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## Encouraging Remanufacturing in the Retail Refrigeration Industry

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### Abstract

The Circular Economy is an economic and industrial system in which resources are used for as long as possible. This typically involves businesses implementing a range of alternative business models, such as remanufacture. With the manufacture of Refrigerated Display Cabinets (RDCs) being a material and energy intensive process, there is scope for remanufacturing to support a more resource-efficient production of RDCs. Despite the potential, the remanufacture of RDCs in the UK is uncommon. Many Retailers and RDC Manufacturers typically have unfavourable attitudes towards the purchase and production of remanufactured RDCs. However, more favourable attitudes could increase their Behavioural Intentions towards the purchase and production of remanufactured RDCs, which could lead to the adoption of remanufacturing across the industry. This paper gives an overview of interventions that could be implemented to encourage Retailers and RDC Manufacturers to adopt the pro-circular behaviours. The three interventions discussed in this paper are: Financial Incentives, Quality Standards and Process-Supporting tools.

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## 1. Introduction

The Circular Economy is an industrial and economic system underpinned by a variety of theories including Stahel's Closed-Loop Framework [1], McDonough and Braungart's Cradle to Cradle [2] and Pauli's Blue Economy [3], which advocate the necessity of keeping resources in circulation, in order to reduce waste and consumption of raw materials in industrial processes. The adoption of the Circular Economy involves businesses implementing a range of alternative business models (Figure 1.), such as remanufacture.

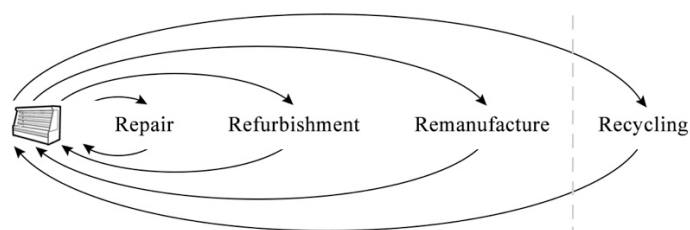


Fig. 1. RDCs and achievable steps of Circular Economy [4]

Remanufacture is a process in which good quality reusable components in end-of-life cores are used in the production of 'good-as-new' products. Products can be remanufactured depending on their technical capabilities, namely easy-disassembly, content of high quality components and long-life materials. An example of products that have a technical capability for remanufacture are Refrigerated Display Cabinets (RDCs). RDCs are extensively used in the food retail sector to display chilled food and beverages. At present, RDCs are used for 5 years on average before they are disposed of. The remanufacture has a potential to increase the functioning life of RDCs up to 15 years [5]. This could reduce waste and decrease the demand for raw materials (e.g. steel, aluminium, copper) that are used in the production of new RDCs.

Remanufacturing in the retail refrigeration industry is still uncommon and the industry continues to produce large amounts of waste from the disposal of RDCs (estimates show that in 2015, approximately 69,000 potentially remanufacturable RDCs were disposed and replaced by new units [6]). This could be due to stakeholders holding unfavourable attitudes and perceptions towards the purchase and production of remanufactured RDCs. More favourable attitudes and perceptions towards remanufacturing, could be encouraged through the introduction of appropriate behaviour change interventions.

This study uses structured surveys to measure the potential impact that Financial Incentives (the Enhanced Capital Allowance), Quality Standards and Process-Enabling Tools have on changing the Behavioural Intentions towards the purchase and production of remanufactured RDCs. Participants in this study are Retailers (who purchase RDCs for retail grocery stores in the UK) and Manufacturers (who produce and sell RDCs to UK retail grocery stores).

The results show that the Financial Incentives (the Enhanced Capital Allowance), Quality Standards and Process-Enabling Tools had a positive and statistically significant impact on the participants' Behavioural Intentions towards the purchase and production of remanufactured RDCs. This suggests the importance of further research into the development of the proposed interventions with the aim to positively influence stakeholder behaviour, that will in turn support the development of the Circular Economy in the Retail Refrigeration Industry.

## 2. Influencing Pro-Circular Behaviours: Behaviour Change Interventions

Behaviour change interventions are methods used to change human behaviour. The three interventions discussed in this paper were specifically designed and have the potential to encourage pro-circular behaviours<sup>†</sup> and if adopted, they could drive the uptake of remanufacturing in the retail refrigeration industry. Research into the development of the interventions is key in influencing more resource-efficient practices in this industry and examples are now discussed.

