What hinders remanufacturing, how stable such obstacles are and who can remove them? Evidence from the field

Marta Jakowczyk (marta.jakowczyk@postgrad.manchester.ac.uk) (corresponding author)
Sustainable Consumption Institute and the School of Mechanical, Aerospace and Civil Engineering (MACE), University of Manchester, UK

João Quariguasi Frota Neto
School of Management, University of Bath, UK

Jens Roehrich
School of Management, University of Bath, UK

Luk N. Van Wassenhove
INSEAD, Fontainebleau. France.

Andrew Gibson
School of Mechanical, Aerospace and Civil Engineering (MACE), University of Manchester, UK

Abstract

To the best of our knowledge this study is the first to systematically examine the barriers faced by companies engaged in product remanufacturing. We interview twenty-two key informants from eleven companies working in the key B2C and B2B sectors. An attribution model is subsequently developed, based on the causal understanding of the low levels of engagement in product remanufacturing, and their characterisation in terms of level of control, stability and locus. We find that remanufacturers perceive external factors to be the main impediments, e.g. poorly devised legislation, and that they have little influence on how those external situations may be averted. We also find that remanufacturers perceive that such barriers are not going to disappear in the foreseeable future. We finalise the paper with the practical implications of our research.

Keywords: remanufacturing, closed-loop supply chains, barriers, multiple case-study, attribution theory

1. Introduction

Product remanufacturing is sometimes referred to the 'hidden giant', given its (large) size, and how little we know about it. The list of products that are remanufactured is extensive. Airplane and car engines (Ferrer et al., 2011, Souza, 2012), copy machines, home appliances (Kissling et al., 2013), personal computers, mobile phones (Quariguasi and Van Wassenhove, 2013, Huang et al., 2014), heavy construction machinery (Dongmin, 2012) and sophisticated medical equipment (Rudi and Pyke, 2000, Ferrer and Ketzenberg, 2004) are only some of the many products currently remanufactured. Yet, little is known about the barriers that currently affect OEMs and Independent Remanufacturers (IRs) involved in product remanufacturing (henceforth simply referred to as *remanufacturers)* (Souza, 2013). A large body of research has alluded to the issues hindering product remanufacturing, but evidence is largely inconclusive and scattered throughout the literature. A limited number of extant studies have empirically addressed barriers were either unsystematic in nature, or focused on companies currently not involved in product remanufacturing. Therefore prior research presents barriers to the *adoption* of product recovery, i.e. why companies are not actively engaged in product remanufacturing, leaving open the question of what actually hinders remanufacturing (e.g. Gonzalez-Torre et al., 2010, Shaharudin et al., 2014).

This paper's main contribution is twofold. First, we contribute examining the view of remanufacturers as to where the barriers to the implementation of financially viable remanufacturing operations lie. This is perhaps one of the first papers to carry out such systematic examination. It is also the first to interview a large number of organisations that are already strongly engaged in product remanufacturing (as opposed to organizations asking themselves whether they should enter it). We believe that the former is fundamental to enhance our understanding, as these are organisations that have faced real rather than anticipated issues with respect to product remanufacturing. An organisation that does not engage in product remanufacturing can only speculate what the difficulties may be, whereas a remanufacturer can actually report what issues it faces in its day-to-day operations. Second, this research also examines the causes of such obstacles. We examine remanufacturers' perception with respect to the levels of controllability and stability of obstacles. We draw on attribution theory, which is used to explain our initial findings in light of stakeholder pressures and causal characteristics. More specifically we examine control, stability and locus of the overall low levels of participation in product take back. The development of the attribution model allows us to identify whether the main issues remanufacturers have to deal with

are due to external or internal factors, and whether they find they have a sense of control with respect to removing these barriers to product remanufacturing.

To achieve this we interviewed twenty-two key informants from eleven companies across the electric and electronic equipment (EEE), aerospace engines and healthcare systems in order to cover experiences from multiple types of remanufacturers regarding industry context and business model. B2B and B2C organisations where interviewed. In addition, five sets of observations were made during visits to remanufacturing facilities throughout 2013 and 2014. To triangulate primary data, secondary data was collected from business and government reports to increase research reliability.

The remainder of the paper is structured as follows. In Section 2 we review extant literature, present an initial conceptual framework and introduce the research questions. The methodology and data collection are discussed in Section 3. The discussions of the results can be found in Sections 4 and 5. In Section 6 we discuss the main implications of our results. The paper ends with conclusions drawn from findings, limitations of the research and future research recommendations in Section 7.

2. Theoretical background

2.1. Barriers to Product Remanufacturing

The barriers discussed by prior research are summarized in Table 1. It is worth repeating that prior research has mostly drawn from companies not engaged in product remanufacturing. Table 1 presents both the focus – remanufacturing (R), reuse (RU) or more general environmental practices (G) and the stage of implementation investigated in each study - that is, whether the companies investigated were considering adoption (A), had already adopted Reverse Supply Chain (E) or did not specify (NS). The barriers listed in the table are grouped and discussed below depending on their stakeholder relevance: customers, governments, competitors, suppliers or remanufacturer itself.

<Include Table 1 here>

2.1.1. External barriers

2.1.1.1. Customer-related barriers

Marketing uncertainty is a commonly mentioned issue with reverse supply chains (RSCs). This uncertainty is a consequence of the different factors hampering predictability in the demand for recoverable goods. Examples of such factors include difficult market positioning (Post and Altman,

1994), consumer non-confidence in recovered equipment and low reputation of social enterprises (Ongondo et al., 2013). The fear of sales cannibalisation where OEMs attempt to prevent competition between new and used products on the market is another issue (Dindarian et al., 2012, Guide and Li, 2010, Kissling et al., 2013, Quariguasi et al., 2014), despite the fact that some studies claim that used products are in fact addressed to different customer segments than new ones (Atasu et al., 2010, Ongondo, 2013).

Meanwhile on the supply side, the most common characteristic of RSC practices is the difference in quality of returned products (Thierry et al., 1995). Indeed, Herold (2007), Kissling et al. (2013) and Quariguasi and Van Wassenhove (2013) show that access to sufficient volumes of good quality used equipment is ranked by practitioners involved in reuse as the most significant barrier. Galbreth and Blackburn (2006) emphasize the highly variable condition of the end-of-life products acquired by independent remanufacturers and the importance of the sorting process. Gatekeeping is a base for making a decision about product disposition and elaborating new prices for recovered goods (Ravi and Shankar, 2005). Finally, the lack of appropriate performance metrics is a subject of concern for manufacturers willing to adopt product take-back and recovery practices (Presley et al., 2007).

2.1.1.2. Government-related barriers

Legislation has long been associated with adoption of RSC practices. However, in practice environmental regulation frameworks have turned out to not be clear and strict enough. Furthermore, in many places they do not exist or are lax (Quariguasi and Van Wassenhove, 2013). As a result, manufacturers different ways (David and Sinclair-Desgagne, 2005). This hinders product take-back in general. Recent research has also pointed to the fact that legislation may complicate remanufacturing supply chains. Kissling et al. (2013) for instance, suggest that national and international regulation significantly hinder the trans-boundary movements of used EEE.

