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The newly created Publicly Available Specification (PAS 141) for reusable electrical/electronic products: Goals and research needs for successful uptake

Abstract

In 2011, a governmental initiative driven by the Department for Business Innovation and Skills invited the British Standards Institute (BSI) to write and publish a Publically Available Specification (PAS) for the reuse of waste electrical and electronic equipment entitled PAS 141. The specification's ambitious goals, chief among them to reduce the amount of e-waste generated in the United Kingdom, has prompted debate as to whether they are realistic and the extent to which they can be influenced by the certification. In this paper, we propose a comprehensive framework that can be used in future research to enhance understanding of the mechanisms by which the introduction of PAS 141 certification could lead to the fulfillment of its goals, that is, successful uptake. We believe this framework can serve as a roadmap for those interested in the investigation of this novel certification and its effect on the market for reusable electrical and electronic products.

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Keywords: PAS 141, Reverse Logistics, Reuse, Illegal exports, WEEE, product reuse.

1. Introduction

Improper disposal of electrical and electronic products continues to be a growing concern of governments worldwide. European governments have attempted to address the problem by implementing the WEEE Directive, which holds manufacturers and importers physically and/or financially responsible for the waste generated by their products. Japan and parts of the United States have enacted similar legislation. Such legislation reflects what is known as the extended producer responsibility (EPR) principle (Sander et al., 2007).

Reuse, organized by individuals and manufacturers as well as reuse and recycling organizations, is one approach to curbing e-waste in the United Kingdom and elsewhere. In the United Kingdom, products recovered for reuse are prepared for resale by diverse organizations across multiple sectors including leasing organizations, white goods remanufacturers, charity shops, and third party sector organizations.

One of the main issues associated with reused products is uncertainty about quality. To date, product reuse has been bound up with uncertainty, some reused products having been tested and upgraded to a quality similar to those of new counterparts (“remanufactured” is a term often found in the literature), others not even tested. Uncertainty hinders sales of reused products because it drives quality remanufacturers out of the market. Consumer inability to gauge product quality limits reuse organizations’ incentive to offer products that are as good as new, or any good at all. A market in which consumers and sellers have asymmetric information about the products traded is unlikely to flourish (see Akerlof, 1970).

Affected at the other end of the supply chain by uncertainty with respect to product quality are original equipment manufacturers (OEMs). Lack of quality standards is a major concern for OEMs, which believe products refurbished and sold by independent remanufacturers to be of lower quality compared to new counterparts and, hence, potentially harmful to the manufacturers' brands, e.g. consumers buying faulty or poorly refurbished products may hold manufacturers are partially (Toffel, 2004; Dindarian et al., 2012).

Governments and Non Governmental Organizations (NGOs) alike are concerned about the lack of standards for reusable products, especially as relates to the export of illegal e-waste sometimes disguised as reused products.¹ Such exports, are likely to be sent abroad to be recycled using rudimentary and unsafe techniques, potentially represent serious health and environmental problems (Yang et al., 2008).

It was to reduce uncertainty about the quality of reused products that a diverse steering group representing a cross section of all sectors that manufacture, sell, use, repair, reuse, recycle, and dispose of electrical and electronic products in the United Kingdom came together under the aegis of the British Standards Institute (BSI) to develop a publicly available specification (PAS) for the reuse of electrical and

¹ This practice is outlawed by the Trans-frontier Shipment of Wastes Regulations 2007 (HM Government, 2007), supported by the terms of the Basel Convention and ratified by the member nations of the Organization for Cooperation and Economic Development (OECD, 2009).

electronic equipment (UEEE) and waste of electrical and electronic equipment (WEEE).^{2,3,4} The original aim of PAS 141 was to create for the Environmental Agency an auditable trail to discourage illegal exports to developing countries (BSI, 2011).

