Sustainable production and consumption by upcycling

Understanding and scaling-up niche environmentally significant behaviour

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A thesis submitted in partial fulfilment of the requirements of Nottingham Trent University for the degree of Doctor of Philosophy

School of Architecture, Design and the Built Environment

May 2017

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ABSTRACT

Upcycling is the creation or modification of a product from used materials, components and products which is of equal or higher quality or value than the original. Scaling-up upcycling, in theory, contributes ultimately to reducing carbon emissions by extending lifetimes of used materials, components and products, and thereby decreasing embodied energy. This PhD focuses on the emerging household behaviour of upcycling as niche environmentally significant behaviour. It aims to understand the current upcycling behaviour and factors that influence behaviour in order to develop design and policy interventions to influence behaviour in order to upscale upcycling.

Interviews, a short questionnaire study, a survey and use of a 'semi-Delphi' method (a questionnaire study followed by a workshop with experts) were employed. The interviews provided insights into current upcycling behaviour (e.g. approaches to and context for upcycling), behavioural factors influencing upcycling, and potential differences arising from demographic characteristics. The short questionnaire study showed that upcycling has potential to create high attachment leading to product longevity. The survey revealed UK-specific key behavioural factors of upcycling (intention, attitude and subjective norm) and the potential target groups for scaling-up (people in art and design aged 30 years or older) based on group differences. Synthesising the data from the interviews and surveys, 15 promising design and policy interventions for upscaling upcycling were formulated. These interventions were subsequently explored and evaluated through the semi-Delphi study. The outcome pinpointed the suitable actor(s) for each intervention and sets of important and feasible interventions for short-term and long-term success in scaling-up.

This research contributes further to knowledge in design for sustainable behaviour by suggesting interventions beyond product and communication design to influence behaviour, and demonstrating novel use of mixed methods consumer research based on a behaviour model and an existing framework for behaviour understanding and intervention. The research also contributes to knowledge in upcycling theory and

practice by providing behavioural insights, factors influencing upcycling and promising interventions for upscaling upcycling in the UK. Finally, a contribution was made to consumer behaviour theory by suggesting and testing a new combination model to understand behaviour.

ACKNOWLEDGEMENTS

I would like to acknowledge that this research was funded by Nottingham Trent University with support from the RCUK Energy Programme's funding for the Centre for Industrial Energy, Materials and Products, grant reference EP/N022645/1. Data collection and research dissemination activities were also funded partially by Design Research Society (student research bursary 2015) and Santander (travel bursary 2016).

I would like to thank everyone who has helped and supported me directly or indirectly throughout my PhD journey for the last three years as below:

- My supervisors, Prof. Tim Cooper and Dr. Sarah Kettley, for academic support and guidance as well as practical help and encouragement;
- Independent assessor, Leslie Arthur, for his insightful questions and advices;
- Examiners, Prof. Jonathan Chapman and Prof. Anthony Kent, for examining my thesis and viva;
- Research mentor, Prof. Michael White, for reviewing statistical analyses;
- Professional Research Practice tutors, Prof. Steve Allin, the late Dr. Anthony Crabbe, Lindsay Davies, Prof. Matt Henn, Prof. Rebecca Parry, Andy Sutton and other lecturers and professors that have helped me with the research, for invaluable sessions and assignments;
- CIE-MAP NTU (past and present) members, Dr. Naomi Braithwaite, Dr. Christine Cole, Dr. Alex Gnanapragasam, Patrick Keen, Dr. Ana Mestre, Carina Millstone, Dr. Mariale Moreno, Alex Rodrigues and Dr. Giuseppe Salvia, as well as other office colleagues, Chris Barr, Angharad McLaren and Dr. Laura Piscicelli, for their shared expertise, information and inspiration;
- Other CIE-MAP (past and present) members (including previous UK INDEMAND Centre members) from University of Bath, Cambridge, Leeds and Cardiff, and the Green Alliance: Prof. Julian Allwood, Prof. John Barrett, Dustin Benton, Dr. Paul Brockway, Dr. Catherine Cherry, Dr. Samuel Cooper, Simone Cooper, Dr. Jon Cullen, Dr. Jannik Giesekam, Prof. Geoff Hammond, Suzana Matoh, Dr. Jonathan Norman, Dr. Anne Owen, Prof. Nick Pidgeon, Dr. Katharine Rietig, Dr. Katy Roelich,

Dr. John Rogers, Dr. Sally Russell, Dr. Marco Sakai, Kirsten Saward, Dr. Kate Scott, Fran Sergent, Dr. André Serrenho, Dr. Katharine Steentjes, Robin Styles, and Dr. Danielle Tingely, for their intellectual stimulation, various opinions and technical support, and special thanks to Dr. Catherine Cherry again for her thorough review and proofreading of my interview analysis;

- All of my interview participants, survey respondents, and semi-Delphi study participants for their time and priceless inputs to my study;
- NTU product design team staff members, Grant Baker, Alan Crisp, Chris Ebbert, Dr. Rebecca Gamble, Bella Malya, and Dr. Daniel Shin, for helpful information and support, and special thanks to Jamie Billing, Tracy Cordingley and Prof. Tom Fisher for their initial inputs and inspiration to shape my research;
- Upcycling artist and designer, Sarah Turner, for her great work and passion, and the participation in my interview study for the portrait section;
- Postgraduate research tutor, Prof. Mike Hoxley, for giving me appropriate advice when I was in a difficult situation;
- Research support staff members, Sarah Dossor and Claire Wragg, as well as Graduate School, IT support, library, and student support staff members for their help and assistance;
- All of the people I have met at conferences (Sustainable Innovation 2014; Product Lifetimes and the Environment 2015; International Conference on Environmental, Cultural, Economic and Social Sustainability 2015; Symposium on Sustainable Development Research at Universities in the UK 2016; and Design Research Society 2016) for their shared knowledge and insights;
- My family and friends in South Korea for emotional support and faith in me;
- Fellow PhD students and other friends in Nottingham for sharing their lives with me;
- Big Bang, especially G-Dragon, for cheering me up in the darkest moments of my PhD;
- Last but not least, my brilliant partner, Dr. Julian Robinson, for his proofreading, love and care, and his lovely family members for making me feel at home.

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AUTHOR'S DECLARATION & PUBLICATIONS

I declare that the information in this thesis is original work by the author, Kyungeun Sung. The following is a list of publications by the author related to this thesis.

Sung, K., Cooper, T. and Kettley, S., 2017. Individual upcycling in the UK: Insights for scaling-up towards sustainable development. In: W. Filho (Ed) *Sustainable Development Research at Universities in the United Kingdom.* London: Springer, 193-227.

Sung, K., Cooper, T. and Kettley, S., 2016. An alternative approach to influencing behaviour: Adapting Darnton's Nine Principles framework for scaling-up individual upcycling. In: P. Lloyd & E. Bohemia (Eds) *Proceedings of DRS2016: Design + Research + Society – Future-Focused Thinking (Volume 4),* 27-30 June, Brighton. DRS, 1277-1290.

Sung, K., Cooper, T. and Kettley, S., 2016. Action across multiple levels for scaling-up sustainable behaviour: The case of individual upcycling in the UK. *In: 1st Conference on Management and Environmental Sustainability,* 20 May, Leicester.

Sung, K., 2015. Appropriate technology (Volume 1, p.46); Renewable resource (Volume 3, p.156); Source reduction (Volume 3, p.243); Waste (Volume 3, p.414). In: C. Edwards (Ed) *The Bloomsbury Encyclopedia of Design,* London: Bloomsbury Academic.

Sung, K., & Cooper, T., 2015. Sarah Turner – Eco-artist and designer through craft-based upcycling. *Craft Research,* 6(1), 113-122.

Sung, K., Cooper, T. and Kettley, S., 2015. An exploratory study on the links between individual upcycling, product attachment and product longevity. In: T. Cooper, N. Braithwaite, M. Moreno and G. Salvia (Eds) *Proceedings of* the *Product Lifetimes And The Environment (PLATE) 2015 Conference,* 17-19 June, Nottingham. NTU, 349-356.

Sung, K., Cooper, T. and Kettley, S., 2015. An exploratory study on the consequences of individual upcycling: Is it worth making people feel attached to their upcycled products? *Nottingham Trent University CADBE Doctoral Conference 2015,* 8-9 June, Nottingham (selected as the best paper).

Sung, K., 2015. A review on upcycling: Current body of literature, knowledge gaps and a way forward. *In: Proceedings of the 17th International Conference on Environmental, Cultural, Economic and Social Sustainability,* 13-14 April, Venice. WASET, 28-40.

Sung, K., Cooper, T. and Kettley, S., 2014. Individual upcycling practice: Exploring the possible determinants of upcycling based on a literature review. *In: Proceedings of the Sustainable Innovation 2014 Conference,* 3-4 November, Copenhagen. The Centre for Sustainable Design, 237-244.

1 INTRODUCTION

This chapter introduces the rationale for this PhD and describes the scope and objectives of the enquiry. It ends by providing an overview of the thesis.

1.1 Why this study?

This section explains why upcycling was selected as an alternative, but complementary, strategy to durable product design or professional services of repair or upgrading for product lifetime extension. The potential relationship between upcycling and product attachment for product longevity is described.

1.1.1 Sustainability in design and product lifetime extension

Sustainability has been emphasised by many different actors since the Brundtland report (1987) popularised the term 'sustainable development' with its widely known definition of "[meeting] the needs of present without compromising the ability of future generations to meet their own needs" (Brundtland, et al. 1987, p.41). Amongst the various advocates of sustainable development or sustainability positioned in public, private and third sectors, design academics and practitioners have also been keen to address this issue. A variety of often overlapping research themes, therefore, has emerged in the design discipline. Examples include green design (e.g. Mackenzie, et al. 1991, USA Congress 1992), eco design (e.g. Fuad-Luke 2002, Knight and Jenkins 2009), design for sustainability (e.g. Bhamra and Lofthouse 2007, Birkeland 2002, Crul and Diehl 2006), design for sustainable behaviour (e.g. Lilley 2009, Lockton, Harrison and Stanton 2008, Wever, Van Kuijk and Boks 2008), emotionally durable design (Chapman 2005), and cradle to cradle (Braungart and McDonough 2002), to name a few.

Among such diverse approaches, one way to (environmental) sustainability is sustainable consumption by increased product lifetime (Cooper 2005, Van Nes and Cramer 2005) or product lifetime optimisation (Tischner and Charter 2001, Van Hemel 1998). An extended lifetime is not per definition an environmental improvement (Van Nes and Cramer 2005) since it is recognised that in some cases

shortening lifetime is environmentally preferable – e.g. more energy efficient products for high energy consuming products such as washing machines (Brezet, et al. 1997, Charter and Tischner 2001, Kostecki 2013). Overall, however, for most products, lifetime extension is desirable from an environmental point of view (Van Nes and Cramer 2005).

1.1.2 Challenges to product lifetime extension

There are a number of ways to extend product lifetime. For example, increased product lifetime can be achieved by greater intrinsic durability, or through professional repair or upgrading services (Cooper 2002). The former, despite its straightforwardness, has been challenged by: a) negative perception of longer lifetime of products from manufacturers regarding the potential reduction of sales and profit (Van Nes and Cramer 2005); b) early replacement buyers who are more concerned with styling and image and less concerned with costs or environmental issues (Bayus 1991); c) absolute obsolescence (due to technical failure) which exerts less influence upon product lifetime than relative obsolescence (due to the evaluation of existing products in comparison with new models); d) many consumers who are wary of being locked into the prevailing technology; and e) durability which is not the major priority in purchase decision by many consumers (Cooper 2004). The latter (increased product lifetime through professional repair or upgrading services) also has its own challenges. For instance, the high cost of labour relative to energy and raw materials in most industrialised countries makes the service of repair and upgrading less cost effective than replacement purchase (Cooper 1999). Considering these challenges, the emerging consumer trend of upcycling (e.g. Cambridge News 2014, Boumphrey 2016) – making new furniture, objects, etc. out of old or used items or waste material (Cambridge Dictionary 2016) – appears to be one good alternative for product lifetime extension, satisfying consumers in terms of new style, additional functions, or other desirable product attributes, and not needing to involve potentially reluctant manufacturers or high cost professional repair or upgrade service.

1.1.3 Upcycling for sustainable production and consumption

This thesis uses the working definition of upcycling, over other existing definitions, as "the creation or modification of any product from used materials, components or products to generate a product which is equal or higher quality or value than the compositional elements" (Sung, Cooper and Kettley 2014, p.238). Other possible definitions are in Section 2.1.1. The concept incorporates creative reuse, repair and refurbishment as well as sustainable making, crafting, personalising and (re)manufacturing products without recycling. By extending the useful lifetime of products, components and materials, it is, in theory, a more sustainable way of production and consumption by individuals and industry. Such lifetime extension of products, components or materials is one of important options for material efficiency (Allwood, et al. 2012). Material efficiency, reducing the amount of new material inputs per given level of service or output, implies improving resource efficiency of an economy and reducing the energy demand for the production of goods and services, and therefore ultimately reducing greenhouse gas (GHG) emissions (Cooper, et al. 2016). See more benefits in Section 2.1.4.

1.1.4 Product attachment through upcycling

Upcycling might also be able to contribute to creating (or increasing) 'product attachment'. Product attachment, the emotional bond experienced with a product (Schifferstein and Pelgrim 2003), is an emerging concept with the potential to engender sustainable consumption (Chapman 2005, Cooper 2005, Mugge, Schifferstein and Schoormans 2004, Van Hinte 1997). The logic behind it is that so long as people are attached to any product, they might be more likely to handle the product with care, postpone its replacement or disposal, and repair it when it breaks down (Cramer 2011, Mugge 2007, Ramirez, Ko and Ward 2010, Van Hinte 1997), while not necessarily requiring people to commit themselves to pro-environmental behaviour (Van Nes 2010). Past studies have shown that such attachment can be created through the context of how the product was obtained such as special circumstances (Cooper 2002, 2005), extensive product customisation or personalisation to the user (Diegel, et al. 2010, Mugge 2007), or sheer familiarity over

time (Cooper 2002, 2005). Upcycling may be able to: a) give participants special circumstances to create or modify something by themselves; b) allow participants to extensively customise the products; and c) offer participants extended familiarity with the existing products used for upcycling (see Section 2.1.6).

1.1.5 Research needs in upcycling by consumers

Many anecdotal evidences suggest that the number of people who upcycle has increased or at least they have become more visible recently. It is possibly a response to the contemporary 'maker movement' (Anderson 2012, Lang 2013), readily available physical resources such as Hackspaces and Makerspaces, and shared digital resources (e.g. Instructables, Etsy, Folksy). Despite this growth, the absolute number of households or individuals that upcycle in developed countries is apparently not big enough to have meaningful impacts on environment, economy or society. Furthermore, regardless of its potential benefits listed above, upcycling by consumers has not yet been extensively investigated (see Section 2.1.3).

1.2 Scope of the study

This section defines the scope of this PhD by providing fundamental premises and the focus of the study, and explaining the multidisciplinary nature of the investigation.

1.2.1 Household upcycling

The particular interest of this PhD is in household upcycling (or upcycling by consumers) because: a) there is an emerging consumer trend of upcycling (Sections 1.1.2 and 1.1.5); b) upcycling extends lifetimes of used materials, components or products (Sections 1.1.2 and 1.1.3); c) it could be viewed as a promising alternative to durable design or professional services of repair or upgrade for product lifetime extension (Section 1.1.2); d) there is a potential for consumers to create product attachment by upcycling therefore leading to further product longevity (Section 1.1.4); and e) there is a clear research need in household upcycling (Sections 1.1.5 and 2.1.3).

1.2.2 Upcycling as environmentally significant behaviour

Stern provides two definitions of environmentally significant behaviour (Stern 2000, p.408):

> Environmentally significant behaviour can reasonably be defined by its impact: the extent to which it changes the availability of materials or energy from the environment or alters the structure and dynamics of ecosystems or the biosphere itself. […] Through human history, environmental impact has largely been a by-product of human desires for physical comfort, mobility, relief from labour, enjoyment, power, status, personal security, maintenance of tradition and family, and so forth […] Only relatively recently has environmental protection become an important consideration in human decision making. This development has given environmentally significant behaviour a second meaning. It can now be defined from the actor's standpoint as behaviour that is undertaken with the intention to change (normally, to benefit) the environment.

The motivation and intention behind upcycling may not necessarily be to change or benefit the environment: it can be emotional (e.g. having fun), economic (e.g. saving money) and/or social (e.g. feeling a sense of belonging to a community). This study, therefore, adopts Stern's impact-oriented definition (i.e. defining environmentally significant behaviour by its impact) and sees consumer upcycling as 'environmentally significant (impact) behaviour'.

1.2.3 Scaling-up upcycling and interventions in the UK

The UK is legally obliged to reduce its greenhouse gas emissions by at least 80% from 1990 levels by 2050 (UK Government 2015). As part of the Government's commitment to achieving this target, the Research Council's UK Energy Programme established six End Use Energy Demand centres (EUED 2015). The Centre for Industrial Energy, Materials and Products (CIE-MAP) is one of these and focuses on identifying all the opportunities along the product supply chain that may ultimately deliver a reduction in materials and energy in the UK (CIE-MAP 2015).

This study is part of CIE-MAP and looks at upcycling as an important opportunity at the household level (and potentially beyond) for contributing to reducing carbon emissions related to materials and energy consumption (Section 1.1.2 to 1.1.5). The challenge is, however, in the marginal or niche status of upcycling in the UK at the current time (Section 1.1.5). The most relevant question to ask at this point, therefore, may be how to 'scale up' (Van den Bosch 2010) this marginal activity into mainstream, everyday activity in households (and industries) to make a bigger impact on the environment. Bearing in mind the ultimate goal of creating real impacts, the particular interest of this study is in providing actionable recommendations (e.g. design and policy interventions) to influence household behaviour (and other relevant actors' behaviour) for scaling-up upcycling in the UK.

1.2.4 Multidisciplinary study

This study is approached primarily from the perspective of sustainable design (e.g. Bhamra and Lofthouse 2007, Chapman 2005, Fuad-Luke 2002, Lilley 2009), and is intended to contribute mainly to the body of knowledge in design discipline. However, it adopts theories and models from psychology to understand the behaviour of upcycling (e.g. Bamberg and Schmidt 2003, Triandis 1977), and from sociology to understand scaling-up mechanisms (e.g. Geels 2011, Van den Bosch 2010), and uses various academic and government publications dealing with behaviour change to benchmark existing interventions and intervention frameworks (e.g. Darnton 2008a, Defra 2008, Michie, van Stralen and West 2011).

1.3 Research aim and objectives

The aim of this research is to develop actionable recommendations for scaling-up upcycling in households (and possibly beyond) in order to contribute to sustainable production and consumption by reducing materials and energy consumption, with the ultimate goal of reducing carbon emissions (Section 1.2.3).

The central question addressed by this thesis is as follows:

“How might upcycling be scaled up enough to significantly contribute to sustainable production and consumption in the UK by influencing households and other relevant actors through appropriate interventions?”

The objectives based on the research question are:

- To gain insights into upcycling in the UK, paying special attention to product attachment and product longevity;
- To identify UK-specific key behavioural factors for upcycling; and
- To formulate design and policy interventions for upscaling upcycling.

1.4 Overview

The structure of this PhD and the thesis chapters are shown in Figure 1. In a bigger picture, studies on ‘understanding behaviour and consumers’, and ‘identifying key factors influencing behaviour’ lead to ‘developing interventions’ in empirical research after the literature review and research design.

Chapter 1, Introduction, explains the rationale behind the selection of the topic; justifies the scope of the study; describes the research aim and objectives; and provides this overview.

Chapter 2, Theoretical background, provides review sections based on three key knowledge domains: upcycling, understanding behaviour and scaling-up. The chapter concludes with the research gaps identified, reflections on the approaches to understand and scale up niche environmentally significant behaviour, and next steps with the selected approaches.

Chapter 3, Research methodology, begins by explaining mixed methods as research paradigm and strategy, and describes research design with research questions, the overarching framework, and the research methods and their justification. This chapter justifies sampling strategies (method, area and size) for each study; explains

validity and reliability issues; and specifies data analysis for qualitative and quantitative studies.

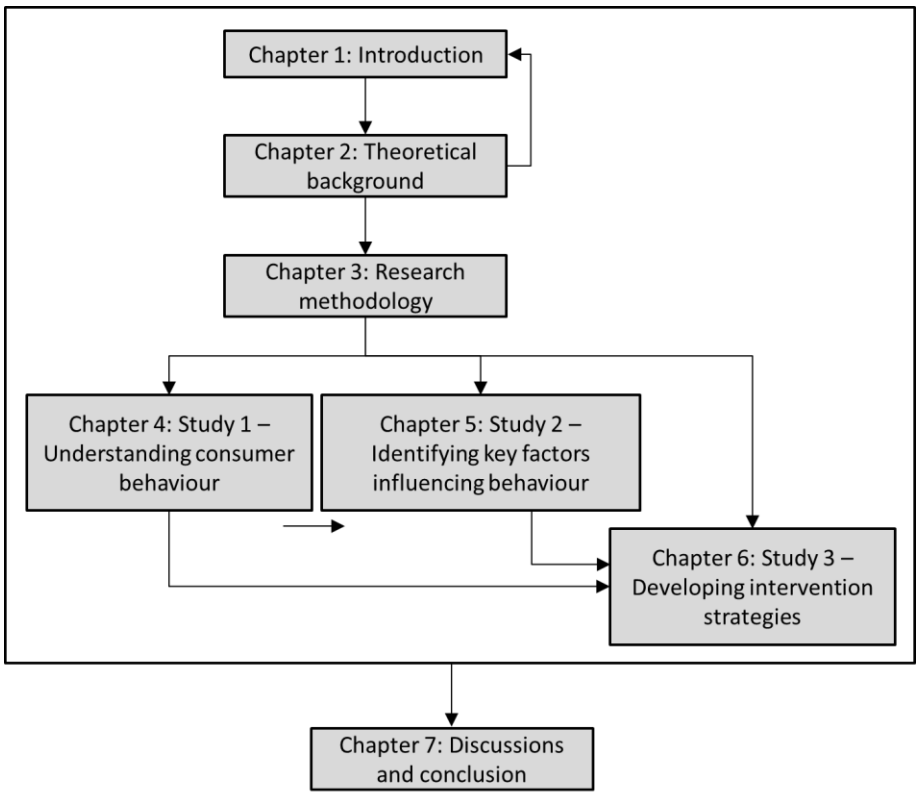


Figure 1 Thesis structure

Chapter 4 presents the first study, understanding consumer behaviour. It starts by illustrating the methods: semi-structured interviews and a short questionnaire study of 23 UK-based consumers with practical upcycling experiences. It then presents the results: current upcycling behaviour, influencing factors for upcycling, and the links between upcycling, product attachment and longevity. The chapter concludes by summarising major findings and describing the links between the results and next steps.

Chapter 5 presents the second study, identifying key factors influencing behaviour. It begins with explaining methods (a survey study with 122 British residents): descriptive statistics, correlation analysis, logistic regression, and non-parametric statistics for comparing groups on behaviour factors of upcycling. The chapter presents results and ends by summarising key findings, and illustrating the links between the results and next steps.

Chapter 6 presents the third study, developing interventions. It synthesises main findings from Chapters 4 and 5, translates them into actionable, guiding information, and generates promising interventions for upscaling upcycling. The chapter further illustrates the last empirical study (semi-Delphi: an expert questionnaire study combined with a workshop) to explore and evaluate the suggested interventions. Results of the semi-Delphi study show importance, feasibility and suitable actor(s) of each intervention; interventions for short-term and long-term success; and discussions on each intervention. The chapter concludes with a summary of results and final recommendations.

Chapter 7, Discussions and conclusion, explains how the thesis meets its aim and objectives; draws conclusions; discusses the limitations, applicability of the findings, contribution to knowledge and suggestions for future research.

2 THEORETICAL BACKGROUND

This chapter reviews literature related to three key knowledge domains in this thesis: upcycling, understanding behaviour and scaling-up.

2.1 Upcycling

This section critically reviews literature concerning upcycling in general, without applying the working definition (Section 1.1.3) as a filter to exclude certain literature. It captures a big picture of multidisciplinary research on upcycling (with different definitions, publications, trends, benefits, drawbacks and barriers from diverse subject areas and viewpoints). Section 2.1.6, however, uses the working definition as the section concerns the links between consumer upcycling and product attachment.

2.1.1 Definitions of upcycling

The term upcycling was coined and can be traced back to an interview with Riner Pilz (Kay 1994). Pilz, in the context of architecture and interior design, said, “Recycling, I call it down-cycling. They smash bricks, they smash everything. What we need is upcycling, where old products are given more value, not less.” (Kay 1994, p.14). The more widely understood meaning of upcycling in academia, however, comes from Braungart and McDonough (2002, pp.109-110):

> A technical nutrient is a material or product that is designed to go back into the technical cycle, into the industrial metabolism from which it came. […] Isolating them [technical nutrients] from biological nutrients allows them to be upcycled rather than recycled – to retain their high quality in a closed-loop industrial cycle.

Pilz (1994) appears to consider upcycling as keeping its original form as much as possible and adding more value, whereas Braungart and McDonough (2002) see upcycling as the process that maintains or upgrades materials’ value and quality in their second life and beyond in a closed-loop industrial cycle. A large number of authors cite Braungart and McDonough (e.g. Emgin 2012, Martin and Eklund 2011) or Pilz (e.g. Pak 2014, Vadicherla and Saravanan 2014) to define upcycling. Others

similarly define upcycling as the recreation of new products (artistic, scientific or functional) with higher values or qualities (Barber and Hale 2013, Eder-Hansen, et al. 2012, Garg 2012, Kibert, Chini and Languell 2000) and a more sustainable nature (Barber and Hale 2013) by converting, turning, transforming or repurposing waste or used materials or products (Ali, Khairuddin and Abidin 2013, Bramston and Maycroft 2013, Garg 2012), by reusing an object in a new way without degrading the material (Ali, Khairuddin and Abidin 2013, Gomez 2014), or by remanufacturing (Steinhilper and Hieber 2001), giving it another new life while reducing unnecessary resource expenditure (Ali, Khairuddin and Abidin 2013, Bramston and Maycroft 2013, Gomez 2014).

Overall, the central idea about upcycling is converting or transforming waste materials or used products into high value or quality outputs, either as products or materials. This thesis, however, focuses on product-level upcycling (rather than improved material recycling), adopts Pilz's perspective, and defines upcycling as the creation or modification of any product from used materials, components or products for a product which is equal or higher quality or value than the original (see Section 1.1.3).

2.1.2 State of knowledge

There are a growing number of general books on upcycling since 2008 in subject areas such as 'craft and hobbies' (53%), 'art and design' (10%), 'house and home DIY' (10%), 'science and technology' (9%), and 'business and economics' (8%) (Sung 2015). After reviewing 55 academic publications, Sung (2015) shows that most theses on upcycling (37 out of 41) have been published since 2009 (90% of the sample) within the subject areas of design engineering, textiles and clothing, art, architecture, environmental study, engineering, and business and management. Sung also exhibits a rapid growth of publication since 2008 in the areas of engineering and technology, design, business, waste management, science, literature and lifestyles, dealing with the sectors of fashion and textiles, plastic recycling, construction, organic waste treatment, automotive, electronics, and interiors.

Depending on the subject area or industrial sector, academic researchers use different language, foci and viewpoints. For example, the literature in the context of plastic recycling sees upcycling as upgraded recycling as opposed to downcycling (e.g. Czvikovszky and Hargitai 1997, Kreiger, et al. 2013, Munroe, Hatamiya and Westwind 2006). Dobrovszky (2011) explains that, during recycling process, polymer fractions can be added together with fibre reinforcement and quality improver additives to increase the value and quality of plastics. The literature in fashion and textiles, not surprisingly, focuses on textile waste in order to 'refashion' (Fraser 2011) or 'resurface' (Goldsworthy 2009) it, or make it a more valuable new product (Earley 2011, Politowicz 2009). Some researchers pay more attention to packaging (e.g. Slotegraaf 2012) and some others see upcycling as a broad approach for waste materials recovery (e.g. Farrer 2011). The importance of design assistance and the integration of bio-inspiration concepts is emphasised by design researchers (e.g. Santulli and Langella 2013), whereas engineering researchers argue that remanufacturing is the key solution for transforming downcycling into upcycling of electronics (e.g. Steinhilper and Hieber 2001).

The overall impression from such publications is that besides fashion and textiles, and plastic recycling, researchers have not paid attention to, for instance, housewares, furniture, jewellery and accessories, even though general (mostly practical) upcycling books are categorised mainly as craft, hobbies, and home DIY, and much consumer upcycling appears to be taking place in households to create these products, as shown on numerous internet websites (e.g. Google Images 2016, Instructables 2016, Pinterest 2016).

2.1.3 Trends in upcycling

Even though the term 'upcycling' is a neologism, Szaky (2014) suggests that converting waste or used objects into higher value or quality objects has existed for thousands of years as an individual behaviour. Szaky explains that reuse and upcycling were common around the world before the Industrial Revolution, and are now more common in developing countries due to limited resources. Recently, however, developed countries including the USA and the UK have paid more

attention to upcycling in commercial perspectives, due to the current marketability and the lowered cost of reclaimed or recycled materials (e.g. fibres in Vadicherla and Saravanan 2014). In the United States, for example, the number of commercial products generated through upcycling increased by more than 400% in 2011 (Slotegraaf 2012). The range of products produced by upcycling includes: rugs from fabric scraps, refashioned clothes, remade furniture, soaps and fertilisers (and energy) from organic waste, artistic objects from scrap metal, and even a whole building from reused components from deconstruction (e.g. Bramston and Maycroft 2013, Farrer 2011, Gomez 2014, Martin and Eklund 2011, Vadicherla and Saravanan 2014). The creation of jewellery, bags, clothes and other fashion items by upcycling, in particular, has been called 'trashion' (Bramston and Maycroft 2013). Competitions have been organised around trashion, numerous websites are promoting and selling commercially upcycled products, and digital and printed resources explaining how to upcycle at home are available (Emgin 2012).

The emerging debates on and actions for a circular economy embed the concept of upcycling as reuse, refurbishment, remanufacturing and recycling (Ellen MacArthur Foundation 2013). The circular economy is "gaining increasing attention in Europe and around the world as a potential way for our society to increase prosperity, while reducing dependence on primary materials and energy." (MacArthur, Zumwinkel and Stuchtey 2015). One of the strong advocates of circular economy, the Ellen MacArthur Foundation (2016) provides models and case studies with the aim of accelerating the transition to the circular economy. The case studies include remanufacturing of refuse vehicles (remanufacturing as upcycling), effective industrial symbiosis (reuse for upcycling), business-to-business (B2B) asset sharing (reuse for upcycling), cradle to cradle design of carpets (improved recycling as upcycling), retailer shifts to remanufacturing, and production of nylon yarn from waste materials (Ellen MacArthur Foundation 2016). The case studies from Ellen MacArthur Foundation (2016) show that their focus is chiefly on B2B reuse, remanufacturing and improved recycling, questioning who is doing what, when, where, and how, and querying how (un)/successful it is.

Unlike B2B reuse, remanufacturing or improved recycling in industry, consumer upcycling at households (as a deep-rooted collective human behaviour) has not yet been fully investigated. For example, how consumer upcycling can be harnessed at the household level and beyond to make a bigger impact or how it has evolved over time has not been studied. The commercial perspective of product-level upcycling beyond household behaviour is recently acknowledged (e.g. Slotegraaf 2012) and the known range of new products is broad; yet the market potential of most of these product categories is still questionable. Trashion (upcycling in fashion) might be one of the successful examples (both for amateurs and professionals), but scalability has not yet been proved.

2.1.4 Benefits of upcycling

Many researchers assert that upcycling, either as improved material recycling or product-level upcycling, generally provides reductions in environmental impact (Emgin 2012, Park and Kim 2014, Pol 2010, Santulli and Langella 2013) or contributes to a higher environmental value or performance of products (Ali, Khairuddin and Abidin 2013, Martin and Eklund 2011, Martin and Parsapour 2012, Martin and Stott 2011). Braungart and McDonough (2002) explain that upcycling as improved recycling alters the linear process of 'from cradle to grave' (or make-use-dispose) by material reutilisation in safe, perpetual cycles, which therefore eliminates the concept of waste and reduces toxic materials in biosphere. Some authors pay more attention to the role of upcycling in solid waste reduction or at least in delaying the addition of waste to landfill, or saving landfill (e.g., Bramston and Maycroft 2013, Park and Kim 2014, Zhuo and Levendis 2014). Product-level upcycling also eliminates the need for a new product (Szaky 2014), which means reducing the use of raw materials (material efficiency) and industrial energy for production, ultimately reducing greenhouse gas emissions (Cooper, et al. 2016).

Along with environmental benefits, general economic benefits are also commonly claimed. Some view economic benefits largely in cost savings in new product production (e.g. Zhuo and Levendis 2014) or in new stock material production (e.g. Hellmann, Malluche and Hellmann 2007, Munroe, Hatamiya and Westwind 2006). In

art, craft and design education, upcycling is also an easy and economical way of getting materials for student projects (Gomez 2014). The economic benefit is not limited to cost savings but also includes new profit opportunities by, for example, increasing the aesthetic values of existing products, giving uniqueness to the design, improving material quality or value (e.g. reinforcement or adding aroma to polymers), and providing other added value to materials or products (Ali, Khairuddin and Abidin 2013, Czvikovszky and Hargitai 1997, Hellmann, Malluche and Hellmann 2007, Santulli and Langella 2013, Sung and Cooper 2015). Household upcycling can also be economically beneficial for consumers by fulfilling needs with fewer financial resources and having a potential income opportunity (Frank 2013, Lang 2013, Sung, Cooper and Kettley 2014).