2.1.1.3. Competitor-related barriers

Due to gaps in environmental management trans-boundary movement of used EEE has been seen as a profitable opportunity (Chi et al., 2011). Informal and illegal practices include exporting e-waste which has been declared as functioning EEE for reuse. Recyclers and brokers are taking advantage of lower cost from informal recycling in developing countries. Informal actors compete with

remanufacturers who respect social and environmental regulations at higher cost. Kissling et al. (2013) state that "shame reuse" is one of the most impactful barriers to acquisition of used products as well as to their distribution when prepared for reuse.

2.1.2. Internal barriers

2.1.2.1. Uncertainty regarding financial payoffs

Uncertainty regarding financial payoffs refers to cost considerations which are a prime challenge in the Reverse Supply Chain (Ravi and Shankar, 2005, Post and Altman, 1994, Del Brio and Junquera, 2003). Studies have pointed to the significant investment costs (Gonzalez-Torre et al., 2010), which often deter managers who prefer to invest in activities that have more rapid and visible economic returns (Zilahy, 2004). Closely related to the costs is the labour intensive nature of remanufacturing (Seitz and Peattie, 2004, Kapetanopoulou and Tagaras, 2009). Another factor that may hinder the acquisition of used products is the high cost of transportation from collection points to OEMs' facilities. Quariguasi and Van Wassenhove (2013) found that to be the case for personal computers in Brazil.

2.1.2.2. Lack of environmental leadership

Extensively mentioned in papers related to the adoption barriers is the lack of commitment by top management, as effective leadership is needed to provide clear vision and value to reverse logistics programs. Negative manager attitude towards environmental initiatives and an adverse company culture hinder the implementation of remanufacturing (Hillary, 2004, Ravi and Shankar, 2005, Zhu et al., 2008). The economic and environmental benefits of remanufacturing are generally overlooked by companies (Zilahy, 2004, Gonzalez-Torre et al., 2010). Del Brio and Junquera (2003) suggest that if an OEM does not have the organizational structure that allows the creation of a specialised department, then the introduction and implementation of advanced environmental strategies like product take-back and recovery is very difficult if not impossible.

2.1.2.3. Difficulties associated with human resources

Another barrier acting against the adoption of environmental activities is a lack of human resources (Del Brio and Junquera, 2003, Hillary, 2004, Ravi and Shankar, 2005). The need for reverse logistics permeates an entire organisation, from management to operations staff (Hillary, 2004). Personnel

need to be given adequate training in new technology and processes that come with reverse logistics (Post and Altman, 1994).

2.1.2.4. Difficulties in management of reverse product flows

Difficulties in management of product reverse flows are also mentioned by literature to affect companies involved in RSC. Lack of good information systems is an important problem faced by firms that have already adopted RSC practices and those considering it (Seitz and Wells, 2006). At the product development stage, a product's material content and structure are the important variables for consideration (Ravi and Shankar, 2005, Shaharudin et al., 2014). Good information systems are also required to individually track and trace product returns linked to previous sales. Linking a return and a past sale in this way supports forecasting of product returns and assists in inventory management (Gonzalez-Torre et al., 2010). The planning and control of product recovery activities is dependent upon good information systems, described by Landers et al. (2000), Maslennikova and Foley (2000) and Mok et al. (1997) who give examples of the use of information and new technologies to improve processes in the reverse chain in various contexts. Good, commercially available reverse logistics information management systems are scant. Independent remanufacturers are faced with an additional problem of information that OEMs do not have to contend with (Chapman et al., 2010).

2.2. Theoretical foundation: attribution theory

Apart from the existing body of literature on product take-back, this research's theoretical basis is grounded in attribution theory. Analysing the prior research on the barriers faced by remanufacturers only takes us as far as telling what the barriers to product remanufacturing are. Attribution theory provides us with a tool to enrich our analysis by considering issues such as control, stability and locus, e.g. do organisations find themselves able to circumvent or remove some of the barriers affecting their remanufacturing operations?

Attribution is described as individual or collective perceptions about the causes of an event (Martinko et al., 2011). It is suggested to provide valuable contribution to the growing field of study which focuses on perception understanding of different stakeholders and their behavioural responses to supply chain dynamics (Bendoly, 2006, Tokar, 2010). The main focus of an attribution

model is interpreting and making sense of certain events, especially those which are negative or unexpected, people usually try to link them with possible causes (Wong and Weiner, 1981, Folkes, 1982).

In this paper, we explore the pivotal concepts of attribution theory proposed by Heider (1958) and further refined by Weiner (1979, 1986, 2000), who suggests classifying causes in order to predict certain behaviours. Typically causes are categorised along three underlying dimensions: (1) locus, the location of the cause, (2) stability, whether the cause is relatively permanent over time or fluctuates and (3) controllability, how much influance a person has over the cause. A systematic analysis of casual inferences seeks to answer "why?" questions and to predict what types of attributions lead to specific responses (Folkes, 1984).

It is worth mentioning that our unit of analysis is the organisation, as opposed to individuals engaged in product remanufacturing. While primarily used in social psychology research, attribution theory has been broadly applied to organizational behaviour, mostly to investigate safety management in the workplace (e.g. Green and Mitchell, 1979, DeJoy, 1994) or customer behaviour. Marketing literature on attribution has explored product or service failure/success (e.g. Richins, 1983, Curren and Folkes, 1987), customer product selection (Folkes, 1986), seller motivation (Weitz et al., 1986) and consumer-seller conflict (Folkes and Kotsos, 1986).

From a theoretical viewpoint, attribution theory barely figures in supply chain research. There are only a few studies which examine the causes of product safety failures and attribute them either to supply chain issues, manufacturing related issues or design related issues (Marucheck et al, 2011b, Pyke and Tang, 2010). Thomas et al. (2014) explain attribution effects on time pressure in retailer-supplier relations. They argue that the sources of time pressure and different perception of their impact collaborative and relational outcomes. Ni et al. (2014) show unique characteristics of retailers as members of supply chains and highlight harmful effects of product recall announcements on them. Our research also contributes to the existing literature, as it is one of the first to deploy attribution theory in the context of supply chain management, and the first to examine it in the context of reverse supply chains, to the best of our knowledge.

2.3. Towards an initial conceptual framework and research questions

Overall, our objectives are to explore both the *sources* and *attributions* of barriers to remanufacturing performance in order to gain more understanding on *how* current recovery practices are constrained by different stakeholders (sources, RQ1 and RQ2) and to learn *why* they cause these obstacles (attributions, RQ2 and RQ3).

RQ1. How are current remanufacturing practices constrained?

RQ2. What external and internal issues are perceived causes hindering remanufacturing performance? Who are the main actors hindering remanufacturing?

RQ3. How stable are such issues (e.g. are they ephemeral?) and to what extent remanufacturers believe they are able to resolve them?