Upon consultation with the steering group, a broader, more encompassing scope was defined and the following overarching aims were added: to encourage reuse; to reduce e-waste; to provide a quality benchmark and specification for UEEE and WEEE; to mitigate the problem of brand damage caused by commercialization of remarketed, low quality, reused products; to deter the illegal export of WEEE deliberately mislabeled reused; to enable consumers to differentiate products that have been prepared for reuse; to promote job creation in the reuse sector.⁵

As with numerous other similarly well-intentioned environmental initiatives, there is no guarantee that PAS 141 will serve the purposes for which it was created. PAS 141's successful uptake will depend on a number of determinants and their interrelationships with the standard and its goals, which, having yet to be fully examined and understood, suggest a number of new avenues for research.

This paper aims to create a framework that can be used in future research to support PAS 141's successful certification, and to identify and translate into hypotheses these new avenues of research. The framework can also be used to identify potential threats to PAS 141, and ways they might be forestalled or circumvented.

The practical importance of better understanding how this certification might work, and ways in which it might be improved, should not, in our view, be underestimated. As the amount of e-waste continues to grow in the face of legislation (even in places in which it is stringent, legislators in Europe, in their discourses at least, having favored reuse over recycling⁶) that has failed to drive reuse to full capacity, it is of great importance that as much consumer interest as possible be generated in reused products. Certification may play an important role not only in this, but, its scope being intended to extend well beyond the United

² Reuse protocols previously published in the United Kingdom, as by the Wastes and Resource Action Program (WRAP), are regarded as reporting good practice and not to constitute certifications underpinned by legislation (WRAP, 2012).

³ The UK Department of Business Innovation and Skills (BIS) funded the PAS 141 project, which grew out of a pilot project started by the subsequently disbanded WEEE Advisory Board (WAB). Industry representatives included: Association of Manufacturers of Domestic Appliances, British Retail Consortium, British Standards Institution (Healthcare & Testing Services), Chartered Institute of Wastes Management, Community Recycling Network, Department for Business Innovation & Skills, Environment Agency, Industry Council for Electronic Equipment Recycling, Intellect, Mobile Take Back Forum, WEEE Advisory Body.

⁴ One of the co-authors participated in the preparation of PAS 141.

⁵ PAS 141, which is presently at an early stage of development, could evolve into a global standard if adopted by the International Organization for Standardization (ISO, 2011).

⁶ "Where appropriate, priority should be given to preparing for re-use of WEEE and its components, sub-assemblies and consumables. Where this is not preferable, all WEEE collected separately should be sent for recovery, in the course of which a high level of recycling and recovery should be achieved. In addition, producers should be encouraged to integrate recycled material in new equipment." Source: Directive 2012/19/EU of the European parliament and of the council of 4 July 2012 on waste electrical and electronic equipment (WEEE).

Kingdom, may potentially influence reuse of electrical and electronic products worldwide.

This rest of this paper is organized as follows. In Section 2, we describe the procedures used to elaborate our research framework. In Section 3, we outline and discuss the goals of PAS 141 together with underlying complicating issues, and review the relevant literature. In Section 4, we propose a research framework based on the preceding discussion. Our conclusions are related in Section 5.

2. Methodology

The framework proposed in this paper for needed research on PAS 141 certification is based on personal observations as well as group discussions. We began with a simple conceptual map, the initial node of which was the genesis of the certification. This node was linked directly to seven other nodes, each of which represented one of the goals of the certification. (This constituted phase 1.) The arrows, as is customary in research frameworks, denote the expectation that a construct represented in a node will moderate its successors. Observing this simple initial framework, it became evident that certain of the objectives of the certification involved obvious mental leaps. It was unclear, for example, how the creation of PAS 141 would increase employment in the reuse sector.

To enhance our understanding of the relationships among the goals of PAS 141, we included intermediate moderating factors drawn from the extent literature. These were used to help form an explanatory framework and identify any factors underlying a potential causal relationship between the creation of the certification and fulfillment of its goals. (This constituted phase 2.) Our framework, and, consequently, choice of moderating determinants was also informed by new information obtained through discussions with managers at one large independent, and one medium size independent nonprofit, remanufacturer, both UK-based.

In a subsequent step (dubbed phase 3), we formalized the relationships in terms of questions to be answered by future research.