Social benefits are rarely discussed in the literature, although Bramston and Maycroft (2013) suggest that consumer upcycling offers an opportunity to develop inherent understanding of objects, merge disciplines, cultures and experiences, and create subjective and individual beauty while keeping the sentimental value of a used product. Other social benefits related to psychological wellbeing include experience benefits (the upcycling process as a meaningful journey and learning experiences), empowerment benefits (unlocking potential, and becoming more capable and self-reliant), a sense of community through upcycling networks, and relaxation (Frank 2013, Gauntlett 2011, Lang 2013, Sung, Cooper and Kettley 2014).

These benefits are, however, are mostly generic and descriptive rather than specific and quantified. More empirical research is needed to show the environmental impact of upcycling. When adding possible negative environmental impacts from new materials, toxicity, energy, waste and emissions in the process of upcycling from collection of the used materials, components and products to reproduction and redistribution (especially the industrial process), it may not be far better than any other forms of waste treatment. Cost-benefit analysis with real-life cases (of design change, process innovation, new ventures, etc.) may be able to confirm or dispute the cost-saving and profit generation potential. Social benefits are especially underexplored, and it is hard to quantify the real impact. More structured

longitudinal studies to monitor the social impacts in groups of people may help shed light on this area. The links between social benefits and larger environmental benefits is another underexplored area.

2.1.5 Drawbacks and barriers to upcycling

For industrial upcycling (improved recycling and remanufacturing) some researchers assert that a systemic approach (e.g. whole supply chain change, recycling networks, multidisciplinary approach) is required to make upcycling work (McDonough and Braungart 2013, Zhuo and Levendis 2014). Companies need to have a system which tracks the material flow during the lifecycle of each product they produce, and plans for how to take back and reutilise them for another product (McDonough and Braungart 2013). Such a systemic approach is not easy to achieve due to a number of issues. Technical issues include: a) possible trade-offs between current value and quality of the products and future upcyclability (e.g. durability/reliability vs. ease of disassembly) (Martin and Stott 2011); b) immature upcycling streams of different technological capacity with inability to handle all types of materials (Eder-Hansen, et al. 2012); c) difficulties and inefficiencies in collecting, cleaning, sorting, drying and homogenising materials (Czvikovszky and Hargitai 1997, Martin and Stott 2011); and d) inconsistent supply of materials with controlled quality (in terms of composition and impurities) and process complexity (Zhuo and Levendis 2014). These issues may be likely to discourage big companies from making a systemic change. Other issues appear to be mostly related to low awareness or knowledge of upcycling. McDonough and Braungart (2013) claim that companies fear that the changes are either impossible or too costly, or that they do not have enough information. Eder-Hansen et al. (2012) mention that consumers' lack of awareness of an option for their products' end of life could be another serious barrier.

For individuals as consumers, artists, makers, or entrepreneurs, there are different issues which might make product-level upcycling less attractive. Szaky (2014) gives examples of potential problems: a) relatively low-volume solution for waste reduction or prevention compared with the total volume of waste; b) small current market size; c) the niche nature of upcycled products not appealing to everyone; and

d) the limited number of consumers who are willing to separate and clean waste (e.g. packaging) for upcycling purposes. Bramston and Maycroft (2013) add that individuals find it difficult to have access to many complicated and process-intensive production methods, and the outputs from consumers can therefore often be underdeveloped or unrefined.

These drawbacks and barriers of upcycling appear to be many and varied, depending on the level of the upcycling (industrial vs. individual), types of industry, and contextual situations (e.g. market dynamics, regulations and policies, socio-cultural background). In order to ensure the success of upcycling, more case studies (industry-, product- or material-specific) are required to list systemic issues to tackle.

2.1.6 Links between upcycling and product attachment

Some types of products have been studied regarding product attachment (Section 1.1.4): for example, family heirlooms and jewellery as consumers' most favourite or most cherished possessions (Schultz, Kleine and Kernan 1989, Wallendorf and Arnould 1988) or mass-produced ordinary consumer durables (Mugge, Schoormans and Schifferstein 2005, 2006b, 2010). Past studies have shown interests in product personalisation, mass customisation and participatory design to increase product attachment (i.e. strengthening the person-product relationship) as design strategies for sustainable consumption (e.g., Chapman 2005, Cramer 2011, Fletcher 2008, Mugge, Schoormans and Schifferstein 2009). Despite the emphasis on consumer involvement in professional design practice, past studies have not paid much attention to design and creation solely by consumers or 'everyday creativity' activities (Gauntlett 2011) which do not involve professional designers or manufacturers. The examples include individual making, crafting or upcycling.

Although it is not always the case that whenever consumers upcycle items the aim is to personalise products, upcycling may include product personalisation – the process that defines or changes the appearance or functionality of a product to increase its personal relevance to an individual (Blom 2000). In such a case, upcycling is particularly relevant to product attachment. For instance, Monk and Blom (2007)

found significant correlations between the extent of personalisation (personalising the appearance of their PCs and mobile phones) and enduring emotional effects. Mugge et al. (2009) found the effects of personalisation (painting bicycles) on the strength of attachment as a result of self-expression and the extended time spent with the product. Grant et al. (2013) explored the reasons why participants felt connected to products, and found that the main reasons are strong memories, a sense of achievement and the amount of time and efforts invested. In addition, it is also possible that consumers utilise old products with which they have already developed an emotional bond. Moreover, upcycling as a creative, engaging consumer activity may offer the experiences of group affiliation (i.e. feeling affiliated to other upcyclers) and pleasure (from the process of upcycling and from the aesthetics and functionality of the end products) together with self-expression and special memories. Group affiliation, pleasure, self-expression and special memories are regarded as possible determinants of product attachment (Mugge, Schifferstein and Schoormans 2006a). Taking this into account, upcycling may have the same or similar effect as product personalisation on creating strong product attachment and potentially lead to product longevity.

2.1.7 Summary

The definitions of upcycling were reviewed, either as product-level upcycling for a higher quality and value product (e.g. Pilz in Kay 1994), or as improved recycling for higher quality or value materials (e.g. Braungart and McDonough 2002). Pilz's perspective was adopted and upcycling was defined as the process of creating or modifying any product from used materials, components or products for a product which is equal or higher quality or value product than the original (Section 2.1.1). The trend in upcycling publications revealed a gap between academic research (fashion, textiles, plastic recycling) and public interest (craft, hobbies, home DIY for housewares, furniture, jewellery and accessories) and a need to investigate household upcycling behaviour (Section 2.1.2). Environmental, economic and socio-cultural benefits of upcycling were listed (Section 2.1.4). The varied drawbacks and barriers to upcycling in different industries and contextual situations were described

(Section 2.1.5). Links between consumers' upcycling behaviour and product attachment was illustrated in relation with product personalisation (Section 2.1.6).

Future use of the term upcycling in this thesis is based on the working definition provided (Sections 1.1.3 and 2.1.1) and is in the context of consumer behaviour.

2.2 Understanding upcycling behaviour

This section provides the rationale behind the choice of behaviour model initially used to understand upcycling, and explores the selected model for empirical research. As the review reveals some issues in the chosen model, the later sub-sections suggest an alternative model to resolve the problems identified.

2.2.1 Environmentally significant behaviour

Environmentally significant behaviour can be defined by either its impact or intent behind it (Fryxell and Lo 2003, Stern 2000, Whitmarsh 2009). This thesis adopts Stern's impact-oriented definition of environmentally significant behaviour (Section 1.2.2) rather than intent-oriented definition. There are, of course, overlaps between pro-environmental intent behaviour and environmentally significant impact behaviour (Whitmarsh 2009). Certain environmentally significant impact behaviours are, however, not necessarily motivated mainly by pro-environmental intent or values (ibid). For example, in a study by Defra, of the 40% of the English public who claim to 'regularly cut down the amount of household electricity/gas', over 80% answered that they do so to save money whereas 15% do so to 'help the environment/reduce pollution' (Defra 2002). Similarly, of the 39% claiming to 'cut down car use for short journeys', about 60% do so for exercise and 25% for saving money, whereas 17% do so for environmental reasons (ibid). Another research also found that financial motivations are most common for energy conservation behaviour (Brandon and Lewis 1999).

Research on intent-oriented environmental action examines behaviour from the perspective that the motivation of the actor is related mostly to environmental issues,

and often suggests that there is a moral basis for pro-environmental action (Gatersleben, Steg and Vlek 2002, Thøgersen 1996, Whitmarsh 2009). On the other hand, research on impact-oriented environmental action tends to understand multiple factors influencing environmentally significant impact behaviour (Kollmuss and Agyeman 2002, Lindenberg and Steg 2007, Steg, Vlek and Slotegraaf 2001, Stern 2000, Tanner 1999).

2.2.2 Behaviour models to understand behaviour

Amongst psychologists and policy makers it is a common knowledge that behaviour understanding and behaviour change policies rest on certain behavioural models (either explicitly or implicitly) – exhibiting, for example, what the behaviour is, what its antecedents are, and how it is influenced, shaped and constrained. It is, therefore, crucial to decide which behaviour model to use for understanding particular behaviour.

For the environmentally significant behaviour, Stern (2000) summarises the evidence on the factors, and provides four types of causal variables: a) attitudes, values and beliefs; b) contextual forces (e.g. social, economic, institutional and political factors); c) personal capabilities and resources; and d) habit. Similarly, many researchers share a common perspective that (environmentally significant) behaviour is complex and therefore should be understood by both internal (e.g. attitude, social factors, emotions, habits) and external factors (e.g. situational constraints and conditions) (e.g., Jackson 2005a, Kallbekken, Rise and Westskog 2008, Martiskainen 2007). Most notably, Jackson extensively reviewed the literature on consumer behaviour and behaviour change regarding sustainable consumption, and concluded that “a grand unified theory of human behaviour is probably impossible. But a pragmatic synthesis is a useful starting point for policy design. Triandis’ early theory of interpersonal behaviour provides a good illustration of such a synthesis.” (Jackson 2005b, p.5). Similarly, Martiskainen (2007) reviewed different models of behaviour and change regarding households’ energy-related behaviour, and recommended Triandis’ model for its comprehensiveness.

Some researchers, in an attempt to understand the complexity of behaviour, proposed a pragmatic synthesis instead of choosing an existing model. Feola and Binder (2010) suggested an Integrative Agent-Centred framework to better understand farmers' behaviour; Klöckner and Blöbaum (2010) introduced and examined the Comprehensive Action Determination Model of ecological behaviour; Kallbekken et al. (2008) combined the Theory of Planned Behaviour (Fishbein and Ajzen 1975) and the Value-Belief-Norm Theory (Stern, et al. 1999). Despite the differences, one common aspect is that most factors in these models are included in Triandis' Theory of Interpersonal Behaviour. This provides the corroboration for Jackson's conclusion and Martiskainen's recommendation.

Triandis' model is known for its wide applicability, unlike other models: for instance, Norm Activation Theory is more appropriate for predicting altruistic behaviour and Health Belief Model for preventative health behaviour (Darnton 2008b). It has been used for technology adoption behaviour (Gagnon, Sánchez and Pons 2006), civic behaviour (Cotterill, Stoker and Wales 2008), dietary behaviour (Salonen and Helne 2012) and design intervention model for sustainable product use at home (Tang 2010), in addition to sustainable consumption (Jackson 2005a) or energy-related behaviour (Martiskainen 2007).

As noted earlier (Section 1.2.2), upcycling is environmentally significant (impact) behaviour, not necessarily motivated by pro-environmental intention. Some consumers may see it as an environmentally conscious or friendly action, while for others it may be a way of engaging with their community, or about product personalisation. From this respect, upcycling needs a versatile model which can not only explain environmentally significant behaviour but also other behaviour domains such as community participation and self-expression. Triandis' model, from its comprehensive nature and wide applicability, is, therefore, considered to be the most suitable model to understand upcycling behaviour.

2.2.3 Triandis' Theory of Interpersonal Behaviour

Triandis (1977) explained three determinants of the probability of behaviour: the behaviour intention; the strength of the habits; and the presence or absence of conditions that hinder or facilitate performance of the behaviour (See grey in Figure 2). The equation for probability of an act is: $P_a = (W_H*H + W_I*I)*F$. W_H is the weight of the habit, H is the habit to act, W_I is the weight of intention, and I is the intention to act. F is facilitating conditions – "the total situation in which a subject and another find themselves" (Triandis 1977, p.208). How Triandis defined the facilitating conditions is vague, and the examples he provided are not a comprehensive list (e.g. "the ability of the person to carry out the act, the person's arousal to carry out the act, the person's knowledge" (Triandis 1977, p.10)).

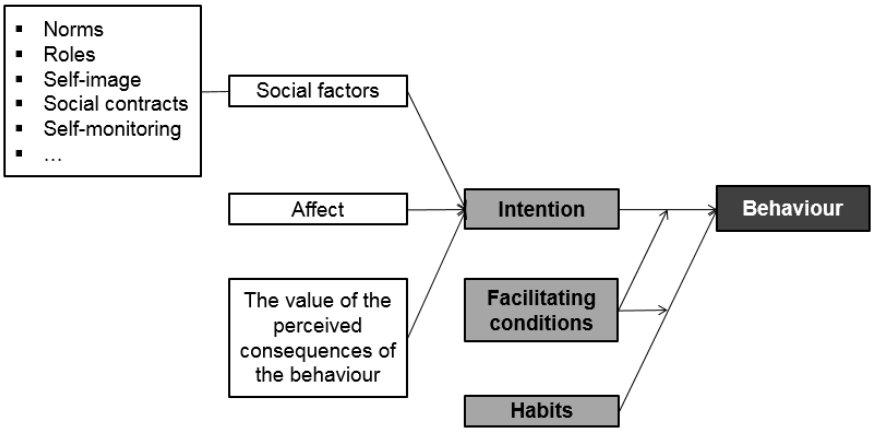


Figure 2 Triandis' Theory of Interpersonal Behaviour model

Triandis (1977) identified three determinants of behaviour intention: social factors such as norms, roles, self-image, social contracts and self-monitoring; affect (i.e. emotions) attached to the behaviour; and the value of the perceived consequences of the behaviour (Figure 2). Social norms are "beliefs that certain behaviours are correct, appropriate, or desirable and other behaviours are incorrect, inappropriate, immoral, or undesirable" (Triandis 1977, p.8). Roles are "sets of behaviours that are considered appropriate for persons holding particular positions in a group" (ibid). Self-image is "a person's ideas about who he or she is" (Triandis 1977, p.9). These three elements are commonly used to explain social factors. Affect is "the emotion a person feels at the thought of the behaviour, which might be positive (pleasant) or negative (unpleasant) and strong or weak" (ibid). Triandis explained perceived

consequences and value of the consequences separately. Perceived consequences are "the subjective probability (the person's bet) that certain consequences will follow a behaviour" (ibid). The value of the consequences is "how good or bad one would feel if a particular consequence actually happened" (ibid). The equation for behaviour intention is: $I = W_S * S + W_A * A + W_C * C$. S is social factors; A is affect; and C is the value of the perceived consequences. W_S, W_A, W_C are weights of social factors, affect and the value of the perceived consequences.

In theory, if respondents (to the survey created on the basis of the model) answer that there are relevant social factors, positive affect, and positive value of the perceived consequences of the behaviour, those answers are positively correlated with the extent of intention. High intention and highly frequent past behaviour explain the high percentage of variance in the frequency of present and future behaviour. The effect of intention and habits are however moderated by facilitating conditions.

2.2.4 Elements of Triandis' Theory of Interpersonal Behaviour

A refined model and explanation of Triandis' Theory of Interpersonal Behaviour can be found in Jackson's work (2005a). Jackson explains that social factors and emotions (i.e. affect), along with attitude, play the key role in forming intention, that past behaviour (i.e. habits) exerts a significant influence on present behaviour, and that the influences from intention and habits are moderated by facilitating conditions (Jackson, 2005a). "My behaviour in any particular situation […] is a function partly of what I intend, partly of my habitual responses, and partly of the situational constraints and conditions under which I operate" (Jackson, 2005a, p.95) (see Figure 3).

As Jackson's work is more understandable and compatible with other contemporary behavioural theories (e.g. inclusion of attitude[1]), the following sub sections explain each factor based on Jackson's model.

1 Triandis believed that attitude is a non-expert's concept and should be used by social scientists in a loose way. He argued that for precise discussions, scientists should use three terms: behavioural intention, affect and beliefs about the attitude object. He

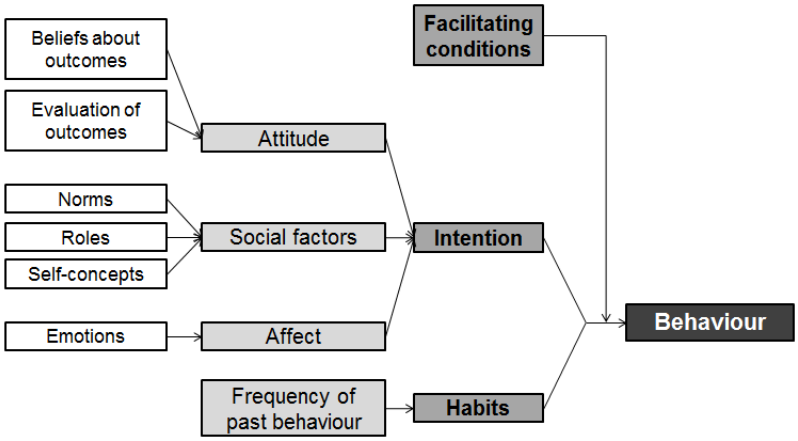


Figure 3 Triandis' Theory of Interpersonal Behaviour model as adapted by Jackson

2.2.4.1 Intention

Intention is the immediate antecedent and key determinant of behaviour in many popular behaviour models such as the Theory of Reasoned Action (Fishbein and Ajzen 1975) and the Theory of Planned Behaviour (Ajzen and Madden 1986) as well as the Theory of Interpersonal Behaviour (Triandis 1977). It is generally regarded as a key predictor of behaviour unless the behaviour is either entirely habitual or entirely altruistic. Intention predictors in the Theory of Interpersonal Behaviour are attitude, social factors and affect (Jackson, 2005a).

2.2.4.2 Attitude

Attitude toward a behaviour is "a person's overall evaluation of performing the behaviour in question (Ajzen 2002, p.5) or "the perceived value of the expected consequences" (Jackson, 2005a, p. 94). It is one of key determinants of intention in Theory of Interpersonal Behaviour (TIB), as well as in Theory of Reasoned Action and Theory of Planned Behaviour. Both beliefs about outcomes and evaluation of outcomes shape the attitude (Jackson, 2005a).

therefore avoided using the term, attitude. However, in his model without using the term, he explained that behavioural intention depends on the attitude towards the act, and attitude toward the act depends on beliefs about the act and on the evaluative aspect of each of these beliefs (Triandis 1977, p.200).

2.2.4.3 Social factors

Social factors are one of three predictors of intention. Social factors include norms, roles and self-concept. Norms are "social rules about what should and should not be done" (Jackson 2005a, p.94). Jackson referred the original definition from Triandis to explain roles (see Section 2.2.2). Self-concept is "the idea that I have of myself, the goals that it is appropriate for this kind of person to pursue or to eschew, and the behaviours that this kind of person does or does not engage in" (Jackson 2005a, p.94).

2.2.4.4 Affect

Affect is another predictor of intention as an unconscious input to decision-making. It is based on "emotional responses to a decision or to a decision situation […] distinct from rational-instrumental evaluations of consequences [which are] both positive and negative emotional responses of varying strengths" (Jackson, 2005a, p.94).

2.2.4.5 Habits and facilitating conditions

Habits determine behaviour along with intention in the Theory of Interpersonal Behaviour (Jackson, 2005a). Facilitating conditions as the moderator of the effects from intention and habits are regarded by Jackson as "a similar concept to Stern's notion of external contextual factors" (Jackson, 2005a, p.93). Stern (2000) defined such external contextual factors as follows: a) interpersonal influences; b) community expectations; c) advertising; d) government regulations; e) other legal and institutional factors; f) monetary incentives and costs; g) physical difficulty of specific actions; h) capabilities and constraints provided by technology and the built environment; i) the availability of public policies to support behaviour; and j) various features of the broad social, economic and political context.

2.2.5 Issues in the Theory of Interpersonal Behaviour

Bamberg and Schmidt (2003) acknowledged that Triandis' Theory of Interpersonal Behaviour (TIB) has received little attention, whereas the Theory of Reasoned Action (TRA) and the Theory of Planned Behaviour (TPB) were more frequently utilised and cited in research since the 1970s (Armitage and Conner 2001, Conner and Sparks

2005, Fishbein 1979, Francis, et al. 2004, Madden, Ellen and Ajzen 1992, Montano and Kasprzyk 2015, Sheppard, Hartwick and Warshaw 1988). Jackson (2005a) similarly recognised that TIB has been used far less than TPB or the Norm-Activation model (De Groot and Steg 2009, Harland, Staats and Wilke 2007, Joireman, et al. 2001, Monteith, Deneen and Tooman 1996, Liere and Dunlap 1978), especially in relation to pro-environmental behaviour. Jackson argues that it is partly because of the greater complexity in TIB, or the lack of parsimony of the model.[2] Godin (in Araújo-Soares and Presseau 2008) used similar reasons to explain why TIB is so rarely tested: a) researchers' preference towards parsimonious models[3]; b) no clear guidelines for the operational definition of the variables in TIB; and c) relatively late awareness of the value of TIB by the scientific community. The vagueness in Triandis' work, including the lack of clear guidelines for the operational definition, is partly because he intended it: "My formulation is intentionally vague, to encourage further research and avoid premature freezing on a particular form" (Triandis, 1977, p.233).

There are a few recent examples showing a clear framework and guidelines to use TIB for empirical research (Gagnon, et al. 2003, 2006, Bamberg and Schmidt 2003, Knoeri and Russell 2014). They are, however, not strictly based on the original model of TIB. The reasons behind this may include the ambiguities in the original model, researchers' different interpretations of them, and, to some extent, unavoidable adaptation depending on the behaviour under investigation.

For example, Gagnon et al. (2003) used perceived consequences in a way that encompasses the value of the consequences by referring to the Technology Acceptance Model (Venkatesh and Davis 2000). They separated norms as perceived social norms (including role beliefs and normative beliefs) and personal normative belief. Gagnon et al. (2006) in the context of health practitioners' behaviour, slightly modified the theoretical model such that it has three belief categories: a) social

2 The principle of parsimony (also known as Ockham's Razor) is a fundamental aspect of science (Hone 2008). The idea of Ockham's Razor has been expressed as "It is vein to do with more what can be done with less" or "An explanation of the facts should be no more complicated than necessary" (Jefferys and Berger 1992).
3 A model that accomplishes a desired level of explanation or prediction with as few predictor variables as possible (Meys 2011) or a model that contains the minimum number of factors needed to fully capture the information (Stork and Keenan 2010).

normative beliefs (including normative beliefs and role beliefs); b) personal normative beliefs (including personal norm, self-identity, and professional norm); and c) attitudinal beliefs (including perceived consequences and affect). In a more recent paper on health technology adoption behaviour (Gagnon, et al. 2010), they used the same model from 2003. Following Gagnon et al.'s research, Knoeri and Russell (2014) designed the survey to study everyday energy and water saving actions in households. They used Gagnon et al.'s adapted model (see Figure 4 for two adapted models).

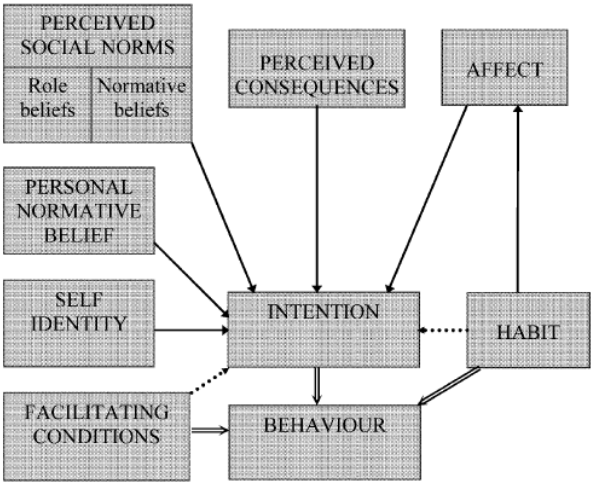
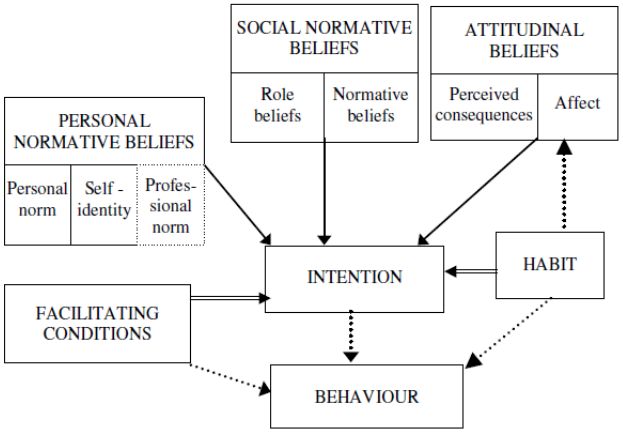


Figure 4 The adapted model of Theory of Interpersonal Behaviour (TIB) for technology adoption



The adapted TIB model for health practitioner's behavior, and energy and water saving actions in households

Bamberg and Schmidt (2003) used a different set of variables, with different terms, to test TIB in a study to compare the predictive power of three different behaviour models in the context of car use. They used behavioural beliefs rather than perceived consequences, and control beliefs rather than facilitating conditions, and omitted self-identity element (on the left in Figure 5). Behavioural beliefs are the likely consequences of the behaviour (Bamberg and Schmidt 2003), which can be considered as a synonym of perceived consequences. Control beliefs are required resources and potential impediments or obstacles, which are similar to facilitating conditions. The difference is that Triandis (1977) saw the facilitating conditions as the external factors which moderate the effects of intention and habits; Gagnon et al., (2003; 2006; 2010) saw it as a possible common predictor for both intention and behaviour; and Bamberg and Schmidt (2003) borrowed the term 'control beliefs' from TPB and used it as a predictor of intention. When looking at the actual questions

for facilitating conditions or control beliefs, there is not much difference in survey questions: researchers ask about monetary incentives and costs, physical difficulty, capabilities and constraints provided by technology and the built environment (Gagnon, et al. 2003, Bamberg and Schmidt 2003, Knoeri and Russell 2014). How the question was formed is slightly different: Gagnon et al. (2003) used an impersonal question (e.g. to what extent could the following elements impede telemedicine utilisation in their practice?), whereas Bamberg and Schmidt (2003) used a personal question (e.g. do you own a car?).

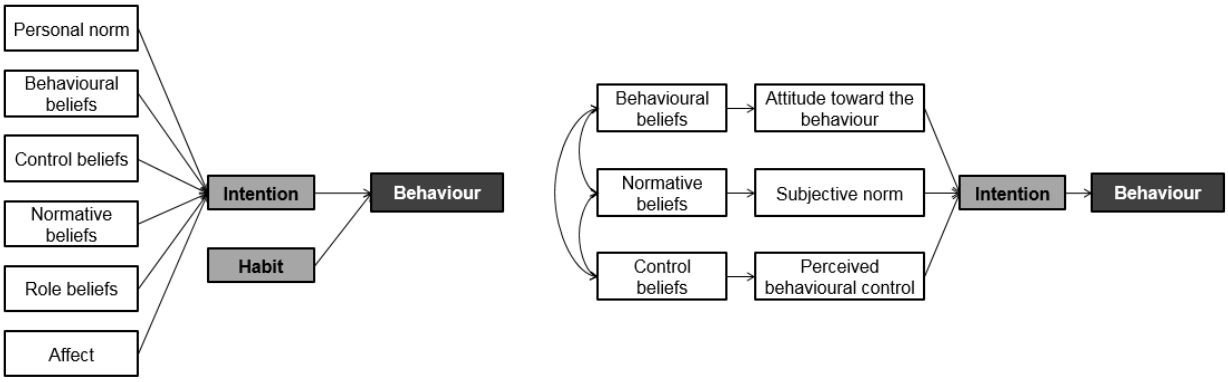


Figure 5 Triandis' Theory of Interpersonal Behaviour model

Ajzen's Theory of Planned Behaviour model

Bamberg and Schmidt (2003), after the comparative analysis between TIB, TPB and the Norm-Activation model in the car use, reported findings regarding empirical research with these three models (but mainly about TIB and TPB) [4]. Three out of six constructs in TIB were statistically significant direct predictors of intention: behavioural beliefs, control beliefs and role beliefs. Compared to TPB, the much more complex TIB explained only 8% more intentional variance. Attitude, subjective norm and perceived behaviour control seemed to mediate the effects of affect, behavioural beliefs, control beliefs, social normative beliefs, and moral beliefs (personal norm) on intention as suggested by TPB. Role beliefs in TIB had a significant, very strong effect on intention. If one subsumes the subjective norm and the role beliefs under social factor, TPB is empirically confirmed that attitude, perceived behaviour control and social factors are the three main determinants of the intention building process. Habit significantly increased the predictive power of TPB.

4 The central variable of the Norm Activation model – personal norm – exerted no significant effect either on intention or on behaviour (Bamberg and Schmidt 2003).

2.2.6 Revised behaviour model

Taking into account the complexity and vagueness of Triandis' Theory of Interpersonal Behaviour (TIB) in operationalisation,[5] and the limited explanatory or predictive power of Ajzen's Theory of Planned Behaviour (TPB), the two were combined in order to achieve better operationalisation (than TIB) as well as stronger explanatory or predictive power (than TPB) (see Figure 6).

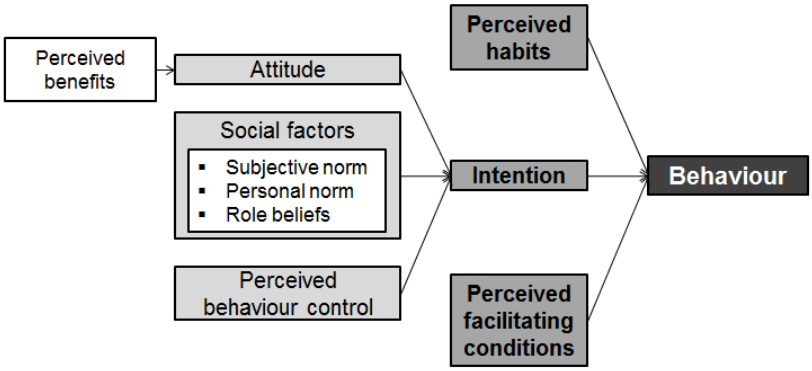


Figure 6 Combination model of Theory of Interpersonal Behaviour and Theory of Planned Behaviour

2.2.6.1 Intention and attitude

The (empirically confirmed) three main determinants of the intention building process (attitude, social factors and perceived behaviour control, subsuming the subjective norm and the role beliefs under social factors) were included in the combination model. Although perceived benefits are not a direct predictor for intention or behaviour, this study includes it for the potential implication of the findings from the studies. Triandis (1977) and Jackson (2005a) regarded both 'perceived consequences' and 'value of consequences' (either good or bad) as the attitude determinants, but this study only considers 'perceived consequences with positive value attached to the expected and/or experienced consequences,' which can then be translated simply into 'perceived benefits'.

5 "A process of defining the measurement of a phenomenon that is not directly measurable, thought its existence is indicated by other phenomena" (Wikipedia 2016a)

2.2.6.2 Social factors

The combination model includes subjective norm and role beliefs as two major social factors. As normative beliefs in the Theory of Interpersonal Behaviour (in the adapted models) appear to be breakdowns of subjective norm in Theory of Planned Behaviour,[6] it was excluded from the combination model. Self-concept was also excluded for the lack of consensus in testing.[7] This study, however, does not exclude personal norm[8] different from subjective norm.[9] The combination model, therefore, contains three elements as social factors: subjective norm (as in Theory of Planned Behaviour), personal norm and role beliefs, as in the adapted Theory of Interpersonal Behaviour by Gagnon et al. (2003; 2006).

2.2.6.3 Perceived behaviour control, facilitating conditions and habits

Perceived behaviour control is one of three direct predictors of intention in the Theory of Planned Behaviour. It refers to the "control over performing the defined behaviour" (Ajzen, 2002, p.2). As objective facilitating conditions are not observed by the investigator but are enquired through interviews in this study, it was considered more appropriate to use 'perceived facilitating conditions' and regards it as the predictor of the behaviour, as in adapted Theory of Interpersonal Behaviour models. Habits are included as perceived habits which can be remembered and stated by the respondents (rather than objective habits which can be objectively observed).

2.2.7 Summary

Various behaviour models to understand environmentally significant behaviour were reviewed. The review concluded that Triandis' Theory of Interpersonal Behaviour (TIB) is the most appropriate model to understand the behaviour of upcycling (Section 2.2.2). The original model from Triandis (1977) and its interpretation by Jackson (2005a) were used (Sections 2.2.3 and 2.2.4). The complexity and vagueness of the

6 Subjective norms asks 'If I do this, most people who are important to me would support/approve it' whereas normative beliefs asks 'If I do this, my friends/partner/parents would support/approve it' (Bamberg & Schmidt, 2003).
7 Self-concept was either not asked (ibid) or asked with different questions: Gagnon et al. (2003) asked respondents' beliefs about someone who does the particular behaviour (e.g. using telemedicine is a proof of a physician's competence) whereas Knoeri and Russell (2014) asked if the respondents identify themselves as someone who should do the particular behaviour.
8 "the feeling of personal obligation regarding the performance of a given behaviour" (Gagnon et al., 2006, p.3)
9 "the perceived social pressure to do so" (Ajzen, 2002, p.2).

original TIB model were identified as issues for operationalisation (Section 2.2.5). TIB was compared with other more recent adapted models and the Theory of Planned Behaviour (TPB), a more widely tested behaviour model. The refined behaviour model was suggested by combining TIB and TPB for better operationalisation and improved explanatory or predictive power. The combination model includes: a) TPB intention constructs and terms (Ajzen, 2002; Bamberg & Schmidt, 2003); b) adapted TIB social factors (Gagnon et al., 2003; 2010), except for self-concept; c) adapted TIB perceived habits (suggested as the ones that can be remembered and stated by the study participants); d) TPB perceived behaviour control (Ajzen, 2002; Bamberg & Schmidt, 2003); and e) perceived facilitating conditions (suggested as the ones that can be stated by the study participants) (Section 2.2.6).