To address these research questions and in an effort to develop theory for explaining the barriers to remanufacturing, this research draws upon the widely accepted method of theory elaboration through a multiple case study approach (Choi et al., 2014).

The model presented in Figure 1 pictures the role of causal understanding of barriers to remanufacturing.

<Insert Figure 1>

Moving from left to right in the figure, the occurrence of difficulties related to remanufacturing performance provides the stimulus for causal thinking. Attribution research suggests that causes are typically categorized along three major dimensions: locus of causation, stability and controllability (Weiner, 1980). Looking at the right side of the figure, the way in which causes are classified plays an important role in the types of corrective actions that are pursued. This research also demonstrates the importance of understanding "why?" as some attributions assigned to external stakeholders may allow to justify their behaviour that hinder remanufacturing practices, understand causes and plan corrective actions.

3. Method and data collection

3.1. Research approach

To explore the positioned initial conceptual framework, the study utilises data from multiple case studies and company reports across different industries, allowing us to challenge the concepts under study from multiple perspectives. This approach helps to capture diversity of practices and contexts and thus increase the potential robustness of the theory induced from our empirical findings. The inductive case study approach is suitable for exploration of complex practices (Eisenhardt, 1989) such as the remanufacturing activities. We chose analytic induction because it explicitly accommodates existing theories (Smith and Manning, 1982) by offering an interactive process of data collection and theory elaboration. In other words, an initial extensive literature review supported the development of the initial conceptual framework. This was then followed by collecting rich primary and secondary datasets to test our framework in an effort to develop theory (Smith and Manning, 1982). Data collected directly from those engaged with the business of remanufacturing provided a better understanding of these issues rather than merely relying on statistical procedures or data (Saunders et al., 2009). Such approach allows the researchers to consider a range of relevant concepts, offering an open and flexible approach to support the emergence of new concepts that were not previously known (Auerbach and Silverstein, 2003). In on-going iterations, relevant literature sources are revisited, research questions and conceptual framework modified, and additional data collected, which helps to address discrepancies between existing theory and our empirical data (Bansal and Roth, 2000).

3.2. Case selection

The study includes case companies from the electric and electronic equipment (EEE), aerospace engines and healthcare systems sector. As a sector, EEE presents an interesting context for this study for a number of reasons. Firstly, these products clearly pose an environmental problem, in that many contain hazardous substances (EC, 2003, Tsydenova and Bengtsson, 2011). Moreover, most products contain durable components which present opportunities for reuse (Herold, 2007). The fast pace of innovation within EEE manufacturing also means that product life cycles are relatively short, hence end of life products become an issue more quickly in the EEE sector. Recent estimates put the average lifespan of computers in economically developed countries at just two years, compared to six years in 1997 (Berridge, 2010, Ongondo et al., 2011). While lifespan has decreased, sales have continued to rise. The market for these goods is considerable. Giving the example, the

number of computers sold around the world in 2004 was 183 million, while in 2009 the number stood at 281 million (Greenpeace, 2010).

The aerospace sector is perceived to be one of the most economically important in the UK (Resource Recovery Forum, 2004). According to SBAC (2002) it has a global reputation of technical excellence and innovation in military and civilian applications and represents an income of over £18b per year and profits of nearly £3b. There are more than 400 British companies which provide services in this sector. Remanufacturing within the aerospace sector is used interchangeably with overhaul although aerospace regimes go beyond traditional remanufacturing requirements because of safety regulations. However, it requires the same operations of disassembly, testing, repair, reconditioning or replacement and reassembly with demands of performance (Resource Recovery Forum, 2004). Some airline operators estimate remanufacturing as 30% and upwards in higher margin areas. For the military applications 40% of the value of sales refers to aircraft and systems, 20% to engines and 40% to guidance, control, life-support and weapons systems (SBAC, 2002).

The increased risk of safety and effectiveness also poses a challenge for the healthcare sector (COCIR, 2009). Remanufacturing of medical devices such as X-ray equipment, CT and MRI scanners has been noted as a strong market in the USA and a growing market in Europe. The National Health Service (NHS) in the UK spent around £1.5 billion on purchasing medical equipment and medical supplies in 2003 (CfR&R, 2010). Average healthcare spending in the EU is estimated at 8-9% of GDP, with 10% of employment in this sector (COCIR, 2009). High market competition forces research and development to ensure improved devices constantly enter the market. Given this pressure to update to the latest equipment health organisations can reduce costs by remanufacturing activities (Medical Equipment Market Report, 2003).

In order to select relevant case studies, contacts with businesses engaged in the remanufacturing were formed through conferences, academic networking and previous industrial engagement. Our cases are selected based on theoretical sampling (Denzin, 1989), to highlight theoretical issues and to test the theory (Eisenhardt, 1989). Our datasets were selected from 11 case companies across different sectors (see Table 3 - case companies). Company names were anonymised to encourage openness of responses.

<Include Table 3>

3.3. Data sources and analysis

Overall, we interviewed twenty-two key informants and the composition and nature of the interviewees were as follows: senior directors were interviewed in order to get an overall picture about remanufacturing practices and how each company fits in the supply chain. Additional participants came from a variety of roles including environmental managers, marketing and operations personnel. Data were collected from semi-structured interviews and observations made during visits to remanufacturing facilities. Interviews were digitally recorded, subsequently transcribed and collated with detailed notes we took during the interviews. Interviewees can be separated into two different categories: (i) individuals from multiple levels of the organisational hierarchy such as a vice president, director, manager, specialist, technician and (ii) individuals from different departments including Asset Recovery, Take Back Operations, Sales, Eco-design or Environment Health and Safety. This extensive range of interviewees helps to capture a variety of perspectives and build rich case insights into our concepts under study. Participating companies' business reports, presentations and information available on their websites also provided useful input to this study and helped to triangulate our datasets. Secondary data were collected such as annual environmental and financial reports, environmental policies, supplier evaluation questionnaires and internal newsletters. Results, which emerged from data analysis process, were given to participants for feedback. All of this was taken into account to produce final results.

An interview framework was developed on the basis of the reviewed literature and discussions held with two experts in closed-loop supply chain management. These experts provided feedback on questions to be included in interviews. The interview format covered the following areas: organisation background, objectives and attitude towards environmental issues, the assessment of product suitability for remanufacture, remanufacturing process and difficulties encountered at each step of the process, the impact of legislation and certification, collaboration with other actors in supply chain and influence of product and country specific factors.

Semi-structured interviews were then conducted with at least one senior director in each participating organisation.

