in order to quantify obsolescence?