

13th Global Conference on Sustainable Manufacturing – Decoupling Growth from Resource Use

Sustainability Assessment of Remanufactured Computers

Yun Arifatul Fatimah^{ab*} and Wahidul Karim Biswas^b

^aDepartment of Industrial Engineering, University of Muhammadiyah Magelang, Indonesia

^bSustainable Engineering Group, Curtin University, Australia

* Corresponding author. Tel.: +62 85701108686; fax:+62 293 325554. E-mail address:yun.fatimah@ymail.com

Abstract

The accelerating growth of communication and information technologies (CITs) worldwide has caused the exponential growth of end-of-life (EoL) computers and e-waste. Remanufacturing of EoL computers has thus potential to enhance resource conservation and prevent natural resources degradation, which obviously have social, economic and environmental benefits. Fatimah et al (2013) framework has been applied to determine remanufacturing strategies to achieve the sustainability of remanufactured computers. The results showed that remanufactured computers could be technically, environmentally, economically and socially feasible if there is an adequate supply of quality cores, involvement of high skilled workers, incorporation of standardization process, and the use of advanced machines tools.

© 2016 The Authors. Published by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Peer-review under responsibility of the International Scientific Committee of the 13th Global Conference on Sustainable Manufacturing

Keywords: Sustainable manufacturing; remanufacturing; computers

1. Introduction

The current world is overwhelmed by fast innovations of modern computers while on the other hand innovations of managing end of life computers (e.g. recycling and remanufacturing) are less. These, therefore, lead to the increase of end of life computers and e-waste significantly. The number of end of life computers was 500 million during 1994-2003, while it was predicted that e-waste has increased from 20 to 50 million tons annually recently [1,2]. In developed countries, most of EoL computers are not recycled, instead they are disposed to developing countries.

Whilst computers have short life cycle but many of them are still durable and reliable when reused [3]. There are a number of strategies for repairing, reconditioning and remanufacturing EoL computers. Repairing is replacing damaged parts with new ones, reconditioning is returning to obtain better functionality and performance and remanufacturing is returning an EOL product to achieve at least the same specifications and warranty period as a new product. Through remanufacturing process, EoL computers are restored to their original functionality by using a number of steps including core collection, initial

inspection and sorting, cleaning, machining, replacement of damage parts with new one or used components, reassembling, upgradation, installation and final checking [4].

Remanufacturing could achieve sustainable manufacturing by conserving material and energy resources, alleviating poverty, increasing reliability and affordability and by offering profitable e-waste reduction strategy [3,5]. In addition, remanufactured computer offers affordable price without compromising the quality of the products [3,6]. In China, about ¥ 10 million profits could be earned and about 300 labor could be employed for remanufacturing 100 thousand used computers per year [7].

The computers regardless of whether they are new or remanufactured do not concern the people in developing countries as long as these electronic items are affordable and serve their needs. The used computer in Asian markets has been doubled during 2004 - 2009 [8]. Whilst about two third of 2 million computers in Indonesia, are second hand computers, the percentage of computer ownership is only 1% (2.5million) of the total population (250million) due to affordability issue [9]

In term of marketing opportunity, the demand for used computers including refurbished and remanufactured

computers is often influenced by affordable price and extended warranty period, reliability, and durability.

The market for second hand reuse, recondition, and remanufactured computers has also developed significantly in the recent years. Microsoft estimates that remanufactured computers contributed more than 10% of computer market in 2007 worldwide [10] and generated 4% of the total revenue from selling computers in 2008 [11]. In addition, a number of major computer manufacturers, including Apple, Dell, HP, and IBM have actively refurbished their end of life computers. For example, Dell refurbishes and sells at least about 90% of all restored computers [12]. Microsoft authorized a refurbishing program to deal with their unusable computers [10].

Therefore, this article reviews as to whether the remanufacturing of computers is technically environmentally, economically, and socially sustainable for SMEs of developing countries such as Indonesia. Firstly, the existing situation of Indonesian SMEs remanufacturing computers was discussed for sustainability assessment. Secondly, the factors affecting the SMEs to achieve sustainable manufacturing were identified. Finally, a sustainable remanufacturing strategy was developed for the SMEs.