To strengthen internal validity, we probed inconsistencies further (Eisenhardt, 1989). We encouraged informants to illustrate their statements with examples from various situations and specific events. In order to address construct validity, this study deploys different remedies: using multiple sources of evidence, establishing a chain of events, and having key informants review individual case reports (Gibbert et al., 2008). Discrepancies between different informants were

addressed by triangulating primary interview data with secondary data sources from company and government reports. During the data analysis process, we coded, summarised and displayed our data in an iterative fashion to derive valid constructs (Miles and Huberman, 1994). The barriers that emerged from the literature review and the case studies were compiled. This is the first stage of coding, known as open coding. This is the most basic level of coding, in which a researcher reads a transcript, line by line, and highlights the core subject of each line. In this case, the responses of interviewees were read carefully and any barriers mentioned were distinguished from other information given. Empirical findings were then compared with our conceptual framework to challenge conceptual and observed patterns (Yin, 2003). Axial coding was used to focus on a single category at a time, facilitating the process and eliciting relationships between core concepts under investigation (Strauss, 1987). In this study, this meant merging similar barriers affecting similar areas of remanufacturing. Examples included barriers relating to legislation, data security and work environmental issues. With groups of barriers established, these were then placed into broader categories. This is referred to as selective coding. In this research, the source of pressure coming from different stakeholders was used as these core categories, namely: customer, competitor, government, supplier and remanufacturer. Moreover, an additional category was created for barriers that affect the entire remanufacturing process, such as country specific factors and economies of scale. The repetition of information and consistent verification of our understanding during data collection and interviews was an indication that we had reached saturation.

4. Main barriers to product remanufacturing

This section addresses the first research question. Barriers to remanufacturing derived from interviews are categorised by the source of pressure that has impact on difficulties faced by our companies. These pressures come from stakeholders: governments, suppliers, customers, competitors or the firm itself.

<Include Table 4>

4.1. Barriers that result from government pressure

4.1.1. Lack of legislative incentives or enforcements for remanufacturing

Unsuccessful legislation is considered as one of the most impactful barriers to remanufacturing but the lack of any legislation is a problem as well. Many markets still do not have laws for the treatment of used EEE products and hazardous substances. This is a matter particularly for companies which operate in multiple countries. The Director of International Partners Compliance (Company E) says *"Driven by legislative pressure and willingness to be recognized by customers as reliable remanufacturer, we pose high requirements to our partners from other countries which do not need to comply with any specific legislation. Supplier evaluation is crucial in this matter. However, finding partners in such countries is very difficult, sometimes requires providing suppliers with financial support and training"*.

4.1.2. Impractical and ill-devised legislation

All interviewed companies must follow the legislation for EEE, which includes two directives: the Waste Electrical and Electronic Equipment Directive (WEEE) and the Restriction of Hazardous Substances Directive (RoHS). Each Directive only defines required outcomes and each country might choose the best framework to achieve its obligations. Because both directives apply to 28 EU countries and 3 EEA countries, currently there are 31 different types of implementations, different cost allocations and reporting. An Environmental Policy & Programs Manager (Company B) admits: *"it is a nightmare for a company that operates in most of these countries"*. While importing used products and exporting refurbished ones, companies need to be mindful that national rules for implementing each Directive differ from country to country. The interviewee explains *"The WEEE Directive is mainly a matter that imposes administrative burn of rules/regulations"*. Gathering the information about the variety of directive implementations and adjusting the company's operations according to requirements set by each country takes considerable amount of time and costs. In contrast to regulations which are harmonized, directives differ depending on country. In addition, these national rules are written in each country's language and are updated mostly every year. Companies who want to enter a new market and those who want to stay on the existing market struggle also with significant costs of translations. EU legislation is considered as unsuccessful also because of the overlap between legal requirements. RoHS was given as an example because it regulates substances in parallel to REACH. Some interviews (Company B, Company E, Company H) suggested that legislation is drafted without proper consultation with industry and it results in impractical guidelines for remanufacturers.

4.1.3. Poorly defined quality standards

Informal and illegal export of e-waste has a negative impact on public attitude towards the remanufacturing business. Electronic waste wrongly declared as functioning EEE for reuse is sent to developing countries for informal recycling which is harmful for people and environment. Some countries have imposed bans on the import of used equipment. The example given by the interviewee from Company E is the limit of used product age imposed in Egypt, India and Brazil, i.e. items older than 3 years cannot be resold. Malaysia, worried about digital dumping, has set a new rule that any used equipment entering the market needs to be accompanied by a letter from the Environmental Regulator confirming positive test results on the product. These bans usually fail to distinguish between high-quality refurbishment to the OEM's specifications and second-hand equipment of undefined quality with the effect that customers may be denied access to the safe and economical equipment they need. A Vice President for Environmental, Health and Safety Issues (Company F) explains: *'What constitutes a difficulty is that refurbishment and remanufacturing are not well defined. There are two views: legislative and regulatory. Medical devices are heavily limited by regulation and then you need to distinguish: refurbishment in a regulatory point of view doesn't require changes in a product license, the original CE declaration. When it comes to remanufacturing and regulatory view you may change a product license for the CE marking and you have a new system in the regulatory explanation, it means that you need to fulfil all current applicable standards and regulations. Although in the legislative point of view the remanufactured product is used product, not new. We only refurbish systems so they are used products in the legislative and regulatory sense."* It means that Company F is not allowed to sell their refurbished products to some countries that perceive them in the same way as second hand products. Ill-defined quality standards together with on-going concern about dumping create a barrier to remanufacturing, specified as the most significant by ICT and healthcare companies.

4.1.4. Need for advanced price evaluation

Pricing constitutes a difficult case for remanufacturers because of the number of factors that should be considered in order to propose a product price appropriately integration operational costs and prices of new and used counterparts. A Company B's employee explains: *"When a product comes in, e.g. Switzerland take back centre is shipping a product to Germany, we need to pay Switzerland centre for a tax reason, because you need to pay a certain price, otherwise you are avoiding tax. For that reason we have a transfer price, which is based on certain circumstances. There is a mechanism behind that which is used especially by the Tax Department to define a transfer price. Now, a transfer price plus a remanufacturing cost create a minimum to cover your costs and*

of course we need to make a margin on the top of it." Moreover, the algorithm that helps set a proper price should include product age and market, e.g. a 5 year old product can be attractive in Germany but too expensive in Egypt.

4.1.5. Heavily regulated market

Market restrictions for products differ depending on company. When it comes to medical devices and aircraft engines it is clear that the market for these products is much more regulated than for ICT products or white goods. Healthcare and aerospace companies have greater impact on and the same responsibility for human health and life. Heavily regulated market hinders especially remanufacturing practices because the quality of used products input to the process is unknown and requires additional operations to ensure safety and reliability of remanufactured products. Legal and regulatory requirements therefore constitute a significant barrier for remanufacturers who want to enter the market. According to the Environmental Manager in Company F, in most cases small companies with limited financial resources are simply unable to follow these requirements and thus to conduct remanufacturing business in a proper and legal way.

4.2. Barriers that result from customer pressure

4.2.1. Changes in customer demand (e.g. from laptops to tablets)

As with traditional manufacturing, changes in consumer demand impact on remanufacturing. The demand for tablet devices illustrates this. The representative from Company E described how tablets are growing in popularity based on their cost relative to laptops, but that tablets are more difficult to remanufacture and refurbish because of their design. That said, the interviewee maintained that customer needs are changing depending on innovation: *"People buy low-end desktops for offices because they can plug them into a server, they don't need DVD readers or input devices. But equally there are more sophisticated homeworkers who need more advanced laptops and computer equipment."* The same is true for medical systems, Company F and Company I build hybrid products (new systems combined with refurbished ones) in order to fulfil changing customer needs at the lowest price.