3. What are, and what questions arise from, the goals of PAS 141?

In this section, we present the goals collected directly from the existing PAS 141 documentation. We also identify factors that moderate the achievement of each of these goals. This discussion refers to phases 1 and 2 described in Section 2.

3.1. Goal: "Encourage the reuse of WEEE as promoted by the WEEE Directive (2002)."

In light of anecdotal evidence that in the United Kingdom as well as in other industrialized countries only a very small proportion of products deemed to be at the end of their useful lifetimes are currently reused, the

first objective of PAS 141 is to expand that proportion. PAS 141's effectiveness at increasing product re-use will depend, however, on myriad factors that affect production costs and/or consumer appetite for reused products. It is therefore impossible, in the view of the authors, to predict with certainty whether this certification will lead to higher levels of reuse, or be promulgated beyond the borders of the United Kingdom. We consequently focus here on factors we deem likely to moderate the effectiveness of PAS 141 as an instrument for encouraging product reuse.

For PAS 141 to have any effect on current levels of product reuse, the perceived added value needs to outweigh the cost of the certification. An anonymous industry insider puts the cost of implementing PAS 141 in the thousands of pounds in subscription and auditing fees.⁷ Adherence must thus be perceived by companies to have value if the certification is to generate sufficient critical mass to achieve relevance.

Moreover, PAS 141 addresses only some of the sources of the currently low levels of product re-use in the United Kingdom. Product design for remanufacturing, for example, is not even on the radar. Designing products to last longer and be easily repairable, considered of paramount importance in reducing e-waste, is ignored in the current certification (Sundin et al., 2009), as is the issue of *cannibalization*, new product sales compromised by competition from reused counterparts (discussed in the following sections; a definitive treatment can be found in Atasu et al., 2010).

Misalignment of incentives among manufacturers, reuse organizations, and recyclers is also neglected in the certification. Consider a dyad composed of a reuse organization and a recycler. A product returned in good condition can generate income by being resold as a reused product, by selling on its warranty, or by recycling it. If, however, the incentives related to reuse and recycling are not aligned, part of the potential recovered value is lost. A recycler will pass a reusable product to a reuse organization only if the price paid is higher than the profit generated from recycling because, although the product will eventually be recycled following reuse, it will not necessarily be recycled by the recycler that initially acquired, and subsequently sold, it to the reuse organization.⁸

3.2. Goal: "Reduce the amount sent to landfill and incineration by diverting WEEE to be prepared for reuse."

Should PAS 141 succeed in increasing reuse, a reduction in e-waste will not necessarily follow. A product diverted from waste or recycling to reuse will eventually be returned for disposal. Reuse delays the disposal process, creating a second life for the product and value for the reuse organization and buyer (in the form of producer and consumer surplus). But this phase also has an environmental footprint (Quariguasi Frota Neto

⁷ It is also worth investigating which manufacturing sectors will benefit most from implementation of PAS 141.

⁸ The authors observed this situation. In the United Kingdom, where recyclers, being the main collectors of e-waste, are to some degree controllers of the waste stream, reuse and recycling are direct competitors.

and Bloemhof, 2012). E-waste is reduced only if the purchase of a reused product prevents a new counterpart from being bought (and manufactured). Although sometimes assumed to be the case in the literature, substantiating empirical evidence is to the best of our knowledge nonexistent. Some authors have argued that remanufacturing may, in fact, increase the overall environmental impact of a product line (Quariguasi-Frota-Neto et al., 2010; Raz et al., 2012). Another important hypothesis that needs to be tested is, therefore, whether increasing levels of reuse decreases manufacturing output.

3.3 Goal: "Provide a framework for assuring consumers of the quality and safety of REEE as differentiated from WEEE and UEEE that has not been prepared for reuse."

To generate, move, handle, reuse, recycle, treat, or dispose of WEEE in the United Kingdom an organization must register for an exemption, license, or environmental permit issued by the EA in England and Wales, Northern Ireland Environment Agency (NIEA) in Ireland, and Scottish Environment Protection Agency (SEPA) in Scotland. In the United Kingdom, volume determines options for dealing with recycling; WEEE reuse organizations, if they handle less than 1,000 tons of WEEE annually, pay the EA for an exemption, and if they process more than 1,000 tons of WEEE annually, register (and pay) the EA for an environmental permit (i.e., waste license) (Environment Agency, 2012).

