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Laptop Use Patterns Research on Product Lifetime and Obsolescence Aspects

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Keywords: Laptop Obsolescence; Use Pattern; Survey; Students.

Abstract: The aim of this study is to acquire information on the user behavior of laptop (including notebooks, laptops, subnotebooks, netbooks, or ultrabooks) users. A questionnaire-based survey was carried out at a University in Southwestern Germany in 2015, and duplicated in 2018. Results show amongst others that on average no defect occurs immediately after the manufacturers' warranty period. About 80% of all devices worked flawlessly throughout their use phase. Life time expectation for the devices clearly exceeded 5 years, but the actual use phase duration was found to be only about 80% of this time span. Almost 2/3 of all predecessor notebooks were stored after the end of their useful life, and only 11% disposed of.

Introduction and Study Goal

Planned obsolescence is an effect often discussed but not proven in empirical research. Portable computers according to literature typically show use phase lengths between 3 and 6 years (Hennies & Stamminger, 2016). Research shows that the duration of the first usage period of electrical products such as notebooks, TV sets or other household appliances was observed to become lower in recent years (Prakash et al., 2016).

The aim of this study is to present the current state of discussion on the obsolescence of electrical and electronic devices and to acquire information on the user behavior of laptop users by evaluating empirical data, which can be associated with obsolescence observations. Research was carried out not only to define the exact use phase length of portable computers, but also to identify the user's expectations and attitudes towards use patterns, use phase length expectations, and tentative planned obsolescence experiences. The hypothesis to be researched was that laptop users may claim to have become victims of planned obso-lescence if their devices fail to meet their use phase length expectations, regardless of the actual technical performance of the devices.

Definitions

In this study, all portable computers such as notebooks, laptops, subnotebooks, netbooks, or ultrabooks are counted under the term "laptop".

The useful life is defined as the period between the first and last use of a product. It may also denote the period of time between the first and last use of a product by the same person, family or organization. In this case, it is referred to as the first/second/… usage period.
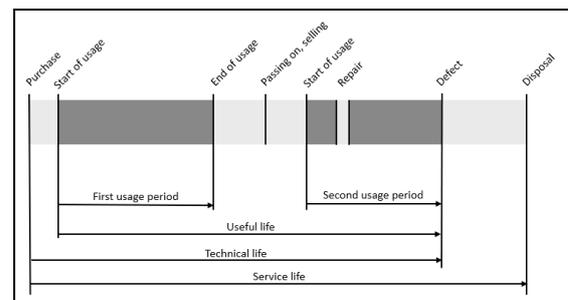
Figure 1. Use phase and life time of products (based on Tröger et al., 2017)

The service life is defined as the period between the purchase or acquisition of the product and its disposal. The technical life, on the other hand, indicates the time between the purchase and the defect of the device. Technical life and service life may not be necessarily identical (Figure 1) (Tröger et al., 2017).

The term "obsolescence" includes all processes that lead to the wear and tear, ageing or loss of value of a product, regardless

of whether these occur naturally or artificially (Reuß, 2015; Prakash et al., 2016).

Natural obsolescence expresses ageing due to normal wear and tear, whereas artificial obsolescence can be caused either by the users' misconduct or intentionally by the manufacturer or the retailer. The latter is referred to as "planned obsolescence". (Hübner, 2013)

State of Technology

In 2018 alone, approximately 164.1 million notebook devices were sold worldwide (IDC, 2019). Table 1 shows the manufacturers' market shares of notebook sales worldwide. The three most successful manufacturers in recent years have been HP, Lenovo and Dell. Since 2015, these three manufacturers together have covered more than half of the market, and in 2018, their projected market share was at 60.8%.

Literature research shows a wide range of the average useful and service life (Table 2) for laptop computers, in the case of useful life span ranging from 4 to 6 years, with service life ranging from 4.1 to 5.6 years.

	2013	2014	2015	2016	2017	2018**
HP	17.5 %	20.1 %	20.5 %	22.4 %	24.3 %	24.4 %
Lenovo	15.9 %	17.5 %	19.9 %	21.7 %	20.2 %	20.8 %
Dell	11.3 %	12.3 %	13.7 %	15.4 %	15.2 %	15.6 %
Asus	9.7 %	11.0 %	10.3 %	10.3 %	9.5 %	9.8 %
Apple	6.6 %	9.3 %	10.3 %	8.3 %	9.6 %	10.4 %
Acer	10.4 %	10.0 %	8.9 %	8.1 %	8.0 %	8.2 %
Samsung*	7.7 %	2.7 %	1.7 %	-	-	-
Toshiba*	7.5 %	6.6 %	4.2 %	-	-	-
Sony*	3.7 %	0.6 %	-	-	-	-
Other	9.8 %	9.9 %	10.3 %	13.8 %	13.0 %	11.0 %
* The source does not provide information on sales in all quarters.						
** Forecast						

Table 1. Manufacturers' market shares of notebook sales worldwide (Trendforce, 2017).