### 2.1. Incentivising Pro-Circular Behaviours through the extended Enhanced Capital Allowance Scheme

Financial incentives are important in driving individuals and businesses to adopt circular business models [7], particularly remanufacturing [8]. In many commercial environments price is a key consideration when purchasing products. This is particularly true in the retail refrigeration industry, where individuals (Retailers) who buy RDCs are very price-sensitive and follow the general principle that the ‘cheapest is the best’ [6].

Retailers can potentially benefit from as much as a 30% reduction in the cost of purchasing remanufactured RDCs, when compared with the price of purchasing new RDCs [9]. However, the cost of remanufacture is strongly dependent on the quality of core components at end-of-life. Therefore, any potential savings on purchasing remanufactured RDCs will vary due to the amount of remanufacturing required. The introduction of a regulated financial incentive (i.e. tax rebate) that provides a fixed discount on remanufactured products, could positively influence the purchasing behaviour of Retailers and drive demand for remanufactured RDCs. As a result Manufacturers would be more willing to implement remanufacturing into their business models.

An example of a successful financial incentive is the Enhanced Capital Allowance (ECA) scheme. The ECA scheme was introduced in the UK in 2001 to encourage businesses to reduce their energy consumption by purchasing energy-efficient products. The ECA scheme provides 20% tax relief on the purchase of new energy-efficient products on the Government’s Energy Technology List (ETL). The ETL lists 3,967 products under the ‘Refrigeration Equipment’ category, including energy-efficient RDCs [10]. Despite remanufactured RDCs meeting the eligibility criteria for the ECA scheme in terms of energy efficiency and technical specifications, they are excluded from the ETL [9]. The inclusion of remanufactured products in the ECA scheme would ultimately encourage pro-circular behaviors by providing Retailers with more stable financial incentives to purchase remanufactured RDCs [4,6].

### 2.2. Influencing Attitudes and Perceptions towards the purchase and production of remanufactured RDCs through Quality Standards.

With the quality of remanufactured products often being perceived as low [11], the development of product-specific remanufacturing quality standards could help to change behaviours [8].

At present, there is no recognised industry standard for the quality of remanufactured RDCs. This has contributed to the misconception that remanufactured RDCs are inferior to new RDCs, which goes some way to explaining why Retailers possess unfavourable attitudes to remanufacturing and can subsequently lessen their intentions to purchase remanufactured RDCs. A recognised quality standard would provide Retailers with an assurance on the quality of remanufactured RDCs and positively impact their attitudes and perceptions towards remanufacturing. The result being an increase in the demand and therefore the supply of remanufactured RDCs [9].

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<sup>†</sup> Pro-circular behaviour is “an action which is brought about due to prioritising resource-efficiency. This behaviour benefits or at least reduces damage to the environment, economy and society” [12]. Behaviours such as *purchasing* and *producing* remanufactured products are considered as pro-circular.

### 2.3. Encouraging the uptake of Pro-Circular Behaviours through Process Supporting Tools.

Having Process-Supporting Tools that provide clear guidance on how to successfully implement and practice circular business models, are important instruments to support businesses shifting to circular business practices [13, 14]. The development of industry-specific supporting tools that provide best practice and guidance on the processes of purchasing and producing remanufactured products could be key in encouraging businesses to adopt remanufacturing [8, 15].

There are currently no widely available Process-Supporting Tools that focus on remanufactured RDCs. Potential tools would include a made-to-order process which would facilitate dialog between Retailers and Manufacturers when discussing the sale of remanufactured RDCs. There are also currently no process-supporting tools available to produce remanufactured RDCs. Potential tools would include a remanufacturing framework for remanufacturers and an established library of available remanufacturable cores that are specific to RDCs.

## 3. Research Methodology

The data investigated in this study was collected from questions embedded in structured surveys. The questions were designed to evaluate the impact of Financial Incentives (extended Capital Allowance scheme), Quality Standards and Process-Supporting Tools on stakeholders' Behavioural Intentions to perform two pro-circular behaviours. The first pro-circular behaviour (1) was defined as '*buying remanufactured RDCs*' and performed by Retailers. The second pro-circular behaviour (2) was defined as '*producing remanufactured RDCs*' and performed by Manufacturers. This section outlines the research methodology used in this study.