In both instances, a detailed description of the reuse process is scrutinized by the EA before an exemption or permit is awarded. Prior to the introduction of PAS 141, operators simply had to submit a description of the reuse process, the EA having no guidance with respect to what constitutes a good process. Not surprisingly, the quality of products sold as reused varies substantially across remanufacturers. It is intended that PAS 141 become an industry benchmark for minimum quality standards against which exemption and permit applications can be measured.

We believe there to be a fair chance that PAS 141 can increase consumer confidence in reused products by providing a clear definition that enables consumers to differentiate between products that have and products that have not been prepared for reuse. We further believe, however, that more research is needed to establish a link between the PAS 141 certification and greater perceived attractiveness of reused products. Prior research has established that markets, that is, sellers and buyers, have over the years found ways to reduce information asymmetry and adverse selection costs, which are particularly acute in the reused products market. Among myriad cues used by consumers to assess seller and product quality are advertisements (Milgrom and Roberts, 1986), brand names (Doods et al., 1991) and country of origin (Miyazaki et al., 2005), seller's reputation (Lucking-Reiley et al., 2007, Resnick et al., 2006). We are unaware, however, of any prior research that has established whether the quality cues provided by PAS 141 could affect consumers' perceptions of, and appetite and Willingness to Pay (WTP) for, reused products. Further investigation is also needed to establish what information provided on PAS 141 certification labels will be

most effective at reassuring consumers about the quality of reused products, and how such information should be displayed. Termed information framing, the content and display of information significantly affect consumer choice, and the effect is greater for products consumers have not yet tried (Levin and Gaeth, 1988), which is, to some extent, the case for PAS 141 certified items.

Whether cosmetic and functional conditions will be similar between PAS 141 certified products and new counterparts, and whether the former will be of better quality than counterparts commercialized as used, also warrant study. Because the certification is granted on the basis of the methods employed for rework rather than on the quality of the reused products sold, it is possible for a remanufacturer following all the prescribed steps in the PAS 141 documentation to remanufacture products of inferior quality. Surely, there is no control over the quality of the end product. More research is needed to establish a link between the certification and superior product quality. Absent demonstration of such a link, further research is needed to remediate this problem if the certification is to be successful.

3.4. Goal: "Provide a framework for assuring manufacturers that placing products on the market for reuse will not adversely affect their brands or reputations for safety and quality."

Although OEMs are responsible, under WEEE regulations, for the disposal of appliances at the end of their functional lives, and duty bound by those regulations to follow the waste hierarchy and consider reuse, recycling is commonly preferred over remanufacturing and reuse for reasons chiefly of brand image. OEMs have long been resistant to reuse because of the potential for problems related to the safety and quality of reused products to negatively affect their brands, among other reasons (Toffel, 2004; Dindarian et al., 2012). Product quality is perceived to be an issue even absent the involvement of independent remanufacturers, in cases in which remanufacturing would be done entirely by OEMs. *The Guardian*, for instance, reported the following from an interview with Nokia's environmental team.

Our policy is to recycle the returned handsets, not to redistribute. Product quality is extremely important to us, and it's difficult to guarantee that on a product that we don't know how it's been used. Everybody deserves a phone that is of top quality and can last a long time, especially in places where the mobile phone can still be an investment for many people. (Source: *The Guardian* (2010)).

Such poor engagement partly explains why so few returned products are reused in the United Kingdom. Another avenue of research that warrants pursuit is, thus, whether PAS 141 certification mitigates brand damage and safety related concerns, and, if so, increases manufacturers' engagement in product reuse, i.e. manufacturers being afraid of damaging their brands do not fully engage in reuse. Even were it to assuage

manufacturers' concerns about brand image, the certification may not translate into substantially higher levels of direct engagement in reuse, that is, of manufacturers engaging as well in remanufacturing, as other factors may also play a greater role in engagement. Everything else held constant, product reuse would be expected to increase, that is, the first goal to be achieved. Higher engagement is, therefore, another instance of determinants that warrants further investigation.