Type of data collection	Useful life in years	Service life in years	Reference [* data reference year]
German household survey (2004-2007)	5.4 – 6 (2004-2007*)		(Prakash et al., 2016)
German household survey (2010-2012)	5.1 (2012*)		(Prakash et al., 2016)
Consumer survey in the Netherlands verified by data from recycling facilities		4.1 (2000*)	(Bakker et al., 2014)
Consumer survey in the Netherlands verified by data from recycling facilities		4.3 (2005*)	(Bakker et al., 2014)
Student survey (2015)	4		(Adrion, 2015)
Online survey in Austria	4.1		(Wieser & Tröger, 2015)
Online survey in Germany (2013/2014)		5	(Hennies & Stamminger, 2016)
Student survey (2018)	4.7		(Müller et al., 2018)
Life-cycle assessment study		5.6	(IVF, 2007)
Life-cycle assessment study		4	(O'Connell & Stutz, 2010)
Life-cycle assessment study		5	(Prakash et al., 2012)

Table 2. Useful life and service life of laptops in literature.

Survey Methods

Adrion (Adrion, 2015) carried out a question-naire-based survey in a student environment in Southwestern Germany with several hundred students. A pre-tested questionnaire comprising in total 29 questions on the previously used and on the actual laptop was used.

Details on the interviewees' attitudes, laptop use phase lengths and use pattern, repairs, and also sociological milieus were collected.

Based on multi-stage cluster sampling, randomly selected groups (courses) of bachelor students (8 out of 21 bachelor study programs) and master students (6 out of 12) of

the schools of Engineering and Business/Law were selected as interviewees. After coding of the answers, SPSS was used for answer processing and analysis. This panel study was carried out in May 2015 by Adrion (Adrion, 2015), and duplicated after small modifications in June 2018 by Müller et al. (Müller et al., 2018).

With SPSS, the data were analyzed both statistically and graphically. For the evaluation of special cases, minimum scopes, such as at least 10 valid answers, were defined. In a final step, all data sets of the 2015 and 2018 works were checked for consistency.

As recommended by Akremi et al. (2011), the data window is first viewed, to notice any unusualness. In the next step, the data values are compared with the values in the code plan. Subsequently, questions that are related to each other are considered. First, all questions about the current notebook were displayed and then all questions about the previous notebook. This is intended to eliminate or adapt inconclusive answers. The inconsistencies determined with the help of Excel are changed and improved in the data set before the actual evaluation of the data takes place. The data is then analyzed and evaluated regarding the user behavior of the respondents.
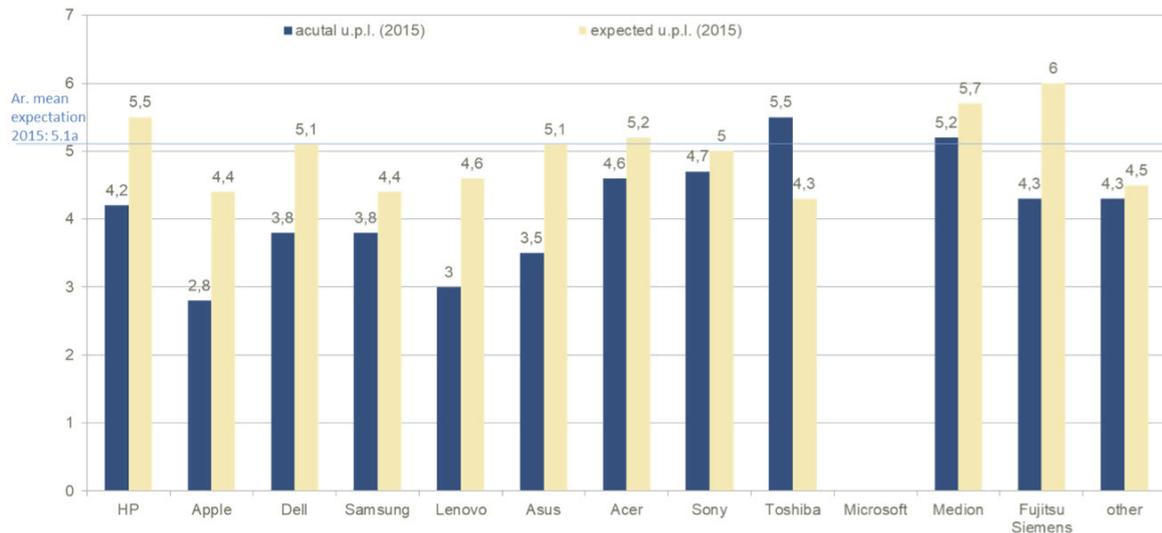
Figure 1. Expected and actual use phase lengths of laptops (2015 survey results).
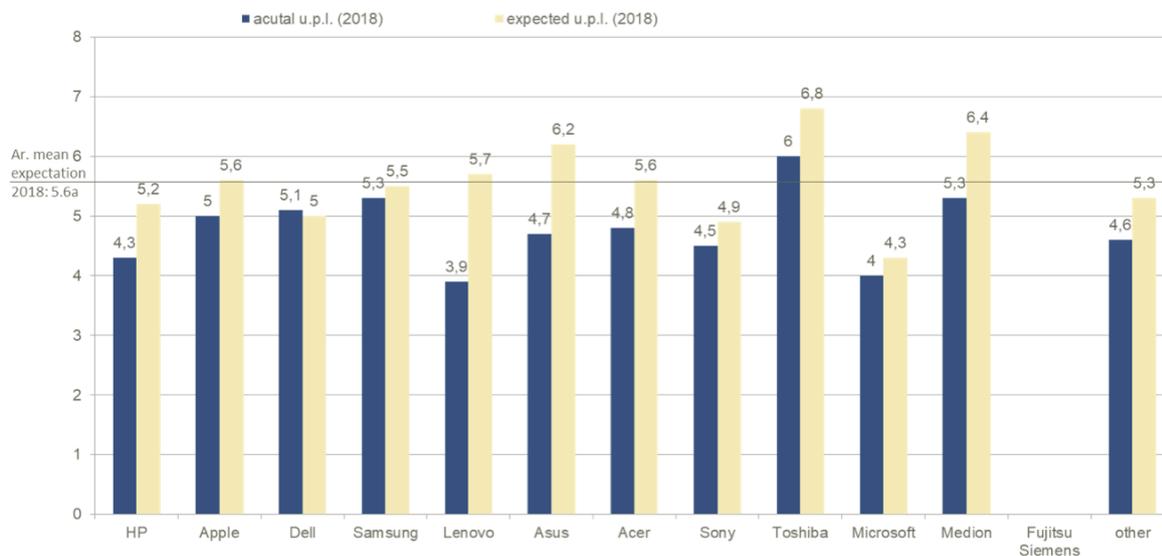
Figure 2. Expected and actual use phase lengths of laptops (2018 survey results).