### 3.1. Population Sample and Research Procedure

Two groups of stakeholders participated in this study. The first group of stakeholders are Retailers; these include individuals who buy RDCs for retail grocery stores in the UK. The second group of stakeholders are Manufacturers; these include individuals who produce and sell RDCs to UK retail grocery stores.

The data in this study was collected between January and September 2017. The responses from the two stakeholder groups were either completed on-line or in person. In total 25 participants including Retailers (N=19) from retail grocery stores (including 5 leading supermarket chains, 4 convenience stores and 5 symbol and independent shops) and Manufacturers (N=6) took part in the study. The majority of participants were in senior management roles (N=11), followed by a number of mid-level (N=6) and junior (N=2) managers. The participants' ages ranged from 26 to 65 years ( $\bar{x}=39$ ). The majority of them were male (90%). To ensure confidentiality, the participants' names and retail or manufacturing brands are not disclosed.

### 3.2. Survey Design

The impact of the three behaviour change interventions on the Behavioural Intentions of the stakeholders was examined using the appropriate questionnaire measures, which were developed with the support of three industry experts.

Following the development of the questionnaire measures, the questionnaire was piloted on seven individuals, including five random contributors (i.e. engineers) and two industry experts (who had expertise similar to the target population). Two individuals completed the questionnaire on-line and five in person. Their feedback was used to refine instructions, clarify the questions and improve the scales. The revised questionnaire is presented in section 3.2.1.

A reliability analysis was carried out on the Behavioural Intentions comprising of the below 4 items. Cronbach's alpha<sup>‡</sup> showed that the questionnaire items reached an acceptable reliability (*Retailers' survey*:  $\alpha = 0.77$ ; *Manufacturers' survey*:  $\alpha = 0.92$ ).

### 3.2.1. Questionnaire Items

#### a) Measuring current Behavioural Intentions of Retailers and Manufactures to purchase remanufactured RDCs

This was assessed using two single-response statements. The first statement was directed at Retailers and defined as: “*I would like to buy some factory-remanufactured RDCs for stores next year*”. The second statement was directed at Manufacturers and defined as: “*I would like to produce some factory-remanufactured RDCs for stores next year*”. The statement was assessed on a 7-point Likert [16] scale, which enabled participants to express their intention to perform the pro-circular behaviour by rating how strongly they *agree* (scored at 7) - *disagree* (scored at 1) with the statement. To ensure that participants' responses were impartial to the content of the survey, this measure was introduced prior to questions related to behaviour change interventions.

#### b) Measuring the impact of the Enhanced Capital Allowance on Behavioural Intentions of Retailers and Manufactures to purchase and produce remanufactured RDCs

This was assessed using two single-response questions. The first question was directed at Retailers and defined as: “*If factory-remanufactured RDCs were included in the Enhanced Capital Allowance (ECA) scheme, how likely would this encourage you to purchase them?*”. The second question was directed at Manufacturers and defined as: “*If factory-remanufactured RDCs were included in the Enhanced Capital Allowance (ECA) scheme, how likely would this encourage you to produce them?*”. The items were accompanied by a 7-point Likert scale, enabling participants to express how *likely* (scored at 7) - *unlikely* (scored at 1) the presence of the ECA scheme would influence their Behavioural Intentions to perform pro-circular behaviours.

This question was also accompanied by a brief explanation of what the ECA scheme entails, specifically that it provides a 20% discount on eligible energy-efficient RDCs. Despite the assumption that all stakeholders involved in the study were familiar with the scheme, this explanation was included to ensure all participants were fully aware of the benefits.

#### c) Measuring the impact of the Quality Standards on Behavioural Intentions of Retailers and Manufactures to purchase and produce remanufactured RDCs

This was assessed using two single-response questions. The first question was directed at Retailers and defined as: “*If there was a new Industry Standard for the quality of factory-remanufactured RDCs, how likely would this encourage you to purchase them?*”. The second question was directed at Manufacturers and defined as: “*If there was a new Industry Standard for the quality of factory-remanufactured RDCs, how likely would this encourage you to produce them?*”. The items were accompanied by a 7-point Likert scale, enabling participants to express how *likely* (scored at 7) - *unlikely* (scored at 1) the presence of the Quality Standards would influence their Behavioural Intentions to perform pro-circular behaviours.