2.3 Scaling-up upcycling

This section defines scaling-up and explains how scaling-up can be understood in transition theories. Four approaches for scaling-up upcycling are described: a) design for sustainable behaviour; b) policies and other interventions; c) transition management; and d) behaviour intervention approaches and principles.

2.3.1 Transition and multi-level perspective

In order to understand 'scaling-up' as part of a 'transition', it is necessary to understand transition theory. Van den Bosch (2010, pp.37-38) explains transitions as follows:

> Transitions can be understood as a specific type of social change, which is characterised by non-linearity, a long time frame (covering at least one generation) and structural transformation. In a transition the dominant way in which a societal need is fulfilled changes fundamentally. These fundamental societal changes include interrelated changes in behaviour, technology, environment, rules and regulations, financing systems and perceptions.

The development of transition theory has two main sub-fields: 'transition dynamics' and 'transition management'. The theories in transition dynamics aim to develop

fundamental knowledge on the dynamics of transition processes, whereas theories in transition management aim to develop practical knowledge to influence and direct transitions towards sustainability (Van den Bosch 2010) (the latter is further described in Section 2.3.5). The former suggests 'transition dynamics concepts' as an attempt to understand and explain how transitions in societal system occur as a non-linear, long-term, complex system-level process. One of the widely used frameworks is 'multi-level perspective' (Rip and Kemp 1998, Geels 2002). This uses three levels in a societal system – niche (micro-level), regime (meso-level), and landscape (macro-level) – as an analytical tool to explain the dynamics of transitions depending on the interactions between the different levels (Ceschin 2012, Geels 2002, Van den Bosch 2010). Some academics add 'niche-regime' to niche and regime, and consider these three as 'sub-systems' or 'constellations' embedded in the landscape (Haxeltine, et al. 2008, de Haan and Rotmans 2011). Van den Bosch (2010, pp.40-41) explains all three levels and niche-regime as follows:

> The regime is dominant in fulfilling the societal need. Examples are the fossil fuel regime that is dominant in the energy domain and the automobile regime that dominates the mobility domain. A regime can be defined as the dominant structure, culture and practices […] Niches are societal sub-systems that deviate from the regime and provide a context for experimenting with new, sustainable practices and related culture and structure. […] A niche-regime can be defined as a constellation of culture, practices and structure that challenges the power of the regime in fulfilling a societal need. […] The constellations of niches, niche-regimes and regimes are nested in the landscape, which can be understood as the environment of the societal system. The landscape encompasses large-scale and long-term developments like cultural trends, demographics, international politics, worldviews, etc.

2.3.2 Scaling-up

In transition studies, scaling-up is understood as the dynamic process of transitioning from niche (practices) to mainstream (practices) in niche-regime or regime in the multi-level perspective (de Haan and Rotmans 2011, Smith 2007). Van den Bosch (2010, p.68) provides detailed description on scaling-up:

> What is scaled up is […] the deviant structure, culture, practices. […] Through scaling-up, a new or deviant constellation of structure, culture and practices attains more influence and stability and increases its share in meeting a societal need. The constellation increasingly becomes part of the dominant way in which a societal need is fulfilled. The outcomes of scaling-up are fundamental changes in the dominant way societal needs are fulfilled […] Scaling-up implies that sustainable practices that are initially deviant or unusual become the dominant or mainstream practice.

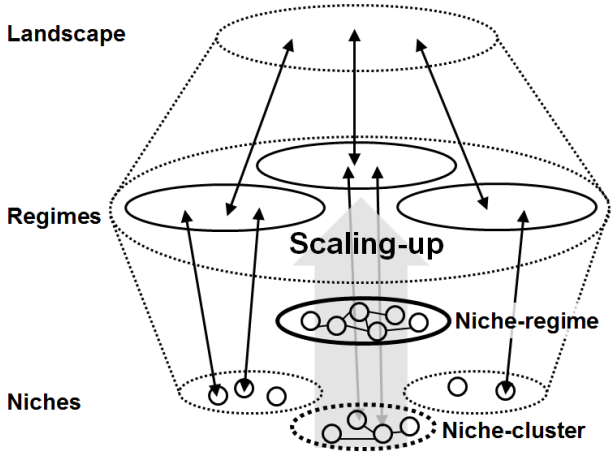


Figure 7 Scaling-up from niches to regimes adapted from Van den Bosch

This thesis is based on the understanding that practice and behaviour can be used interchangeably (Darnton, et al. 2011).[10] Van den Bosch's (2010) description of scaling-up therefore can be interpreted as follows: what is scaled up is the deviant behaviour. […] Scaling-up implies that sustainable behaviour that is initially deviant or unusual becomes the dominant or mainstream behaviour. Upcycling, as a niche environmentally significant behaviour, can therefore also be scaled up to become the dominant or mainstream behaviour in households and industries. From this respect, scaling-up may be broadly defined as 'the process in which an initially niche way of fulfilling a particular societal need becomes dominant or mainstream in any part of society'. Scaling-up upcycling may mean that: a) mainstream consumers upcycle used

10 In our everyday language, behaviour and practice may well be used interchangeably. In academic world, however, psychologists call it behaviour and sociologists practice. The difference is that behaviour is understood as the result of a series of factors such as individuals' motivations, capabilities, social factors, and environmental or contextual factors, whereas practices are understood as the emergent outcome of elements (e.g. materials, competence and meaning), considering individuals as the carriers of practices (Darnton, et al. 2011).

materials, components and products on a regular basis; b) passionate upcycling hobbyists become producers of upcycled goods for mainstream consumers; or c) mainstream producers adopt upcycling production techniques and ideas for mass-production. Considering these possible options and the scope of this thesis (consumer upcycling), the following sub-sections review different approaches for scaling-up, focusing on behaviour change interventions.

2.3.3 Approach 1: Design for Sustainable Behaviour

There have been some efforts from design practitioners and academics to influence human behaviour for sustainability in addition to fulfilling the needs and wants of consumers or users (Ernevi, Palm and Redström 2007, Jelsma and Knot 2002, Kuijer and Jong 2012, Lilley 2009, Lockton, Harrison and Stanton 2013, Oliveira, Mitchell and Badni 2012, Pettersen and Boks 2008, Scott, Bakker and Quist 2012, Tromp, Hekkert and Verbeek 2011). This relatively recent design practice is often referred to as Design for Sustainable Behaviour (DfSB) and aims to reduce the environmental and social impacts of products, services and systems (Bhamra and Lilley 2015).

In the context of DfSB, Lilley (2007) suggested possible approaches for designing behaviour change, such as: a) feedback (i.e. informing users of their impacts in an attempt to persuade them to modify their behaviour) (McCalley 2006); b) behaviour steering (i.e. prescribing certain outcomes) (Ackrich 1992, Jelsma and Knot 2002); and c) intelligence (i.e. persuasive technology persuading, coercing or controlling user behaviour, sometimes automatically) (Fogg 2002). Tang (2010), building upon Lilley's three approaches, identified seven behaviour intervention approaches to reduce the impacts of product use: a) eco-information (expressing the presence and consumption of resources such as water, energy, etc.); b) eco-choice (e.g. eco-mode, energy-saving mode); c) eco-feedback (tangible, aural, visual or tactile signs as reminders to inform users of resource use); d) eco-spur (rewarding incentive and penalty as a consequence of users' actions); e) eco-steer (affordances and constraints to reform users' use habits); f) eco-technical intervention (advanced technology to persuade or control user behaviour automatically); and g) clever design (decreasing

environmental impact without changing users' behaviour, e.g. integration of toilet and washbasin).

More recently, Lenneke (2014) pointed out the limitations of such interaction-oriented approaches. Her critique is as follows (Kuijer 2014, pp.17-19):

> A focus on product-user interaction tends to isolate specific situations and metrics and thereby runs the risk of disappearing in larger trends [e.g. people buying bigger screen TVs and bigger fridges]. […] Users may resist the predefined use scenario by simply ignoring it or even sabotaging the particular function. […] What is 'good' or 'bad' behaviour is defined by the designers of the technology, placing them in an unjustified position of authority over other people's lives. […] A fourth and final critique that touches on the core of these approaches is that they delegate responsibility for the reduction of society's resource consumption to individuals – whether designers or users.

Taking into account this critique together with the recent increasing interest in design as a way of thinking and as an effective tool for policy and service innovation in the public sector (Bason 2010, 2014, Boyer, Cook and Steinberg 2011, European Commission 2012), researchers and practitioners in DfSB may need to focus more on services and system-level design than product-level design. Design interventions for scaling-up upcycling therefore will be focused on services and system-level design.

2.3.4 Approach 2: Policies and other interventions

Various policies and policy frameworks have been developed and implemented for the purpose of behaviour change. Defra (Department for Environment, Food and Rural Affairs), for example, has suggested a 4Es model and claimed that influencing behaviour is most effective when measures are combined from across four broad categories of policy tools (Defra 2008, 2011). 4Es represents 'Enable', 'Engage', 'Exemplify', and 'Encourage' as a package to catalyse change. Enable means making the behaviour easier: measures including removing barriers, ensuring an ability to act, building understanding, providing facilities and viable alternatives, educating and training to provide skills, and providing capacity. Engage means getting people

involved: measures including working with trusted intermediaries, using networks, coproducing, using insight to mobilise different segmentations of people. Exemplify means demonstrating shared responsibility: measures including leading by examples, consistency in policies, and demonstrating that others are acting. Encourage means providing incentives and disincentives to ensure the target audience responds.

Egmond et al. (2005) provides four main types of policy instruments in the context of the Dutch Ministry of Environmental Affairs: judicial, economical and communicative instruments and physical provision. Judicial instruments include law and legislation as well as voluntary agreements. Economic instruments include subsidies (decreasing the relative cost of environmentally favourable behaviour); levies (e.g. environmental taxes); and tax-differentiation (e.g. for unleaded petrol). Communicative instruments have two forms: written information (e.g. information and promotion documents, labels) and personal communication (e.g. coaching, guidance and training, personal advice). Physical provision refers to infrastructure (e.g. public transport facilities).

Michie et al. (2011) in the context of behaviour change in health care identified nineteen frameworks covering nine intervention functions and seven policy categories (see Table 1).

Table 1 Nine interventions and seven policy categories

Interventions	Policies
1. Education 2. Persuasion (using communication and imagery) 3. Incentivisation (prize and reward) 4. Coercion (financial cost) 5. Training 6. Restriction (rules to reduce the opportunity to engage in a certain behaviour) 7. Environmental restructuring (changing physical or social context) 8. Modelling (providing an example of people to aspire to or imitate) 9. Enablement (increasing means and reducing barriers to increase capability or opportunity for the target behaviour)	1. Communication and marketing (print, electronic, telephonic or broadcast media) 2. Guidelines (creating documents that recommend or mandate practice, behaviour, protocols) 3. Fiscal (using tax system to reduce or increase the financial cost 4. Regulation (rules or principles) 5. Legislation (laws) 6. Environmental or social planning (designing and/or controlling the physical and social environment) 7. Service provision

2.3.5 Approach 3: Transition management

Transition management (TM) as a governance approach to scaling-up niches (or influencing transitions towards sustainability) was initially developed by Dutch scientists with policy makers and social actors (Rotmans, Kemp and Van Asselt 2001). It is a governance process combining long-term envisioning with short-term action and reflection (Kemp and Loorbach 2003, Loorbach 2007). The underlying assumption is that it is possible to influence the direction and pace of transitions by a series of interventions at different levels (Rotmans and Loorbach 2010, Van den Bosch 2010, Ceschin 2014). The TM approach neither starts with a particular solution nor focus on achieving a particular outcome; it is explorative, process-oriented and decision-oriented (Ceschin 2014, Van den Bosch 2010). In other words:

> [It] aims to achieve long-term societal goals, chosen by society through the political process or […] a consultative process. [And] these goals are […] constantly assessed and re-adjusted. […] It builds on bottom-up initiatives, ideas and experimentations in niches and they are complemented by policies putting pressure on the existing socio-technical regime. […] [It effectively] combines bottom-up initiatives and top-down measures (Ceschin 2014, p.114).

Van den Bosch (2010, p.44) describes the characteristics, elements and activities of TM in the context of sustainability:

> TM uses the concept of sustainable development as a normative frame to develop a future orientation (vision) and to structure and organise a search-and-learning process […] The TM framework encompasses a portfolio of systemic instruments: a complex systems analysis, sustainability visions, transition arena and transition pathways, a transition agenda, transition experiments, monitoring and evaluation, and transition coalitions and networks.

Although scaling-up is part of transition theory, TM as a governance approach is not suitable for scaling-up upcycling because TM neither starts with particular target behaviour nor aims to achieve a particular behaviour outcome.

2.3.6 Approach 4: Behaviour intervention approaches and principles

From the perspective of social psychology and behaviour, there are a number of approaches and principles to foster sustainable or environmentally significant behaviour. One of the most widely used is 'community-based social marketing' (McKenzie-Mohr and Smith 1999). Community-based social marketing (CBSM) was developed as an alternative to information-sensitive campaigns to respond to growing understanding of the limited ability of media advertising to foster behaviour change. This approach involves five steps: a) carefully selecting the behaviour to be promoted; b) identifying barriers and benefits associated with the behaviour; c) designing a strategy that utilises behaviour-change tools to address these barriers and benefits; d) piloting the strategy with a small segment of a community; and e) evaluating the impact of the programme with large-scale implementation (McKenzie-Mohr and Smith 1999).

Stern (2000) has identified useful and practical principles for behaviour intervention (see Table 2).

Table 2 Principles for behaviour intervention

No.	Principle (Stern 2000)
01	Use multiple intervention types to address the factors limiting behaviour change
02	Understand the situation from the actor's perspective
03	When limiting factors are psychological, apply understanding of human choice processes
04	Address conditions beyond the individual that constrain pro-environmental choice
05	Set realistic expectations about outcomes
06	Continually monitor responses and adjust programme accordingly
07	Stay within the bounds of actors' tolerance for intervention
08	Use participatory methods of decision making

Darnton (2008a) suggested the Nine Principles framework based on theory-based guidance for planning behaviour interventions such as CBSM (McKenzie-Mohr and Smith 1999) and Stern's principles (Stern 2000). He, however, put the building of behaviour models into the heart of the process, and designed the framework to "integrate behaviour models with theoretical understanding of effective approaches to change" (Darnton 2008a, p.23). The nine principles are:

1. Identify the audience groups (or actors) and the target behaviour;

2. Identify relevant behaviour models and draw up a shortlist of influencing factors;
3. Select the key influencing factors to design objectives in a draft strategy for the intervention;
4. Identify effective intervention techniques;
5. Engage the target audience for the intervention;
6. Develop a prototype intervention;
7. Pilot the intervention and monitor continuously;
8. Evaluate impacts and processes; and
9. Feedback learning from the evaluation.

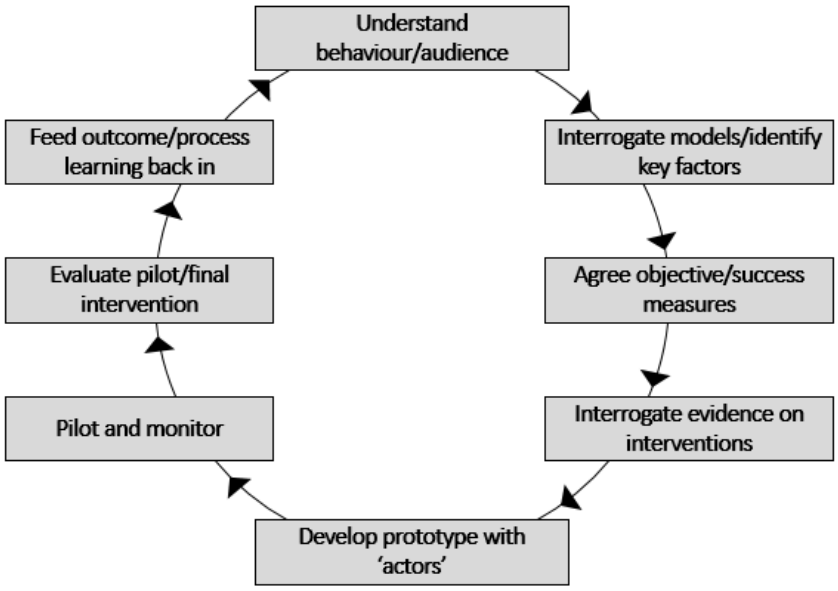


Figure 8 The Nine Principles framework from Darnton

(Note: Darnton suggested nine principles yet provided eight stages in the framework by combining principles 5) engage the target audience for the intervention and 6) develop a prototype intervention for the stage five, develop prototype with 'actors')

Darnton's framework was considered as a useful model to provide a starting point for understanding environmentally significant behaviour and developing behaviour interventions. His model, however, appears to have limitations. Darnton's report presents that identifying target behaviour and actors (principle 1) is identical with understanding behaviour/audience (stage 1). The report has not provided information about how to understand behaviour through empirical research. The report shows that extracting key influencing factors from the models and past

empirical research result (principle 2) is identical with interrogate models/identify key factors (stage 2). It has not provided information about what to do in a situation in which new empirical research is required for underexplored behaviour. Darnton's model therefore may not be the most useful guide for any attempts to understand and intervene underexplored behaviour such as upcycling.

2.3.7 Summary

Transition theory was introduced, and the multi-level perspective with three levels (micro-level niche, meso-level regime, and macro-level landscape) was explained (Section 2.3.1). The definition of scaling-up was provided with a schematic diagram, and the examples of scaling-up upcycling were listed (Section 2.3.2).

Four approaches to scaling-up upcycling were reviewed: a) Design for Sustainable Behaviour; b) policies and other interventions; c) transition management; and d) behaviour intervention approaches and principles. The review of literature on Design for Sustainable Behaviour (DfSB) revealed a need for future research and practice in DfSB to be directed more towards services and system-level design in order to overcome the limitations in product-user interaction-oriented approaches to behaviour change (Section 2.3.3). The review on policies and other interventions provided different intervention types, functions and policy instruments (Section 2.3.4). The review of transition management (TM) revealed a mismatch between TM and the case of scaling-up certain niche environmentally significant behaviour, suggesting behaviour intervention approaches as more suitable for this research (Section 2.3.5). The review of behaviour intervention approaches and principles identified Darnton's Nine Principles framework as a useful starting point for understanding environmentally significant behaviour and developing behaviour interventions, and critiqued its limitations (Section 2.3.6).

2.4 Conclusions

Gaps in the current state of knowledge were identified as below:

- Besides fashion and textiles, and plastic recycling, academic publications have not paid sufficient attention to public interest such as upcycling craft, hobbies, and home DIY for housewares, furniture, jewellery and accessories (Section 2.1.2).
- Whereas industrial upcycling practices (mostly recycling and remanufacturing) have gained more attention through the emerging global debate and action for a circular economy, consumer upcycling behaviour (product-level) has not yet been investigated (Section 2.1.3).
- Benefits of upcycling from existing literature appear to be mostly generic and descriptive rather than specific and quantified, lacking the details on all quantifiable positive and negative environmental impacts, the social benefit aspects, and the links between social benefits and larger environmental benefits are especially underexplored (Section 2.1.4).
- Despite the emphasis on consumer involvement in design regarding creating product attachment (or strengthening product-user relationships), past studies in relation to product attachment have not yet paid sufficient attention to 'everyday creativity' activities without involving manufacturers, including upcycling at the household level (Section 2.1.6).
- The current literature shows a vast interest in interaction-oriented approaches in Design for Sustainable Behaviour, lacking services and system-level design other than product-level design (Section 2.3.3).

Taking into account the lack of research in upcycling craft or consumer upcycling behaviour, the scope of investigation was narrowed down to product-level consumer upcycling at the household level. On the basis of such scope, and in line with the goal of the Centre for Industrial Energy, Materials and Products (Section 1.2.3), the aim of the PhD research was set to provide actionable recommendations for scaling-up upcycling in households (and possibly beyond) to contribute ultimately to the reduction of greenhouse gas emissions. In order to meet the aim, the focus of the study is on understanding consumers' upcycling behaviour and developing

interventions to influence people for scaling-up upcycling. Regarding the lack of study in 'everyday creativity' activities including upcycling in relation with product attachment and longevity, understanding upcycling behaviour includes exploration on the potential links between upcycling and product attachment (and longevity). Recognising the lack of literature dealing with services and system-level design in Design for Sustainable Behaviour, the interventions for scaling-up are to be focused on these understudied areas. The rest of them are beyond the scope of this PhD: research on quantifiable environmental impacts, long term social benefits or the links between social benefits and larger environmental benefits (see Section 7.6).

Three objectives were suggested as: a) gain insight into upcycling in the UK; b) identify UK-specific key behavioural factors for upcycling; and c) formulate design and policy interventions for upscaling upcycling (Section 1.3). In Section 2.2.1, Triandis' theory and model of interpersonal behaviour were considered to be most suitable to understand upcycling behaviour for their comprehensive nature and wide applicability. Triandis' theory is therefore to be used for qualitative research to meet the first objective (gaining insight into upcycling in the UK). Section 2.2.4 showed the complexity and vagueness of Triandis' model for operationalisation, and Section 2.2.5 subsequently suggested to combine Triandis' Theory of Interpersonal Behaviour with Theory of Planned Behaviour as an alternative model. This alternative combination model is to be used for quantitative research to meet the second objective (identifying UK-specific key behavioural factors for upcycling). Section 2.3.7 summarised useful approaches which can be applied to this PhD. Darnton's Nine Principles framework is to be adapted and used as an overarching framework for the research. Design for Sustainable Behaviour is to be applied as service- and system-level design to provide both bottom-up (design-oriented) and top-down (policy-oriented) interventions. Defra's 4Es model and intervention categories are to inform the process of designing detailed interventions.

3 RESEARCH METHODOLOGY

This chapter describes the research paradigm adopted, and outlines the research approach and design. Sampling, validity and reliability, and data analysis for three consecutive studies are addressed.

3.1 Research paradigm and strategy

This section explains the research paradigm – shared beliefs among groups of researchers influencing what should be studied, how research should be done, and how results should be interpreted (rather than a pure philosophical stance) (Bryman 2003, Denscombe 2008, Morgan 2007). It then explains research strategy – a general orientation to the conduct of research such as the use of quantitative or qualitative data (Bryman 2012), fixed designs, flexible designs, or mixed methods (or multi-strategy) designs (Robson 2011). It describes the strengths and weaknesses of the chosen paradigm and strategy, and explains their applicability to this thesis.

3.1.1 Mixed methods as research paradigm with pragmatism

There are largely two traditions in social research: the quantitative paradigm (often positivism, post-positivism) and the qualitative paradigm (often social constructionism) (Robson 2011). Many advocates of quantitative and qualitative research paradigms have argued the superiority of each paradigm over the other and also claimed that two research paradigms cannot and should not be mixed (e.g. Ayer 1966, Lincoln, Lynham and Guba 2011, Maxwell and Delaney 2004, Schwandt 2000). This thesis takes the “third paradigm” for social research (Denscombe 2008, Johnson and Onwuegbuzie 2004), that is, mixed methods. Taking a pragmatist’s pluralist position, the general characteristics of pragmatism (Johnson and Onwuegbuzie 2004) are adopted in this thesis (Table 3).

Table 3 General characteristics of pragmatism

General characteristics of pragmatism (Johnson and Onwuegbuzie 2004)	
• It rejects traditional dualisms and generally prefers more moderate and common-sense versions of philosophical dualisms based on how well they work in solving problems • It recognises the existence and importance of the natural or physical world as well as the emergent social and psychological world that includes language, culture, human institutions, and subjective thoughts. • Knowledge is viewed as being both constructed and based on the reality of the world we experience and live in. • It endorses fallibilism (current beliefs and research conclusions are rarely, if ever, viewed as perfect, certain, or absolute). • Theories are viewed instrumentally (they become true and they are true to different degrees based on how well they currently work; workability is judged especially on the criteria of predictability and applicability). • It endorses eclecticism and pluralism (e.g. different, even conflicting, theories and perspectives can be useful; observation, experience, and experiments are all useful ways to gain an understanding of people and the world).	• It endorses a strong and practical empiricism as the path to determine what works. • It views current truth, meaning, and knowledge as tentative and as changing over time. What we obtain on a daily basis in research should be viewed as provisional truths. • Instrumental truths are a matter of degree (i.e. some estimates are more true than others). • It prefers action to philosophising (pragmatism is, in a sense, an anti-philosophy). • Organisms are constantly adapting to new situations and environments. Our thinking follows a dynamic homeostatic process of belief, doubt, inquiry, modified belief, new doubt, new inquiry, … , in an infinite loop, where the person or researcher (and research community) constantly tries to improve upon past understandings in a way that fits and works in the world in which he or she operates. The present is always a new starting point.

3.1.2 Mixed methods as research strategy

Mixed methods are adopted as research strategy (i.e. a general orientation to conduct research). Mixed methods research is “the class of research where the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts or language into a single study” (Johnson and Onwuegbuzie 2004, p.17).

A mixed methods approach has strengths and weaknesses. The strengths (or potential benefits) of mixed methods (or multi-strategy designs) were thoroughly listed by Robson (2011, p.167) (see Table 4).

Table 4 Strengths of mixed methods research

Strengths	Description
Triangulation	Corroboration between quantitative and qualitative data enhances the validity of findings
Completeness	Combining research approaches produces a more complete and comprehensive picture of the topic of the research
Offsetting weaknesses and providing stronger inferences	Using these designs can help to neutralise the limitations of each approach while building on their strengths, leading to stronger inferences
Answering different research questions	Multi-strategy designs can address a wider range of research questions than single method designs
Ability to deal with complex phenomena and situations	A combination of research approaches is particularly valuable in real world settings because of the complex nature of the phenomena and the range of perspectives that are required to understand them.
Explaining findings	One research approach can be used to explain the data generated from a study using a different approach (e.g. findings from a quantitative survey can be followed up and explained by conducting interviews with a sample of those surveyed to gain an understanding of the findings obtained). This can be particularly useful when unanticipated or unusual findings emerge.
Illustration of data	Qualitative data can illustrate quantitative findings and help paint a better picture of the phenomenon under investigation.
Refining research questions (hypothesis development and testing)	A qualitative phase of a study may be undertaken to refine research questions, or develop hypotheses to be tested in a follow-up quantitative phase.
Instrument development and testing	A qualitative phase of a study may generate items for inclusion in an instrument (e.g. questionnaire, test or scale, or structured observation schedule) to be used in a quantitative phase of a study.
Attracting funding for a project	Agencies funding research projects are showing increased interest in interdisciplinary research involving collaboration between disciplines traditionally using different approaches.

The weaknesses of mixed methods were listed by Johnson and Onwuegbuzie (2004, p.21) and Robson (2011, p.166) (see Table 5).

Table 5 Weaknesses of mixed methods research

Johnson and Onwuegbuzie (2004)	Bryman (2004)
• It can be difficult for a single researcher to carry out both qualitative and quantitative research, especially if two or more approaches are expected to be used concurrently; it may require a research team. • A researcher has to learn about multiple methods and approaches and understand how to mix them appropriately. • Methodological purists contend that one should always work within either a qualitative or a quantitative paradigm. • More expensive. • More time consuming. • Some of the details of mixed research remain to be worked out fully by research methodologies (e.g. problems of paradigm mixing, how to qualitatively analyse quantitative data, how to interpret conflicting results).	• Skills and training: The skills and inclinations of many researchers are either quantitative or qualitative and they feel uncomfortable with the other tradition. • Timing issues: Quantitative and qualitative components sometimes have different time implications. Most frequently, this takes the form of quantitative research being completely more quickly than the qualitative component. • Limits of multi-strategy research: Multi-strategy research is not obviously beneficial when the rationale for combining quantitative and qualitative research is not made explicit. • Lack of integration of findings: Responses indicated that only a small proportion of studies fully integrate the quantitative and qualitative components when the research is written up.

Four strengths of mixed methods were considered particularly applicable for this study: a) the ability to deal with complex phenomena and situations; b) answering different research questions; c) research instrument development and testing; and d) completeness. First, this study involves understanding behaviour in real world settings, which is complex (Section 2.2.1). Mixed methods, therefore, would be helpful to tackle such complex task of understanding behaviour. Second, the three objectives are varied and cover a wide range of research questions, and hence, mixed methods will be more appropriate to answer these. Third, this study involves two consecutive studies: qualitative research for exploration and quantitative research for explanation of the behaviour. Thus, the insight-gaining qualitative research as the first study could feed into the development of the survey instrument for the second study to explain key behaviour factors (Section 3.2.3). Fourth, the combination of different studies with mixed methods approach could, in theory, produce a more complete and comprehensive picture of the study. Most weaknesses of mixed methods are related to knowledge, skills, cost and time, which are relatively negligible considering the potential benefits.

3.2 Research design

This section explains the design components of the research. It starts by elaborating research questions to meet objectives and illustrates an overarching framework with three stages (or three studies) in this PhD. It further justifies the selection of different research methods to answer different questions.

3.2.1 Research questions

In the Introduction, aim and objectives were explained (Section 1.3). Table 6 shows how research aim and objectives are linked to research questions.

Table 6 Research aim, objectives and research questions

Aim	Objectives	Research questions
Provide actionable recommendations for scaling-up upcycling in households (and possibly beyond) in order to contribute to sustainable production and consumption by reducing materials and energy consumption, with the ultimate goal of reducing carbon emissions	a. To gain insights into upcycling in the UK, paying special attention to product attachment and product longevity	1. What could be drivers or facilitators for upcycling? What could be barriers to upcycling?
		2. When, where, with whom, or how often do they upcycle?
		3. What materials do they use for upcycling? How or where to get them? How to choose particular materials? What do they do with end products?
		4. What could be the relationship between upcycling, product attachment and product longevity? How do upcycled products affect attachment and longevity differently from the mass-produced products with same functions?
		5. Are there any noticeable differences in data based on demographic characteristics?
	b. To identify UK-specific key behavioural factors for upcycling	6. Which behaviour factors explain the variance in frequency of upcycling as key drivers, facilitators or barriers? Which behaviour factors shape the intention for upcycling as key motivators?
		7. Are there any significant differences in data based on demographic characteristics?
	c. To formulate design and policy interventions for upscaling upcycling	8. What policy and design interventions can be generated for scaling-up upcycling?
		9. What policy and design interventions might be more effective and feasible in scaling-up upcycling for short term and long term?

3.2.2 Overarching framework

In the Literature review (Section 2.3.6), Darnton's Nine Principles framework (Darnton 2008a) was identified as a useful up-to-date model to provide a starting point for understanding environmentally significant behaviour and developing behaviour interventions with its limitation (not suitable for underexplored behaviour). One of the conclusions, therefore, was to adapt this framework and use it as an overarching framework for this PhD (Section 2.4).

This section illustrates an adapted framework based on the Darnton's Nine Principles framework as an overarching framework. It focuses on the early stage activities in the behaviour intervention (i.e. understanding behaviour and developing interventions). The adaptation in these early stages was made to understand relatively unexplored behaviour and prioritise interventions for prototyping and piloting. The empirical

research on understanding behaviour is to extract valid key influencing factors as well as other behavioural insights, all of which are to inform the process of designing and developing effective interventions. The adapted model does not suggest that later stages of prototyping and piloting are unnecessary. Rather, it suggests how the cycle can be split up between a research-led intervention generation process and the rest of the process for the decision-making and planning in order to invest resources effectively in prototyping and piloting of the prioritised intervention options.

The premise in this approach is that the design researcher or practitioner has already identified which specific behaviour to target (in this case, upcycling). There are three stages in the early stages of this adapted framework. Each consists of two steps. The first stage includes identifying the behaviour model and understanding consumer behaviour. The second consists of refining the behaviour model for operationalisation and identifying key drivers, facilitators and barriers. The third comprises designing effective interventions and evaluating and improving the draft interventions (Figure 9). The following sub-sections elaborate each stage with steps in detail.

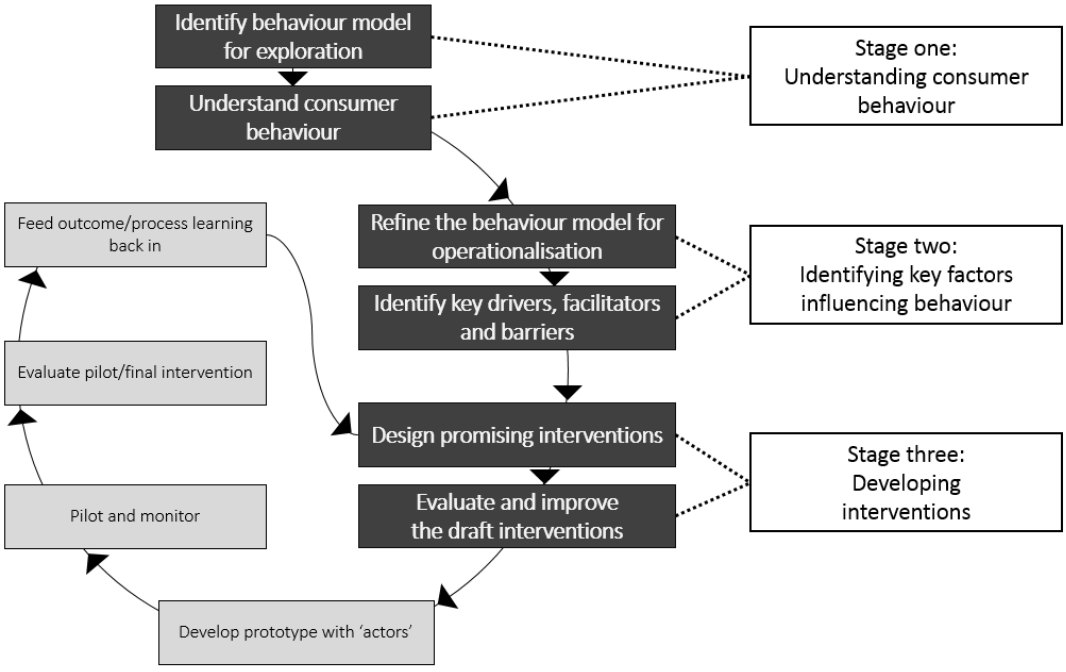


Figure 9 Adapted framework based on the Darnton's Nine Principles framework

(Note: Dark grey boxes represent research-led intervention generation process where the adaptations were made, and light grey boxes are part of Darnton's original framework)

3.2.2.1 Stage one: Understanding consumer behaviour

Stage one had two steps: identifying a behaviour model for exploration, and understanding consumer behaviour. Identifying a suitable model for the targeted behaviour by a literature review is a crucial first step in a sense that "different behaviours are driven by different factors and in different combinations" (Darnton 2008a, p.25). In addition, the model used determines the scope of the understanding in terms of the number of factors influencing behaviour. For example, Schwartz's Norm Activation Theory (Schwartz 1968, 1975) is more suitable for moral or ethical behaviour, and is a more parsimonious model with only three behaviour factors (i.e. awareness of consequences, ascription of responsibility, and personal norm). On the other hand, Bagozzi's Comprehensive Model of Consumer Action (Bagozzi and Warshaw 1990, Perugini and Bagozzi 2001) is more suitable for complex and multifaceted behaviour such as consumption, and provides more than 20 factors (e.g. goal feasibility, anticipated positive emotions, outcome expectations, attitudes, subjective norms, situational forces, etc.). In this study, a thorough literature review was conducted (Section 2.2.1) and the decision was made to use Triandis' Theory of Interpersonal Behaviour (Triandis 1977) as a groundwork to understand upcycling behaviour for its comprehensiveness and wide applicability.