2. Review of Indonesia SMEs remanufacturing computers

The implementation of remanufacturing in Indonesia is not free from limitation as there are plenty of opportunities for improvement in this sector for attaining sustainable industrial development.

2.1. Technical challenges and opportunities

Remanufactured computers should be both affordable and durable to meet customers' basic requirements. A number of strategies including appropriate warranty, component quality assurance and reviewing customer expectation are usually provided to meet the customer needs. In addition, the production of remanufactured computers involves less complicated process compared to other remanufactured products (e.g. automobile parts, household appliance etc.), thus the components are easily disassembled and recovered [3].

In developing countries like Indonesia, users usually prefer to purchase second hand, refurbished and remanufactured computers due to affordability reasons. However, the quality requirements arise which require special concern for remanufacturers. The problem is that the reliability issue is often become one of factors affecting the low penetration of remanufactured computer market in developing countries [8]. Unpredicted quality and reliability of core components, unstandardization process, low and unsophisticated technology and the lack of skilled workers are key barriers to develop remanufacturing industries in developing countries [9].

2.2. Economic challenge and opportunities

Remanufacturing a computer is more economically efficient than manufacturing a new computer [5]. The remanufacturing operation is designed to produce cheaper products which not only offers affordable price but also profitable for the company

[6]. The use of less virgin material by using used materials and reduced level of manufacturing activities could significantly decrease the life cycle cost as well as price of the of remanufactured computer. The average price of remanufactured computer was 40% of new one. The market for remanufactured computer has also been found to increase significantly as more than 50% of the remanufactured computers which were advertised online was sold in 2010 [5].

End of life computers in Indonesia is likely to be apparent as high economic value products [13]. Therefore, the remanufacturing of durable computers could strengthen Indonesian secondhand and refurbishment markets [14]. Interestingly, Indonesian remanufactured and reconditioned computers have been found to be sold in the international market [9].

2.3. Social challenge and opportunities

Remanufacturing is labor intensive activity [3], therefore, this activity creates potential job opportunities. Remanufacturing IT products including computer in USA was estimated to provide employment for about 11,493 employees in 2009, which was increased by 34.4% in 2011[15]. In addition, there are indirect job creation opportunities in remanufactured products supply chain (e.g. supplier, scavengers, collection centre) [14]. By creating employment, the remanufacture of computer help society to improve their living standard, health and education levels which lead to the reduction of poverty. However, the lack of knowledge and the availability of skilled workers have impeded the development of remanufacturing industries in Indonesia as inefficient and effective processes decrease the labor productivity. In addition, the lack of salary has become a crucial problem faced by employees [9]. The majority of the employees worked in SMEs has lower wage than the Indonesian minimum wage.

2.4. Environmental challenge and opportunities

Remanufacturing conserves energy and materials significantly. Williams and Sasaki [8] and Williams [16] stated that the amount of energy used in the remanufacturing computer is very less when new parts are avoided. In addition, the consumption of energy in the remanufacturing computer was estimated to be 1,750 MJ which is approximately about 30% of the total energy consumed in manufacturing new computer [8,16].

However, the lack of waste management strategy, facilities, infrastructure, technical capacity and technologies and non-transparent regulations are number of challenges in waste management in developing countries such as Indonesia [17]. The majority of EoL computers and e-waste are not properly recycled due to lack of facilities [14]. Ironically, majority of workers are exposed to dangerous chemicals when involved in treating e-waste due to lack of health and safety concerns [17].

E-waste including EoL computers which are not properly disposed and managed are potentially hazardous for human health and the environment. The leaking of toxic components from e-waste such as arsenic, cadmium, chromium, copper,

Download English Version:

<https://daneshyari.com/en/article/1699035>

Download Persian Version:

<https://daneshyari.com/article/1699035>

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