4.2.2. High expectations for remanufacturing operations

Interviews reveal that data security determines customers' decision whether to return used products to remanufacturers and enable their reuse. Company E describes data cleaning as a "key part of the remanufacturing business". Decisions relating to data cleaning are made based on the outcome of a risk assessment test. These decisions are important because large fines can be levied if data is not handled properly. The many operations involved in data cleaning are described below (Company C): *"We don't access data on customers' computers but use a software program to watch the size of hard drives and their structure. Mostly two sectors are on the computer, one which can be easily formatted and another one unformatted named also "ghost sector" that acts as backup file and needs special tools to clean.* The Director of International Partners Compliance (Company E) explains the same process: *"We have 0% tolerance and don't accept any part that can contain data which can be recovered later. If the drive fails we move to 2 options: if the hard drive is large we degauss using electromagnetic pulse (only a magnetic hard drive's data can be cleaned this way). The second option is shredding.*" However, degaussing and shredding make reuse impossible. It is a common requirement for customers such as military, police and government departments for whom the assurance that confidential data are completely destroyed is essential. Such customers pay also attention to the safety level in a recovery facility. Company C is obligated to maintain a safe site with limited access and security screening of employees. The Director of International Partners Compliance of the Company E describes some more data cleaning problems which might, for less experience remanufacturers, be unforeseen: *"we find quite often disconnected hard drives. In large organisations people who are upgrading a hard drive after 2 years add a new one but forget about the old one, usually left for a back-up. It is a major issue for security because 10-15% of used computers have disconnected hard drives"*. Printers can also have hidden data: *"Regarding printers we run an electric safety test and a print test. It is important, because often they have some confidential documents in their memory and we have to shred them."*

The reverse stream of used cores is limited not only by customer trust in data protection but also by their perception of what quality products they eager to return and at what price. They expect to sell their used systems at high price that exceed refurbishment operations costs. In such a situation when acquisition of used products is too expensive for OEMs, they prefer to focus on production and product development rather than product recovery. Moreover, the collection of ICT products from private households (B2C) is very limited. Firstly, customers return used products at a lower rate than businesses. Secondly, they often do so in an inaccessible way for remanufacturers. Company B reported that *"When you look at what is coming back from private households, this is not for reuse because everything is in a big container so you can only destroy it"*. This means that there is only a "tiny portion that could be reused".

4.2.3. Breakdown in communication with customers

Communication with customers is a problem area for some independent remanufacturers. Company A works closely with charity and places its products in charity shops, which get a commission for every product sold. Both parties (Company A and charity shops) benefit from this collaboration but to some degree only. The remanufacturer loses control over the product location after purchase when the free service period still applies. Charity shops usually do not inform individual customers that if they are located far away and want to return the product under warranty they need to take it back to the area that Company A logistically operates.

4.3. Barriers that result from supplier pressure

4.3.1. Issues related to product acquisition contracts

Agreements with suppliers of used cores were mentioned in interviews as having great impact on product acquisition and therefore remanufacturing performance. Company A explains restriction towards collection of used products, e.g. lack of the possibility to select items, obligation to return used products which are not suitable for reuse to a council site as it is not allowed for remanufacturer to get a scrap value from these defected goods itself. This results in revenue decreases because Company A needs to handle transport and inspection operations related to these products but cannot earn by sending products to recycling centre when unsuitable for reuse. What is more, companies A and H cannot choose even the brands of goods during collection because of their non-profit status. It is an important constraint because there might be a smaller demand for less attractive brands and thus lower sales prices for these products. In addition, the remanufacturing process itself is made more difficult for two reasons. Firstly, lack of selection leads to uncertainty about the quality of used products. Secondly, there are differences in product design between different brands, which can slow down the remanufacturing process. It is easier to use or cannibalize parts from used products of one brand and to increase the availability of spare parts needed for parts replacement in defective goods.

4.3.2. Difficulty in sourcing spare parts

Most companies do not consider using new parts in their remanufactured products. For instance, interviewed IT companies operate high volumes of used products so they often have a great choice of well-functioning parts taken from collected items in order to replace defective parts. Non-profit remanufacturers seem to be in worse position because of small volumes and lower quality of collected goods. This means that technicians need to spend much time on searching the market resulting in time and opportunity costs. Technicians are taken away from other tasks in order to find new parts.

4.3.3. Communication problems with collection sites or partners

Interviews reveal that non-profit remanufacturers struggle with the communication with collection sites. Company A and Company H need to contact collection sites first in order to agree whether there are some used products available. This sometimes can be done by phone but mostly staff members need to visit a site. This is time consuming and generates transport costs. Moreover, when staff arrives at a site, they can find that competitors have already been there and collected used products.

Collaboration with partner companies can prove difficult, especially given shortages of experienced staff at one of the companies. Company B outsources some of its remanufacturing operations to Company C. Representatives from Company C suggest that due to internal changes at Company B, communication can be hindered if Company B staff lack experience, knowledge and expertise related to the remanufacturing process: *"We have to explain the process to them, which is not so easy. We are also required to fulfil a lot of firm's corporate procedures, so we have this responsibility but many of Company B's employees don't know these procedures"*.

4.3.4. Issues related to sales contracts

The financial health of any business is vital to its success, regardless whether a business is intended to make a profit or not. Non-profit Company A faces a serious problem with finances. The turnover of the company is not enough to cover the costs of operations. Typically, the remanufacturer supplies charity shops with products and does not charge for these products in advance. Instead, the company only receives payment once the product has been sold. Sometimes Company A needs to take back unsold products from a charity shop or has to discount the products. This discount can also cause financial problems, when the price is lower than refurbishment costs.

Besides frequent delays in return on investment, interviews reveal that the Defence Aerospace Division (Company G) faces market limitations because of being dependent either on air framer which has prime contract or one supplier-customer. The company is contracted to remanufacture aircraft engines for use by the government of the country that supplies them. For example they cannot remanufacture the engine that comes from Spain and sell it to the French government. There is also strong dependence upon other actors in the IT sector. EMEA Take Back Program Manager (Company H) explains *"all remanufactured products are first sold to brokers who then sell to individual customers. Brokers decide what warranty they offer with an item excluding the certified products which comes with warranty from manufacturer, e.g. a server. Price, marketing strategy and after-service depends in most cases from brokers. It means that their business affects brand image of OEM".*

