



Full length article

## The current status of the consumer electronics repair industry in the U.S.: A survey-based study



Mostafa Sabbaghi<sup>a</sup>, Willie Cade<sup>c</sup>, Sara Behdad<sup>a,b,\*</sup>, Ann M. Bisantz<sup>a</sup>

<sup>a</sup> Industrial and Systems Engineering Department, University at Buffalo, State University of New York, Buffalo, NY, USA

<sup>b</sup> Mechanical and Aerospace Engineering Department, University at Buffalo, State University of New York, Buffalo, NY, USA

<sup>c</sup> PC Builders & Recyclers Inc., Chicago, IL, USA

### ARTICLE INFO

#### Article history:

Received 20 May 2016

Received in revised form 5 September 2016

Accepted 8 September 2016

#### Keywords:

Consumer electronics

Repair business

Service pricing

Design for repair

K-means clustering

Consumer behavior

### ABSTRACT

Consumer electronics are turning into consumable devices nowadays, and consumers generally show little inclination to repair broken products due to the lack of repair infrastructures and relative high repair costs. On the other hand, technical, operational, and economic barriers impede the growth of repair businesses. In this paper, we provide a look into the repair industry through an analysis of a survey conducted by a third-party repair service provider. 2170 repair technicians have participated in a survey consisting of 23 questions about repair challenges in their profession. At first, we take a look at the economic barriers that dissuade consumers from repairing products. Next, a demand-based repair service pricing framework is introduced. The optimal pricing levels are found based on the consumers' repair demand. Finally, other aspects of repair businesses, e.g. reparability degree of consumer electronics and consumer expectations of repair services, are thoroughly investigated. As an example of findings, different types of consumer electronics are clustered based on the associated repair difficulties. Moreover, some insights are provided to promote the repair businesses.

© 2016 Elsevier B.V. All rights reserved.

## 1. Introduction

In a “throw-away society” with short-lived products and consumers' over-consumption behavior (Cox et al., 2013), the repair activities may fall into decline gradually due to factors such as the high cost of labor and spare parts. The costly repair services dissuade consumers from repairing their obsolete products (McCullough, 2009), even when the consumers may favor repair over disposal (Sabbaghi et al., 2016). The repair workforce will shrink even faster in the developed regions since the labor cost is drastically higher than the cost in developing regions (Cooper, 2002). Reported by the U.S. Census Bureau, the number of annually-established firms in the consumer electronics repair and maintenance industry (NAICS code 811211<sup>1</sup>) has decreased from 4623 in 1998 to 2072 in 2015. In a survey conducted by Wei et al. (2015), 50% of car remanufacturers pointed out that they have

problem with accessing the well-trained and skilled but cheap technicians in China that has been known for a long time as a place for low-cost labor.

There is a consensus among the electronic waste (e-waste) research community that a significant proportion of used equipment generated in developed countries is exported to developing countries for recycling activities (Kahhat and Williams, 2012; Wang et al., 2012). It is hard to track the way in which the exported equipment will be recovered in their destinations. However, for the case of unwiped disposed data storage devices, the data stealing that may result in cybercriminals shows that the devices were still functional and being reused somehow (Warner, 2011). Although a significant number of discarded products seem to be reusable, it has been observed that 75% of PCs exported from the U.S. to Nigeria are not reusable and just being recycled (Field, 2015) due to a long delay in issuing the export-import license which results into the technological obsolescence and the unavailability of spare parts (Milovantseva and Fitzpatrick, 2015).

In a typical repair process, the nonfunctional products are brought into repair shops, when often the level of needed repair is not clear before a laborious troubleshooting is performed. The repair businesses, furthermore, suffer from the barriers of technical, operational and logistical limitations, e.g. lack of repair manuals, inappropriate repair tools, and unavailability of spare parts. What-

\* Corresponding author at: Industrial and Systems Engineering Department, State University of New York, University at Buffalo, Buffalo, NY, USA. Tel.: +1 716 645 5914.

E-mail address: [sarabehd@buffalo.edu](mailto:sarabehd@buffalo.edu) (S. Behdad).

<sup>1</sup> Source: The United States Census Bureau, The North American Industry Classification System, <http://www.census.gov/eos/www/naics/>

ever the repair issues are, consumers expect that their broken products will be repaired fairly quickly and accurately for a reasonable cost (Chang et al., 2013). However, there might be a risk that the repair shops come into conflict with the clients since they sometimes do not elucidate what outcomes may possibly be associated with the repair process. When consumers' expectations of repair outcome are not met, an aversion to repair products may develop (Boon-Long and Wongsurawat, 2015). For example, consumers would rather replace an obsolete product with a new one, which leads to more generation of End-of-Use/Life (EoU/L) items (Estrada-Ayub and Kahhat, 2014).

As a certain right, consumers and independent repair businesses should be aware of the products' repairability at the time of purchase. The independent repair businesses and initiatives, e.g. the Digital Right to Repair Coalition, have formed worldwide campaigns against the profit-driven policies of manufacturers and urge them to produce more repairable electronics, share the repair guides, and supply the spare parts in the market. The contemporary repair groups, e.g. Repair Café, motivate consumers toward products' repair as an advance sustainable practice (Rosner, 2014). Furthermore, the waste reduction strategies, such as the Circular Economy, are motivated by many governments, which promotes repair and reuse as the first lines of defense against waste (Ghisellini et al., 2015).