Concern about the potential for remanufacturing to tarnish brand image may, however, translate into reduced attention to design for remanufacturing (which, in turn, would translate into higher remanufacturing costs). In other words, manufacturers worried that poorly reconditioned products could damage their brands may opt to design products so as to make reuse more difficult.

Concerns about *cannibalisation*, that is, about the potential impact on new product sales of competition from reused counterparts, commonly cited in the extant literature as a serious barrier to OEMs' participation in product reuse (even when there is a clear business case in favour of it), are not addressed by the PAS 141 certification (Atasu et al., 2010, Guide and Li, 2010).

3.5 Goal: "Deter the illegal export of WEEE under the guise of sham reuse."

To prevent the burden of paying for the toxic waste generated by industrialized countries from being shifted to third world countries, the Trans-frontier Shipment of Wastes Regulations made shipment of waste to non-OECD countries illegal. But shipment to these countries of end-of-life electrical appliances disguised as reuse remains of concern. The hazardous content of such waste includes lead, mercury, hexavalent chromium, and other compounds extremely polluting of soil and waste streams and harmful to human health (DIRECTIVE 2002/95/EC of the European Parliament and of the Council).

PAS 141 was initially commissioned at the request of the EA to fulfill its need for a tool to use when examining opened shipping containers destined for developing countries suspected of containing waste labeled as reused products. EA Officers (EAOs) believed some operators to be deliberately reclassifying and labeling WEEE as reuse to exploit a loophole in the Trans-frontier Shipment of Wastes Regulations, which applies only to waste and not to appliances that have completed a reuse process. Absent such a tool, EAOs' suspicions about what they perceived to be WEEE were refuted by container owners, who could nevertheless offer no supporting evidence that the contents had been through any kind of documented process leading to reuse. The content of suspect containers included, for example, defective products and products missing parts (e.g., remote controls), and inappropriately packaged products that, if they were not waste at the time of departure from UK ports, surely would be by the time they reached a port of destination in the developing world.

EAOs' work could be made more effective by PAS 141, which prohibits any but certified products

from leaving UK ports. Such regulation is pivotal to the proper functioning of a regulated market for the export of reused products, especially at a time when the EA is facing budget cuts. We thus believe that the certification can contribute to a reduction in the amount of illegal waste exported to third world countries. There remains, however, the need to provide the EA with an effective, cost-efficient way to inspect products for certification. Among technologies that might be used to ensure that products destined for export are certified is RFID tagging, which could be done at the time of refurbishing at a small and ever decreasing cost per tag. Moreover, databases containing information on products properly reused could be shared between PAS 141 certifying organizations and the EA. Systems for storing such information and certifying products as treated for reuse are already in place at some large-scale remanufacturers (interview with a large UK remanufacturer of personal computers). Previous studies that have explored the application of RFID and similar identification technologies in the context of reverse logistics (e.g., Spengler et al., 2003; Johansson and Luttrupp, 2009; and Luttrupp and Johansson, 2010) have focused on improving recycling efficiency and not considered the use of identification devices for the purpose of monitoring the export of e-waste. The authors believe, given the requisite substantiating research, that RFID technology could be usefully implemented for purposes of inspection.

It will, of course, be up to governments to decide whether to restrict export to products with PAS 141 certification. Doing so would significantly increase the visibility of the supply chains of reused products destined for export, but would result in PAS 141 certified products monopolizing the international reuse market. More research is needed to establish whether the benefits outweigh the drawbacks of restricting exports to PAS 141 certified reused products.

3.6 Goal: "Provide a tool for identifying REEE that has been subject to the preparing for reuse process as set out in PAS 141."

Providing consumers with a means to identify products subject to preparation for reuse, another of PAS 141's goals, is related to other issues discussed above, in particular, in Section 3.3.

3.7. Goal: "Encourage job creation in organizations involved in preparing WEEE and UEEE for reuse."

PAS 141 is also posited to promote job creation by increasing demand for remanufactured products and, thereby, for remanufacturing activities. The underlying assumption is that PAS 141 will increase the number of products re-sold, which, assuming all else constant, will foster job creation in the sector.