#### d) Measuring the impact of the Process-Supporting Tools on Behavioural Intentions of Retailers and to purchase

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<sup>‡</sup> Cronbach's alpha [17] is a measure of the internal consistency of a scale. Cronbach's alpha describes the extent to which all the items in a test (e.g. items of Behavioural Intention) measure the same construct (e.g. the Behavioural Intention). It is expressed as a number between 0 and 1, with an acceptable value of alpha typically ranging from 0.70 to 0.95.

and produce remanufactured RDCs

This was assessed using two single-response questions. The first question was directed at Retailers and defined as: “If there was a tool or a system that could make buying factory-remanufactured RDCs easy, how likely would this encourage you to purchase them?”. The second question was directed at Manufacturers and defined as: “If there was a tool or a system that could make producing of factory-remanufactured RDCs easy, how likely would this encourage you to remanufacture them?”. The items were accompanied by a 7-point Likert scale, enabling participants to express how likely (scored at 7) - unlikely (scored at 1) the presence of the Process-Supporting Tools would influence their Behavioural Intentions to perform pro-circular behaviours.

#### 4. Results

This paper presents an analysis of data collected this study. It provides a descriptive statistical analysis of data (section 4.1. - 4.4.), including calculations of means, standard errors and standard deviations. It also contains an inferential statistical analysis of data, specifically a paired sampled t-test (section 4.5.) which was conducted to compare the means between currently held Behavioural Intentions and Behavioural Intentions impacted by presence of behaviour change interventions.

##### 4.1. Stakeholders' Behavioural Intentions

The results (shown in Table 4.1.) suggest a mix of neutral and low Behavioural Intentions towards the performance of pro-circular behaviours by the participants in both stakeholders' groups. The Behavioural Intentions of Retailers ( $\bar{x}=4.52$ ,  $SE=0.33$ ,  $SD=1.47$ ) to purchase remanufactured RDCs were more neutral, with a mix of positive and negative responses. The Behavioural Intentions of Manufacturers ( $\bar{x}=3.33$ ,  $SE=0.92$ ,  $SD=2.25$ ) to produce remanufactured RDCs were low, suggesting there was little or no intention to perform the pro-circular behaviour.

Table 4.1. Stakeholders' current Behavioural Intentions.

	N	$\bar{x}$	SE	SD	minimum	maximum
Retailers	19	<b>4.52</b>	0.33	1.47	1	7
Manufacturers	6	<b>3.33</b>	0.92	2.25	1	7

##### 4.2. ECA Scheme: Impact on Behavioural Intentions

The results (shown in Table 4.2.) suggest that the presence of an ECA scheme that includes remanufactured products would have a positive influence on Retailers ( $\bar{x}=5.74$ ,  $SE=0.21$ ,  $SD=0.93$ ) and Manufacturers ( $\bar{x}=5.33$ ,  $SE=0.33$ ,  $SD=0.82$ ) Behavioural Intentions to purchase and produce remanufactured RDCs.

Table 4.2. Influence of the extended ECA scheme on Behavioural Intentions.

	N	$\bar{x}$	SE	SD	minimum	maximum
Retailers	19	<b>5.74</b>	0.21	0.93	4	7
Manufacturers	6	<b>5.33</b>	0.33	0.82	4	6

##### 4.3. Quality Standards: Impact on Behavioural Intentions

The results (shown in Table 4.3.) suggest that the presence of a Quality Standard for remanufactured RDCs, would have a positive influence on the Behavioural Intentions of the Retailers ( $\bar{x}=5.26$ ,  $SE=0.24$ ,  $SD=1.05$ ) and Manufacturers ( $\bar{x}=5.33$ ,  $SE=0.33$ ,  $SD=0.82$ ) to purchase and produce remanufactured RDCs.

Table 4.3. Influence of Quality Standards on Behavioural Intentions.

	N	$\bar{x}$	SE	SD	minimum	maximum
Retailers	19	<b>5.26</b>	0.24	1.05	3	7
Manufacturers	6	<b>5.33</b>	0.33	0.82	4	6

#### 4.4. Process-Supporting Tools: Impact on Behavioural Intentions

The results (shown in Table 4.4.) suggest that the presence of Process-Supporting Tools would have a positive influence on the Behavioural Intentions of Retailers ( $\bar{x}=5.53$ ,  $SE=0.19$ ,  $SD=0.84$ ) and Manufacturers ( $\bar{x}=5.33$ ,  $SE=0.33$ ,  $SD=0.82$ ) to purchase and produce remanufactured RDCs.