Using a survey-based approach, we aim to explore the obstacles that the consumer electronics repair businesses encounter and quantify their impacts on the performance of the repair industry. The findings of this study together with the addressed issues have potential implications for future research in repair businesses, green product design and manufacturing, and consumer purchase and post-purchase behavior.

The rest of this paper is organized as follows. The prior literature is reviewed and the research gaps are discussed in Section 2. Next, the methodology of the research study is explained. A brief overview of the conducted survey is provided in Section 4. After quantifying the uncertainty of the repair labor cost, a demand-based repair services pricing model is presented to determine the optimal per-time-unit labor cost based on the repair demand in Section 5. In this section, a sensitivity analysis on the spare parts supply is provided for further insights. In the subsequent sections, the repairability of the current consumer electronics, the design of repair tools, enhancing the skills of repair workforce, the clients' expectations of repair services, and the potential role of repair businesses in raising the public awareness about repair are comprehensively discussed, respectively. In Section 9, the lessons learned from the repair businesses are summarized. Finally, we conclude the paper by outlining some possible steps for the future research.

## 2. Literature review

Research on making policies to promote efficient consumption of resources is going beyond the traditional techno-economic business modelling approaches. Now, it is also studied from a wide spectrum of aspects—including the cultural phenomena of sustainable practices like local repair communities (Rosner and Turner, 2015) and behavioral decision-making process (e.g., capturing consumers' repair behaviors (Scott and Weaver, 2014)). In fact, social impacts and attitudes towards such green policies are also of great importance to develop a successful sustainable business model (Kissling et al., 2012). Hence, it is essential to identify what matters most to consumers' willingness to receive green services, as well as the main operational and technical-driven challenges and barriers that the businesses may encounter in interacting with other stakeholders. In this section, we first review the literature relevant to the repair businesses from social, technical, and economic research

perspectives. Next, it is described how this paper will contribute to the growing attention towards repair of products as promising solutions to use resources more efficiently.

As mentioned in the Introduction, the relatively high cost of repair and falling cost of product replacement (McCollough, 2007) are the main deterrent to repair broken products. Hence, the repair businesses need to efficiently set a demand-based repair service pricing strategy. Although consumers often care about the costs of their repair decisions, other contributory factors such as consumers' perception of the product' technological and functional obsolescence (Cooper, 2004), and psychological factors (Okada, 2001) are important in the decision-making process. Consumers may even throw a nonfunctional device away since it does not seem repairable.

McCollough (2010) proposed an analytical model, where the individual repair/replacement decision is made based on the discounted net benefits of repair and replacement over the use cycle of a product. Hence, the repair businesses must keep track of changes in prices of products together with consumers' preferences, perspectives, and their attitudes toward repair and replacement to carry out a fair value appraisal of repair services. To address this point, Calabrese and De Francesco (2014) explained how the service firms would benefit more from implementing a demand-based service pricing approach rather than just adopting a cost-based pricing policies. In another study, the consumers' loss aversion toward price and delay in receiving services is considered in price modelling (Yang et al., 2014). The delay is more important when the full-service contracts, in which the consumers pay a fixed fee for the periods of time (compared with the on-call services that consumers are charged based on the time and materials used for the repair). Huber and Spinler (Huber and Spinler, 2012) proposed a model to determine the optimal pricing of the full-service contracts. The optimal pricing strategy is very sensitive to the volatility of failure events, repair time and cost.

The way that the repair services are provided influences the consumers' referral behavior, in which consumers' dissatisfaction with the repair services equates to reduced repair demand (Field, 2015), (Barrot et al., 2013). Consumers usually express dissatisfaction through direct complaints, but it is not always the case. Ro (2014) reported that factors such as attitude toward complaining, affectional bond, and failures criticalness distinguish non-complainer, patience, and neglect consumers from the complainers. She also compared the return intentions of consumers based on their reactions to receiving imperfect services.

The amount of time that a technician spends on repairing a device determines the associated labor cost. Among all factors that prolong the repair time, e.g. repair skills, the product repairability is a critical factor (Blanchard et al., 1995) that should be considered in the early phase of product design. To give an example, Coulibaly et al. (2008) developed an approach to evaluate the maintainability and safety of a product using the information of components' reliability and disassembly-repair-assembly process decomposition. Recently, the estimation of the mean time to manually dismantle (Ardente et al., 2014) and the mean time to generally repair the products (Gupta et al., 2013), disassembly path planning (Behdad and Thurston, 2012), ergonomic repair process design (Regazzoni and Rizzi, 2014), and experience-based monitoring of product repairability (Mashhadi et al., 2016) have been getting attention in the sustainable design literature.

The unavailability of spare parts (or limited access to them) is another obstacle in the repair industry. The spare parts may be available over the large-scale manufacturing life cycle of the products. Once the manufacturers put an end to the production, the products are no longer available in the market. However, 3D printing is going to be a suitable solution to produce the spare parts in order to reduce the supply cost (Clift and Druckman, 2016). To over-

Download English Version:

<https://daneshyari.com/en/article/5118763>

Download Persian Version:

<https://daneshyari.com/article/5118763>

[Daneshyari.com](https://daneshyari.com)