A link between the certification and job creation relies on two assumptions, (1) that certification increases the number of products being manufactured (all else being held constant), an intermediate

condition that is the basis of the first goal, which was discussed earlier, and (2) that more jobs are created in remanufacturing than may be eliminated in manufacturing as a result of competition.

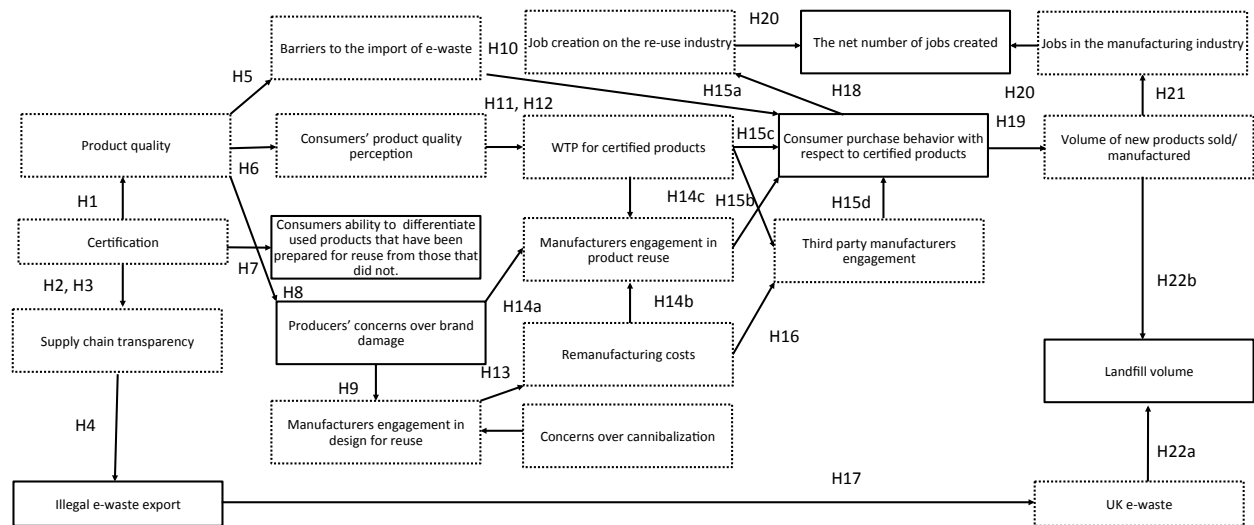
4. Overview of uncertainties surrounding PAS 141 and the research framework

In Section 3, we summarized potential moderators of the successful uptake of PAS 141, notably, the supply of, and demand for, reused products. Investigating such interrelationships will yield insights into whether and how certification might achieve its goals.

Visualization of these interrelationships is, however, not as straightforward as one might expect. A clearer picture of the complexities of the research that lies ahead is afforded by Figure 1, which elaborates the research framework we developed to summarize the relationships between creation of the certification and its goals and the influence of factors expected to moderate them.

It is clear from this framework that, as argued above, achievement of the goals of the certification is conditional on a host of external factors. As discussed in Section 2.2, for instance, a reduction in the amount of e-waste disposed of in the United Kingdom is contingent on certain intermediate conditions (e.g., some volume of reused being substituted for new products) obtaining.

Figure 2. Research framework.



Note: The network depicted in Figure 2 illustrates the interrelationships between the many goals of PAS 141 and some of the moderating factors likely to influence the outcome/attainment thereof. Dashed rectangles represent moderating factors, solid rectangles the goals.

The interrelations depicted in Figure 1 need to be investigated to enhance understanding of the way the certification will work in practice and what outcomes should be expected from it. We summarize needed venues of research in the form of 28 hypotheses (designations with a number and lower-case letter, e.g., H15a. signify that two hypotheses share the same dependent variable/construct) that need to be tested.