4.3.5. Insufficient security and difficulties in accessing used products

Difficulties in physical handling of used products are related to insufficient product security in transportation, preventing stealing and getting special permissions to enter collection sites. In contrast to new products that are manufactured and packed at the same production plant, used products come from customers who mostly do not have dedicated packages and then these items are exposed to the risk of damage during their transport to the recovery facility. It generates a huge loss. Moreover, poorly estimated quantities of collected products might be a temptation for some people engaged in product handling to steal some. In addition, Company C, an IR who provides logistics and refurbishment services for Company B struggles to meet strict time for shipment and running a test. Company C is informed by Company B when there are 30 days till the end of the leasing contract for their customers. However, a customer is able to extend a contract even on the last day. Therefore it hinders not only organisation of transport but also planning of remanufacturing operations, a verification test in particular. The company is obliged to process whole shipment and inspection in 15 days and when the volume of used goods is unknown until the latest moment it becomes very difficult. An interviewee explains *"15 days refers to a shipment of 10 machines but also to a shipment of 1000 machines. 15 days from the moment that we pick up goods from customer anywhere in Europe to bringing them to Germany and running a verification test".*

4.4. Barriers that result from competitor pressures

4.4.1. Product design and issues with proprietary software

As results from some case studies of non-profit remanufacturers (Company A and Company H) OEMs tend to be reluctant to share knowledge about product design and to give access to used products. Product design can significantly hinder remanufacturing operations. While fixing appliances the lack of part standardisation causes lots of trouble. It is not possible to replace defective parts of one brand with working parts taken from a different brand. More surprising is that even with the same brand and model there can be completely different parts that the manufacturer takes into the production process. Part cannibalization then becomes very difficult – sometimes neither the product nor its parts can be reused because of the absence of universal parts used in production. In addition, the technician (Company A) revealed that there are also so-called 'blank machines', made by one manufacturer and then branded by another. These products are produced mostly in developing countries at a lower price and allow OEM to save costs. For technicians a brand usually signals the content of a product. However, in the case of these 'blank machines' it does not and this can cause delays in refurbishment operations. The Sales and Customer Service Specialist (Company E) explains that the brand of IT products gives a strong clue to the remanufacturer about the ease of recovery operations and cost predictions and that is why it is taken into account in pricing for secondary market.

Aside from the physical design of a product, the software designed by a manufacturer is also identified as a barrier for remanufacturing. The design of white goods can significantly hinder the remanufacturing process by increasing workload especially in the operations related to inspection, data eradication and part replacement. Regarding inspection, the identification of defects at first glance is very difficult; it takes time to find a faulty part that causes the problem. Although almost every product has software designed by the manufacturer that is printed on the circuit board, the difficulty is to find out what every code means. OEMs rarely share such data, Similarly, data eradication does not come easily; different codes depending on brand and model are necessary to reset a machine in order to cancel a problem when a part is replaced.

4.4.2. Informal remanufacturing conducted by unlicensed actors

Established companies face competition from firms that only exist for a short period and do not engage in remanufacturing in the same way. The Vice President of Environment, Health and Safety (EH&S) (Company F) suggested that such questionable business practices on the part of these competitors damage Company F's remanufacturing business. This position was outlined as such:

compared to new equipment, used medical equipment may bear additional risks (e.g. contamination, worn parts and misalignment) for the patient, user, third parties and the environment if not adequately maintained. Most independent remanufacturers of Company F's products seem to conduct poor (if any) refurbishment processes. This usually includes only cleaning and painting before reselling it to another customer. This way they cannot provide the required quality of refurbished medical systems resulting in increased risk of health and environmental damage. Moreover, bad practices of IRs negatively affect the brand image of Company F. Although the same restrictions about market access apply to third parties, independent remanufacturers deal only with refurbished products in contrast to Company F which offers also new products and has developed its own quality philosophy. The manufacturer cares about customer safety and satisfaction from the purchase and service while IRs offer only an attractive price to customers and compete with Company F.

4.5. Barriers that result from the firm's internal organisation

4.5.1. Selection requirements

High end products tend to have a long product lifetime. This affects remanufacturers working with such products. Economic reasons restrict the effective lifetime of the equipment for a particular user because they may want to take the equipment out of service and replace it with a new product. *"A product life cycle is usually 7 to 8 years, however it differs from product to product. Usually we offer to customers 10 years of spare parts availability after producing the last system, for refurbished systems this period is at least 5 years."* (Company F). It is crucial to pick used systems at the right moment of the product lifetime because when production of a new counterpart ends, manufacturing of parts becomes very expensive and negatively affects remanufacturing profitability.

4.5.2. Cost-related issues

The following operations were outlined as time-consuming and costly: cleaning, testing and data wiping. *"Cleaning is a bottleneck, e.g. for fridges it takes approximately 15 minutes per item while for cookers it lasts for a minimum of 1.5 hours per item."* (Company A). Although cookers bring the largest part of the company' income, they also generate large costs that include labour and the use of washing tools. Meanwhile, Company E asserts that asset verification test is the biggest cost driver. The company

manages to conduct physical inspection at the same time as technical testing but it is still the most time consuming. A full diagnostic test takes around 7 hours. Finally, data wiping emerged as a commonly reported time-consuming operation for ICT products. Some remanufacturers face a problem with unskilled labour and short-term employment contracts which cause a big rotation of workers under the government scheme (Company A and Company H). People who can participate in this scheme often have criminal records and no qualifications. A complex training is required to get them up to the target. A need to repeat training every half a year generates significant costs for the company.

4.5.3. Planning-related issues

IRs, even those who have contracts with OEMs, face problems with forecasting of the amount and quality of used products that enter a remanufacturing process. "*Even with leasing which is preserved to control time of return, forecasting does not seem to be easy. Although the ending time of lease contract is known it can be always extended, a customer can buy a product or return and replace"* (Company C). Keeping a constant contact with customers might help to receive feedback from them about upcoming used products. However, the relationship management employs resources such as the customer database with purchasing history that OEMs often have in relation to sales of their new products, but are not accessible for IRs. "*The uncertainty of the amount and quality of collected products means that operations work cannot be planned in advance. Technicians never know what they can expect to enter the company. It affects negatively the efficiency of work in terms of scheduling the tasks, e.g. causing delays between the operations and part replacement when new parts are needed and a used product is waiting for their delivery" (*Company J).

4.5.4. Infrastructure problems

Infrastructure problems are related to the work environment and the location of remanufacturing facilities. Company A operates in a facility where the ambient temperature changes drastically. It affects the performance of appliances, especially refrigerators and fridge freezers which need to remain at a constant temperature. This problem particularly affects refurbishment operations because the work environment plays an important role for the inspection and testing of products when external variables such as ambient temperature should stay the same. Moreover, a very low temperature in the facility during winter time has a negative impact on worker efficiency. Company A notices more staff absences during this period.

Despite online and billboard advertising of refurbished appliances, the location of Company A is inconvenient for customers who would like to visit the showroom. The facility is a part of a factory with special security restrictions and visitors need to be allowed in by security staff. Moreover, because of the location in a residential area, the facility does not attract passers-by. Company A is more a destination for customers who have planned to visit. This issue negatively affects the company's image and limits its marketing strategy.