Understanding behaviour and consumers could be more exploratory than Darnton's original approach which only includes identifying which actors and which specific behaviour to target (Darnton 2008a). This study, in order to answer to the research questions 1 to 5 (Table 6), uses semi-structured interviews followed by a short questionnaire study (see Section 3.2.3.1 and Chapter 4).

3.2.2.2 Stage two: Identifying key factors influencing behaviour

Stage two had two steps: refining the behaviour model for operationalisation, and identifying key drivers, facilitators and barriers. In the first step, one can make sure that the selected model is operationalisable for quantitative research (i.e. usable for a survey). In this study, some issues of the selected model (Triandis' model of interpersonal behaviour) were identified through further investigation: there are no clear guidelines for the operational definition of the variables in the model, and a few

adapted models do not show an agreed approach to measure each variable (Section 2.2.5). In order to address such issues, Triandis' model was combined with another model, the Theory of Planned Behaviour (Fishbein and Ajzen 1975) (one of the most widely used models in behaviour research, and yet with weaker explanatory power than Triandis' model), for better operationalisation (Sections 2.2.5 and 2.2.6). Key drivers and facilitators for and barriers to the targeted behaviour were identified through quantitative research (e.g. survey) based on the combination model. The results from the previous qualitative research feed into the survey design (see Section 3.2.3.2 and Chapter 5).

3.2.2.3 Stage three: Developing interventions

Stage three had two steps: designing effective interventions, and evaluating and improving the draft interventions. The former was based on behaviour insights from the qualitative study, and key factors influencing behaviour and other implications from the quantitative study. This first step of intervention generation was facilitated by the existing policy frameworks and intervention typologies (Section 2.3.4). The initial intervention ideas were generated on the basis of the research results and mapping onto the benchmarked policy frameworks and intervention categories (see Section 6.1).

Evaluating and improving the draft interventions is an important final step before developing any prototype with actors (or the targeted population for intervention). In this step, the draft interventions were explored and evaluated by a group of experts, utilising a semi-Delphi method. The evaluation criteria included importance (in terms of potential impact on scaling-up) and feasibility (technical, financial and political). New suggestions were made. Taking into account the agreed evaluation results, as well as new suggestions and comments, the draft interventions were improved and prioritised for prototyping and piloting (see Sections 3.2.3.3 and 6.2).

3.2.3 Research methods

This PhD study incorporates three stages allocated within the adapted Darnton's framework (Section 3.2.2). Table 7 shows the links between stages and steps from the framework (Figure 9), research objectives and questions and methods selected to answer each research question. The following sub-sections justify the selection of methods. Literature review and idea generation are not elaborated further, as they are self-explanatory.

Table 7 Methods linked to stages, steps and research questions

Stages *(objectives)*	**Steps**	**Research questions (numbered ones from Table 6)**	**Methods**
Stage one: Understanding consumer behaviour *(To gain insights into upcycling in the UK, paying special attention to product attachment and product longevity)*	i. Identify behaviour model for exploration	Which behaviour model should be used to understand upcycling?	Literature review
	ii. Understand behaviour and consumers	1. What could be drivers or facilitators for upcycling? What could be barriers to upcycling?	Semi-structured interviews
		2. When, where, with whom, or how often do people upcycle?	Semi-structured interviews
		3. What materials do people use for upcycling? How or where do they get them? How do they choose particular materials? What do they do with end products?	Semi-structured interviews
		4. What could be the relationship between upcycling, product attachment and product longevity? How do upcycled products affect attachment and longevity differently from mass-produced products with same functions?	Questionnaires
		5. Are there any noticeable differences in data based on demographic characteristics?	Semi-structured interviews + questionnaires
Stage two: Identifying key factors influencing behaviour *(To identify UK-specific key behavioural factors for upcycling)*	iii. Refine the behaviour model for operationalisation	Is the selected model operationalisable? If not, what could be the alternative model?	Literature review
	iv. Identify key drivers, facilitators and barriers	6. Which behaviour factors explain the variance in frequency of upcycling as key drivers, facilitators or barriers? Which behaviour factors shape the intention for upcycling as key motivators?	Online survey
		7. Are there any significant differences in data based on demographic characteristics?	
Stage three: Developing interventions *(To formulate design and policy interventions for upscaling upcycling)*	v. Design promising interventions	What policy and design interventions can be generated for scaling-up upcycling?	Idea generation
	vi. Evaluate and improve the draft interventions	8. What policy and design interventions might be effective and feasible in scaling-up upcycling (for short term and long term)?	Semi-Delphi

3.2.3.1 Understanding behaviour and consumers

Most of question topic 2 (when, where, with whom or how often to upcycle) and question topic 3 (what materials, how/where to get the materials, what to do with end products) may be best studied by observation. It is because observation study avoids problems of memory (misremembering aspects of the occurrence of certain forms of behaviour), social desirability effect (a tendency towards replying according to the perceived desirability of certain kinds of answer), interviewer characteristics (influence of interviewer on answers), and gaps between stated and actual behaviour (Bryman 2012). A major problem in using observation as a method in this PhD was the difficulty in certain practical issues. For instance, it was hard to find sufficient number of people who were about to upcycle things within the given time. Another issue was that people may not necessarily start and complete upcycling one product within an observable time; it may take a week or month for some people to finish one product, and people may spend, for example, 30 minutes every day over an extended period of time (e.g. several months). When it comes to the frequency of upcycling, some people may upcycle things just once a year or even less frequently. Accordingly, it is likely to take more than several months to collect sufficient data based on observation. Interview was, therefore, considered a more feasible method within the limited time period. Besides, questions 1 (potential factors influencing upcycling behaviour) and 4 (the relationship between upcycling, attachment and longevity) are hard to observe. The facilitating or prohibiting conditions that people have (as part of question 1) may be observed, but people's intentions, attitudes, perceptions and beliefs cannot be observed; they can only be asked. Likewise, how long people use and keep their upcycled products may be observed (as part of question 4), but how much emotional attachment they feel from the upcycled products cannot. For these reasons, interview appeared to be the only suitable method.

There are different types of interview: structured, semi-structured, unstructured, non-directive, focused, telephone, internet-based (and focus groups) (Robson 2011). Among these, semi-structured interview technique turned out to be the most

appropriate based on the study requirements in this PhD (see Table 8 and Appendix J).

Table 8 Study requirements for interviews

Requirements
• The technique should allow asking individuals about their individual behaviour, attitudes, motivations, etc. behind the behaviour instead of group opinions or group decisions. • The technique should be able to ask certain questions, which requires some levels of structure (from highly structured to loosely structured). • The technique should have some levels of flexibility which allows probing when necessary (especially to clarify meanings behind short answers). • The technique should take at least 30 minutes up to one hour to cover all questions. • The technique should not require any prerequisite study (e.g. observation as situational analysis). • The technique should not have any issues in sampling – i.e. interview participants should definitely have experience of upcycling. • The technique should not encourage incomplete answers.

Product attachment or product-user relationship has been empirically studied extensively by Mugge et al. (2004, 2006a, 2010). The decision was therefore made to use these existing studies (based on questionnaires) for investigating the relationship between upcycling, product attachment and product longevity (question 4). Hence, the first study to understand consumer behaviour included a short questionnaire study along with semi-structured interviews.

3.2.3.2 Identifying key behaviour factors

Question 6 (key behaviour factors) may be best answered by survey since: a) surveys provide a relatively simple and straightforward approach to the study of attitude, values, beliefs and motives; b) they may be adapted to collect generalisable information from almost any human population; and c) they offer high amounts of data standardisation (Robson 2011). Especially surveys work best with standardised questions[11] and in a situation that researchers know what kind of information needs to be collected, which is the case for the question 6. There are four approaches to survey data collection: postal questionnaires, internet surveys, face-to-face interviews and telephone interviews. Each has different strengths and weaknesses in relation to resource factors, questionnaire issues, and data quality. Taking into

11 Where we have confidence that the questions mean the same thing to different respondents (Robson 2011)

account the study's requirements (Appendix K), it was decided to use an internet survey mainly for its ability to reach large number of people within a relatively short time with relatively inexpensive cost (Fink 2003, 2012).

3.2.3.3 Evaluating and improving draft interventions

Question 9 (effective and feasible interventions for scaling-up upcycling) may be best answered by prototyping and piloting initial interventions in a small scale and comparing the results. As the assumption of this study was to prioritise interventions before selecting interventions for prototyping and piloting, (Section 3.2.2), a 'Delphi' method was used as a preliminary prioritisation method to explore and evaluate initial interventions. Delphi is known as the reliable and creative method to explore ideas or produce suitable information for decision making often in the fields of social policy and public health for creative or judgemental problem solving (Ziglio 1996). It aims to obtain relevant intuitive insights of experts and use their informed judgement as systematically as possible to extract the satisfactory conclusion especially when there is high uncertainty. The Delphi method is a research technique or tool to improve group communication among a panel of geographically dispersed experts, often comprising a series of questionnaires sent to a pre-selected group of expert. The Delphi method often consists of two phases: an 'exploration phase' where "the subject under discussion is fully explored and additional information is provided" and an 'evaluation phase' where consensus or disagreement is made through "the process of assessing and gathering the experts' views" (Ziglio 1996, p.9).

The Delphi method was selected for the following reasons. First, deciding effective and feasible interventions for scaling-up upcycling in the UK requires knowledge from people who understand the economic, social, cultural, behavioural, technical and political issues related to upcycling or other similar, niche environmentally significant behaviour in the UK. Therefore the study required a panel of carefully selected experts who may not be able to meet physically at the same time and at the same place. Thus, the Delphi method is suitable as it does not require physical interaction. Secondly, it can serve the dual purpose of gathering opinions from experts on the initial interventions and having the experts to rank the interventions according to the

importance and feasibility. As one of the biggest challenges was time constraint, it was also decided to have one questionnaire study combining exploration and evaluation, and a subsequent workshop for further discussion and making conclusions.

3.3 Sampling

Target population and sampling used are explained in this section. Sub sections describe sampling method and area, and sample size for each study.

3.3.1 Semi-structured interviews with a short questionnaire study

Semi-structured interviews were for exploring current upcycling behaviour and potential behaviour factors. A short questionnaire study, following the interviews, was to investigate the links between upcycling, product attachment and longevity. The target population for these studies therefore had to have practical upcycling experiences as upcycling consumers or upcyclers in the UK. The study participants were identified by purposive sampling – a non-probability sampling based on the specific needs in a project (Bryman 2012, Robson 2011). The common strategy of purposive sampling is to determine sampling areas (i.e. geographic areas) and then participants (Bryman 2012).

3.3.1.1 Sampling method

Hackspace/Makerspace is an open workshop which provides local residents with a membership including access to tools, materials and expertise for crafting, making, hacking, woodwork, metalwork, programming, fixing, maintenance and modification. Hackspaces have increased in number since 2009 and exist in more than ninety locations (Nesta 2015, UK Hackspace Foundation 2015). As such, Hackspaces were considered as a good starting point to recruit target consumers.

Most workshops have a google group or other forms of fora in which members can ask and answer questions. The advertisement for interviewee recruiting, therefore, was posted on these fora. As a contingency plan, snowball sampling – initial

interviewees becoming informants to identify other members for the sample (Robson 2011) – was used as necessary.

3.3.1.2 Sampling area

Forty four workshops in the UK were considered for sampling based on the information retrieved from the UK Hackspace Foundation website in May, 2014. The screening criteria were 'accessibility' to potential interviewees (whether or not the community had a google group or other forms of fora on which to put recruiting advertisements) and 'activeness' of potential interviewees (how active members were on the basis of the number of postings; or, how likely they were to see and respond to the advertisement). Based on these two criteria, ten workshops in ten cities (of nine regions) in England were selected.[12] Scotland, Wales, and Northern Ireland were excluded because all of their fora were inaccessible, inactive or emerging (see Appendix L).

3.3.1.3 Sample size

Theoretical saturation is the most common approach to determining purposive sample sizes (Bryman 2012). This means that successive interviews or observations have reached the point where new data no longer stimulate new theoretical understanding or new dimensions of the principal theoretical categories (Bryman 2012, Charmaz 2006). Although it is impossible to know the sample size for theoretical saturation in advance (Bryman 2012), knowing an approximation of the required number of interviews assists in the design, execution and budgeting of a research project (Thomson 2011). As a rule of thumb, the scope of the study and comparisons between groups in the sample (e.g. between males and females, different age groups) are linked to the sample size (Warren 2001); the broader the scope and the more comparisons required, the bigger sample should be.

12 (1) Nottingham Hackspace in Nottingham, East Midlands; (2) Makespace in Cambridge, East of England; (3) London Hackspace in Greater London; (4) MakerSpace in Newcastle upon Tyne, North East England; (5) HACMan in Manchester, North West England; (6) Build Brighton Hackspace in Brighton, South East England; (7) Reading Hackspace in Reading, South East England; (8) OxHack in Oxford, South West England; (9) Potteries Hackspace in Newcastle-under-Lyme, West Midlands; and (10) Leeds Hackspace in Leeds, Yorkshire and the Humber.

Warren (2001) suggests between 20 and 30 of interviews for a qualitative interview study. Thomson (2011) performed a content analysis of one hundred articles that utilised grounded theory and interviews as a data collection method, and recommended 30 interviews to fully develop patterns, concepts, categories, properties and dimensions of the given phenomena. Taking into account other suggestions, such as 6 to 12 participants (Thomas and Pollio 2002) or between 5 and 25 (Polkinghorne 2005), and the fact that this study has relatively narrow focus and scope with a clear topic, between 20 and 30 interviews were considered sufficient.

3.3.2 Survey

The survey study was for identifying the key factors influencing upcycling behaviour. As this was to find out which behaviour factors contribute strongly to explaining the variance in frequency of upcycling and intention to upcycle (from non-existent or low to high), the target population did not have to be current upcycling consumers or upcyclers. Instead, this survey targeted 'makers' defined by Anderson (2012)[13] as a bigger group of population that could potentially explain the different degrees of frequency of upcycling and intention related to various behavioural factors.

Survey studies often use probability samples based on random selection or systematic sampling in order to have representativeness of the targeted population and also for generalisation of the results (Bryman 2012, Robson 2011). However, the difficulty of identifying the sampling frame (the listing of all units in the population from which the sample are selected (Bryman 2012)) with limited time and resources was acknowledged, and it was decided to use purposive sampling – a non-probability sampling based on the specific needs in a project (Bryman 2012, Robson 2011).

13 Anderson (2012, p.13) considered everyone as potential makers: "We are all makers. We are born makers: just watch a child's fascination with blocks, Lego, etc. It's not just about workshops, garages, and man caves. If you love to cook, you are a kitchen maker, and your stove is your workbench. If you love to paint, you are a garden maker. Knitting and sewing, scrap-booking, beading, and cross-stitching – all making."

3.3.2.1 Sampling method

Makers are also active in producing and consuming the shared digital resources such as Instructables, Etsy and Folksy (also briefly mentioned in Section 1.1.5). Recognising this and also taking into account the researcher's unawareness of the broad range of such digital resources, it was decided to ask the interview participants about the websites they use in relation to upcycling. The identified websites were therefore used as the starting point to contact the target population.

3.3.2.2 Sampling area

As this PhD is about upcycling in the UK, the respondents' geographical area was limited to the UK; the respondents were British residents (with or without British nationality). As access to websites is usually not limited by any particular geographical area, potential survey respondents could be international. Demographic questions were therefore used to distinguish between British and non-British residents, but initial screening questions to preclude non-British residents from participation were not included.

3.3.2.3 Sample size

The decision about sample size in surveys is not straightforward; it depends on considerations such as the need for precision, and the constraints of time and cost (Bryman 2012, Robson 2011). In general, the bigger the sample, the more representative it is likely to be (as well as offering more precision). Most of the time, however, decisions about sample size are affected or compromised by limited time and cost. Bryman (2012) claims that a sample size of 1,000 is the point where sharp increases in precision become less pronounced, and Borg and Gall (1984) recommends about 100 for each of the major subgroupings (e.g. makers), with 20 to 50 for minor subgroupings (e.g. makers with upcycling experience). It was therefore aimed to have at least 100 responses, and ideally, up to 1,000 in total.

3.3.3 Semi-Delphi

The semi-Delphi study was for exploring and assessing the initial policy and design interventions for scaling-up upcycling in terms of potential effectiveness and feasibility. The target population was appropriate experts considered to be qualified to answer questions in this area of knowledge.

3.3.3.1 Sampling method

The selection of experts for a Delphi panel ought to follow a procedure governed by explicit criteria (Ziglio 1996). Although such criteria may vary, depending on the aims and context, 'expertise' is usually the key requirement. Ziglio (1996, p.14) explains: "the first component of expertise is […] knowledge and practical engagement with the issues under investigation. Another criterion is the capacity and willingness […] to contribute."

Okoli and Pawlowski (2004) suggest five steps of procedure for selecting experts:

1. Prepare knowledge resource nomination worksheet to identify relevant disciplines or skills, relevant organisations, and academic and practitioner literature;
2. Populate the worksheet with names of individuals;
3. Nominate additional experts;
4. Rank experts based on their qualifications; and
5. Invite experts.

Taking into account the limited time and potential unavailability of many experts, it was decided to skip the step of ranking experts, and shorten the process into three steps as follows: a) identify relevant disciplines and keywords; b) identify names of individuals in relevant disciplines and literature (found by the keyword-based search); and c) invite the identified experts and ask contacts to nominate other experts (and invite the nominated experts later on).

3.3.3.2 Sampling area

The study participants were British residents (with or without British nationality) with sufficient background knowledge in current British context. The sampling area was anywhere in the United Kingdom.

3.3.3.3 Sample size

The literature suggests 10 to 15 (Ziglio 1996) or 10 to 18 (Okoli and Pawlowski 2004) as a moderate size, and over 100 (Goldschmidt 1996) as considerably larger sample for a comprehensive study utilising a Delphi method. The aim was therefore set to have a minimum of 10 experts (for both questionnaire and workshop).

3.4 Validity and reliability

Validity is concerned with "the integrity of the conclusions that are generated from a piece of research" (Bryman 2012, p.47) and "being accurate, or correct or true" (Robson 2011, p.156). Reliability is concerned with "whether the results of a study are repeatable" (Bryman 2012, p.46).

3.4.1 Semi-structured interviews

To check general validity (if the interview schedule gathers the intended data) and reliability (if the interview procedure is repeatable), pilot interviews and analysis were conducted. During the pilot interviews, short feedback questionnaire was carried out. Based on the feedback, improvements (e.g. change the order of questions, time allocation for each topic) were made for the interviews. The following sub-sections explain detailed validity and reliability issues in qualitative research, and actions undertaken to address them.

3.4.1.1 Validity

There are three types of threats to validity in qualitative research: description, interpretation and theory. The main threat to providing a valid description is inaccuracy or incompleteness of the data. For the data validity, all interviews were fully audio-recorded rather than being partially recorded or based on notes. The main

threat to providing a valid interpretation is through imposing a meaning rather than letting it emerge. Extra care was therefore taken to let the meaning and themes emerge from the ground. The main threat to providing a valid theory is precluding alternative explanations. The applied theory (Triandis' Theory of Interpersonal Behaviour) therefore was not considered as self-evident or the only explanation.

3.4.1.2 Reliability

Robson (2011, p.159) explains that "the general non-standardisation of many methods of generating qualitative data precludes formal reliability testing". Nevertheless, there are common pitfalls to all types of data collection and transcription such as equipment failure, environmental distractions and interruptions, and transcription errors. To minimise the issue of technical problems, it was ensured that the audio-recording device was working, interview environment was with moderate background noise, and all transcriptions were carefully created by the researcher/interviewer rather than an independent/external transcriber. For the reliability of methods and research practices, a full record of the activities (e.g. raw data and details of data analysis) was kept as audit trails.

3.4.2 Short questionnaire study and survey

To check general validity and reliability, pilot data collection and analysis and a series of pre-tests (for a survey) were conducted before the main questionnaires and survey. During the pilot study, the respondents were asked to look for any issues in clarity while completing the questionnaire, and to give verbal feedback after completion. Pre-tests for internet survey were for fine-tuning the language and format of the survey. Any corrections or improvements were made for the main questionnaire/survey. The following sub-sections explain actions to deal with detailed validity and reliability issues.

3.4.2.1 Validity

Validity presumes reliability: if the measure is not reliable, it cannot be valid (Bryman 2012). Reliability was achieved by adopting or adapting tested and proven measures. When a new measure (any deviations from the proven measures) was introduced, it was established that it has 'face validity' (asking other people whether the measure seems to be getting at the concept) and 'construct validity' (based on relevant theory) (Bryman 2012, Robson 2011).

3.4.2.2 Reliability

Reliability in quantitative studies means stability or consistency to measure something (Bryman 2012, Robson 2011). In order to ensure reliability, the questionnaire was designed on the basis of tested and proven measures. There are various causes of unreliability, including participant error and bias, and observer error and bias. Participant error means that answers to certain questions might fluctuate widely from occasion to occasion on a random basis (Robson 2011). To avoid participant error, any relatively difficult questions were sent to the respondents in advance. Participant bias means that they might seek to please or help the researcher. To avoid this, the detailed context of the study (sustainable production and consumption by extending product lifetimes through upcycling) was not shared with the respondents. Observer error means that researchers' observation might fluctuate widely from occasion to occasion on a random basis and to avoid this, the data entered in SPSS were double checked for accuracy. Observer bias means potential biased interpretation of the data and to avoid this, any further inference beyond the statistical analysis was not made.

3.4.3 Semi-Delphi

Taking into account the difficulty in finding sufficient number of participants as well as the constraints in time and cost, a pilot study or pre-test was not carried out to check general validity and reliability. Instead, the draft report was shared with participants to validate the researcher's interpretation and categorisation.

For the validity of the questionnaire, existing questions and formats were used for reliability, and face validity was checked with any changes made. To avoid participant bias and error, the questionnaire was conducted via email, minimising the interaction between the researcher and participants, offering sufficient time for participants to respond accurately. To avoid observer bias, any inference from the data was either avoided or carefully made.

For the validity of the subsequent workshop, all conversations were fully audio-recorded; themes were emerged; and no theory was imposed for analysis. For the technical reliability, two audio-recording devices were used in a silent room. Transcriptions were thoroughly double checked for accuracy. For the methodological reliability, a full record of the activities was kept for potential auditing.

3.5 Data analysis

This section describes data analysis methods for qualitative and quantitative data. Thematic analysis with QSR NVivo and statistical analysis (descriptive statistics and non-parametric statistics) with SPSS are elaborated.

3.5.1 Qualitative data analysis

Approaches to qualitative analysis include quasi-statistical approaches, grounded theory approach, thematic analysis, and narrative analysis (Robson 2011, Bryman 2012). Among these, thematic analysis was considered the most suitable as the study requires a descriptive and exploratory analysis within a given theoretical framework (Appendix M).

3.5.1.1 Thematic analysis

Thematic analysis (or thematic coding analysis) is a generic and flexible approach which can be used with virtually all types of qualitative data (Braun and Clarke 2006, Bryman 2012, Robson 2011). As it is not tied to any particular philosophy or theory, it can be used in a wide variety of fields and disciplines. The results can be easily communicated to practitioners, policy makers and an educated general public. The

only major disadvantage is the lack of focus: the potential range of themes that could be meaningfully extracted from the raw data is broad, which can inhibit researchers from deciding which aspects of the data to focus on. This issue is not applicable here as the study starts with a particular theory and framework.

3.5.1.2 Phases of thematic coding analysis

Robson (2011) provides five phases of thematic coding analysis, and Braun and Clarke (2006) similarly propose a six-phase guide (Table 9). Based on these two approaches, the following phases were used in this study: a) familiarising oneself with the data; b) categorising into manageable pieces; c) generating initial codes; d) identifying themes; e) fine-tuning the codes and themes; and f) producing the report with integration and interpretation. Phase 1 involved repeatedly reading the data while actively searching for meanings and patterns by taking notes and writing memos about initial thoughts about themes. Phase 2 (categorising into manageable pieces) means creating the initial big pieces of data according to questions, broad topics and relevant theory to reduce cognitive loads. Phase 3 was initial coding in which several passages were identified and linked with the codes (Gibbs 2008). Codes refer to "the most basic segment or element of the raw data or information that can be assessed in a meaningful way regarding the phenomenon" (Boyatzis 1998, p.63). Phase 4 involved collating codes into potential themes. Themes were identified through repetitions, similarities and differences, or comparison with theories (Ryan and Bernard 2003). Phase 5 means iterating the meaning or pattern recognition process to fine-tune the coherent collective themes. Phase 6 was producing the report by exploring, describing, summarising and interpreting the patterns and making comparisons between different aspects of the data using display techniques (e.g. tables).

Table 9 Phases of thematic coding analysis comparison

Robson (2011)	Braun and Clarke (2006)	This PhD
1. Familiarising oneself with the data	1. Familiarising oneself with the data	1. Familiarising oneself with the data
2. Generating initial codes	2. Generating initial codes	2. Categorising into manageable pieces
3. Identifying themes	3. Searching for themes	3. Generating initial codes
4. Constructing thematic networks	4. Reviewing themes	4. Identifying themes
5. Integration and interpretation	5. Defining and naming themes	5. Fine-tuning the codes and themes
	6. Producing the report	6. Producing the report with integration and interpretation

3.5.1.3 Use of QSR NVivo

Researchers with a substantial amount of qualitative data often use a software package such as CAQDAS (Computer Assisted Qualitative Data AnalysiS) package. There are advantages of specialist CAQDAS packages: a) single location storage system for all stored material; b) quick and easy access to coded material without using 'cut and paste' techniques; c) quick big data handling; d) forced, line-by-line detailed consideration of all text in the database; e) facilitated consistent coding schemes; f) easy detection of differences, similarities and relationships between coded elements; and g) a range of ways of displaying results (Robson 2011). There are disadvantages, such as time and effort for proficiency in use; potential difficulties in changing categories of information after initial coding; and particular analysis approaches embedded in each programme.

CAQDAS packages include ATLAS.ti, Dedoose, HyperRESEARCH, NVivo and Transana. Among such, QSR NVivo is known to be the preferred option for qualitative data analysis in many institutions (Robson 2011). After checking the differences amongst a variety of packages (see Appendix C), NVivo was chosen as it did not appear to have any significant weaknesses comparing to other options.

3.5.2 Quantitative data analysis

Specialist software is essential to carry out complex statistical tests (Robson 2011). As this study required different tests and two data sets (Table 10), specialist software was considered appropriate. Software packages include Excel with 'analyse-it', SOFA

statistics, SPSS, Minitab, SAS, R, and Stata. SPSS (Statistical Package for the Social Sciences) has been the market leader, and therefore was chosen for carrying out statistical tests in this PhD.

The statistical tests in SPSS explore largely either relationships among variables or the differences between groups. To explore relationships, for example, correlation, partial correlation, multiple regression or factor analysis can be used. To explore differences between groups, T-tests, one-way analysis of variance, two-way analysis of variance, multivariate analysis of variance or analysis of covariance can be used. Choosing the right statistical test depends on research questions, the type and number of variables, and the distribution and sample size of data (Pallant 2013).

Pallant (2013) provides six steps to choose the right statistical test:

1. List up all the questions;
2. Find the questionnaire items and scales;
3. Identify the nature of each variable (e.g. categorical, ordinal, continuous);
4. Draw a diagram for each research question;
5. Decide whether a parametric or a non-parametric statistical technique is appropriate (depending on the distribution and sample size of data); and
6. Make the final decision.

Table 10 shows the appropriate statistical tests selected for each research question. The subsequent sub-sections provide more details about each test.

Table 10 Appropriate statistical tests for research questions

Objectives	Research questions (from Table 6)	Statistical tests
a. To gain insights into upcycling in the UK, paying special attention to product attachment and product longevity	4. What could be the relationship between upcycling, product attachment and product longevity? How do upcycled products affect attachment and longevity differently from the mass-produced products with same functions?	- Descriptive statistics (to describe the data) - Correlation analysis (Spearman's Rank Order Correlation) to describe the strength and direction of the relationships between variables
	5. Are there any noticeable differences in data based on demographic characteristics?	- Non-parametric statistics to compare groups (Mann-Whitney U Test and Kruskal-Wallis Test)
b. To identify UK-specific key behavioural factors for upcycling	6. Which behaviour factors explain the variance in frequency of upcycling as key drivers, facilitators or barriers? Which behaviour factors shape the intention for upcycling as key motivators?	- Descriptive statistics (to describe the data) - Correlation analysis (Spearman's Rank Order Correlation) to describe the strength and direction of the relationships between variables - Regression analysis to assess how well the set of behaviour factors explains the behaviour
	7. Are there any significant differences in data based on demographic characteristics?	- Non-parametric statistics to compare groups (Mann-Whitney U Test and Kruskal-Wallis Test)

3.5.2.1 Descriptive statistics

Descriptive statistics include the mean, standard deviation, range of scores, and frequencies (Pallant 2013). For categorical variables (nominal level data, e.g. gender), frequencies can be used, whereas for continuous variables (interval level data, e.g. age), basic summary statistics (e.g. mean, median, standard deviation) can be used.

3.5.2.2 Non-parametric statistics

Most statistical tests exploring relationships among variables or group differences are classified into two groups: parametric and non-parametric (Pallant 2013). Parametric statistics are more powerful and sensitive than non-parametric statistics but have more stringent assumptions, such as a normal distribution or exclusive use of continuous variables as independent variables. When the assumptions are not met for parametric statistics, there are three options. Option 1 is to use the parametric technique anyway, as most parametric tests tolerate minor violations of assumptions, particularly with a good size sample. Option 2 is to manipulate the data to make it a

normal distribution. Option 3 is to use a non-parametric test. When the assumptions were violated, option 3 was consistently applied in order to avoid any unintended distortion of results.

In the case of the short questionnaire, the variables were mostly ordinal (see Table 13). Taking this into account, the correlation analysis between upcycling, product attachment and longevity was carried out with a non-parametric test (Spearman's Rank Order Correlation) rather than a parametric test (Pearson product-moment correlation coefficient). In the same way, comparing the (socio-demographic) groups was also carried out with a non-parametric test such as Mann-Whitney U Test (testing for differences between two independent groups) and Kruskal-Wallis H Test (comparing the scores for three or more groups), rather than a t-test or ANOVA (analysis of variance).

The circumstances of the survey (to determine statistical tests) were not dissimilar to those of the short questionnaire. The variables were mostly ordinal (Section 5.1.3). Accordingly, Spearman's Rank Order Correlation was used for correlation analysis, and Mann-Whitney U Test and Kruskal-Wallis Test was used for group comparisons. Furthermore, logistic regression (non-parametric) was used instead of multiple regression (parametric) to explain the impact of a set of predictors (factors influencing behaviour) on a dependent variable (behaviour frequency).

4 UNDERSTANDING CONSUMER BEHAVIOUR (Study 1)

The aim of the study is to provide actionable recommendations for scaling-up upcycling in households (and possibly beyond) in order to contribute to sustainable production and consumption by reducing materials and energy consumption, with the ultimate goal of reducing carbon emissions (Section 1.3). In order to achieve this aim, three objectives were set as: a) to gain insights into upcycling in the UK, paying special attention to product attachment and longevity; b) to identify UK-specific key behavioural factors for upcycling; and c) to formulate design and policy interventions for upscaling upcycling. This chapter addresses the first study, understanding consumer behaviour (Section 3.2.2), to meet the first objective (gaining insights into upcycling in the UK). It presents methods, results, discussions and implications of the first study. Instruments, results, discussions and implications are separately presented for current upcycling behaviour, upcycling-influencing factors, and the links between upcycling, product attachment and longevity.

4.1 Methods

The data collection method used to understand consumer behaviour (gaining insights into upcycling) was the combination of semi-structured interviews and short questionnaire. The data was collected between April and July 2014. The procedure, participants, instruments and analysis approach are described below.

4.1.1 Procedure

Four interviews were conducted and analysed as a pilot study to ensure the validity and reliability of the study. After each pilot interview, participants were asked about the general appropriateness of the interview procedure, setting, interviewer, and questions. Reflecting on the results and feedback from the pilot study interviewees, the topic guide, questionnaire, and general planning for the main study were adjusted.[14]

14 The initial topic guide asked several questions about informal networked learning (e.g. what kinds of online digital resources or contents they use, how and why they use them) for upcycling, and the revised version dropped those questions for the limited time and its loose connection with the central thesis. Topic and question orders were slightly modified accordingly. The

In the main study, a recruiting advertisement was posted on Google groups and fora of the ten selected Hackspaces/Makerspaces, with the only inclusion criterion being previous experience of practical upcycling (see more details in Section 3.3.1). Thirteen people answered the advertisement and another ten were identified by snowball sampling.