Table 4.4. Influence of Process-Supporting Tools on Behavioural Intentions.

	N	$\bar{x}$	SE	SD	minimum	maximum
Retailers	19	<b>5.53</b>	0.19	0.84	4	7
Manufacturers	6	<b>5.33</b>	0.33	0.82	4	6

#### 4.5. Paired sample t-test: Stakeholders' Behavioural Intentions

The results of the paired sample t-test (presented in Table 4.5.) show that in the Retailers group, the ECA scheme [ $t(18)=3.67$ ,  $p<0.001$ ], Quality Standards [ $t(18)=1.83$ ,  $p=0.042$ ] and Process-Supporting Tools [ $t(18)=3.38$ ,  $p=0.002$ ] had a significant influence on the Behavioural Intentions to purchase remanufactured RDCs, with the Behavioural Intentions influenced by the behaviour change interventions scoring highly. In the Manufacturers group, all [ $t(5)=2.74$ ,  $p=0.020$ ] the ECA scheme, Quality Standards and Process-Supporting Tools also had a positive and statistically significant influence on the Behavioural Intentions to produce Remanufactured RDCs.

Table 4.5. Summary of paired sample t-test on Behavioural Intentions (BI) before and after behavior change intervention.

Behavioural Intentions	t	df	p
<b>Retailers</b>			
Current BI – BI with ECA	<b>3.67</b>	18	< .001*
Current BI – BI with Quality Standard	<b>1.83</b>	18	0.042*
Current BI – BI with Process-Supporting Tools	<b>3.38</b>	18	0.002*
<b>Manufacturers</b>			
Current BI – BI with ECA	<b>2.74</b>	5	0.020*
Current BI – BI with Quality Standard	<b>2.74</b>	5	0.020*
Current BI – BI with Process-Supporting Tools	<b>2.74</b>	5	0.020*

Hypothesis: BI before < BI after

\* Significance:  $p<0.05$ \*

Note: Student t-test

## 5. Discussion

The results (in section 4.1.) suggest that currently the Behavioural Intentions of Retailers and Manufacturers to adopt remanufacture into their business practice are low. This is demonstrated by them holding negative attitudes and perceptions towards the performance of pro-circular behaviours. An explanation for this can be attributed to concerns over price certainty, lack of guidance on how to adopt remanufacturing into business models and absence of recognised industry quality standards for remanufactured RDCs.

The results (in section 4.2. - 4.4.) suggest, that behaviour change interventions aimed at addressing those barriers (i.e. ECA scheme could help to diminish price uncertainties), could help to influence more positive Behavioural Intentions of Retailers and Manufacturers to adopt pro-circular behaviours. Together, the ECA scheme, Quality Standards and Process-Supporting Tools have shown to have a positive influence on both stakeholders' groups. Small standard deviations (*ranging from 0.82 to 1.02*) indicates that the given ratings were close to the mean, suggesting the stakeholders' answers showed little variance. Small standard error (*ranging between 0.19 and 0.33*) indicates that the investigated sample could represent a larger population, of both stakeholder groups - Retailers and Manufacturers, suggesting the potential interventions could have a similar influence on the stakeholders across the industry.

In addition, the results of paired-sample t-test (in section 4.5.) used to investigate the influence on Retailers' and Manufacturers' Behavioral Intentions, shows there were statistically significant differences between stakeholders' current Behavioural Intentions and Behavioural Intentions influenced by the behaviour change interventions, suggesting the interventions had a considerable effect.

## 6. Conclusion

The extension of the Enhanced Capital Allowance scheme to include remanufactured products, could act as a strong regulatory and financial instrument that could drive the development of a Circular Economy in the Retail Refrigeration Industry. Proposing a new product-specific Quality Standard for remanufactured RDCs could help to change stakeholders' attitudes and perceptions. The development of Process-Supporting Tools guiding the adoption of remanufacture across the sector could help the transition towards a more resource-efficient practices.

This paper encourages further research and dialogue between Retailers, Manufacturers and Policy makers on the development of the proposed behaviour change interventions. Their collective engagement is pivotal in encouraging the industry to become more resource-efficient and pro-circular.

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