5. An attribution model on the barriers to remanufacturing - control, stability and locus.

While all barriers are described in Section 4 in terms of how they hinder remanufacturing, this section addresses the second and third research questions and investigates the causes of these barriers to remanufacturing performance. All issues listed in Table 4 are given attributions in Table 5. In the following subsections, each of the dimensions of causal attributions, moderating factors and types of corrective actions is discussed in more detail. Specific findings from our research are highlighted as appropriate.

5.1. Locus of causation

The locus of causality dimension defines the location of a cause as internal or external to the individual. Assigning causality to something about the person or to something about the situation is perhaps the basic attributional task. Within remanufacturing business, this dimension brings into play the basic contrast between internal impediments that exist in the company itself and external barriers which involve hindrance from outside of the firm (Table 5). Similarly to Section 4, we distinguish causal attributions depending on the impact of shareholders: competitors, customers, government, suppliers or remanufacturer. When describing findings in Section 4 we introduce barriers that emerge from interviews and explain how they can be assigned to particular stakeholders, in Section 5 we explain why these barriers occur, what are possible causes for such stakeholder behaviours that hinder remanufacturing performance. Locus of causality identifies the source of the cause and suggests where to apply remedies: to the remanufacturer itself or to its relations with external stakeholders.

<Include Table 5>

It becomes apparent from our analysis of locus that remanufacturers' perception is that the main barriers arise from external factors, and can be attributed to external stakeholders rather than stakeholders directly involved in the remanufacturing process.

5.2. Stability

This dimension is basically a continuum that varies from temporary (variant) to permanent (invariant). Referring to Table 1, all attributions that are associated to competitors are stable. The overall perception is that most issues hindering product remanufacturing are classified as invariant. Take price fluctuations, for instance. Despite the fact the price always fluctuates, companies believe that the price of a new counterpart will continuously impact remanufacturing. Competitors can play with product pricing especially when they are afraid the reputation will suffer because of low quality remanufacturing and that sales of new products will decrease if remanufacturing is promoted. It is more common to act this way from competitors not directly involved in reuse (Company A and Company H). Generally, interviewed companies feel that OEMs view them as competition and when the price of a new product is so low that selling a remanufactured counterpart, obviously at even lower price, does not cover the costs of recovery operations, it constitutes a serious barrier. Product design and licence are also considered to be more enduring or stable factors. OEMs tend to be reluctant to share knowledge about product design and to give an access to product software. In addition, the lack of part standardisation discourages remanufacturing.

Attributions about the stability of causes have important implications for expectations about future behaviour and events. Looking at customer-related barriers, both low collection of used B2C products and high requirements to data security relate to the specific way of product usage. Individual customers tend to use their IT products till the very end of their life and even after these products do not longer fulfil their needs, they still store them just for keeping personal data saved on these devices. If customers decide to pass their products to remanufacturers they always value data security as priority to their return action. Given such stable attributions, similar patterns in customer behaviour can be expected in the future unless something is changed. For instance, the reverse stream of used cores is limited by customer perceptions of what quality products they are eager to return and at what price, they expect to receive cash back for their used items and often overestimate their product value. Interviewed healthcare companies complain that customers (Healthcare Service Providers) do not distinguish refurbished medical equipment from used one.

However, negotiations strongly influence, especially in case of high-value products, whether customers agree to return a product at a certain value profitable also to the remanufacturer. Negotiations are seen as a transitive attribution, which means that they can be improved in the future and beneficial for remanufacturing.

Causal attributions assigned to government pressure are mostly stable because they focus on long-term regulations. Problems that emerge from interviews include their inconsistency among different countries and misunderstanding regarding quality standards. Environmental laws are still fairly new, lacking incentives for reuse because of their development stage. On the other hand, the issue of drafting the new legislation in consultancy with practitioners is a less stable factor. Remanufacturers seek to discuss new regulations because they are obliged to adjust their business to legal principles and it is in their interest to have impact on legislation before its implementation into practice. Legislators in turn are in power of preparing new regulations and unless discussed with practitioners they can have a poor perception of the implementation phase. This is an issue that, according to remanufacturers, does not have a short-term solution.

Similarly, product acquisition and sales contracts with suppliers (collection sites and brokers) are more stable than communication problems that happen occasionally over the collaboration period. Insufficient product security which leads to stealing or product damage also occurs sporadically in transportation from collection sites to recovery facilities, mostly in long distances, depending on country and development of its logistic networks. Stable causes attributed to internal barriers such as product lifetime and operations costs, facility location and work environment strongly depend on product complexity and investment costs incurred at the beginning of remanufacturing processes. Instead, problems related to qualified human resources and predictions of quality are changing over time, e.g. depending on job applicants, their experience and ability to learn and being precise.

5.3. Controllability

The third dimension is controllability, which reflects the degree to which the cause is controllable. It refers to a cause as a subject of personal responsibility or the influence of one's own volition. Attributions of barriers to remanufacturing performance either derive from controllable or uncontrollable factors. Consistent with attribution theory, the stakeholders have varying quantities of control over their actions, so in some instances stakeholders use control over the imposed

obstacles and in other instances they do so because of constraints outside of their direct control. The controllability dimension is somehow problematic when it comes to defining whether external causes are controllable (Weiner, 1979). It appears to depend on how far back one goes in the causal chain, almost all causes are controllable by someone at some point.

All identified barriers related to competitors are controllable because they result from OEMs' preservation of intangible resources, e.g. their brand image, product design and aftermarket services offered to customers. OEMs prefer to keep an ownership of their branded used products and outsource remanufacturing operations to IRs but still manage acquisition of used cores and sales (Companies A, B, C and H). However, product design is questionable because it can be considered also uncontrollable. A representative from Company E suggested that this is likely to be the result of trends in product design, rather than a deliberate attempt by manufacturers to make remanufacturing more difficult. *"There is more work to dismantle device to take off a hard drive from domestic model (more operations), with business it is only two screws and a hard drive comes out. Two minutes job. The reason is that for a private household market device needs to be slimmer, it is made to look good rather than easy to repair. But I don't think that it is done in order to prevent independent remanufacturers from reuse, more for the cosmetic appearance."*

Competition from non-licenced IRs, instead, is a result of their financial savings. Such companies are usually present on the market for a few months only to close up their business after that and move on to another location. They pay for acquisition of used products because they decrease costs by cheap (and in many cases, poor) refurbishing operations and avoiding administration costs by not applying for a licence. Instead remanufacturers who are following legal regulations gain a competitive power by following resources: licence, brand image and reputation. The presence of non-licenced IRs constitutes an important barrier especially in the market of price-sensitive customers or for specific products which in their used conditions may bear additional risks, e.g. used medical equipment, if not adequately maintained, can cause a contamination, worn parts and misalignment for the patient, user, third parties and the environment.

Customers decide to return their used products, expect cash back and negotiate this transaction while they may have less control in terms of data security or communication with the remanufacturer. They usually have high requirements towards data eradication because they may be in charge to protect private information, promising before to somebody else not to share it with anyone. Breakdown in communication was mentioned in interviews (Company A, Company B, Company H) when sales of their remanufactured products is outsourced to charities or brokers

whose business affects their reputation. Company A complains to lose control over the product location after purchase when the free service period still applies. It happens because charity shops usually do not inform individual customers that if they are located far away and want to return the product under warranty they need to take it back to the area that Company A logistically operates. This causes misunderstanding between the remanufacturer and customers. Moreover, due to innovation demand changes (e.g. from laptops to tablets) are rather uncontrollable since customers choose products whose functionality better addresses their needs.