Once the potential interviewee agreed to participate, a pre-interview questionnaire was sent to the participant. The questionnaire asked about: a) the number of upcycling projects/products completed and in progress; b) a list of upcycling project/product names with approximate start and end dates, and duration; and c) a list of websites, forums or blogs used for upcycling (see Appendix A for the full questionnaire). The completed pre-interview questionnaire was obtained before the interview took place. The convenient day, time and location (a comfortable public space) were decided by the interviewee.

The interview session began with casual conversation, building quick rapport with the participant. The researcher first introduced herself and described the general purpose of the interview and 'rules'– informality, honest and open opinions. The interview procedure, duration, and reasons for recording were explained. Participants were given the informed consent form, had a chance to ask any questions regarding the study, and signed the form (see Appendix B for the informed consent form). Permission to record the whole conversation as well as anonymity were emphasised before starting the interview.

Brief demographic information was asked (i.e. age, gender, ethnicity, nationality, marital status, cohabitants, occupation, language and disability). A topic guide with two themes was used to guide the interview: current upcycling behaviour and factors influencing upcycling behaviour (see Section 4.1.3.1 and 4.1.3.2). At the end of the interview, the respondents were asked to select up to three products to which they

initial idea of providing financial incentives for interview participation was dropped since all pilot interviewees expressed that they would have participated in the study without it.

had the most emotional attachment from the list of their upcycled products in their pre-interview questionnaire. They were then asked to fill in up to three identical questionnaires based on their selection, about the link between upcycling, product attachment and longevity (see Section 4.1.3.3).

Each session was intended to take an hour: a) 10 minutes of introduction (including the consent form); b) 20 minutes to explore current upcycling behaviour; c) 20 minutes to explore factors influencing behaviour; and d) 10 minutes for the short questionnaire study. In practice, the sessions were varied in time, but were in a range of 30-90 minutes.

4.1.2 Study participants

A total of 23 participants were from nine different cities[15] and aged between 24 and 66 years old. Seventeen (74%) were British and six (26%) non-British. Fifteen (65%) were male and eight (35%) female. Twelve (52%) worked in science and engineering, seven (30%) in art and design, and four (17%) in other areas (health service, business and management) or were unemployed.[16]

4.1.3 Instruments

The interview schedule was structured amongst two themes: current upcycling behaviour and factors that influence upcycling behaviour. The questionnaire explored the links between upcycling, product attachment and longevity.

4.1.3.1 Interview questions to explore current upcycling behaviour

The basic questions of 5W1H (i.e. who, what, when, where, why and how), excluding who and why were asked (Table 11). It is because who was answered by study participant demographic information (Section 4.1.2) and why was asked separately as factors influencing upcycling (Section 4.1.3.2).

15 Brighton, Cambridge, London, Newcastle, Nottingham, Oxford, Portslade, Stoke on Trent, and Stowmarket

16 A mathematics student, an ICT engineer or manager, a software or computer engineer, a web developer, and general engineering-related occupations were categorised as science and engineering. A product designer, a graphic designer, a craft-based designer and maker, and artists were categorised as art and design. A therapeutic counsellor was categorised as health service. A university administrator and Hackspace administrator were categorised as business and management.

Table 11 Interview questions to understand current upcycling behaviour

Category	Sub category	Questions
Approaches to upcycling	Upcycling materials	- What kinds of materials do you use for upcycling?
	Ways of acquiring materials	- Where or how do you get those materials?
	Material selection criteria	- How or why do you choose particular materials?
	End product usage	- What do you do with the end products after upcycling?
Context for upcycling	When	- When do you usually upcycle items?
	How often	- How often do you upcycle items?
	Where	- Where do you usually upcycle items?
	With whom	- Do you upcycle items by yourself or with others? If with others, who are they? What is the occasion?

4.1.3.2 Interview questions to explore factors influencing upcycling

The theoretical model to explore factors influencing upcycling was based on the Triandis' Theory of Interpersonal Behaviour as adopted by Jackson (Section 2.2.4). Whereas Jackson's model portrays norms, roles and self-concept as determinants of social factors, and emotions as determinant of affect, what he described was that norms, roles, and self-concept are part of social factors and emotions are equivalent to affect. Jackson separated evaluation of outcomes from beliefs about outcomes as determinants of attitude, but in this PhD it was decided that they are combined and called 'perceived benefits'. This is because this PhD only considers 'perceived consequences with positive value attached to the expected and/or experienced consequences' which can be translated simply into 'perceived benefits' (Section 2.2.5.1) (see Figure 10).

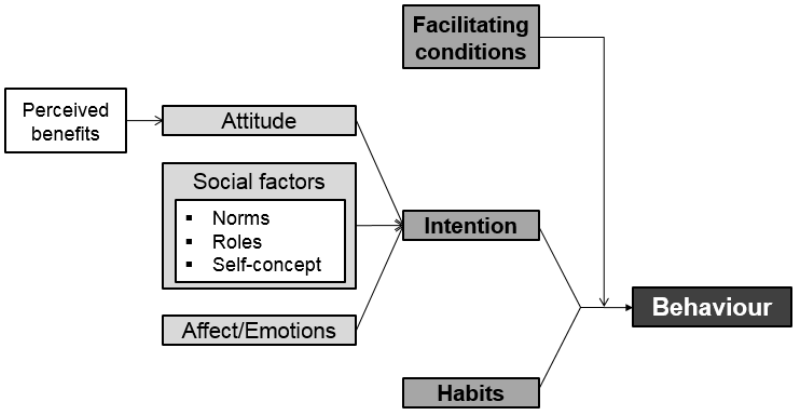


Figure 10 Triandis' Theory of Interpersonal Behaviour model, adapted from Jackson

As upcycling was presumed not to be purely habitual behaviour for everyone, an assumption was made that the people with practical upcycling experience have intention to upcycle (to different extents), as well as a positive attitude (to different degrees) towards upcycling. For this reason, it was decided not to explicitly explore these two factors with the interviewees. The rest of the factors were asked with the questions presented in Table 12. Most are based on Triandis' original definitions of each behaviour factor. Exceptions were made as follows. Since affect was defined by Triandis as the person's emotions at the thought of the behaviour, it was considered to be too abstract or difficult to answer. It was, therefore, decided that the researcher asks about the emotions experienced throughout upcycling. Another exception was made on habits. Triandis and Jackson defined the habit to act as the quantifiable number of past behaviour which can be used for quantitative study. The decision was therefore made to explore or understand a variety of upcycling-related activities (i.e. activities similar to upcycling) both in present and past as habits for this (qualitative) study.

Table 12 Interview questions to understand factors influencing upcycling

Category	Sub category	Questions
Behaviour influencing factors	Perceived benefits	- What benefits do you expect and see from upcycling?
	Norms (social factor 1)	- Are there any social norms involved in your motivation? (Norms such as certain behaviours are correct, appropriate or desirable)
	Roles (social factor 2)	- Are there any of your roles involved in your motivation? (Roles such as particular positions in a group, for example as son/daughter, partner, father/mother, friend, employee, etc.)
	Self-concept (social factor 3)	- Are there any of your self-concepts involved in your motivation? (Self-concept such as your idea of who you are, e.g. I am the kind of person who does this)
	Any other motivations	- Are there any other motivations for upcycling besides what you have already mentioned?
	Affect/emotions	- What positive/negative and strong/weak emotions do you feel when working on your upcycling project? What emotions do you feel when you complete the project?
	Habits	- What other activities do you habitually engage in, relating to upcycling? Do you have any childhood activities related to upcycling?
	Facilitating conditions	- Before you tried your first upcycling project, why were you not doing it? What were the barriers? - Have you experienced any problems or difficulties with upcycling? - What conditions do you think have facilitated your upcycling so far?

When asking about the social factors, an additional explanation (the definitions and examples of norms, roles and self-concept) was provided, depending on the participant's reaction. For instance, when the participant immediately answered the question and the answer sounded like it was based on correct understanding of the concept, further explanation was not offered. In the case that the participant enquired or looked hesitant, further explanation was offered.

4.1.3.3 Short questionnaire study to explore the links between upcycling, product attachment and longevity

The questions to explore the links between upcycling, product attachment and longevity were based mostly on Mugge's work on the determinants of product attachment (self-expression, group affiliation, memories and pleasure) and consequences of product attachment (disposal tendency, product care, expected product longevity, irreplaceability, and expected product lifetime) based on consumer durables (e.g. Mugge 2007, Mugge, Schoormans and Schifferstein 2009, 2010). The questions addressed: a) determinants of product attachment to the upcycled products with attachment[17]; b) product attachment to and its change over time for the upcycled products with attachment; c) consequences of product attachment (disposal tendency, product care, expected product longevity, and irreplaceability) of the upcycled products with attachment; and d) the degree of product attachment, its change over time and the estimated product lifetime of mass-produced products with same functions.

Measures for the variables of product attachment, and determinants and consequences of attachment were obtained on seven-point Likert scales (1="strongly disagree", 7="strongly agree"), whereas nine-point scales (1="not at all", 9="to a great extent") were used for measuring the degree of product attachment at different time points. An absolute figure was given in years for the expected lifetime of the upcycled products with attachment and the expected product lifetime for the

17 The study participants were asked to pick three upcycled products which they feel most attached to (Section 4.1.1) as the study setting to identify what kinds of products they are attached to, to what extent they feel the attachment, and how those products are different from the mass produced ones with same functions.

mass-produced product with same functions. Three answer options were provided for the change of degree of product attachment over time (faded away, stayed the same, and got stronger) (Table 13).

Table 13 Variables, questions and answer options to understand the links between upcycling, product attachment and longevity

Variables	Description/questions (answer options)
Self-expression	This product that I made reflects who I am. (1="strongly disagree" to 7="strongly agree")
Group affiliation	This product that I made indicates that I am a maker/crafter/ upcycler/hacker. (1 to 7)
Memories	This product reminds me of people or events that are important to me. (1 to 7)
Pleasure	I feel good when I use this product. (1 to 7)
Product attachment	This product has special meaning to me and I have an emotional bond with this product. (1 to 7)
Disposal tendency	I would like to get rid of this product. (1 to 7)
Product care	I take good care of this product. (1 to 7)
Expected product longevity	I hope that this product will last for a long time. (1 to 7)
Irreplaceability	This product is irreplaceable to me. (1 to 7)
Expected product lifetime	For how many years would you like to use the product?
Degree of product attachment at the point of upcycling project completion	How much emotional attachment did you feel when you just finished making and saw the completed project? (1="not at all" to 9="to a great extent")
Degree of product attachment at the point of purchase	How much emotional attachment did you feel when you just bought the product? (1 to 9)
Change of degree of product attachment over time	Has the emotional attachment faded away, stayed the same, or got stronger over time since you finished making it or purchased it? (faded away/stayed the same/got stronger)
Degree of product attachment at the point of responding to the questionnaire	If the degree of emotional attachment now is different from the initial attachment, how would you rate the degree of present emotional attachment? (1 to 9)
Expected product lifetime for the mass-produced product with same functions	For how many years do you use this type of product on average?

Instead of using multiple sentences to define each variable, the most suitable sentence to describe each variable was determined through a mini questionnaire study with 21 PhD students in the School of Architecture, Design and the Built Environment, Nottingham Trent University (see Appendix D for details).

4.1.4 Analysis

The recorded interviews were transcribed and analysed by the interviewer/researcher. The transcripts were anonymised and entered into QSR

NVivo 10 software. A thematic analysis was conducted, with each transcript examined line by line and categorised into categories: four categories for approaches for upcycling (regarding materials and end products), four context categories (when, where, with whom, and how often to upcycle) and seven behaviour factors (perceived benefits, norms, roles, self-concept, emotions, habits and facilitating conditions). Within these categories, grounded codes were identified and constantly revised to fine-tune the coherent collective themes (for more details see Section 3.5.1).

Forty four questionnaires (i.e. up to three[18] per person) from 23 respondents were analysed by employing descriptive statistics, correlation analysis (Spearman's Rank Order Correlation) and non-parametric statistics for comparing groups (Mann-Whitney U Test and Kruskal-Wallis H Test), using SPSS (Statistical Package for the Social Sciences) version 22.0 (for more details see Section 3.5.2).

4.2 Results

This section describes the interview and questionnaire results. They are presented in three categories: current upcycling behaviour; factors influencing upcycling; and the links between upcycling, product attachment and longevity. Answers from each participant were coded with gender and number (e.g. female participant one is F01, male participant one is M01).

4.2.1 Current upcycling behaviour

The results on current upcycling behaviour are presented in two main categories: a) approaches to upcycling; and b) context for upcycling. All categories and sub-categories arrived at by coding.

4.2.1.1 Approaches to upcycling

Approaches to upcycling as part of current upcycling behaviour provides insights into upcycling in the following four sub categories: a) upcycling materials, b) ways of

18 The study setting was to ask participants to select up to three upcycled products with attachment.

acquiring materials, c) material selection criteria, and d) end product usage (see Appendix N for the full quotations).

Upcycling materials

Many participants mentioned that they utilise wood or furniture: e.g. used furniture (F02; M03); old pallets and used plywood (F06); bits of wood (M11); wooden pegs (M10). Several said that they use anything "[they] come across" (F02), "lying around" (M11), or "in [their] hands" (M13). A few said they use metal: e.g. nuts and bolts (F04); "metal and wires and stuff with copper" (F07); aluminium (F08). Some stated that they use electronics. Some others stated fabrics: e.g. T-shirts (F02); different kind of fabrics (F03; F05; M09). A few said they use packaging: e.g. containers and boxes (M06); paper cardboard (M07); general packaging (F03). Some (M03; M09; M11) mentioned that they use anything required for their particular project. More miscellaneous materials included "waste from the glass industry" (M08), "watches and jewellery" (F04) and plastics (M12).

Ways of acquiring materials

Most participants answered that they get used materials (including used components and products) from online shops or networks – e.g. eBay (F02; M02; M06), Gumtree (F02), Freecycle or Freegle (F02; M03; M06; M07). Many mentioned that they get used materials from everywhere: one participant said "from all kinds of places […] I look out for stuff that are on the street […] I've got a lot of stuff from neighbours leaving goods out […] I am looking at skips and those places where the buildings are renovated." Several stated that they find used materials from skips. Some mentioned that they have utilised their own unused items: "my own consumables" (M06); "excess of stuff that I may have bought for another purpose"; or broken items – "the child swing is actually something we had in our garden, but it had fallen apart. And I used the steel poles" (M04). Some others said that they go to charity shops and other local shops to buy or get used materials. A few mentioned that used materials were given by other people; a few others stated that they go to car boot sales. Building sites were also mentioned by a couple of participants. Other miscellaneous places included a recycling centre (F06), a local factory (M08) and Hackspace (M02).

Material selection criteria

The most frequently mentioned selection criterion for used materials was the project requirement (i.e. applicable to what is needed for the project). Many participants said that they consider potential value: for instance, one participant said "I see things: compressor and electronics. And I see if it's repairable. […] I see value, if I can clean it or if it is recoverable." (M13). Several mentioned financial saving perspective. For example, one participant said "We go to car boot sales simply because we are moving a house and we don't have a lot of money for furniture" (F01) and another said "Mostly I tend to find something cheap or free or second hand and build on to it with new materials" (M03). Some stated that they consider quality: e.g. solid wood rather than cheap MDF (F02); no rotten or moulded wood (M13); colour and texture of the fabric (F03); clean and in good condition (M04). Some others said they do not have any criteria. They may start with materials (crafting based on available materials) and not the other way around (designing first and gathering materials accordingly) (M02) or do not mind trying a varied range of materials (M10). A few said that the materials chosen were something they liked: e.g. "what catches my eye" (M03) or "pretty items, smallest items" (F07). A few others pointed out that used materials need to be easy to handle: e.g. to saw, stick, paint, turn into anything (F02) or to cut and fix without many tools (M06). Other miscellaneous answers included: depending on the person who wants it, when upcycling for someone else (F03); depending on materials already possessed (F08); unrecyclable materials (F08); and relatively unused materials (M04).

End product usage

The most common use of the end product after upcycling was 'use for home or myself'. Amongst those who answered this, some participants added that the end products are not good enough to give to someone else (M06; M13). Many said that they give the upcycled products to family, friends or acquaintances – e.g. when they no longer want it (F02); when they think the product is relevant for someone (F05); for my daughter (F03); as a birthday present (F08). Among these, most mentioned that they occasionally give the product away, and one participant (M04) said he usually does so. Several stated that they considered the option of selling to others.

Some of them have actually sold some upcycled products through craft shows or fairs (F01; F04), internet market places such as Folksy or Etsy (F01; F04), or a (physical) shop (M10). Despite their consideration for commercialisation, some other participants have not sold anything because they "have not put an effort to investigate how feasible it is" (M07); they "faced some legal issues […] and safety issues" when using broken and discarded electronics parts (M08); or they have not found a market for the product (M10). A few mentioned that some of their upcycled objects were used for exhibitions (M08; M11) or Maker Faire (F03). A few others (M11; M13) mentioned that sometimes the value of the upcycling is not so much in the output at the end, but in the fun process. One participant (M01) used upcycling electronics as part of his degree project.

4.2.1.2 Context for upcycling

Context for upcycling as part of current upcycling behaviour provides insights into upcycling in the following four sub categories: a) when to upcycle; b) how often to upcycle; c) where to upcycle and d) with whom to upcycle (see Appendix N for the full quotations).

When to upcycle

The half of participants stated that they upcycle at any time that suits them: the timing may depend on their job situation (F05; M03; M09; M10), amount of free time and distractions (M06), or working space – mostly during summer, since the participant upcycles on the patio or in the garden (F06). Some (F03; M03; M13) stated that they have upcycled goods and materials on a daily basis throughout their lives. A few (F03; F08) mentioned that they sometimes responded to particular events. Other miscellaneous answers included when they find the material they have been looking for (M03); when they feel like upcycling (F04; M02); and when there is need (M03).

How often to upcycle

Many participants mentioned that the frequency of upcycling varies and depends on the project (participants often called their upcycling 'a project'). For example, one

participant (M01) stated that electronics takes longer to upcycle whereas woodwork is relatively quick and easy. They appeared to have one project at one time period, finish it and move on to the next project. Several mentioned that they have been upcycling items almost every day – “maybe 1.5 hours a day” (M13); “probably four days a week” (M09); “4-5 days a week, 4-6 hours a day” (M12) – or all the time (M02). A few mentioned that their upcycling “tends to spread out through a very long period time” (F05) sometimes in such a way that upcycling “is interwoven into [their] lives” (F03). One participant stated that frequency of upcycling depends on her job situation: she said “If I have no contracts, then I have been here [Hackspace] up to 5 days a week […] If I do have work, maybe once or twice a month” (F05). Frequency of upcycling from the rest of the participants varied from once a week (M06) to once a month (F01), once every three months (M11), twice a year (M04) or once a year (M07).

Where to upcycle

Regarding the place for upcycling, many participants stated that they upcycle at home, without specifying any particular spaces. Several reported that they use their shed or garage. Some mentioned particular rooms at home: living room (F04); office room (M03); workshop (M09); dining room (F03); and bedroom (M10). Some other participants said that they use a patio. A few said that they use the local Hackspace or Makerspace, mostly for tools (M01; M07) and space (F05). A few others stated that they have their individual or shared studio or workshop outside home.

With whom to upcycle

When the participants were asked about with whom they upcycle, most answered that it is just by themselves. This was because they could not find people with similar interest (M01; M06); they could be more productive on their own (M02); they tried collaboration and it did not work (F05); or they do not want to be interrupted nor told what to do (M10). Many participants mentioned using local experts for consultation (M03), mutual help (M02), or collaboration (F08; M05; M11; M12). Some stated that their partner is a collaborator (F01; F04) or a companion – i.e. not necessarily working on the same project (F06). Some other participants mentioned

other family members – a father for consultation (M03) or a daughter for collaboration (M04). A few (M08; F03) said that they worked together with expert friends; they got help from people in online communities (M03; M07); or it depended on the project (M03; F03).

4.2.1.3 Summary

The most frequently used materials by participants were wood and furniture, followed by metal, electronics, fabric and packaging. The most popular place to get used materials was online shops (e.g. eBay, Gumtree) and online networks (e.g. Freecycle, Freegle), followed by skips, charity shops and car boot sales. General material selection criteria included potential value, financial saving, (relatively) high quality, ease of handling and recyclability. The use of end products was mostly for the upcycler, followed by gifts to family or friends, and selling (Section 4.2.1.1).

More than half of participants said that they upcycle any time that suits them (as a hobby) or all of the time (as a lifestyle). The frequency of upcycling by participants varied from 'all the time' to 'once a year', sometimes depending on the project or job situation. Their upcycling place is mainly at home (either rooms or shed, garage, patio) but some go to Hackspace/Makerspace, mainly for tools and bigger space. Most participants are engaged in upcycling just by themselves because of the difficulty in finding people with a similar interest, previous bad collaboration experience, productivity, or preference for no interruption or instruction (Section 4.2.1.2).

4.2.2 Factors influencing upcycling

The results on factors influencing upcycling are presented in five main categories: a) perceived benefits of upcycling, b) social factors affecting upcycling, c) emotions experienced through upcycling, d) habits (upcycling-related activities in present and past), and e) facilitating conditions for upcycling. These main categories were predefined according to Triandis' Theory of Interpersonal Behaviour (Section 2.2.4) (see Appendix N for the full quotations).

4.2.2.1 Perceived benefits of upcycling

Economic benefit

The most frequently mentioned perceived benefit of upcycling was 'economic benefit' (coded from the answers by 14 participants). Upcycling was perceived as the cheapest option to furnish the house by one participant (F01). According to another participant (F02), upcycling saves money while giving quality and value: "I don't earn a lot of money, so it's nice to pick something up for five pounds and make it look like something which is worth £65 by painting it really nicely." Some participants said that there is also the potential for earning money: "It has some commercial potential if I am very successful with the project, then there's an opportunity to market it and sell with profit" (M06).

Environmental benefit

The second most frequently mentioned benefit was 'reducing environmental impact' (coded from the answers by 13 participants). When stated, the expressions included "Things are not being in landfill" (M01), "Reusing is more ecological use of material" (M07), "reduction of waste" (M13), "a bit of saving the world" (F05) and "not wasting materials" (M05).

Enjoyment and fun out of the creative process

The third most frequently mentioned benefit was 'having fun and enjoying the work' (coded from the answers by nine participants). Participants found the creative process and challenge in upcycling fun and enjoyable.

Feeling good

The fourth most frequently mentioned benefit was 'making use of abandoned or useless items and feeling good' (coded from the answers by eight participants). This feeling good factor was stated as "Upcycling makes me feel good because I create something worthwhile out of something that there wasn't any worth for someone before" (M13) or "Generally I feel a nice warm glow because I know that this stuff is getting a second life" (F04).

Product personalisation

The fifth most frequently mentioned benefit was 'product personalisation' (coded from the answers by seven participants). Upcycling was seen as the means to "getting products the way we wanted […] acquiring something different and unique […] getting my personality stamped on it" (F01) and "expressing my individuality" (M09).

Learning experience, and recognition and appreciation from others

The sixth and seventh benefits were 'learning experience' and 'recognition and appreciation from others' (each coded from the answers by five participants). Some participants saw upcycling as the process of "developing skills" (M03), "acquiring the knowledge" (M09) and "becoming better" (M03) for the next time. Other participants found other people's recognition and appreciation as simply "nice to have" (M08) to "encouraging" (F01).

Miscellaneous benefits

The rest of the benefits were either practical benefits or psychological or emotional well-being benefits (each coded from the answers by fewer than five participants). The practical benefits included 'improving home' – by putting shelves and making storage by upcycling, or refurbishing and redecorating furniture (F06; F07), 'simpler way of making than doing so from scratch' (M07; M13), 'helping projects at university' – upcycling electronics for the dissertation project (M01), and 'tidying things up' (F03). The psychological or emotional well-being benefits included 'being creative'; 'relaxing' – e.g. by focusing on something different for a while (M06); 'empowering' – e.g. by having the autonomy and capability to create something in one's own way (F06; M13) as well as having control over the personal belongings (F06); 'feeling productive' – unlike not producing anything at work: "I am an administrator. I press buttons […] [which] doesn't seem to actually do anything. But I want to make something solid, real and tangible." (M03); and 'stopping negative thinking' – e.g. by getting into something (F07).

4.2.2.2 Social factors affecting upcycling

Social norms

The frequently mentioned social norm was being 'environmentally conscious' (coded from the answers by ten participants). Those who presented their concern for environment did not agree with "throw-away society" (M11) or "waste society" (M13) as "there are only finite amount resources on this planet" (M03). They thought that it is good or desirable to reuse and upcycle goods. One participant (M08) expressed that he wanted to show alternative ways of production through upcycling. Another participant (M11) argued that we should continue the war-time trend of reuse, recycle, repurpose and upcycle rather than feeding the throw-away society. One participant (F07) stated that her upcycling complied with the social expectation towards individual productivity and using capabilities.

Roles

The most frequently mentioned role affecting upcycling was people's 'occupational roles' (coded from the answers by eight participants). Some (F01; M08) saw their design occupation relevant to upcycling activities. Some student participants (M01; M05) viewed their student status as the major driver to be frugal in what they are doing. Another student participant (M13) mentioned the nature of being a student as "wanting to do new things, doing new culture" which had motivated him. A few (F08; M11) explained that the employee (or industry) expectation towards higher cost-benefit effectiveness had routinized repair, upgrade and remake as part of their job, which affected their skills and motivation. One participant (F04) pointed out how her job made her more conscious about environmental impact of certain manufactured goods (in her case, printed circuit boards), leading her to upcycling.

The second most frequently mentioned role was 'relationship roles' (coded from the answers by six participants). Some participants talked about being or becoming an ideal 'mother figure' who is "able to make, do and mend" (F02) with "a desire for efficiency" (F05), not asking for money. Some (F06; M03; M07) described how their upcycling has been helpful to their partners or direct family members. A few (M03; M11), as active Hackspace members, said that their upcycling also helped their

activities to “make the Hackspace more well-known and well-subscribed […] also make Hackspace work better” (M03).

Self-concept

Some participants (F08; M05; M13) presented strong, life-long opinions to be resourceful and to respect nature as ‘environmentalists’. Some others (F05; F06; M12) identified themselves as ‘makers’. One participant (M12) emphasised that he was not a mender but a maker by saying “I tend to build things so they can be easily repaired, and tend to over-engineer things – make it twice as strong as it used to be because I am a maker not a mender.” A few (F03; F05) regarded themselves as ‘problem solvers’. A few others viewed themselves as close to ‘rebels’ in the sense that they “have always been like a bit hippy” (M13) or “have never been the one for following social norms” (F04). Other self-concepts included ‘creative person’ (M13), ‘Christian’ with stewardship of nature (M13) and ‘Steampunk’ (F04).[19]

4.2.2.3 Emotions experienced through upcycling

Satisfaction

The most commonly experienced emotion was ‘satisfaction’ (coded from the answers by 15 participants). The satisfaction comes from the process and outcome of upcycling as well as proving their personal capabilities. Some felt that they “were very content when they were working on them” (F04) and “got a lot more pleasure from work with hands and building products.” (M05). One participant (F01) mentioned that the quality of the outcome made her satisfied. Many found their skills and ability to finish any upcycling project, regardless of the outcome quality, pleasing (F06; M01; M03; M04; M07; M10; M12). A few (M02; M13) described ‘relief’, with satisfaction because “the stress had gone”. One participant (M09) pointed out that the satisfaction is also longer lasting (and potentially increasing over time) in contrast to ephemeral satisfaction of shopping.

19 A group of people who pursue the culture and lifestyle of incorporating technology and aesthetic designs inspired by 19th-century industrial steam-powered machinery through fashion, home decoration, music and film (Wikipedia 2015).

Frustration (or disappointment)

The second most mentioned emotion was 'frustration' (coded from the answers by 14 participants). In most cases, participants reported that they experienced frustration or disappointment when "things don't work" (M01) or if "it doesn't quite turn out the way one wanted it to" (F01). The major reason appears to be lack of knowledge and skills, especially "if it is that kind of project that one has not worked on before" (F06). The nature of upcycling seems to contribute to the frustration from non-standardised and often defective materials. One participant said, "What you find in a skip is bits of wood that have been rejected. It's because either it's too small or they've got a defect. […] So a lot of it doesn't work." (M04). Although frustration is a negative emotion, it was occasionally seen as an inevitable "part of learning" (M02) which one has to "learn to live with" (M02) and which sometimes "drives one to make things better" (F01).

Happiness

The third most frequently mentioned emotion was 'happiness' (coded from the answers by eight participants). Reasons why the participants felt happy varied. Some (F02; F03; F07) felt happy during the upcycling process "in a very nice stage of flow" (F03). A few (M02; M13) were happy when they finished the projects. Other reasons included satisfactory outcome (F01), "when it works" (M01), "when I solve a problem" (F03) or "if I can make people happy [with upcycled products]" (M10).

Pride and excitement

The fourth and fifth frequently mentioned emotions were 'pride' and 'excitement' (each coded from the answers by six participants). Several participants (F02; F04; M06; M13) used the expression "a sense of achievement" and some (F04; M09; M13) used "proud of myself". The participants said that they felt excitement throughout the whole process: "excited with your ideas when you start working" (M08); excited to "see what will work or not [when] pushing boundaries" during the process (F08); excited "about the outcome" (F01; F03); excited to "see what happens to it [the outcome]" (F01; M05) and, finally, excited about next project (F04).

Angst and sadness

The less commonly experienced emotions were ‘angst’ and ‘sadness’ (each coded from the answers by fewer than five participants). The angst was expressed as the “worry that I will mess up and waste time and resources” (F06) and the constant thinking about the project (M02). The sadness, a “melancholic or bittersweet” feeling (F03), seems to come from the fact that “you have to let it go” at the end of the project, which is almost like a process of being a mother letting go of her children (F03).

4.2.2.4 Habits

Habits here refer to upcycling-related activities in present and past: i.e. current activities related to upcycling and childhood activities related to upcycling.

Current activities

The most frequently stated activity undertaken with upcycling was ‘art and craft’ (coded from the answers by nine participants). Their interest in art and craft covered woodwork, painting and drawing, making jewellery, knitting, crochet and sewing, metalwork, making T-shirts, photography and generally making products from new materials. The second most frequently stated activity was ‘hacking, tinkering and digital creation’ (coded from the answers by eight participants). The objects of hacking or tinkering included electronics, furniture, T-shirts, and materials for teaching. Digital creation included web apps, websites, and anything online or digital. Several participants stated about ‘DIY (Do-It-Yourself) housework, repair and maintenance’ (coded from six participants’ answers). Repairing and fixing items especially bicycles, seems to be some participants’ routine (M02; M07; M11; M13). A few mentioned their “DIY housework, painting and repair” (M03) and “house restoration” (M12).

Other upcycling-related activities included ‘other environmentally friendly behaviour’ and ‘collecting items’. Environmentally friendly behaviour included “repurposing products” (M11), “reusing stuff” (M12), “buying second-hand […] and looking for ways and means to achieve low impact” (F04). A few participants (M03; M04)

explained that they have the tendency to acquire or collect items for potential future use or recycling.

Childhood activities

The most frequently stated childhood activity was 'family-influenced making and DIY' (coded from the answers by 12 participants). Some participants (F01; F03; F05; M05) remembered their grandmother's or mother's knitting, sewing and cooking, and how they taught them these skills, or how their work inspired them. Other participants (F06; F08; M10; M13) remembered their grandfather's or father's making, building, fixing and repairing activities based on house DIY and garage workshop. In other cases, without specifying which parents, participants mentioned how they grew up with their parents' DIY and home repair (M03; M07; M08). Several (F01; F05; F08; M02; M07) highlighted the significance of family influence on their upcycling and making.

The second frequently stated childhood activity was 'school making and drawing' (coded from the answers by eight participants). Among those who mentioned it, female participants (F01; F03; F07; F08) remembered art and design classes at school or college, whereas male participants (M02; M03; M09; M12) remembered woodwork, metalwork, electronics, other engineering classes or science competitions. The third was 'always building and making' (coded from six participants' answers). The fourth was 'taking products apart' (answered by four participants): they mostly remembered that they had always been taking something apart and seeing "how it works" (M01; M06) or "what's in it" (M13). Other childhood activities included 'always reusing, fixing and upcycling', 'playing with toys (especially Lego)', and 'media-inspired making' (e.g. Hartbeat, the children's art programme by Tony (M05), another children's TV programme with arts and crafts, Blue Peter (M05; M07), and a science fiction TV series, Blake's 7 (F04)).

4.2.2.5 Facilitating conditions for upcycling

Facilitating conditions refer to the contextual factors or external influencers which can either hinder or facilitate upcycling (i.e. barriers to and facilitators for upcycling).

Nine barriers and 12 facilitators were identified. See the summary of barriers and facilitators in Table 14 and Table 15.

Barriers

The most frequently stated barrier to upcycling was 'lack of competence' in knowledge and physical skills (coded from the answers by ten participants). In terms of knowledge, some participants (M11; M13) described "knowledge gaps" such as not knowing how things work (M07), what to do next (F03) or which used material to select (F05). Some others (M01; M13) pinpointed the difficulty in learning electronics and coding. In terms of skills barrier, several (F01; F06; F08) asserted the necessity of developing skills to make satisfying products. In the case of upcycling, skills development appears to be more difficult than in traditional craft. One participant (M05) said, "There are some traditional skills dedicated to certain materials, whereas if you are taking something not supposed to be made into something else, you have to adapt existing skills and make up new […] techniques to work with that."