Results and Discussion

The number of interviewees in 2015 was 215 students, and 336 in 2018. In total, 212 evaluable questionnaires (99%) in 2015 were obtained, and 332 questionnaires in 2018 with a share of 98.8% evaluable results. The share of female interviewees in 2015 was 51% and 44.6% in 2018, respectively.

Laptop Useful Life Length

The main result obtained from the surveys was the mean actual life length of the previous laptop, i. e. information on the users' laptop which is not in use any more: This laptops useful life has ended and thus it is clearly defined. The mean actual useful life of these devices in 2015 was 4.0 years (ranging from 2.8 years of Apple devices to 5.5 years of Toshiba devices), and 4.7 years in 2018 (from 3.9 years of Lenovo devices to 6.0 years of Toshiba laptops). Comprehensive brand specific results are shown in Figure 1 for 2015 and in Figure 2 for 2018, both for actual and expected useful life length.

The mean expected useful life duration in 2015 was 5.1 years. This expectation was only met by Toshiba devices (5.5 years actual use phase length), and Medion devices (5.2 years). The expected useful life in 2018 was 5.6 years, which was only exceeded by the actual mean useful life duration of Toshiba devices with 6.0 years.

Brands and Brand Loyalty

In both 2015 and 2018 surveys, Apple (2015: 20.9 %; 2018: 23.8 %) and Lenovo (2015: 20.4 %; 2018: 19.6 %) were the most frequently named brands among current devices. They were able to significantly increase the current number compared to the previous one. ACER and Asus also lead in both years for the predecessor models. In the year 2018, the number of current HP devices (2015: 9.2 %; 2018: 15.6 %) has increased remarkably. Compared to the global notebook market, differences can be identified. Worldwide, HP has the largest market share in all years, while Apple had a market share of 10.3% in 2015, a market share of 10.4% was forecasted for 2018. Another difference includes Dell's shares. In the surveys (2015: 6.3%, 2018: 1.6%), Dell's share in the sample is considerably lower than its global market share (2015: 13.7%, 2018: 15.6%). The differences could originate from the fact that data originate from a specific regional market: Students have different demands and requirements, and they only cover a narrow range of age.