Attributions related to governments are mostly a subject of their control because legislators are in charge to deliver such regulations that are practical and efficient. Impractical legislation, an overlap between regulations and different requirements set by each country often result in remanufacturers being forced to deal with an administrative burden of rules. While governments admittedly have power over many difficult situations faced by remanufacturers trying to keep their business consistent with current and future laws, they argue that regardless of factors within their control, consumers cannot suffer and the reuse activities must be safe for people and environment. That is why market regulations and performance reporting is actually lack of goverments' control because sophisticated law depends strongly on a product, its application and operating country. To achieve a primary aim of product safety, medical and aerospace equipment must meet plenty of requirements to reuse operations and be monitored (performance reporting and advanced price evaluation) when moved between different countries.

Other attributions come from situations that involve suppliers and partners. Issues related to product acquisition contracts are caused by factors in control of suppliers, e.g. the absence of the possibility to select products for reuse is the consequence of suppliers willing to decide to who they will pass used products. "Some collection sites prefer to give used products to recycling companies in order to get the goods' scrap value" (Company A). Lack of any agreement generates uncertainty in the supply of used products which makes planning the remanufacturing process inherently difficult. At the same time, it gives a profit-making opportunity for suppliers who have many different choices for their used products, such as reuse, recycling or scrap. On the other hand, sales contracts are less in control of suppliers because of market limitation. In the aerospace sector product complexity requires involvement of many suppliers where one of them, an air framer keeps a prime contract. Being dependent on other parts engaged in delivery of the final product limits suppliers' control of decision-making. The same applies to the one supplier-customer principle in the Defence Aerospace Division (Company G). Due to safety reasons remanufactured aircraft engines can be

used only by the government of the country that supplies them. There is also strong dependence on other actors identified in IT sector. Brokers decide what warranty they offer to individual customers depending on their contracts with repair services.

Difficulties in communication between partners are viewed to be in their control. Interviews reveal that such problems occur in the situation when an OEM outsources remanufacturing operations to an IR, the latter complains that communication is difficult because the OEM does not put enough importance to remanufacturing and there are few employees dedicated to this process. It indicates the lack of capability for entrepreneurial orientation towards remanufacturing (the focus and a long-term vision) as opposed to the IR. Moreover, uncontrollable attribution assigned to difficult sourcing of spare parts can be explained by suppliers of new parts not always being able to offer IRs attractive prices simply because of economical reasons. Non-profit remanufacturers deal with small volumes of collected goods often characterised by lower quality. They usually buy new parts in order to remanufacture used products. At the same time target groups for their remanufactured white goods include low-income families, charities and landlords. Company H and Company A are forced to keep the price of their final products as low as possible. However, by their nature new parts are of a higher price than used ones and suppliers cannot be blamed for that. Delays in return on investment are also out of control for the IR's partner, a charity shop, because it is dependent on demand and the payment for remanufactured products can be only sent to the IR once the product has been sold.

Looking at internal attributions, the remanufacturer is in direct control for barrier causes related to product lifetime, work environment, facility location and human resources while it has less control over operational costs and predictions. Remanufacturers are dependent on specific tools and equipment needed for recovery operations, their market availability and consumption costs. Relationship management has, in turn, a great impact on forecasting and planning operations and employs resources such as customer databases with purchasing history that OEMs often own in relation to sales of their new products, unfortunately not accessible for IRs.

6. Discussion

The selection of particular corrective action is strongly influenced by remanufacturer's characteristics (firm choices). There can be distinguished three basic options for selecting remedies: do nothing,

change something about the remanufacturers (individual-directed) or change something about the environment, relation with stakeholders (situation-directed).

In this paper we examine the main barriers facing product remanufacturing. We establish that for companies engaged in product remanufacturing internal as well as external issues are the main deterrents for the activity, and that remanufacturers see the later as being the most pressing ones. This results points to the conclusion that if the levels of engagement in remanufacturing is to be extended, external factors would need to be altered. Governments is the stakeholder that seems more likely to gain from this finding, as it is at the same time one of the stakeholders with highest salience, given that governments in numerous parts of the word have both interest in remanufacturing and the necessary power to act on such interest. Improved legislation on product remanufacturing will lift some of the barriers that seem to be entirely out of control of remanufacturers.

The second part of our research examines how such barriers are perceived in terms of control and stability. Investments are carried out as an account of expectation of not only present, but also future cash flows. Our research shows that remanufactures believe that, to a large extent, the issues that hamper remanufacturing are likely not be resolved in the near future. Neither do remanufacturers fell that they can be resolved without the help of other stakeholders, not least governments. It is therefore paramount that governments signal their intention to assuage some of the concerns raised by remanufacturers as to change the perception of stability. Somewhat linked to stability is that of control. This research also uncovers evidence that remanufacturers perceive themselves as having little power to change or overcome some of the main hindrances to product remanufacturing. We believe, therefore, that engaging remanufacturers in the discussions on future legislation could change their perception of power and control over the situation. In other word, by including them more closely to discussions in new legislation aimed at promoting product remanufacturing, governments may achieve two goals. Not only it will be able to perhaps devise more cost-effective legislation, but it will also empower companies to believe that the current obstacles can be removed. Although we can only speculate as to what that will bring, we believe it will cause engagement and investment in the area to increase.

7. Conclusion

This paper explores both the sources and attributions of barriers to remanufacturing performance in order to gain more understanding on how current recovery practices are constrained by different stakeholders (sources), as perceived by organisations engaged in this industry, and to learn why they cause these obstacles (attributions). Our interviews point to the direction that all obstacles can be assigned to stakeholders and indeed companies involved in remanufacturing face problems that result mostly from external pressure while the past literature shows that barriers to adoption of remanufacturing are internal and refer to company's attitude towards product recovery, investment and attention paid to operation efficiency. An attribution model is developed, which highlights that remanufacturers attribute obstacles to remanufacturing to external pressures, perceive most of them stable in time and immutable rather than transitive. More specifically, it points to the fact that organisations are unconvinced that some of the most pressing issues will be resolved in the future, and that they believe that there is not much they can do to resolve or circumvent these issues. Moreover, we show the importance of the link between issues that hinder remanufacturing operations and the actions that are taken to solve them.

Given such stable attributions, similar patterns can be expected in the future unless something is changed. Then solving these problems seems to be more difficult and most often focus on responding to stakeholder needs. Other corrective actions can include intensifying the collaboration with policy makers in establishing efficient product take-back programmes or negotiations with customers in acquisition of used cores. In analysing barriers it is important to have in mind the context of remanufacturer's situation as some obstacles can be associated with some companies and other do not depending on moderating factors which includes firm characteristics and country-specific factors.

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