Table 14 Barriers to upcycling

No.	Barriers	No.	Barriers
01	Lack of competence	06	Lack of spare time
02	Problems with materials	07	Safety issues
03	Lack of space	08	Lack of interest
04	Social situation and cultural perception	09	Quality issues
05	Lack of tools		

The second most frequently mentioned barrier was 'problems with materials' (coded from the answers by eight participants). Inaccessibility to the materials required was one problem: "Generally you don't know where to get the materials from. […] Where do you get, like, 200 estate agency signs? Or where do you get 2000 plastic bottles?" (M05). Two participants (F05; M04) shared their common frustration from taking so long to find the right used materials, and another participant (M10) stated, "sometimes, it's really annoying if you need things you can't get." Unaffordability of the materials is another problem: used materials are sometimes nearly as expensive as new ones (M04) or some additional expensive materials are required for upcycling (M10). The low quality of used materials was a third problem (F05; F08; M04). Other

material-related problems included being “constrained by the physical limitation of what you’ve got as materials” (M02) and time-consuming interruptions due to missing materials (F01).

The third most frequently mentioned barrier was ‘lack of space’ (coded from the answers by seven participants). Some reported that they did not have enough space to store tools, materials and upcycling projects before their first attempt to upcycle. Equally frequently stated was ‘social situation and cultural perception’. One participant (M12) expounded on the changed social situation (i.e. the abundance of products and consumer culture), saying “The kids today are different to when I was a kid. […] They don’t see any charm, anything to be gained in making stuff, because they can just buy one.” Some participants spoke about the “negative view on reusing” (M07) and “a stigma” attached to certain products made by upcycling (F04). “People don’t entirely understand the thinking behind [upcycling]. Either it’s weird or eccentric or they think it’s sort of miserly penny-pinching” (M07). Another negative perception was on getting anything from the bin or a skip (F05; M98; M10; M13).

The fifth most frequently mentioned barrier was ‘lack of tools’. Not having the required tools and equipment was identified as the common barrier: e.g. welding gear or a laser cutter (F04). The sixth and seventh barriers were ‘lack of spare time’ and ‘safety issues’. Safety issues were identified as: a) power tool usage and potential injury (M01; M03); b) no safety guarantee for parts especially for upcycled electronic products (M08); and c) health and safety issues in going into a pile of trash in a recycling centre (M05) and dealing with potentially contaminated materials (F08). Other barriers included ‘lack of interest’ and ‘quality issues’. Two participants stated that used materials do not work properly in some instances (M07) and the product out of used materials is “either not very good or not sellable” most of the time (F05).

Facilitators

‘Having enough space’ to store tools, materials and upcycled items as well as to be able to work (especially on relatively big items), was most frequently mentioned as a facilitator (i.e. a contextual or external factor which can facilitate upcycling), coded

from the answers by 11 participants. Several participants (F01; F06; M03) selected space as the most influential facilitator.

Table 15 Facilitators for upcycling

No.	Facilitators	No.	Facilitators
01	Having enough space	07	Internet (information and helping communities)
02	Having all the right materials	08	Social situation and cultural perception
03	Hackspace	09	Companions
04	Inspiration	10	Interest and imagination
05	Having always had tools around	11	Teachers
06	Sufficient knowledge and skills	12	Spare time

The second most frequently mentioned were 'having all the right materials', 'Hackspace' and 'inspiration from people and experience' (each coded from the answers by six participants). Materials included both used materials (to become part of the outcome) and materials for decoration (e.g. paint) and engineering (e.g. nuts, bolts and screws). Hackspace (Section 3.3.1.1), a space with tools, materials and expertise, was regarded as beneficial for providing the access to tools. Concerning inspiration, some participants spoke about upcycling by the people around them – e.g. partner's mother (F02), Hackspace people (M11), father (M13). Others spoke about certain eye-opening experiences, such as visiting low income countries and seeing how everything is reused (F03; M02), or visiting a waste recycling plant (F08).

The fifth and sixth facilitators were 'tools' and 'competence' (each coded from the answers by five participants). One participant (M07) chose "having always had tools around" as the most influential factor for upcycling. Competence meant having sufficient explicit knowledge and skills (F06; M07), as well as more intuitive or tacit skills such as seeing "beauty in lots of things" (F07), "a way of changing used materials to make them have another life" (F08), or "[picturing objects] three-dimensionally in my head" (F03).

Less frequently mentioned facilitators included 'internet for information and helping communities', 'social situation and cultural perception' and 'companions'. Many participants (F05; M02; M06; M07) found the internet useful for information (technical and inspirational) and sourcing materials, and as a community of people

willing to help on technical issues. The facilitating social situation was to “have a sympathetic partner” (M04), while the positive cultural perception on upcycling seemed to come from the emerging “Maker culture” (M05; M07) or regional frugal culture (M11). Some were encouraged by having a companion (often their partners) as a collaborator (F01; F02; F08) or just “somebody else also making something” (F04). Other facilitators included ‘interest and imagination’, ‘teachers’ and ‘spare time’ (coded from the answers by fewer than four participants).

4.2.2.6. Summary

Perceived benefits of upcycling showed that there are several practical and psychological/emotional benefits, as well as environmental benefits. Practical benefits included economic benefit, product personalisation, improving home, helping projects at university, and tidying things up. Psychological or emotional benefits included enjoyment, fun out of the creative process, feeling good, learning, recognition and appreciation from others, being creative, relaxing, empowering, and feeling productive (Section 4.2.2.1). Social factors affecting upcycling were the social norm of being environmentally conscious, and occupational and relationship roles (Section 4.2.2.2). Emotions experienced throughout upcycling were both positive and negative. Positive emotions were satisfaction, happiness, pride and excitement. Negative emotions were frustration, angst and sadness (Section 4.2.2.3).

Current activities related to upcycling showed some gender differences: art and craft were mostly undertaken by female participants; and hacking, tinkering, digital creation, DIY housework, repair and maintenance by males. Upcycling-related childhood activities were essentially family-, school-, or media-influenced activities (Section 4.2.2.4). The common facilitating conditions between barriers and facilitators included competence, materials, space, social situation and cultural perception, tools, spare time and interest. Various safety and quality issues were less commonly identified but important barriers. People’s impact (for inspiration and as companions, collaborators and teachers) and internet’s role were picked up as important facilitators (Section 4.2.2.5).

4.2.3 Links between upcycling, product attachment and longevity

This quantitative study was combined with the semi-structured interviews (qualitative) as mixed methods as part of understanding consumer behaviour (upcycling). The aim was to identify the links between upcycling, product attachment and longevity, utilising the existing empirical research based on questionnaires (Section 3.2.3.1). The responses (n=44) were from 23 participants who filled in up to three identical questionnaires based on the upcycled products with the most attachment (Sections 4.1.1, 4.1.2 and 4.1.3.3). The number of responses therefore refers to the number of selected upcycled products with attachment (rather than the number of respondents). Three main statistical tests were used: a) descriptive statistics to describe the basic features of the data (e.g. mean, SD); b) correlation analysis to identify the strengths of the relationships between upcycling, attachment and longevity; and c) non-parametric statistics to compare groups based on demographics and product categories.

4.2.3.1 Descriptive statistics

When respondents selected certain upcycled products (n=44) as the ones with the most emotional attachment (*M*=5.41, *SD*=1.59), they reported high mean values for self-expression (*M*=5.27, *SD*= 1.56), group affiliation (*M*=5.66, *SD*=1.45), pleasure (*M*=5.59, *SD*=1.30), product care (*M*=5.09, *SD*=1.36) and expected product longevity (*M*=5.37, *SD*=1.53), and a low mean value for disposal tendency (*M*=1.45, *SD*=.92). Irreplaceability had a slightly lower mean value, with a high standard deviation (*M*=3.61, *SD*=2.34)[20]. Expected lifetime of the selected upcycled products ranged between 1 year and over 50 years, with a mean value of 11.67 years (*SD*=13.23).

When respondents chose the degree of product attachment, on the scale of 1 to 9, at the point of completing an upcycling project, they reported a high mean value (*M*=7.39, *SD*=1.56). But then the initial attachment from 20.5% (n=9) of the upcycled products faded away, whereas the attachment from 68% (30) stayed the same and the attachment from 11.5% (5) got stronger over time. As a consequence, product

[20] A large standard deviation indicates that the data are spread out over a wide range of values.

attachment at the point of responding to the questionnaire was slightly lower than the initial attachment, with a high standard deviation (*M*=6.64, *SD*=2.29).

Table 16 Descriptive statistics for product attachment, determinants and consequences of attachment, product lifetimes and degree of attachment

Categories	Variables	Statistical results			
		Mean	SD	Min.	Max.
Determinants of product attachment (7-point scale)	Self-expression	5.27	1.56	1	7
	Group affiliation	5.66	1.45	2	7
	Memories	4.41	2.37	1	7
	Pleasure	5.59	1.30	2	7
Product attachment (7-point scale)		5.41	1.59	1	7
Consequences of product attachment (7-point scale)	Disposal tendency	1.45	0.92	1	6
	Product care	5.09	1.36	3	7
	Expected product longevity	5.37	1.53	2	7
	Irreplaceability	3.61	2.34	1	7
Product lifetime (Years)	Expected product lifetime	11.67	13.23	1	over 50
	Expected product lifetime for the mass-produced product with same functions	7.06	11.59	2	over 50
Degree of product attachment (9-point scale)	Degree of product attachment at the point of upcycling project completion	7.39	1.56	4	9
	Degree of product attachment at the point of responding to the questionnaire (upcycled product)	6.64	2.29	1	10
	Degree of product attachment at the point of purchase of the mass-produced product with same functions	3.25	2.08	1	9
	Degree of product attachment at the point of responding to the questionnaire (mass-produced product with same functions)	3.06	1.61	1	6

Sixteen out of 44 (36%) upcycled products with attachment had been purchased as mass-produced products with same functions by the respondents. When these had been purchased, respondents reported a low mean value of the degree of product attachment, with a high standard deviation (*M*=3.25, *SD*=2.08). Attachment from the mass-produced products mostly stayed the same over time (81%; 13) whereas 13% (2) faded away and 6% (1) got stronger. As a consequence, attachment at the point of responding to the questionnaire was slightly lower (*M*=3.06, *SD*=1.61). The mean value of expected lifetime for the mass-produced products was 7.06 (*SD*=11.59) (see Table 16).

In general, the mean values for the determinants and consequences of attachment were high; and the expected lifetime and the degree of attachment from the upcycled products (with attachment) were higher than those from the mass-produced products for the same functions.

4.2.3.2 Correlation analysis

Correlation analysis was conducted to identify the strength of relationships between product attachment, and determinants and consequences of product attachment. Spearman's Rank Order Correlation revealed that product attachment is positively correlated with each of the four determinants of product attachment (r=.45 to .66, p<.001). Determinants of product attachment were mostly positively correlated with one another: only group affiliation and pleasure were not significantly correlated (Table 17). The overall results mean that there is a high likelihood that self-expression, group affiliation, memories and pleasure are indeed determinants of attachment to the upcycled products.

Table 17 Spearman's rho between product attachment and its determinants, based on the upcycled products with attachment

Categories	Variables	Spearman's rho				
		SE	GA	M	P	PA
Determinants of product attachment	Self-expression (SE)	-				
	Group affiliation (GA)	.515**	-			
	Memories (M)	.631**	.461**	-		
	Pleasure (P)	.692**	.351	.519**	-	
Product attachment (PA)		.664**	.451**	.627**	.644**	-

**p<.001 (2-tailed)

Spearman's Rank Order Correlation showed that product attachment is positively correlated with irreplaceability (r=.516, p<.001), but there was no statistically significant correlation of product attachment with the other consequences of attachment. Irreplaceability, however, is also positively correlated with product care (r=.44, p<.001) and expected product longevity (r=.48, p<.001). Expected product longevity is also positively correlated with expected product lifetime (r=.45, p<.001) (Table 18). The overall results mean that the most likely consequence of attachment to the upcycled products might be creating the sense of irreplaceability, which can potentially lead to product care and expected product longevity.

Table 18 Spearman's rho between product attachment and its consequences, based on the upcycled products with attachment

Categories	Variables	Spearman's rho					
		DT	PC	EL1	I	EL2	PA
Consequences of product attachment	Disposal tendency (DT)	-					
	Product care (PC)	-.343	-				
	Expected product longevity (EL1)	-.365	.679**	-			
	Irreplaceability (I)	-.122	.442**	.479**	-		
	Expected product lifetime (EL2)	-.363	.252	.445**	.237	-	
Product attachment (PA)		-.274	.371	.364	.516**	.363	-

**p<.001 (2-tailed)

4.2.3.3 Non-parametric statistics for comparing groups

Gender group difference

A Mann-Whitney U Test revealed statistically significant differences between male and female answers concerning product attachment, all four determinants of product attachment (self-expression, group affiliation, memories, and pleasure) and most consequences of product attachment (product care, expected product longevity, irreplaceability and expected product lifetime). In all cases, median scores for female respondents were higher than for males. This means that women may feel higher self-expression, group affiliation and pleasure, and stronger memories through upcycling than men. Women may feel stronger attachment to the upcycled products than men. Women may tend to feel a stronger sense of irreplaceability from the upcycled products; care the upcycled products more; and expect longer product lifetimes of the upcycled products than men. A large effect was shown in self-expression (r=.57) and expected product longevity (r=.51). This means women may feel particularly higher self-expression through upcycling and expect significantly longer lifetime of the upcycled products than men do. Disposal tendency did not show gender difference (Table 19).

Table 19 Mann-Whitney U Test, effect size and medians of the significantly different variables across gender groups

Categories	Variables	Mann-Whitney U Test, effect size and median scores					
		U	Z	Sig.	r	Md	n
Determinants of product attachment	Self-expression	76	-2.89	.000**	.57	M: 4 F: 7	27 17
	Group affiliation	121	-2.72	.007**	.41	M: 6 F: 7	27 17
	Memories	111	-2.92	.003**	.44	M: 4 F: 7	27 17
	Pleasure	146	-2.08	.038**	.31	M: 5 F: 7	27 17
Product attachment		113	-2.89	.004**	.44	M: 5 F: 7	27 17
Consequences of product attachment	Disposal tendency	189	-.591	.555	.09	M: 1 F: 1	26 16
	Product care	92	-3.21	.001**	.49	M: 4 F: 6	27 16
	Expected product longevity	87	-3.34	.001**	.51	M: 5 F: 7	27 16
	Irreplaceability	108	-.2.97	.003**	.45	M: 2 F: 6	27 17
	Expected product lifetime	138	-1.96	.050**	.30	M: 4 F: 15	27 16

**p<.05

Age group difference

A Kruskal-Wallis H Test revealed a statistically significant difference across three age groups (Gp1, n=23: 20-29yrs, Gp2, n=13: 30-49yrs, Gp3, n=8: 50+yrs) in group affiliation: X^2=7.12, p=.028 and pleasure: X^2=6.75, p=.034 (df=2, n=44). The older the age group, the higher was the median score. This means that older people may feel stronger group affiliation and pleasure from upcycling than younger people. The two other determinants of attachment (self-expression and memories), product attachment and all consequences of attachment did not show significant difference across age groups (Table 20).

Table 20 Kruskal-Wallis H Test and median scores of the significantly different variables across three age groups

Categories	Variables	Statistical results			
		X^2	Sig.	Md	n
Determinants of product attachment	Group affiliation	7.12	.028**	Gp1: 5 Gp2: 6 Gp3: 7	23 13 8
	Pleasure	6.75	.034**	Gp1: 5 Gp2: 6 Gp3: 7	23 13 8

**p<.05

Occupational group difference

A Kruskal-Wallis H Test revealed a statistically significant difference across three occupational groups (Gp1: art and design, Gp2: science and engineering, Gp3: other – see Section 4.1.2) in self-expression, memories, product care, expected product longevity and irreplaceability. For self-expression and memories, 'art and design' had the highest median scores (both *Md*=7). For product care and irreplaceability, 'other' had the highest median scores (Md_{CARE}=6.5, Md_{IRRE}=7). For expected product longevity, 'art and design' and 'other' had the same higher median score (both *Md*=7) than 'science and engineering'. 'Science and engineering' had the lowest median scores for all five variables (Table 21). This means that people working in art and design may feel stronger self-expression and memories through upcycling and expect longer product lifetime of the upcycled products than those in other occupations. The people working in science and engineering may feel lower self-expression, and weaker memories and sense of irreplaceability from the upcycled products; and tend to less care about and expect shorter product lifetimes of the upcycled products than those in other occupations.

Table 21 Kruskal-Wallis H Test and median scores of the significantly different variables across three occupational groups

Categories	Variables	Statistical results			
		X^2	Sig.	Md	n
Determinants of product attachment	Self-expression	7.72	.021**	Gp1: 7.0 Gp2: 5.0 Gp3: 6.5	13 23 8
	Memories	8.36	.015**	Gp1: 7.0 Gp2: 3.0 Gp3: 6.5	13 23 8
Consequences of product attachment	Product care	10.17	.006**	Gp1: 5.5 Gp2: 4.0 Gp3: 6.5	12 23 8
	Expected product longevity	12.74	.002**	Gp1: 7.0 Gp2: 4.5 Gp3: 7.0	13 22 8
	Irreplaceability	18.56	.000**	Gp1: 5.0 Gp2: 2.0 Gp3: 7.0	13 23 8

**p<.05

Group difference based on product categories

Understanding group difference based on product categories is not as straightforward as demographic group differences, since some products can be classified into more than one category. For example, when a wind chime was categorised as an outdoor product, a recycling bin as furniture, and a USB battery charger as an experimental project, a Kruskal-Wallis H Test revealed a statistically significant difference in irreplaceability levels across five different product category groups.[21] When the wind chime and the recycling bin were re-categorised as a small home product, and the USB battery charger as other personal belongings, however, a Kruskal-Wallis H Test revealed a nearly significant difference in self-expression levels across product category groups: X^2(df=4, n=44)=9.23, p=.053. Other personal belongings recorded the highest mean score (*Md*=7), followed by inside-the-home furniture and small home products and decorations (both *Md*=6), and experimental and artistic projects (*Md*=5). Garden, shed, workshop and outdoor products showed the lowest median score (*Md*=4) (see Appendix E for a description of product categorisation).

4.2.3.4 Summary

Comparisons between upcycled products with attachment and mass-produced products with same functions showed that when people are strongly attached to their upcycled products, the degree of product attachment at the point of upcycling completion can be much higher than mass-produced products at the point of purchase. Attachment to the upcycled products, however, presented a slightly greater tendency to fade away over time than the mass-produced products. Attachment to the upcycled products also presented a higher tendency to increase in strength compared to the mass-produced products. Taking into account such changes over time, the degree of product attachment to the upcycled products at the point of responding to the questionnaire was still much higher than mass-produced

21 (Gp1, n=14: experimental and/or artistic projects, Gp2, n=10: inside-the-home furniture, Gp3, n=8: garden, shed, workshop and/or outdoor products, Gp4, n=6: small home products and/or decorations, Gp5, n=6: other personal belongings), X2(df=4, n=44) = 11.02 (p=.026). Small home products and/or decorations recorded the highest median score (*Md*=6.5), followed by other personal belongings (*Md*=5.5) and inside-the-home furniture (*Md*=3.5). Experimental and/or artistic projects (*Md*=2) and garden, shed, workshop and/or outdoor products (*Md*=1.5) showed lower median scores than other product categories.

products. Corresponding to the difference in the degrees of product attachment, the mean expected lifetime of upcycled products with attachment was 4 years longer than that of mass-produced products (Section 4.2.3.1).

There were statistically significant correlations between product attachment and determinants of attachment for the upcycled products with attachment. Only one significant correlation was found, between product attachment and irreplaceability (Section 4.2.3.2). Female respondents generally reported higher scores for product attachment and determinants and consequences of attachment to the upcycled products. There was a tendency for older respondents to score higher for group affiliation and pleasure than younger respondents. The respondents in art and design scored higher for self-expression, memories, product care, product longevity and irreplaceability than others, whereas those in science and engineering scored lowest for the same variables. Group differences based on product categories showed the possibility that people may feel greater self-expression when they create personal belongings, furniture, and small home products and decorations, than when they create experimental or artistic projects, and garden, shed, workshop or outdoor products (Section 4.2.3.3).

4.3 Discussion

This section discusses the results of the interviews and short questionnaire study. The discussion is presented in three categories: a) current upcycling behaviour; b) factors influencing upcycling; and c) links between upcycling, product attachment and longevity.

4.3.1 Current upcycling behaviour

The varied frequency of upcycling from the participants showed that there are two kinds of upcyclers: one is enthusiastic hobbyists (or environmentalists) and the other is pragmatists (or pragmatic makers who upcycle only when necessary). Participants' frequently used materials (e.g. furniture, electronics, fabric), sources for acquiring materials (e.g. online shops and networks), and material selection criteria (e.g.

potential value, financial saving) should be taken into account to generate interventions for scaling-up (e.g. more effective and efficient materials provision). The participants' main upcycling space (home) should also be reflected in the interventions.

Evidence of differences based on demographic characteristics is not conclusive. Nevertheless, there were some meaningful observations. For instance, male participants appeared to utilise online shops and networks, and skips more frequently than female participants. Participants aged 50 and over did not mention charity shops, car boot sales, building sites, Hackspaces, local factories or recycling centres as sources for their used materials. Participants aged 50 and over did not mention potential value, financial saving or ease of handling as used material selection criteria. Male participants aged under 30 reported most often that they have been to Hackspace/Makerspace.

4.3.2 Factors influencing upcycling

Most perceived benefits of upcycling were individual benefits (practical and psychological/emotional). Such individual benefits are known to be a common motivator for pro-environmental behaviour (Defra 2008) or sustainable lifestyles (Defra 2011). Some are also similar to upcycling determinants identified through reviewing the literature on crafts, DIY and the maker movement (Sung, Cooper and Kettley 2014): for example, fulling needs with less financial resources (Szaky 2014), 'long tail' [22] market opportunity (Anderson 2012, Frank 2013), self-expression (Gauntlett 2011, Parker 2012), simply being creative (Levine and Heimerl 2008, Soule 2008), learning experience (Gauntlett 2011, Lang 2013, Turney 2009), and empowerment (Gauntlett, 2011; Parker, 2012; Turney, 2009).

The social factors frequently answered (e.g. social norm of being environmentally conscious, and occupational and relationship roles) confirm that norms and roles are other common motivators for environmentally significant behaviour (Defra, 2008;

22 The theory of the Long Tail is that our culture and economy is increasingly shifting away from a focus on a relatively small number of hits at the head of the demand curve and toward a huge number of niches in the tail (Anderson 2016)

2011). Both positive and negative emotions experienced through upcycling support Gauntlett's (2011) argument that 'everyday creativity' activities such as upcycling arouse a range of emotions, including excitement, frustration and mostly a feeling of joy (or happiness). Whether or not the emotion of 'being contented or happy' experienced by the participants was short-lived or contributed significantly to their overall happiness was not conclusive. However, since some meta-analysis and comparative studies found that a goal-oriented activity is a major contributor to happiness (Lyubomirsky, Sheldon and Schkade 2005, Sheldon and Lyubomirsky 2009), upcycling may have high potential to induce well-being.

The current and childhood activities related to upcycling showed the continuity and repetition of similar activities over time (close to habits). Habits, in the study of environmentally significant behaviour, are often portrayed as barriers or challenges to overcome or change (Darnton, et al. 2011, Defra 2008, Jackson 2005a). In this case, however, these types of habits might be subjected to development in early years, and nurturing and maintaining during the upcyclers' life time. The facilitating conditions for upcycling revealed several external barriers and facilitators. Such external, practical limits to choosing certain behaviour as well as negative perceptions on 'green' lifestyles (i.e. not for the majority), are known barriers to any environmentally significant behaviour (Defra, 2008). Defra (2011) also argued that skills and ability are more important than understanding.

Differences in demographic characteristics were not conclusive in any category. Nevertheless, there were some meaningful observations. For instance, besides the three major perceived benefits (economic benefit, environmental benefit and having fun), it appeared that female participants found product personalisation more beneficial, whereas males found learning experiences more beneficial. Participants under 30 seemed to put more weight on product personalisation and recognition and appreciation from others than those aged 30 and over. Female participants appeared to view their relationship roles as more relevant to upcycling, whereas males viewed the occupational roles as more relevant. Participants under 50 seemed to have experienced frustration more commonly than older participants. Female participants

said that they have engaged more in art and craft, whereas males were active in hacking, tinkering, DIY and repair. Participants under 30 gave the impression that they have more often found lack of competence and space as the major barriers, whereas problems with materials and social situation and cultural perception might be a bigger issue for those aged 30 and above. These observations, if proven quantitatively, might provide more meaningful and valuable information for demographic-sensitive interventions.

4.3.3 Links between upcycling, product attachment and longevity

Overall, the findings showed that when people feel attached to the upcycled products, they tend to feel stronger attachment to and expect longer product lifetime of the upcycled products than mass-produced products with same functions. However, a similar difference in the data could occur if one compares a mass-produced product to which the participants feel most attached with an ordinary mass-produced product without any particular attachment. Moreover, it is also possible that some people already felt attached to certain products and that is why they upcycled them in the first place.

The statistically significant correlation between product attachment and determinants of attachment for the upcycled products with attachment corroborates the findings from past studies on (ordinary) consumer durables (Schifferstein, Mugge and Hekkert 2004, Mugge 2007). This may suggest that the causal relationship between product attachment and the determinants of attachment in consumer durables can also be applied in the case of upcycling. The correlation between product attachment and the consequences of attachment in this study seemed to be limited, unlike the findings from other studies (i.e. irreplaceability, product care, expected product longevity, etc.) (Govers and Mugge 2004, Mugge 2007, Ramirez, Ko and Ward 2010). Only one significant correlation was found between product attachment and irreplaceability. Taking into account the positive correlation between irreplaceability and product care, and between irreplaceability and expected product longevity, however, it might be the case that irreplaceability for makers/upcyclers mediates the effect of attachment on product care and expected product longevity.

Nevertheless, the lack of significant correlations between attachment and other consequences of attachment could be due to the small sample size.

Older age groups' higher scores in group affiliation and pleasure, as well as women's higher scores in product attachment, all four determinants of attachment, and part of consequences of attachment, partially correspond with past research that group affiliation and memories are more relevant for women and older consumers (Csikszentmihalyi and Halton 1981, Dyl and Wapner 1996, Furby 1978, Kamptner 1991). This study, however, found that women, in particular, may be more conducive to developing product attachment through upcycling. Another unique finding on demographic difference concerns occupation: participants with an art and design occupation scored higher in two determinants of attachment (self-expression and memories) and one consequence of attachment (expected product longevity), whereas participants with a science and engineering occupation scored lower in two determinants of attachment (self-expression and memories) and three consequences of attachment (product care, irreplaceability and expected product longevity).

Two results from a Kruskal-Wallis H Test on alternative product categorisations may signify dissimilar degrees of irreplaceability and self-expression depending on product categories. It might be the case that people feel that products are more irreplaceable if they make small home products and decorations, and personal belongings other than furniture, experimental and artistic projects, or garden, shed, workshop and outdoor products by upcycling. If that is the case, the result conforms with the study by Schifferstein, et al. (2004), which found that product attachment is higher for ornaments than functional products. Equally, it might also be the case that people feel higher levels of self-expression if they make personal belongings, furniture, and small home products and decorations than experimental and artistic projects, and garden, shed, workshop and outdoor products.

4.4 Implications

This section draws implications for next step from the results and discussions on the interview and short questionnaire study. The implications are presented in three categories: a) current upcycling behaviour; b) factors influencing upcycling; and c) links between upcycling, product attachment and longevity.

4.4.1 Study on current upcycling behaviour

The major implications from this part of the study concern ideas for scaling-up. Considering the wide spectrum of upcyclers (from enthusiastic upcyclers to pragmatic makers), scaling-up upcycling may include enabling enthusiastic upcyclers to become entrepreneurs (e.g. Sarah Turner in Sung and Cooper 2015), enabling more pragmatic makers to engage in upcycling more frequently, and attracting newcomers to engage in making and upcycling. What kinds of interventions can facilitate such changes or transitions? The results suggest the following possibilities.

Considering the materials used most frequently, it might be helpful if any attempt to improve materials provision first targets wood, electronics, fabric and packaging. Based on the varied places to get materials, if each local authority runs a unified 'used material' centre (instead of many scattered places) in line with the existing waste collection system, and provides an online service in which users can search for materials (similar to Freegle/Freecycle but top-down), it might facilitate both enthusiastic and pragmatic makers to engage in upcycling. Taking into account material selection criteria, any online service for material provision might be more helpful for decision making if it provided users with the estimated potential value in the material with estimated cost saving (comparing to new materials) and a quality rating for each item assessed by trained personnel. Second, reflecting on the aspirations of some people without any commercial experience for selling their upcycled products, specialised services by relevant actors (e.g. local authorities, academic institutions, design experts, social enterprises) may lower the barriers for these enthusiastic upcyclers to become entrepreneurs. Such services may include: a) business feasibility tests based on, for instance, financial analysis, technical analysis

(e.g. durability, reliability), and risk analysis; b) technical safety tests (especially for electronics); and c) suitable niche market identification. Based on the predominant use of the home for upcycling and main reason to use Hackspace (for tools), if people can hire/rent tools, or use the tools in Hackspace by paying, for example, hourly fee (instead of membership fee), it might be more convenient for existing makers, and potentially attract more non-makers to try out upcycling. Considering the difficulty in finding people with similar-interests or good collaborators, a community event (e.g. mini Maker Faire or Hackspace-initiated event) on a regular basis could enable people to find hobby friends, companions, collaborators, or even potential business partners.

4.4.2 Study on factors influencing upcycling

The major implications from this part of the study concern the links to, and basis of, the next study, a large sample survey, which aims to identify which factors have relatively more significant influence to determine the frequency and intention of upcycling. The findings, a list of perceived benefits and facilitating conditions, informed the survey questions. Additional questions (which can be answered in the next study) were formed from the discussions such as: a) which factors (e.g. perceived benefits, social factors) and which elements (e.g. which benefits among all the perceived benefits) are more important?[23]; and b) do the differences observed on the basis of demographics exist in a bigger sample?

4.4.3 Study on the links between upcycling, product attachment and longevity

The major implications from this part of the study concern interventions for scaling-up. Group differences based on demographic characteristics imply that older people, women, or people who work in art and design may be most likely to develop strong attachment to their upcycled products as well as use the upcycled products longer. A combination of these three demographic backgrounds (older, female, working in art and design) may be the best group of people to be targeted by any actors aiming to

23 Which factors (e.g. perceived benefits, social factors, habits and facilitating conditions) are more significant behaviour determinants for upcycling? Which elements (e.g. which benefits among all the perceived benefits) are more important or potentially more influential for scaling-up interventions?

upscale upcycling at household level. Group differences based on product categories imply that small home products and decorations, furniture and personal belongings (other than experimental and artistic projects or garden, shed, workshop and outdoor products) may be the products with which people are more likely to develop strong attachment by upcycling and to use the end products longer. These product categories, therefore, could be considered for scaling-up interventions by design practitioners (e.g. upcycling instruction videos for the general public) or local authorities (e.g. upcycling events for community people).

5 IDENTIFYING KEY FACTORS INFLUENCING BEHAVIOUR (Study 2)

This chapter describes methods (procedure, study participants, instruments and analysis approach), results, discussions and implications of the second study: identifying key factors influencing behaviour. This study aims to find out the foci of interventions for scaling-up upcycling (i.e. which key factors to intervene). The study instruments were designed on the basis of the results from the previous study.

5.1 Methods

The data was collected between June and July 2015 through an internet survey using Google Forms. The procedure, sample selection, instrument used and analysis undertaken are described below.

5.1.1 Procedure

A pilot survey (after pre-tests and revision of the survey) was administered to 23 websites (Hackspace Google forums, Instructables forums and Etsy chitchat)[24] in June 2015, through Google Forms to ensure the validity and reliability of the study. Data was collected from 68 respondents. Pilot analysis included descriptive statistics on demographics and all variables to check general trend of the data and any unexpected results, and Cronbach's Alpha to test the reliability of a scale. No unexpected result was found, and all Cronbach's Alpha values showed above .7 (acceptable) or .8 (preferable), which confirmed the readiness for the survey.

In order to reach the population of makers (a bigger target population than upcyclers, including current and potential future upcyclers) (Section 3.3.2) the interview study asked about the websites that they use for upcycling. A number of identified websites along with other similar websites were used for administering the survey. The online

[24] (1) Nottingham Hackspace; (2) Leicester Hackspace; (3) Maker Space; (4) South London Makerspace; (5) London Hackspace; (6) Cammakespace; (7) Hackspace Manchester; (8) DoES Liverpool; (9) Brighton Hacker Space; (10) SoutHackton; (11) Surrey and Hampshire Hackspace; (12) Make Bournemough; (13) Oxford Hackspace; (14) Cheltenham Hackspace; (15) Birmingham Hackspace; (16) Salop Hackspace; (17) Potteries Hackspace; (18) Sheffield Hardware Hackers; (19) York Hack Space; (20) Instructable art forum; (21) Instructable burning questions forum; (22) Instructable craft forum; and (23) Etsy chitchat.

survey hyperlink was also sent to the previous interviewees to get their responses as well as to disseminate the survey (see Appendix F for list of websites used).

The online survey began with the definition of upcycling, what is expected of respondents, and reward (sharing of the results for those who want, and a £15 Amazon voucher for five randomly selected respondents). Respondents were asked to answer to the questions measuring the theoretical constructs of the combination model of Theory of Interpersonal Behaviour and Theory of Planned Behaviour (Section 2.2.5), such as perceived benefits, attitude, social factors (subjective norm, personal norm and role beliefs), perceived behaviour control, intention, perceived facilitating conditions, and behaviour (frequency). At the end of the survey, socio-demographic information was collected, such as gender, age group, nationality, residence, ethnicity, employment status, occupational area, educational level, and annual household income (see Appendix G for questions).