Table 1. Hypotheses.

n	Hypotheses	n	Hypotheses (cont.)
H1.	Certification increases the overall quality of products being certified.	H12	Information framing, i.e., what information is provided and how it is displayed on PAS 141 labels, can significantly increase the desirability of reused products.
H2	Certification increases supply chain transparency with respect to product quality.	H13	Engagement in design for remanufacturing reduces remanufacturing costs.
H3	RFID and other product identification methodologies can enhance transparency in supply chains for reusable products.	H14	Reduced concern about damage to brand image (H14a), lower remanufacturing costs (H14b), and higher WTP for reused products (H14c) increase OEMs' engagement in remanufacturing.
H4	Higher levels of transparency are positively associated with a reduction in e-waste export.	H15	Opening of new markets (H15a), higher engagement of OEMs and independent parties (H15b, H15d) in remanufacturing, and higher WTP for reused products (H15c) positively affect consumer purchase behavior, i.e., more reusable products are purchased.
H5	Increased quality standards for reused products are positively associated with an international relaxation of barriers to the import of reused products overseas (e.g., Brazil forbids the import of reused electronics; would that change if quality improves?)	H16	A decrease in remanufacturing costs positively affects the participation of independent parties in remanufacturing.
H6	Product quality affects perceived product quality (do quality standards affect <i>perceived</i> quality standards?)	H17	A reduction in the amount of waste exported translates directly into an increase in the amount of waste discarded in the United Kingdom.
H7	Consumers can easily differentiate, based on information available on the product package, between products that have and have not been prepared for reuse.	H18	Greater production of remanufactured items increases employment rates in the sector.
H8	Improving standards for reused products reduces the perceived risk they pose to manufacturers' brand image.	H19	Cannibalisation increases as a function of more reusable products being sold.
H9	Concerns about brand damage caused by poorly refurbished products affect manufacturers' decisions to engage in design for remanufacturing.	H20	The number of jobs created in the reuse sector outnumbers the jobs lost in manufacturing.
H10	Relaxation of the rules governing import of reused certified products will lead to greater demand for such products.	H21	A decrease in the number of products being sold affects employment in the manufacturing sector.
H11.	Consumers perceive certification to be a serious quality cue and are, for that reason, willing to pay more for certified products.	H22	Less waste being exported (H22a), and less product being manufactured (H22b), affects the number of products that end up in landfill.

Note: Table 1 includes some of the hypotheses relevant to the newly created PAS 141 standard.

5. Conclusion and Future Research

PAS 141 is the new certification for product reuse being proposed by the BSI. The steering group that created the certification established a set of goals, most rather ambitious (BSI, 2011). For these to be attained, however, a host of necessary intermediate conditions need to obtain. In other words, moderating determinants may affect the successful uptake of the certification. In this paper, we map these determinants and propose a comprehensive framework for future research related to the certification.

Our research shows that whereas certain goals are more directly linked to certification (albeit not necessarily attainable, e.g., to ensure the quality of certified products), others are based on conditions that may never materialise (e.g., a reduction in the disposal of e-waste).

We propose 28 hypotheses, the answers to which will help chart the course of future research related to the certification. The validation or rejection of these hypotheses can inform decisions that might spur uptake of the certification (e.g., certification increases the overall quality of products being certified). In other words, besides contributing to this stream of research enhanced understanding of some of the theoretical questions related to product reuse, we propose future research, the findings of which will improve the effectiveness of revisions to, and subsequent implementation and promotion of, PAS 141.

It is vital that the avenues of research proposed in this paper are investigated, as they inform the design of certifications aiming at increasing consumer and manufacturers confidence of reused products. The successful uptake of such certifications is very important to the proper functioning of the re-use market for electrical and electronic markets, which is important for the economy, e.g. in the UK alone, we dispose a 200 million pound worth of electronic waste every year (WRAP, 2011) and the environment.

In no way implied to be exhaustive, the proposed hypotheses nevertheless provide a useful point of departure for researchers interested in the PAS 141 certification. Apart from investigating the research questions proposed in Table 1, another possible approach, given that our framework suggests a system that is to a large extent non-linear in nature, would be to apply System Dynamics to analysis of the interrelationships between the introduction of PAS 141 and the moderating factors likely to influence the achievement of its various goals.

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