Looking at the users' brand changing behavior from previous and actual devices, brand loyalty was quantified. The results show that users are predominantly switching between the brands. It is noticeable that Apple is the only manufacturer showing relatively low churn rates in both surveys (2015: 14.29 %; 2018: 33.33 %). In order to further question the facts, the importance of the brand prestige was analyzed. More than 50% of Apple users rate brand prestige as "important" or "very important" in both surveys, again distinguishing it strongly from other users. Consequently, it can be said that notebook users tend to have a low level of brand loyalty, except for Apple users. They seem to value Apple's brand prestige, which is reflected in low churn rates from the brand. Moreover, Apples products form a closed system, which obstructs brand switching ("lock-in effect").

Repairs and Warranty Period

In 2015, more than one fifth of the devices in use were repaired at least once. In the case of the predecessor models, the value was approximately one third. If all repairs are taken together, half of the repairs were carried out within 2 years. 22% of all repairs took place at the devices age between two and three years. (Adrion, 2015)

In 2018, 17.8% of current notebooks and just over a third of old devices are repaired at least once. Most repairs are carried out after one to two years on both the current and the previous notebook. (Müller et al., 2018)

The respondents were also asked about the manufacturers' warranty. Comparison of the average manufacturers' warranty duration with the average useful life shows that on average no defect occurs immediately after the manufacturers' warranty period has ended. (Adrion, 2015; Müller et al., 2018)

Expected Useful Life vs Actual Useful Life

Asking for expectations about how many years of use a notebook should provide, average values of 5.3 years in 2015 and 5.6 years in 2018 were obtained. The average actual useful life of predecessor devices was 4 years (2015), or 4.7 years respectively (2018). Thus, the expected useful life in both cases is significantly higher than the actual useful life of the predecessor devices. (Adrion, 2015; Müller et al., 2018)

Müller et al. note that in 2015 the average actual useful life (4.0 years) corresponded to 75 % of the average expected useful life (5.3 years), while in 2018 the average actual useful life (4.7 years) corresponded to 84 % of average expected useful life (5.6 years).

For the 2015 study a rank correlation according to Spearman was performed. It determined a correlation coefficient of 0.332, which indicates a low positive correlation, meaning that predominantly above-average or below-average x- (actual useful life) and y-values (expected useful life) fall together. Thus, the actual useful life of the predecessor model has a positive influence on the expected useful life. On the one hand, Adrion assumes that the long expected useful life may mean that consumers will not adjust their expectations despite the shorter useful lives of the predecessor. On the other hand, the constant innovations and short time intervals and the high-quality standards of the users could trigger higher expectations. The result of Müller et al. is to be interpreted in a similar way, since they determined a correlation coefficient of 0.324 for 2018.

Moreover, 2015 results showed that devices of those respondents who had read the instructions for use and who thought they were using the device in accordance with the specifications had the highest average useful life of 4.6 years. The lowest useful life was found with the combination "instruction manual not read" and "specifications not known" with 3.3 years. The 2018 survey confirmed the highest average service life for persons who have read the instructions for use and are of the opinion to use the device in accordance with the specifications.

Replacement and Disposal
The survey results indicate that in 2018 a defect is responsible for almost 40% of the disposals of previous notebooks (2015: ca. 50%). 49% (2018) of the respondents identify the item "no longer up-to-date" as a reason (2015: 40%). "Lack of compatibility" does not play a major role with 5% (2018) as a reason for disposal (2015: 6%), and the remaining percentages are covering other reasons. (Adrion, 2015; Müller et al., 2018)

In 2015, the average useful life of defective notebooks is 4.2 years, as well as that of notebooks that have been replaced because they are no longer up to date. In 2018, the useful life of notebooks with the replacement reason "no longer up to date" (5.1 years) exceeds the useful life of the defects (4.5 years). The answer category "Lack of compatibility" is not considered because the number of valid answers (2015: n=8; 2018: n=11) is low.

In 2018, 62% of all predecessor notebooks were stored after the end of their useful life, 17% were given away, 11% disposed of and 7% sold (others: 3%).

It has to be pointed out that, on the one hand, the surveys only measure the useful life (or only one usage period) and, on the other hand, a defect device cannot be regarded as evidence of planned obsolescence. Even under this assumption, in 2018 no shorter useful life (with reason of disposal: defect) than 2015 is determined.

Conclusions
The 2015 and 2018 surveys show that in the students' environment surveyed both the useful life expectations (2015: 5.3 years; 2018: 5.6 years) and the actual useful life length of laptops increased from 2015 (4 years) to 2018 (4.7 years), but with a higher increase of the actual useful life.

It can be seen, that the user behavior (e.g. expressed in reading the instruction manual) and their socioeconomic background (e.g. expressed by self-assignment to a specific milieu) can also have an influence on the useful, technical or service life of a notebook.

Even in the case of a defect, some notebooks are given away instead of being disposed of, resulting in a tentative "second life" after having been repaired by the next owners.

A defect immediately after the end of manufacturer's warranty could not be observed. All in all, proof of planned obsolescence was not obtained in this study.

Acknowledgments

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