5.1.2 Survey respondents

Although a total of 227 people responded, non-British residents (*n*=105) were excluded (Section 3.3.2.2) as the geographical area is limited to the UK as the study scope (Section 1.2.3). The 122 responses from British residents were selected for analysis. The selected respondents (*n*=122) were from all nine official regions of England, Scotland and Wales in the UK (excluding Northern Ireland). The majority of the respondents were White-British and completed higher education. Half of the respondents were aged between 30 and 49 and full-time employed in either creative arts and design, or science and engineering. Their annual household income varied between under £20,000 and over £60,000 (Table 22).

Table 22 Socio-demographic characteristics of survey respondents

Respondents characteristics		Frequency	Respondents characteristics		Frequency
Gender	Male	59 (48.4%)	Ethnicity	White-British	102 (83.6%)
	Female	63 (51.6%)		White-Irish	1 (0.8%)
Age group	Under 30	22 (18.0%)		Any other white	14 (11.5%)
	30 to 49	63 (51.6%)		Any other mixed	2 (1.6%)
	50 and over	37 (30.3%)		Asian-Chinese	1 (0.8%)
Nationality	British	110 (90.2%)		Any other Asian	1 (0.8%)
	American	4 (3.3%)		African	1 (0.8%)
	German	2 (1.6%)	Region of residency	East Midlands	13 (10.7%)
	Irish	1 (0.8%)		East of England	11 (9.0%)
	Italian	1 (0.8%)		London	8 (6.6%)
	Romanian	1 (0.8%)		North East	8 (6.6%)
	Slovakian	1 (0.8%)		North West	23 (18.9%)
	South African	1 (0.8%)		Scotland	6 (4.9%)
Education	Primary	2 (1.6%)		South East	28 (23.0%)
	Secondary	9 (7.4%)		South West	13 (10.7%)
	Further	25 (20.5%)		Wales	3 (2.5%)
	Higher	86 (70.5%)		West Midlands	3 (2.5%)
Annual household income	Under £20K	27 (22.1%)		Yorkshire and the Humber	5 (4.1%)
	£20K-£40K	37 (30.3%)	Occupation/ study area	Business & sales [a]	14 (11.5%)
	£40K-£60K	19 (15.6%)		Creative arts & design	35 (28.7%)
	£60K-£80K	9 (7.4%)		Science & engineering	32 (26.2%)
	£80K-£100K	4 (3.3%)		Teaching & education	14 (11.5%)
	Over £100K	3 (2.5%)		Others [c]	27 (22.1%)
	No answer	23 (18.9%)	Employment [b]	Full time [d]	54 (44.3%)
				Part-time & self-employed [e]	39 (32.0%)
				Currently unemployed [f]	28 (23.0%)

[a]: 'Business, finance, management and marketing' and 'sales and retail' were recoded together as 'business and sales'

[b]*n*=121 (one data is missing)

[c]: 'Others' include 'health service', 'hospitality, leisure, sport and tourism', 'manufacturing', 'public and social service', etc. (specified as agriculture, publishing and call centre by the respondents).

[d]: When the respondent gave multiple answers including full-time employed, it was recoded as full-time employment

[e]: When the respondent gave multiple answers including part-time employed (e.g. together with self-employed or student), it was recoded as part-time employment. When the respondent gave multiple answers including self-employed (e.g. together with retired or student), it was recoded as self-employment.

[f]: When the respondent gave answer of student, retired or unemployed, it was recoded as currently unemployed.

5.1.3 Instruments

The questions were based on the factors in the combination model between Triandis' Theory of Interpersonal Behaviour and Ajzen's Theory of Planned Behaviour (Section 2.2.6). Most questions were formulated by adopting constructs that have already been used and validated by other researchers (Section 3.4.2), including Ajzen (2002), Bamberg and Schmidt (2003), Gagnon, et al. (2003), Francis, et al. (2004) and Tonglet, et al. (2004). The items used in 'perceived benefits' and 'perceived facilitating conditions' came from previous interview data. Perceived benefits had 14 items

(Cronbach's α=.873), attitude had 5 items (Cronbach's α=.888), subjective norm 3 items (Cronbach's α=.737), personal norm 3 items (Cronbach's α=.858), role beliefs 4 items (Cronbach's α=.802), perceived behaviour control 4 items (Cronbach's α=.649), intention 3 items (Cronbach's α=.884), and perceived facilitating conditions 15 items (Cronbach's α=.924). All factors showed the Cronbach's Alpha value between .6 and .8 (suggesting acceptable internal consistency reliability for the scale) or above .8 (indicating good reliability).

Measures for the variables of perceived benefits, subjective norm, personal norm, perceived behaviour control and intention were obtained on seven-point Likert scales (1="strongly disagree, 7="strongly agree"), whereas a 'not applicable' option was additionally provided for role beliefs. Perceived facilitating conditions and perceived habits used different seven-point Likert scales (1="not at all", 7="to a very great extent" and 1="never", 7="very frequently"). Attitude was assessed by means of seven-point bi-polar adjective scales (1="unpleasant", 7="pleasant"; 1="bad", 7="good"; 1="worthless", 7="worthwhile"; 1="harmful, 7="beneficial"; 1="unenjoyable", 7="enjoyable"). To measure the frequency of behaviour in the past 5 years, eight options were given (1="never", 2="less frequently than once a year", 3="about once a year", 4="about once every six months", 5="about once every three months", 6="about once a month", 7="about once a week", 8="more frequently than once a week") (see Table 23).

Table 23 Questions asked in the survey

Factor	Question and answer options
Perceived benefits	How much do you agree or disagree with the following sentences? Upcycling would… (1) save money; (2) reduce environmental impact; (3) be fun; (4) allow me to personalise products; (5) offer learning experiences; (6) result in a high quality product; (7) result in a high value product – e.g. more useful; (8) provide me with extra income opportunities – by selling the upcycled products; (9) allow me to get recognition and appreciation from others; (10) improve my home – e.g. interior refurbishment; (11) allow me to be creative; (12) relax me; (13) be an easier way of making things than making from scratch; (14) empower me; (15) help cut clutter at home (1: strongly disagree – 7: strongly agree)
Attitude	To me, taking part in upcycling is… (1: unpleasant – 7: pleasant; 1: bad – 7: good; 1: worthless – 7: worthwhile; 1: harmful – 7: beneficial; 1: unenjoyable – 7: enjoyable)
Subjective norm (social factor 1)	How much do you agree or disagree with the following sentences? Please read the wording very carefully. (1) Most people who are important to me think that I *ought to* upcycle things; (2) Most people who are important to me *expect* me to upcycle things; (3) Most people who are important to me *would approve* of me upcycling. (1: strongly disagree – 7: strongly agree)
Personal norm (social factor 2)	How much do you agree or disagree with the following sentences? (1) I would *feel guilty if I was not* upcycling things, especially when used materials are available and would become waste otherwise; (2) Upcycling *reflects my principles* about using resources responsibly; (3) It would be *unacceptable to me not* to upcycle things, especially when used materials are available and would become waste otherwise. (1: strongly disagree – 7: strongly agree)
Role beliefs (social factor 3)	How much do you agree or disagree with the following sentences? Upcycling fits my role in… (1) my workplace; (2) my family; (3) my community; (4) my friendship / support networks (1: strongly disagree – 7: strongly agree; not applicable)
Perceived behaviour control	How much do you agree or disagree with the following sentences? (1) For me upcycling things would be *possible*; (2) If I *wanted to i could* upcycle things; (3) Upcycling things would be *easy for me*; (4) It is mostly *up to me* whether or not I upcycle things. (1: strongly disagree – 7: strongly agree)
Intention	How much do you agree or disagree with the following sentences? (1) My likelihood of upcycling is high; (2) If I have the opportunity, I will upcycle things; (3) I intend to upcycle things. (1: strongly disagree – 7: strongly agree)
Perceived facilitating conditions	To what extent do you think the following factors have impeded your upcycling? A lack of… (1) space; (2) tools; (3) used products, components or materials; (4) teachers or helpers; (5) knowledge; (6) skills; (7) imagination; (8) inspiration; (9) information; (10) collaborator or companion; (11) spare time; (12) supporting culture – e.g. traditional craft culture; (13) supporting policy – facilities and training provision; (14) financial incentives; (15) money to pay for materials and tools involved (1: not at all – 7: to a very great extent)
Perceived habits	How frequently do you engage in the following activities? (1) drawing, painting and/or other art work; (2) hacking, tinkering and/or experimenting; (3) donating products to charities; (4) sharing, bartering, lending and/or swapping products; (5) simple reusing (e.g. use plastic package as a food container); (6) handcraft using new materials; (7) repairing and/or fixing things; (8) recycling household waste; (8) composting; (9) digital creation (e.g. use on/offline software to create pictures, articles, videos, etc.); (10) making and/or building using new materials (1: never – 7: very frequently)
Frequency of upcycling	Approximately how often have you upcycled things in the past 5 years? (1: never; 2: less frequently than once a year; 3: about once a year; 4: about once every six months; 5: about once every three months; 6: about once a month; 7: about once a week; 8: more frequently than once a week)

5.1.4 Analysis

Preliminary analysis was first conducted to ensure the reliability of a scale. Cronbach's Alpha values showed above .8 (preferable) for perceived benefits, attitudes, personal norm, role beliefs, intention, and perceived facilitating conditions; and between .7 and .8 (acceptable) for subjective norm. Perceived behaviour control and perceived habits, however, showed below .7 (unacceptable). Factor analysis was, therefore, conducted for these two variables to see if each of these factors has multiple components (instead of one). The confirmatory factor analysis for perceived behaviour control recommended to extract one component: Kaiser-Meyer-Olkin value was .697 (over the recommended value of .6); principal components analysis revealed the presence of one component with eigenvalues exceeding 1 (2.073), explaining 51.8% of the variance; and the Screeplot showed a clear break between the second and third component. It means all items in perceived behaviour control measure one factor. The result of perceived habits, however, recommended to extract three components instead of one. Kaiser-Meyer-Olkin value was .596; principal components analysis revealed the presence of three components with eigenvalues exceeding 1 (2.531, 1.980 and 1.563), explaining 23%, 18% and 14.2% of the variance respectively; and the Screeplot showed a clear break between the fourth and fifth component. As it was clear that the items in perceived habits did not measure one factor, it was removed from the main statistical analysis.

The responses (excluding perceived habits) were analysed by employing descriptive statistics, correlation analysis (Spearman's Rank Order Correlation), logistic regression, and non-parametric statistics for comparing groups (Mann-Whitney U Test and Kruskal-Wallis H Test), using SPSS (Statistical Package for the Social Sciences) version 22.0 (see Section 3.5.2).

When intention was used as an independent variable (e.g. correlation between intention and the frequency of upcycling), the original three items were used. When intention was used as a dependent variable (e.g. correlation between intention and determinants of intention – attitude, social factors, perceived behaviour control), one

intention item ("I intend to upcycle things") was used for the highest correlation coefficient in the relationship with the frequency of upcycling.

Even though there is no consensus on the approach to sample size with logistic regression (Demidenko 2007), a rule of a thumb is to have at least 10 cases for each predictor (Peduzzi, et al. 1996). As the sample size was 122, the number of predictors for the logistic regression was limited to below 12 by extracting items with high(er) correlation coefficient from the correlation analysis. To calculate an R^2 for logistic regression, there is no consensus on which one is the best (Allison 2013). This PhD uses the logistic regression output of SPSS: Cox & Snell R Square and Nagelkerke R Square.

5.2 Results

This section describes the survey results which are structured around the statistical tests used: a) basic description of the data by descriptive statistics; b) relationships between factors influencing upcycling by correlation analysis; c) key factors and models to explain the frequency and intention of upcycling by logistic regression; and d) group differences based on demographics by non-parametric statistics.

5.2.1 Basic description of the data

Descriptive statistics was performed to describe the basic features of the data such as minimum, maximum, mean, standard deviation and frequency (percentage) (Section 3.5.2.1). The data included perceived benefits of upcycling, attitude towards upcycling, three social factors influencing upcycling (subjective norm, personal norm, role beliefs), perceived behaviour control over upcycling, intention to upcycle, perceived facilitating conditions influencing upcycling, and the frequency of upcycling (Section 5.1.3).

When respondents were asked about the perceived benefits of upcycling (7-point scale), what appears to be most important to them (mean above 6.0) included 'be fun', 'allow me to personalise products', 'offer learning experiences' and 'allow me

to be creative'. The second most important benefits (mean between 5,0 and 6.0) included 'save money', 'reduce environmental impact', 'result in a high value product (e.g. more useful)', 'improve my home (e.g. interior refurbishment)', 'relax me' and 'empower me'. The least important benefits (mean below 5.0) were 'result in a high quality product', 'provide me with extra income opportunities (by selling the upcycled products)', 'allow me to get recognition and appreciation from others', 'be an easier way of making things than making from scratch' and 'help cut clutter at home' (Table 24).

Table 24 Perceived benefits

Items	Descriptive statistics (n=122)			
	Min.	Max.	Mean	SD
Save money	1.0	7.0	5.39	1.35
Reduce environmental impact	1.0	7.0	5.82	1.19
Be fun	1.0	7.0	6.03	1.02
Allow me to personalise products	2.0	7.0	6.04	0.98
Offer learning experiences	1.0	7.0	6.05	1.06
Result in a high quality product	1.0	7.0	4.67	1.28
Result in a high value product	1.0	7.0	5.17	1.20
Provide me with extra income opportunities	1.0	7.0	4.17	1.68
Allow me to get recognition and appreciation	1.0	7.0	4.66	1.35
Improve home	1.0	7.0	5.16	1.33
Allow me to be creative	1.0	7.0	6.15	1.03
Relax me	1.0	7.0	5.21	1.32
Be an easier way of making things than making from scratch	1.0	7.0	4.92	1.51
Empower me	1.0	7.0	5.48	1.26
Help cut clutter at home	1.0	7.0	4.02	1.72

Note: Grey cells indicate that the mean values are over 5.0 which is bigger than neutral (1.0: strongly disagree; 2.0: disagree; 3.0: somewhat disagree; 4.0: neither agree nor disagree; 5.0: somewhat agree; 6.0: agree; 7.0: strongly agree).

Most respondents appeared to have positive attitude towards upcycling (mean values of all five items between 5.0 and 6.0 with SD around 1.0). Many respondents did not believe that most people who are important to them expect them to upcycle things or think that they ought to upcycle things (means below 4.0 with SD between 1.0 and 2.0). The majority, however, believed that most people who are important to them would approve of their upcycling (Mean=5.57; SD=1.20). Several respondents answered that they felt (weak) personal, moral obligation to upcycle items, related to guilt and a sense of unacceptability by not upcycling (means between 4.0 and 5.0 with the SD around 1.75). Most, however, answered that upcycling reflects their

principles about using resources responsibly (Mean=5.43; SD=1.44). The respondents appeared to believe that upcycling fits their role more in their community and friendship or support networks (means above 5.0 with SD around 1.30) than in their workplace or family (means between 4.0 and 5.0 with SD around 1.50). The respondents' competence in their ability to upcycle items appeared to be high (means for all perceived behaviour control items between 5.11 and 6.16 with SD between 0.81 and 1.23). Their intention to upcycle was also relatively high (Mean=5.45~5.70; SD=0.96~1.31) (Table 25).

Table 25 Attitude, social factors, perceived behaviour control and intention

Factor	Items	Descriptive statistics (n=122)			
		Min.	Max.	Mean	SD
Attitude	Unpleasant-Pleasant	1.0	7.0	5.75	1.14
	Bad-Good	1.0	7.0	5.96	1.13
	Worthless-Worthwhile	2.0	7.0	5.79	1.25
	Harmful-Beneficial	2.0	7.0	5.85	1.18
	Unenjoyable-Enjoyable	2.0	7.0	5.96	1.05
Subjective norm (social factor1)	Most people who are important to me think that I *ought to* upcycle things	1.0	7.0	3.85	1.39
	Most people who are important to me *expect* me to upcycle things	1.0	7.0	3.93	1.74
	Most people who are important to me *would approve* of me upcycling	1.0	7.0	5.57	1.20
Personal norm (social factor2)	I would *feel guilty if i was not* upcycling things, especially when used materials are available and would become waste otherwise	1.0	7.0	4.43	1.77
	Upcycling *reflects my principles* about using resources responsibly	1.0	7.0	5.43	1.44
	It would be *unacceptable to me not* to upcycle things, especially when used materials are available and would become waste otherwise	1.0	7.0	4.63	1.74
Role beliefs (social factor3)	Upcycling fits my role in my workplace	1.0	7.0	4.15	1.69
	… in my family	1.0	7.0	4.92	1.44
	…in my community	1.0	7.0	5.06	1.33
	… my friendship/support networks	1.0	7.0	5.06	1.36
Perceived behaviour control	For me upcycling things would be *possible*	4.0	7.0	6.05	0.81
	If I *wanted to i could* upcycle things	4.0	7.0	5.98	0.81
	Upcycling things would be *easy for me*	2.0	7.0	5.11	1.23
	It is mostly *up to me* whether or not I upcycle things	3.0	7.0	6.16	0.83
Intention	My likelihood of upcycling is high	1.0	7.0	5.45	1.31
	If I have the opportunity, I will upcycle tings	2.0	7.0	5.70	0.96
	I intend to upcycle things	1.0	7.0	5.68	1.16

Note: Grey cells indicate that the mean values are over 5.0 which is bigger than neutral (1.0: strongly disagree; 2.0: disagree; 3.0: somewhat disagree; 4.0: neither agree nor disagree; 5.0: somewhat agree; 6.0: agree; 7.0: strongly agree).

Regarding perceived facilitating conditions, overall, the respondents did not answer that external factors have impeded their upcycling significantly. A lack of space and spare time appeared to be the most common perceived barriers (means between 4.0 and 5.0 with SD around 2.0). The respondents did not seem to perceive 'teachers or helpers', 'information', 'supporting culture (e.g. traditional craft culture), 'supporting policy (e.g. facilities and training provision)' and 'financial incentives' as common barriers (means below 3.0 with SD around 1.70) (Table 26).

Table 26 Perceived facilitating conditions

Items	Descriptive statistics (n=122)			
	Min.	Max.	Mean	SD
A lack of space	1.0	7.0	4.41	1.92
… tools	1.0	7.0	3.54	1.84
… used products, components or materials	1.0	7.0	3.48	1.75
… teachers or helpers	1.0	7.0	2.85	1.68
… knowledge	1.0	7.0	3.33	1.89
… skills	1.0	7.0	3.39	1.77
… imagination	1.0	7.0	3.14	1.88
… inspiration	1.0	7.0	3.38	1.99
… information	1.0	7.0	2.95	1.70
… collaborator or companion	1.0	7.0	3.03	1.75
… spare time	1.0	7.0	4.51	2.03
… supporting culture (e.g. craft culture)	1.0	7.0	2.72	1.86
… supporting policy (e.g. facilities provision)	1.0	7.0	2.99	1.88
… financial incentives	1.0	7.0	2.62	1.68
… money to pay for materials and tools involved	1.0	7.0	3.64	1.86

On the frequency of upcycling, the answers varied from less frequently than once a year to more frequently than once a week, with most answers for about once every three months (n=32; 26.2%) and about once every six months (n=24; 19.7%) (Table 27).

Table 27 Frequency of upcycling

Frequency of upcycling	Descriptive statistics (n=122)	
	N	Percentage (%)
Never	0	0
Less frequently than once a year	7	5.7
About once a year	14	11.5
About once every six months	24	19.7
About once every three months	32	26.2
About once a month	19	15.6
About once a week	11	9
More frequently than once a week	15	12.3

5.2.2 Relationships between factors influencing upcycling

Correlation analysis (non-parametric, Spearman's correlation) was performed to study the strength of a relationship between factors influencing upcycling (Section 3.5.2.2). The results are meant to prove or disprove the correlations between factors (i.e. if intention and perceived facilitating conditions are correlated with the frequency of upcycling), and provide the items which could be used for the following regression analysis (i.e. the item(s) with high(er) correlation coefficient) (Section 5.1.4).

5.2.2.1 Correlation between determinants and frequency of upcycling

Spearman's correlation was used to see the extent to which intention and perceived facilitating conditions are correlated with the frequency of upcycling. The results revealed that all intention items were positively correlated with the frequency of upcycling; all correlations showed strong relationships – i.e. r=.5 to 1.0 (Cohen 1988). Seven items in perceived facilitating conditions showed statistically significant correlation with the frequency of upcycling: a lack of tools (r=.187), a lack of used products, components or materials (r=.244), a lack of skills (r=.181), a lack of imagination (r=.307), a lack of inspiration (r=.350), and a lack of information (r=.184). Among these, imagination and inspiration showed the medium size correlation (r=.30 to .49), whereas others showed the small size correlation (r=.10 to .29) (Table 28).

Table 28 Spearman's rho between determinants of behaviour and behaviour frequency

Spearman's rho (n=122)		
Factor	**Items**	**Correlation coefficient**
Intention	My likelihood of upcycling is high	.568**
	If I have the opportunity, I will upcycle things	.583**
	I intend to upcycle things	.600**
Perceived facilitating conditions (reversed data)	A lack of space	.139
	… tools	.187*
	… used products, components or materials	.244**
	… teachers or helpers	.183*
	… knowledge	.174
	… skills	.181*
	… imagination	.307**
	… inspiration	.350**
	… information	.184*
	… collaborator or companion	.018
	… spare time	.061
	… supporting culture (e.g. craft culture)	.129
	… supporting policy (e.g. facilities provision)	.131
	… financial incentives	.021
	… money to pay for materials and tools involved	.119

*p<.005 (2-tailed)
**p<.001 (2-tailed)

5.2.2.2 Correlation between determinants of intention and intention

Spearman's correlation was used to see the extent to which determinants of intention (attitude, social factors and perceived behaviour control) are correlated with intention to upcycle.[25] All items tested were positively correlated with intention. All five attitude items showed the medium size correlation. One subjective norm item ("Most people who are important to me *expect* me to upcycle things") showed the large size correlation (r>.50), whereas the other two showed the medium size correlation. All three personal norm items showed the large size correlation. One role beliefs item ("Upcycling fits my role in my community") showed the large correlation (r=.512); two role beliefs items ("… in my family" and "…in my friendship/support networks") showed medium correlation; and one item ("… in my workplace") small correlation (r=.287). Most perceived behaviour control items showed the medium size correlation except for one item ("It is mostly *up to me* whether or not I upcycle things") with small size correlation (Table 29).

25 "I intend to upcycle things" was used as a dependent variable based on the largest correlation coefficient found between intention variables and frequency of upcycling by Spearman Rank Order Correlation analysis (Table 28) (Section 5.1.4).

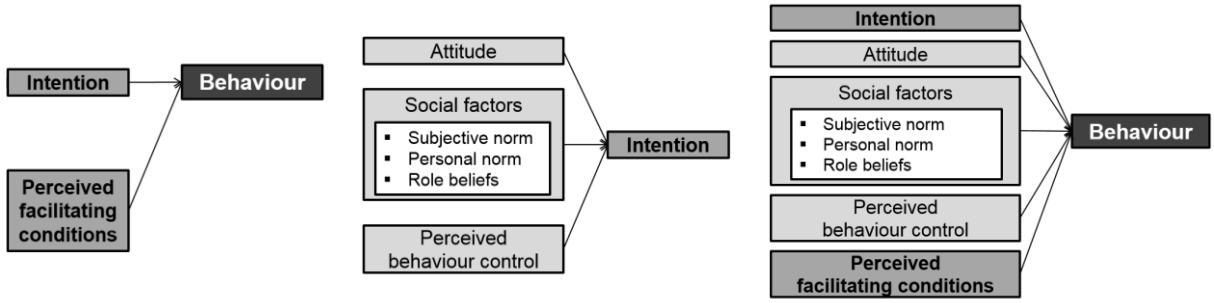
Table 29 Spearman's rho between determinants of intention and behaviour intention

Spearman's rho (n=122)		
Factor	**Items**	**Correlation coefficient**
Attitude	Unpleasant-Pleasant	.447**
	Bad-Good	.423**
	Worthless-Worthwhile	.474**
	Harmful-Beneficial	.401**
	Unenjoyable-Enjoyable	.309**
Subjective norm (social factor 1)	Most people who are important to me think that I *ought to* upcycle things	.362**
	Most people who are important to me *expect* me to upcycle things	.587**
	Most people who are important to me *would approve* of me upcycling	.346**
Personal norm (social factor 2)	I would *feel guilty if i was not* upcycling things, especially when used materials are available and would become waste otherwise	.516**
	Upcycling *reflects my principles* about using resources responsibly	.558**
	It would be *unacceptable to me not* to upcycle things, especially when used materials are available and would become waste otherwise	.599**
Role beliefs (social factor 3)	Upcycling fits my role in my workplace	.287**
	… in my family	.341**
	…in my community	.512**
	… my friendship/support networks	.401**
Perceived behaviour control	For me upcycling things would be *possible*	.435**
	If I *wanted to i could* upcycle things	.355**
	Upcycling things would be *easy for me*	.447**
	It is mostly *up to me* whether or not I upcycle things	.214*

*p<.005 (2-tailed)
**p<.001 (2-tailed)

5.2.3 Key factors to explain the frequency and intention of upcycling

Logistic regression was performed to assess the effects of a number of factors on the likelihood that respondents would report that they engaged more frequently in upcycling (than once every six months), and that they intend to upcycle items. 7-point scale ordinal data and nominal data with more than two options were converted into binary nominal data for logistic regression (see Appendix H). The limited number of items (n=9~10) with high correlation coefficient from the correlation analysis were used as determinants for analysis (Sections 5.1.4 and 5.2.2).



1st model to explain frequency of upcycling

2nd model to explain intention to upcycle

3rd model to explain frequency of upcycling based on both behaviour and intention determinants

Figure 11 Models tested through the logistic regression analysis[26]

The first model to explain frequency of upcycling contained all three intention items and seven perceived facilitating conditions which showed the significant correlation with frequency of upcycling (Table 28). The model was statistically significant [x^2 (df=10, N=122) = 30.90, p<.05], indicating that the model was able to distinguish between respondents who reported that they upcycle more frequently (than once every six months) and those who reported that they upcycle less frequently. The model explained between 22.4% (Cox and Snell R square) and 30.6% (Negelkerke R squared) of the variance in frequency of upcycling, and correctly classified 76.2% of cases. Only one intention item ("I intend to upcycle things") made a unique statistically significant contribution to the model, recording an odds ratio of 9.47. This odds ratio indicated that respondents who intended to upcycle items were over nine times more likely to report that they actually upcycled items more frequently than those who did not intend, controlling for all other factors in the model (Table 30).

26 The models were based on the combination model (Figure 6) suggested in Section 2.2.6. However, perceived habits were excluded from the model for statistical analysis as confirmatory factor analysis revealed that the variables have three components instead of one (Section 5.1.4). Perceived benefits were also excluded as they do not directly affect intention or behaviour. The idea of including perceived benefits was for potential implication of the findings (e.g. which benefits to promote for communication) rather than explaining the factors influencing upcycling (Section 2.2.6.1).

Table 30 Logistic regression explaining likelihood of reporting relatively more frequent upcycling with intention and perceived facilitating conditions variables

Predictor	*B*	*SE B*	Wald's x^2	*df*	*p*	Odds ratio
I intend to upcycle things.	2.248	.909	6.113	1	.013	9.467
My likelihood of upcycling is high	.673	.617	1.189	1	.275	1.961
If I have the opportunity, I will upcycle things	1.446	.997	2.101	1	.147	4.245
A lack of materials	.158	.494	.102	1	.750	1.171
A lack of imagination	.198	.582	.115	1	.734	1.219
A lack of inspiration	.007	.613	.000	1	.991	1.007
A lack of tools	.576	.574	1.007	1	.316	1.779
A lack of teachers/helpers	.192	.477	.162	1	.687	1.212
A lack of skills	.282	.549	.264	1	.607	1.326
A lack of information	-.123	.563	.048	1	.826	.884
Constant	-3.902	1.229	10.077	1	.002	NA
Test			**x^2**	***df***	***p***	
Omnibus tests of model coefficients			30.902	10	.001	
Hosmer and Lemeshow test			10.844	7	.146	
Model summary & classification						
Pseudo R square statistics			.224 (Cox & Snell R^2)			.306 (Nagelkerke R^2)
Overall percentage correct						76.2

Note: Grey cells indicate that the odds ratios are bigger than 2.0.

The second model to explain behaviour intention contained ten items from attitude, subjective norm, personal norm, role beliefs, and perceived behaviour control (two items per behaviour factor; selected for higher correlation with intention in Table 29). The model was statistically significant [X^2 (df=10, N=116) = 30.53, p<.05], indicating that the model was able to distinguish between respondents who reported that they do and do not intend to upcycle. The model explained between 23.1% (Cox and Snell R square) and 41.9% (Negelkerke R squared) of the variance in intention, and correctly classified 89.7% of cases. Only one attitude item ("To me, taking part in upcycling is pleasant") made a unique statistically significant contribution to the model, recording an odds ratio of 17.61, indicating that respondents who found upcycling pleasant were over 17 times more likely to report that they intend to upcycle than those who find upcycling unpleasant, controlling for all other factors in the model. One subjective norm ("Most people who are important to me *expect* me to upcycle things."), one personal norm ("It would be *unacceptable to me not* to upcycle things, especially when used materials are available and would become

waste otherwise."), and one role beliefs ("Upcycling fits my role in my community") showed relatively higher odds ratio of 2.92, 3.86, and 2.42 respectively, without significant p value. Such odds ratios may suggest that both subjective and personal norms as well as role beliefs could meaningfully affect intention to upcycle (Table 31).

Table 31 Logistic regression explaining likelihood of reporting the intention for upcycling with attitude, social factors and perceived behaviour control variables

Predictor	*B*	*SE B*	Wald's x^2	*df*	*p*	Odds ratio
Unpleasant-Pleasant	2.869	.985	8.477	1	.004	17.612
Worthless-Worthwhile	-.869	1.066	.664	1	.415	.420
Most people who are important to me think that I *ought to* upcycle things	.433	.961	.204	1	.652	1.543
Most people who are important to me *expect* me to upcycle things	1.071	.976	1.204	1	.273	2.918
Upcycling *reflects my principles* about using resources responsibly	.619	.869	.506	1	.477	1.856
It would be *unacceptable to me not* to upcycle things, especially when used materials are available and would become waste otherwise	1.351	.945	2.044	1	.153	3.862
Upcycling fits my role in my community	.881	.935	.888	1	.346	2.413
Upcycling fits my role in my friendship/support networks	-.419	.949	.195	1	.659	.658
For me upcycling things would be *possible*	-.045	1.482	.001	1	.976	.956
Upcycling things would be *easy for me*	.001	.812	.000	1	.999	1.001
Constant	-1.246	1.477	.711	1	.399	.288
Test			x^2	*df*	*p*	
Omnibus tests of model coefficients			30.532	10	.001	
Hosmer and Lemeshow test			3.449	7	.841	
Model summary & classification						
Pseudo R square statistics	.231 (Cox & Snell R^2)			.419 (Nagelkerke R^2)		
Overall percentage correct	89.7					

Note: Grey cells indicate that the odds ratios are bigger than 2.0.

The third model was created by putting all behaviour factors as potential determinants to explain behaviour frequency, containing nine items from all behaviour factors – one item with the highest correlation (with behaviour frequency or intention) per factor except for perceived facilitating conditions (three highly correlated items) in Table 28 and Table 29. The model was statistically significant, x^2 (df=9, N=117) = 48.68 p<.001, and better explained frequency of upcycling than the original combination model (the 1st model in Figure 11). This new model explained between 34% (Cox and Snell R square) and 46.4% (Negelkerke R squared) of the

variance in frequency of upcycling, and correctly classified 84.6% of cases. Two items made a unique statistically significant contribution to the model: intention and subjective norm. The odds ratios were 8.97 and 4.59, indicating that respondents with high intention to upcycle were about nine times more likely to report more frequent upcycling than those with low intention; and respondents who believed that most people important to them expect them to upcycle things were over four times more likely to report more frequent upcycling than those who did not believe so (Table 32).

Table 32 Logistic regression explaining likelihood of reporting relatively more frequent upcycling with behaviour frequency and determinants of intention

Predictor	*B*	*SE B*	Wald's x^2	*df*	*p*	Odds ratio
I intend to upcycle things.	2.193	.881	6.193	1	.013	8.966
A lack of materials	.273	.508	.289	1	.591	1.314
A lack of imagination	.768	.641	1.436	1	.231	2.155
A lack of inspiration	-.042	.630	.004	1	.947	.959
Worthless-Worthwhile	.528	.726	.529	1	.467	1.696
Most people who are important to me *expect* me to upcycle things	1.524	.607	6.308	1	.012	4.593
It would be *unacceptable to me not* to upcycle things, especially when used materials are available and would become waste otherwise	.776	.551	1.981	1	.159	2.173
Upcycling fits my role in my community	.251	.543	.214	1	.644	1.286
Upcycling things would be *easy for me*	.692	.581	1.419	1	.234	1.998
Constant	-4.068	1.122	13.138	1	.000	NA
Test			x^2	*df*	*p*	
Omnibus tests of model coefficients			48.682	9	.000	
Hosmer and Lemeshow test			12.397	7	.088	
Model summary & classification						
Pseudo R square statistics	.340 (Cox & Snell R^2)			.464 (Nagelkerke R^2)		
Overall percentage correct	84.6					

Note: Grey cells indicate that the odds ratios are bigger than 2.0.

5.2.4 Group differences based on demographics

Non-parametric statistics (Mann-Whitney U Test and Kruskal-Wallis H Test) were conducted to compare group differences based on demographics. Mann-Whitney U Test was used to test for differences between two independent groups (e.g. male vs female). Kruskal-Wallis H Test was used to compare the scores for three or more groups (e.g. three age groups of under 30, between 30 and 49, and 50 and over) (Section 3.5.2.2).

5.2.4.1 Gender group difference

There were statistically significant differences between male (n=59) and female (n=63) answers in five perceived benefits, two attitude variables, two social factors, one perceived behaviour control variable, one intention variable and behaviour frequency of upcycling. In three cases of perceived benefits (a high quality product, improve home, and be creative), the median scores from female respondents were higher than males; and medians from the other two (reduce environmental impact and personalise products) did not differ. A medium effect was shown in 'improve home' (r=.30) and the rest of them showed a small effect (r<.30). Two attitude variables (Worthless-Worthwhile and Harmful-Beneficial) showed small effect size difference with no median value difference. Two social factors ('approval' subjective norm and 'feeling guilty' personal norm) showed small size effect difference but with female median scores higher than males. The gender difference in perceived behaviour control was small with no median value difference. Intention difference was small with higher female median score. The difference in the frequency of upcycling was small with no difference in median scores. There was no statistically significant difference across gender groups in role beliefs and perceived facilitating conditions (Table 33).

Table 33 Mann-Whitney U Test, effect size and medians of the significantly different variables across gender groups

Factor (number)	Items	Mann-Whitney U Test, effect size and median scores				
		U	Z	Sig.	r	Md
Perceived benefits (5 out of 15)	Reduce environmental impact	1291	-3.04	.002**	.28	M: 6.0 F:6.0
	Personalise products	1376	-2.63	.009**	.24	M: 6.0 F: 6.0
	A high quality product	1295	-2.97	.003**	.27	M: 4.0 F: 5.0
	Improve home	1227	-3.35	.001**	.30	M: 5.0 F: 6.0
	Be creative	1474	-2.13	.034**	.19	M: 6.0 F: 7.0
Attitude (2/5)	Worthless-Worthwhile	1473	-2.06	.039**	.19	M: 6.0 F: 6.0
	Harmful-Beneficial	1479	-2.04	.042**	.18	M; 6.0 F: 6.0
Social factors (2/10)	People WOULD APPROVE of upcycling	1461	-2.13	.033**	.19	M: 5.0 F: 6.0
	I would FEEL GUILTY if not upcycling	1385	-2.46	.014**	.22	M: 4.0 F: 5.0
Perceived behaviour control (1/4)	Mostly UP TO ME whether or not upcycle	1407	-2.51	.012**	.23	M: 6.0 F: 6.0
Intention (1/3)	If I have the opportunity, I will upcycle tings	1408	-2.44	.015**	.22	M: 5.0 F: 6.0
Behaviour (1/1)	Frequency of upcycling	1411	-2.33	.020**	.21	M: 5.0 F: 5.0

***p*<.05
Note: Grey highlights for higher median scores

5.2.4.2 Age group difference

There were statistically significant differences across three age groups {n(Gp1: under 30)=22, n(Gp2: 30-49)=63, n(Gp3: 50 and over)=37} in five perceived benefits, four attitude variables, two social factors, one perceived behaviour control variable, all three intention variables, and frequency of upcycling. Median scores of two perceived benefits (reduce environmental impact and personalise products), two attitude variables (Unpleasant-Pleasant and Unenjoyable-Enjoyable) and perceived behaviour control did not differ across age groups. Respondents under 30 scored slightly higher median value than others in one perceived consequence (learning experiences). Respondents aged between 30 and 49 scored higher median values in two perceived benefits (be creative and relax) and two attitude variables (Bad-Good and Worthless-Worthwhile) than other age groups. Respondents aged 30 and over

reported higher median scores in two social factors (one personal norm and one role beliefs), all three intention variables and behaviour frequency than the respondents under 30. There was no statistically significant difference in subjective norms and perceived facilitating conditions across age groups (Table 34).

Table 34 Kruskal-Wallis H Test and median scores of the significantly different variables across three age groups

Factor (number)	Items	Statistical results				
		X^2	Sig.	Md		
				Gp1	Gp2	Gp3
Perceived benefits (5 out of 15)	Reduce environmental impact	8.81	.012**	6.0	6.0	6.0
	Personalise products	7.99	.018**	6.0	6.0	6.0
	Learning experiences	11.02	.004**	6.5	6.0	6.0
	Be creative	7.96	.019**	6.0	7.0	6.0
	Relax	7.71	.021**	5.0	6.0	5.0
Attitude (4/5)	Unpleasant-Pleasant	10.66	.005**	6.0	6.0	6.0
	Bad-Good	11.18	.004**	6.0	7.0	6.0
	Worthless-Worthwhile	16.32	.000**	5.0	7.0	6.0
	Unenjoyable-Enjoyable	6.40	.041**	6.0	6.0	6.0
Social factors (2/10)	It would be UNACCEPTABLE not to upcycle	7.19	.027**	4.0	5.0	5.0
	Upcycling fits my role in my community	6.63	.036**	4.0	5.0	5.0
Perceived behaviour control (1/4)	Upcycling would be EASY FOR ME	8.61	.013**	5.0	5.0	5.0
Intention (3/3)	My likelihood of upcycling is high	7.25	.027**	5.0	6.0	6.0
	If I have the opportunity, I will upcycle tings	6.80	.033**	5.0	6.0	6.0
	I intend to upcycle things	7.47	.024**	5.0	6.0	6.0
Behaviour (1/1)	Frequency of upcycling	11.37	.003**	4.0	5.0	5.0

***p*<.05
Note: Grey highlights for higher median scores

5.2.4.3 Occupational group difference

There were statistically significant differences across five occupational area groups {n(Gp1: business and sales)=14, n(Gp2: creative arts and design)=35, n(Gp3: science, engineering and technology)=32, n(Gp4: teaching and education)=14, n(Gp5: others)=27} in five perceived benefits, four attitude variables, six social factors, all three intention variables and frequency of upcycling. In general, respondents working in 'arts and design' scored higher median values in most variables than others, whereas respondents working in 'science, engineering and technology' scored lower median values in all variables than others. There was no statistically significant

difference in perceived behaviour control and perceived facilitating conditions across occupational area groups (Table 35).

Table 35 Kruskal-Wallis H Test and median scores of the significantly different variables across five occupational area groups

Factor (number)	Items	Statistical results						
		X^2	Sig.	Md				
				Gp1	Gp2	Gp3	Gp4	Gp5
Perceived benefits (5 out of 15)	Reduce environmental impact	9.65	.047**	6.0	6.0	6.0	6.0	6.0
	A high quality product	26.64	.000**	5.0	5.0	4.0	4.5	5.0
	Extra income opportunities	20.73	.000**	4.0	5.0	4.0	3.5	4.0
	Improve home	14.33	.006**	6.0	6.0	4.5	5.5	6.0
	Be creative	13.09	.011**	6.0	7.0	6.0	7.0	6.0
Attitude (4/5)	Unpleasant-Pleasant	12.27	.015**	6.0	6.0	5.0	6.0	6.0
	Bad-Good	11.65	.020**	6.0	7.0	5.0	6.0	6.0
	Worthless-Worthwhile	17.83	.001**	6.0	7.0	5.0	6.0	6.0
	Unenjoyable-Enjoyable	10.36	.035**	6.0	6.0	6.0	6.0	6.0
Social factors (6/10)	People think I OUGHT TO upcycle	1.23	.037**	4.0	5.0	3.5	4.0	4.0
	I would FEEL GUILTY if not upcycling	13.88	.008**	4.5	5.0	3.5	5.0	5.0
	It would be UNACCEPTABLE not to upcycle	11.69	.020**	5.0	5.0	4.5	5.5	5.0
	Upcycling fits my role in my workplace	25.31	.000**	3.0	6.0	4.0	4.0	4.0
	… in my family	15.38	.004**	5.0	6.0	4.5	6.0	4.0
	…in my community	10.14	.038**	5.0	6.0	4.0	6.0	5.0
Intention (3/3)	My likelihood of upcycling is high	13.18	.010**	6.0	6.0	5.0	6.0	6.0
	If I have the opportunity, I will upcycle tings	13.41	.009**	6.0	6.0	5.0	6.0	6.0
	I intend to upcycle things	12.77	.012**	6.0	6.0	5.0	6.0	6.0
Behaviour (1/1)	Frequency of upcycling	13.57	.009**	5.0	6.0	4.0	5.5	4.0

**p<.05
Note: Grey highlights for higher median scores

5.2.4.4 Household income group difference

There were statistically significant differences across four household income groups {n(Gp1: under £20,000)=27, n(Gp2: £20,000 to £40,000=37, n(Gp3: £40,000 to £60,000)=19, n(Gp4: over £60,000)=16} in ten perceived benefits, two attitude variables, four social factors, one perceived behaviour control variable, one intention variable, and two perceived facilitating conditions. The median score of perceived behaviour control did not differ whereas the rest of them displayed a clear gap between respondents with under £20K and those with over £60K. Under-£20K

income groups scored higher medians in most variables and over-£60K income groups scored lower medians in all variables. There was no statistically significant difference in frequency of upcycling across different household income groups (Table 36).

Table 36 Kruskal-Wallis H Test and median scores of the significantly different variables across four annual household income groups

Factor (number)	Items	Statistical results					
		X^2	Sig.	Md			
				Gp1	Gp2	Gp3	Gp4
Perceived benefits (10 out of 15)	Save money	24.26	.000**	6.0	6.0	5.0	4.0
	Reduce environmental impact	13.28	.004**	7.0	6.0	5.0	6.0
	Personalise products	16.59	.001**	7.0	6.0	6.0	5.0
	A high quality product	17.03	.001**	6.0	4.0	5.0	4.0
	Extra income opportunities	15.86	.001**	5.0	4.0	4.0	3.0
	Recognition and appreciation	9.44	.024**	5.0	5.0	5.0	4.0
	Improve home	7.70	.021**	6.0	5.0	6.0	4.0
	Be creative	11.27	.010**	6.0	7.0	6.0	6.0
	Relax	8.45	.038**	6.0	5.0	5.0	4.0
	Easier making	11.51	.009**	5.0	6.0	5.0	4.5
Attitude (2/5)	Bad-Good	9.75	.021**	7.0	6.0	6.0	5.0
	Harmful-Beneficial	8.03	.045**	6.0	6.0	6.0	5.0
Social factors (4/10)	People WOULD APPROVE of upcycling	10.18	.017**	6.0	6.0	6.0	5.0
	Upcycling REFLECTS MY PRINCIPLES	9.25	.026**	6.0	6.0	6.0	5.0
	Upcycling fits my role in my family	8.57	.036**	5.0	5.0	5.0	4.0
	…in my community	8.12	.044**	6.0	5.0	5.0	5.0
Perceived behaviour control (1/4)	If I WANTED TO I COULD upcycle	9.85	.020**	6.0	6.0	6.0	6.0
Intention (1/3)	I intend to upcycle things	11.77	.008**	6.0	6.0	6.0	5.0
Perceived facilitating conditions (2/15)	Supporting culture (e.g. craft culture)	8.85	.031**	2.0	3.0	3.0	1.5
	Financial incentives	11.03	.012**	3.0	3.0	1.0	2.5

**p<.05
Note: Grey highlights for higher median scores

5.2.4.5 Educational level group difference

There was only one statistically significant difference across three educational level groups {n=(Gp1: primary school or secondary school)=11, n(Gp2: further education or vocational training)=25, n(Gp3: higher education)=86} in the data set: 'save money'

as perceived consequence. The median score from the respondents with higher education was lower than others (Table 37).

Table 37 Kruskal-Wallis H Test and median scores of the significantly different variables across three educational level groups

Factor (number)	Items	Statistical results				
		X^2	Sig.	Md		
				Gp1	Gp2	Gp3
Perceived consequences (1 out of 15)	Save money	6.90	.032**	6.0	6.0	5.0

***p*<.05
Note: Grey highlights for higher median scores

5.2.4.6 Employment status group difference

There were statistically significant differences across three employment status groups {n(Gp1: full-time employed)=54, n(Gp2: part-time or self-employed)=39, n(Gp3: currently unemployed)=28} in four perceived benefits, five social factors, one perceived behaviour control variable, all three intention variables, and frequency of upcycling. Respondents with part-time or self-employment generally scored higher median values than others, whereas the unemployed scored the lower median values for all variables. There was no statistically significant difference in attitude and perceived facilitating conditions across different employment status groups (Table 38).

Table 38 Kruskal-Wallis H Test and median scores of the significantly different variables across three employment status groups

Factor (number)	Items	Statistical results				
		X^2	Sig.	Md		
				Gp1	Gp2	Gp3
Perceived consequences (4 out of 15)	A high quality product	6.83	.033**	5.0	5.0	4.0
	A high value product	7.77	.021**	5.0	6.0	5.0
	Extra income opportunities	10.25	.006**	4.0	5.0	4.0
	Empowering	8.50	.014**	6.0	6.0	5.0
Social factors (5/10)	People WOULD APPROVE of upcycling	8.82	.012**	6.0	6.0	5.0
	I would FEEL GUILTY if not upcycling	10.12	.006**	4.0	5.0	4.5
	Upcycling REFLECTS MY PRINCIPLES	8.59	.014**	6.0	6.0	5.0
	It would be UNACCEPTABLE not to upcycle	6.86	.032**	5.0	5.0	5.0
	Upcycling fits my role in my workplace	6.57	.037**	4.0	5.0	4.0
Perceived behaviour control (1/4)	Upcycling would be EASY FOR ME	6.01	.049**	5.0	6.0	5.0
Intention (3/3)	My likelihood of upcycling is high	7.01	.030**	6.0	6.0	5.0
	If I have the opportunity, I will upcycle tings	14.29	.001**	6.0	6.0	5.0
	I intend to upcycle things	16.57	.000**	6.0	7.0	5.0
Behaviour (1/1)	Frequency of upcycling	8.24	.016**	5.0	6.0	5.0

***p*<.05
Note: Grey highlights for higher median scores

5.3 Summary and discussion

Descriptive statistics revealed the most important perceived benefits of upcycling as be fun, product personalisation, learning experiences, and be creative (means above 6.0), followed by save money, reduce environmental impact, high value product, improve home, relax and empowerment (means between 5.0 and 6.0). It seems that consumers may perceive psychological/emotional benefits (fun, learning, creative) more commonly (or strongly) than economic (save money) or environmental benefits (reduce environmental impact). All attitude items, perceived behaviour control items and intention items as well as one subjective norm (approval), one personal norm (personal principles), and two role beliefs (in community and friendship/support networks) showed high mean values (over 5.0) (Section 5.2.1). Unlike the interview study participants (upcyclers) (Sections 4.2.2.2 and 4.2.2.6), survey respondents (makers or more general population) seemed to consider occupational roles as less relevant to their upcycling. It may suggest that role beliefs are only relevant to upcyclers. Perceived facilitating conditions did not show any high mean values

(means below 5.0). The highest were a lack of space and spare time (means between 4.0 and 5.0) (Section 5.2.1). Space and spare time were one of seven common facilitating conditions identified from the previous interview study (along with competence, materials, social situation and cultural perception, tools and interest) (Sections 4.2.2.5 and 4.2.2.6). It means that facilitating conditions for more general population are varied to a great extent (other than space and spare time), whereas upcyclers may share common difficulties or facilitators.

Correlation analysis revealed statistically significant positive correlation between frequency of upcycling and all intention variables, and between frequency of upcycling and seven perceived facilitating conditions (a lack of: tools, materials, teachers/helpers, skills, imagination, inspiration, and information) (Section 5.2.2). These seven perceived facilitating conditions mean that they may be common barriers for upcyclers (people who answered that they engage in upcycling relatively more frequently). Four of them (tools, materials, skills, inspiration) are consistent with the common facilitating conditions from the interview study, confirming that these are common barriers for upcyclers in a bigger population. Correlation analysis also revealed statistically significant positive correlation between intention to upcycle and all determinants of intention (attitude, three social factors, perceived behaviour control) (Section 5.2.2).

The first logistic repression analysis uncovered that intention is more significant determinant than perceived facilitating conditions for upcycling (Table 30). The regression on intention also revealed that attitude significantly contributes to shaping intention for upcycling. All social factors have moderate impact on intention, but not perceived behaviour control (Table 31). The last logistic regression on frequency of upcycling demonstrated that all behaviour factors together better explain the frequency than just intention and perceived facilitating conditions; and showed stronger contribution by intention and subjective norm (Table 32). Taking into account all three regression analysis results, Figure 12 shows the new model to explain upcycling behaviour. In summary, attitude to upcycling exerts strong influence on intention, whereas all social factors have moderate influence and

perceived behaviour control has weak influence on intention to upcycle. Intention and subjective norm have strong influence to determine the frequency of upcycling, whereas the others (attitude, personal norm, role beliefs, perceived behaviour control and perceived facilitating conditions) have weak influence.

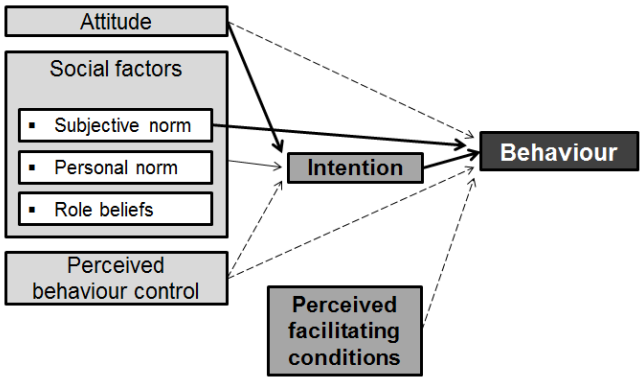


Figure 12 New model to explain upcycling behaviour[27]

(Note: Thick solid line refers to strong contribution, thin solid line to medium contribution, and dotted line to weak contribution)

Non-parametric statistics for comparing groups revealed that, in general, female respondents, 30+ age groups, art & design and teaching & education occupational area groups, under-£60K annual household income groups, and part-time employed or self-employed respondents scored higher median values than other groups in many variables with statistically significant group differences. In particular, regarding the frequency of upcycling and the relatively more important behaviour factors identified from the regression analysis (intention, attitude and subjective norm):

- 30+ age groups, art and design occupational area group, and part-time or self-employed group reported more frequent upcycling;
- Females, 30+ age groups, art & design and teaching & education occupational area groups, and under-£60K annual household income groups reported stronger intention to upcycle;
- 30-49 age group, art and design occupational area group, and under-£60K annual household income groups reported more positive attitude towards upcycling; and

27 This model is based on three models used for logistic regression (Figure 11 in Section 5.2.3). The three models excluded perceived benefits and perceived habits from the initial combination model (Figure 6 in Section 2.2.6) for regression analysis. It is because perceived benefits do not directly affect intention or behaviour (Sections 2.2.6.1 and 5.2.3), and the variables used to measure perceived habits turned out to be inappropriate to use for statistical analysis (Section 5.1.4).

- Females, art and design occupational area group, under-£60K annual household income groups, and employed groups reported stronger compliance with subjective norms.

The group differences identified in the survey were different from the observation in the interview study. The following compares the interview and survey results on group differences. One of the observations from the interview study was that female participants may find product personalisation more beneficial while male participants may find learning experiences more beneficial (Section 4.3.2). The survey results showed that both female and male participants found product personalisation and learning experience beneficial to the similar extent. In the survey, difference across gender groups was instead found in 'high quality product' and 'be creative' – female participants scored higher median values for both (Section 5.2.4.1). The interview study suggested that participants under 30 may find product personalisation as well as recognition and appreciation from others more beneficial than other age groups (Section 4.3.2). In the survey, participants under 30 had higher median scores than others in learning experiences, instead (Section 5.2.4.2). The interview study results seemed to show the tendency that female participants found their relationship roles more relevant to upcycling whereas male participants found their occupational roles more relevant (Section 4.3.2). In the survey, there was no statistically significant difference in role beliefs across gender groups. But there was difference in other social factors (subjective norm and personal norm). The survey results showed that female participants felt more strongly about norms (i.e. more sensitive to people's approval and personal moral beliefs) (Section 5.2.4.1). The observation on the group difference in the perceived facilitating conditions from the interview study was that participants under 30 may find a lack of competence and space as major barriers, whereas participants aged 30 and over may find the problems with materials, and social situation and cultural perception as bigger issues (Section 4.3.2). In the survey, there was no statistically significant difference in perceived facilitating conditions across different age groups (Section 5.2.4.2). These differences imply the possibility that upcyclers (interview participants) are a unique sub-group of makers (survey respondents).

5.4 Implications

The implications from this survey study concern developing interventions for scaling-up upcycling. Two important decisions were made on the basis of the results from regression analysis and non-parametric statistics for comparing groups. The first was about the foci of interventions for scaling-up. The logistic regression analysis results revealed the relative importance of intention (cf. perceived facilitating conditions), attitude (cf. social factors or perceived behaviour control) and subjective norm (cf. personal norm or role beliefs). Accordingly, any actors aiming to scale up upcycling needs to pay more attention to intention shaping which focuses on building positive attitude towards upcycling, and establishing positive subjective norms (or culture) about it. The second decision was about the target population for scaling-up. The results from non-parametric statistics for comparing groups suggested the group of people who may have upcycled relatively more frequently (part-time or self-employed people in art and design aged 30 years or older, based on behaviour frequency) and the group of people who may be more likely to start upcycling or become more frequently engaging in upcycling (i.e. females aged 30 years or older, working in art and design, with under £60K annual household income, based on intention, attitude and subjective norm).

The results from descriptive statistics and correlation analysis provided some ideas for potential scaling-up interventions. For example, when providing information about the benefits of upcycling as part of any scaling-up interventions, psychological or emotional benefits should be emphasised – having fun, learning experiences, being creative, relaxing, empowering (i.e. those with high mean values and small standard deviation from the descriptive statistics). When attempting to provide facilitating conditions as part of any scaling-up interventions, certain elements should be prioritised – tools, materials, teachers/helpers, skills training, intriguing imagination, inspiring, and information (i.e. those with significant correlation with behaviour frequency from Spearman's rho).

6 DEVELOPING INTERVENTIONS (Study 3)

This chapter describes the process of formulating, developing and prioritising potential interventions for scaling-up upcycling. The process includes a synthesis of the previous two studies (Chapters 4 and 5) and mapping these on Defra's 4Es model for formulating and developing initial interventions, and the use of Semi-Delphi method for further developing and prioritising the initial interventions.

6.1 Initial interventions for scaling-up upcycling

This section describes how previous interview and survey studies fed into formulating initial interventions, and also how Defra's 4Es model was used for developing these initial interventions by mapping exercise.

6.1.1 Synthesis of results from previous studies

This sub-section provides a synthesis of the main findings and implications for scaling-up upcycling from previous interview and survey studies (Table 39). The following sub-sections recategorise scaling-up implications to provide guiding information for supporting development and implementation of interventions.

6.1.1.1 Target population for scaling-up upcycling

The consequences of scaling-up upcycling may include: a) mainstream consumers become interested in upcycling and try it out; b) pragmatic makers become engaged in upcycling more frequently; c) enthusiastic upcyclers are turned into entrepreneurs to produce upcycled goods for mainstream consumers; and d) mainstream producers adopt upcycling techniques and ideas for mass-production (see Section 2.3.2 and implication ⑤ in Table 39). Amongst mainstream consumers and pragmatic makers, females working in art and design, aged 30 or older with under £60K annual household income should be targeted (implications ⑨ and ⑭ in Table 39). Among enthusiastic upcyclers, people who work in art and design with part-time or self-employment, aged 30 or older should be targeted (implication ⑭ in Table 39).

Table 39 Synthesis of the main findings and implications for scaling-up

Category	Main findings	Implications for scaling-up
Current upcycling behaviour (Section 4.2.1.3)	Frequently used materials identified	Target wood, electronics, fabric and packaging as main used materials provision ①
	Frequently used source of materials as online	Provide online service (for searching and purchasing) for improved materials provision ②
	Major material selection criteria identified	Provide estimated potential value, estimated money saving (compared to new), and quality rating for used materials ③
	End product use mainly for upcyclers, but high aspiration for commercialisation	Provide specialised services such as business feasibility assessment, technical safety test, and market identification ④
	Wide spectrum of upcycling consumers, from enthusiasts to pragmatic makers	Enable enthusiastic upcyclers to become entrepreneurs, enable pragmatic makers to upcycle more, and convert non-makers into makers and upcyclers ⑤
	Predominant use of home for upcycling	Provide tools hiring/rent service or lower cost for shorter time use of Hackspace instead of long-term membership ⑥
	High demand for people with similar interests or good collaborators	Provide a community event on a regular basis to enable people to find their hobby friends, companions, collaborators or potential business partners ⑦
Links between upcycling, product attachment and longevity (Section 4.2.3.4)	High degree attachment to and longer product lifetimes of the upcycled products with attachment	Encourage more consumers to upcycle; Design experience, which induces self-expression, pleasure, group affiliation and special memories while upcycling; Design the experience, which creates the sense of irreplaceability while upcycling ⑧
	Correlation between attachment and determinants of attachment, and between attachment and irreplaceability	
	Females, older people, and people working in art and design score higher, in general	Target older (30+) females working in art and design ⑨
	Certain product categories more linked to self-expression and irreplaceability	Encourage people to upcycle for small home products and decorations, furniture, and personal belongings ⑩
Key factors influencing behaviour (Section 5.3)	Psychological/ emotional benefits more common than economic or environmental benefits	Emphasise psychological/emotional benefits when providing information about upcycling ⑪
	Certain perceived facilitating conditions statistically significantly correlated to behaviour	Prioritise tools, materials, teachers/helpers, skills training, opportunities to strengthen imagination, inspiration and information when providing facilitating conditions ⑫
	Intention, attitude and subjective norm as relatively more important factors	Design and prioritise interventions to shape intention, build positive attitude, and establish positive subjective norm (culture) ⑬
	Females, people aged 30 and over, people working in art & design, and teaching & education, people with under £60K annual household income, people with part-time or self-employment score higher, in general for all factors influencing upcycling	Target part-time or self-employed people in art and design aged 30 or older to turn enthusiasts into entrepreneurs; Target females aged 30 or older working in art and design, + under £60K annual household income to enable pragmatic makers, or convert non-makers into upcyclers ⑭

Note: Implications are numbered for future reference.

6.1.1.2 Approach to developing interventions for scaling-up

One approach to the development of interventions for scaling-up upcycling is to design and prioritise interventions to shape consumers' intention by building a positive attitude, and establishing a positive subjective norm (implication ⑬ in Table 39).

6.1.1.3 Ideas for scaling-up interventions

All other implications other than ⑤, ⑨, ⑬, and ⑭ in Table 39 were reorganised as ideas for interventions in Table 40. The table also presents how each idea is categorised and relevant to the different scaling-up pathways.

Table 40 Ideas for scaling-up interventions based on the synthesis

Category	Scaling-up pathways (based on consumers)		
	Mainstream consumers → engage in upcycling	**Pragmatic makers → upcyclers**	**Enthusiastic upcyclers → upcycling-based entrepreneurs**
Products	Encourage people to upcycle for small home products and decorations, furniture, and personal belongings ⑩		NA
Materials	Target wood, electronics, fabric and packaging as main used materials provision ①; Provide online service (for searching and purchasing) for improved materials provision ②; Provide estimated potential value, estimated money saving (compared to new), and quality rating for used materials ③		
Specialised services	NA	Provide specialised services such as business feasibility assessment, technical safety test, and market identification ④	
Tools	Provide tools hiring/rent service or lower cost for shorter time use of Hackspace instead of long-term membership ⑥		
Community events	Provide a community event on a regular basis to enable people to find their hobby friends, companions, collaborators or potential business partners ⑦		
	Design the experience, which induces self-expression, pleasure, group affiliation and special memories while upcycling ⑧; Design the experience, which creates the sense of irreplaceability while upcycling ⑧		NA
Information	Emphasise psychological/emotional benefits when providing information about upcycling ⑪		NA
Facilitating conditions	Prioritise tools, materials, teachers/helpers, skills training, opportunities to strengthen imagination, inspiration and information when providing facilitating conditions ⑫		

6.1.2 Development of initial interventions

Preliminary ideas for scaling-up upcycling were generated on the basis of the approach to developing interventions (Section 6.1.1.2) and categories of ideas (Table 40). In order to ensure that there were no missing categories or ideas, Defra's 4Es model to influence behaviour (Defra 2008, 2011) and nine intervention functions and seven policy categories (Michie, van Stralen and West 2011) (Section 2.3.4) were used to create an ideation table. The initial ideas were then mapped onto this table and extra ideas were generated and added to the table. Amongst the 4Es, Engage (get people involved) was excluded as it concerns guidelines for implementation (e.g. work with trusted intermediaries). Amongst the nine intervention functions from Michie et al. (2011), coercion (financial cost) and restriction were excluded as there was not sufficient information about macro socio-economic impact of promoting upcycling by exerting penalty or disincentives for production with new materials. The following sub-sections describe the initial intervention ideas in detail.

6.1.2.1 Enable

To enable consumers and upcyclers, one intervention could be to 'provide facilities', which could be delivered by environmental restructuring, service provision or environmental or social planning. Facilities provision includes the delivery of affordable and accessible used materials (first targeting wood, electronics, fabric and packaging with an online service providing estimated potential value, cost saving and quality rating – implications ①, ②, ③), affordable tools (hire/rent service and short-term payment available in community workshops – implication ⑥), and sufficient space (to work and keep materials, tools, and projects – Section 4.2.2.5). To deliver the aforementioned elements, designers could design: a) an innovative tool hire/rent service, b) affordable toolkits, especially for the novice upcyclers, c) an improved service or system for used materials provision, or d) improved community workshop services. Local authorities or central government could provide and operate: a) reuse/upcycle centres as used material collection points (and also potentially offer space as workshops or studios for upcycling-based local SMEs) or b) community workshops (sufficiently-funded and monitored for wider benefits).

A second intervention could be 'ensure ability' by education and training. More specifically, ensuring ability entails curriculum development (such that schools and universities have teaching and learning materials for advanced upcycling knowledge and skills), workshop sessions (for teaching technical upcycling skills at schools, universities, and community workshops), training (designing and making based on upcycling for art and design teachers and educators as well as the general public), events (company or community events for skills development, networking, etc. – implication ⑦), competitions (on upcycling at different levels – schools, universities, companies, communities), and specialised business services (to provide a business feasibility test, a technical safety test, and suitable market identification – implication ④). To deliver these elements, designers could provide the best practice upcycling guides (exemplars), and relevant skills and knowledge for curriculum development, workshop sessions and training (including inductions for community workshops). They could also contribute to designing the events and workshop sessions (to encourage consumers to upcycle for small home products and decorations, furniture and personal belongings; and induce self-expression, pleasure, group affiliation, special memories and a sense of irreplaceability of the upcycled product – implication ⑧, ⑩). A central government could initiate the curriculum development in art and design (and other subjects). Local authorities could organise community events, workshop and training sessions, competitions, and specialised business services.

A third intervention could be to 'build understanding' by persuasion, communication and marketing. To increase awareness and understanding and to inspire people, a variety of communication and marketing means could be utilised such as national or local dissemination of publications (e.g. handbook, brochures), social marketing communications using digital, social media (e.g. Facebook, Twitter),[28] promotion campaigns (e.g. wow[29] experience), and media demonstration (e.g. YouTube, blogs). In order to deliver these, designers could design communication and demonstration

28 The role of digital, social media in raising awareness and promoting ideas or products has been recognised and investigated in several studies (e.g. Neiger, et al. 2012, Yin, et al. 2012, Hutter, et al. 2013).
29 A concept of wow is a combination of fascination, pleasant surprise, and desire (Desmet, Porcelijn and Van Dijk 2007)

materials (emphasising the psychological/emotional benefits of upcycling – implication ⑪) in print or online, and create wow experience (e.g. pop-up stores) as part of campaign to promote upcycling. Local authorities or central government could play a role in disseminating communication materials, and initiating communication activities. A summary of the 'enable' interventions is presented in Table 41.

Table 41 'Enable' interventions

'Enable' action	Intervention category	Elements to deliver	Designer interventions	Local authority & government interventions
Provide facilities	Environmental restructuring / service provision / Environmental or social planning	- Materials - Tools - Space	- Design tool hire/rent service - Design toolkits for the novice - Improve material provision service/system - Improve community workshops	- Provide material collection centre or reuse/upcycle centre - Provide community workshops
Ensure ability	Education and training	- Curriculum - Workshop sessions - Training - Events - Competitions - Business service	- Provide the best upcycling practices - Provide skills and knowledge - Provide inductions and training sessions - Design community events and workshop sessions	- Advance/develop curriculum in art and design - Organise community workshops, training, events, competitions, and business service
Build understanding	Persuasion / Communication and marketing	- Handbook / brochures - Social marketing communications - Promotion campaigns - Media demonstration	- Design effective communication and demonstration materials in prints or online - Design effective campaigns	- Disseminate communication materials - Initiate and/or subsidise communication activities

6.1.2.2 Encourage

To encourage upcyclers, researchers and businesses, incentives could be used as forms of tax benefits, subsidies, awards, and grants by local authorities or central government (Table 42).

Table 42 'Encourage' interventions

'Encourage' action	Intervention category	Elements to deliver	Designer interventions	Local authority & government interventions
Incentives	Incentivisation / Fiscal / Regulation / Legislation	- Tax benefits - Subsidies - Awards - Grants	NA	- Provide upcycling businesses with tax benefits, subsidies and awards - Provide upcycling initiatives (not for profit) with subsidies, awards (best case) and grants - Provide upcycling researchers with grants

6.1.2.3 Exemplify

Exemplifying means leading by examples, or modelling which provides an example of people to aspire to or imitate. Such modelling could be done through high profile projects which could be easily seen by general public. Popular artists, designers or makers could participate in upcycling projects for public exhibitions and other media. Local authorities or central government could commission artists, designers, or makers to do such projects, and change procurement policy to favour upcycled products (especially for more visible items such as furniture in rooms that are open to public) (Table 43).

Table 43 'Exemplify' interventions

Exemplify action	Intervention category	Elements to deliver	Designer interventions	Local authority & government interventions
Lead by example	Modelling	- High profile projects - Change in government procurement	- Upcycling projects by popular artists, designers or makers	- Commission projects - Change procurement policy

6.1.3 General interventions

The tables and descriptions (Section 6.1.2) were regarded as neither simple nor easy to communicate with participants in the semi-Delphi study. The presentation style was, therefore, changed to a simpler form of 15 general interventions. Table 44 shows the elements and interventions by different actors from Table 41, 42, and 43 with matching general interventions.

Table 44 General interventions for further exploration and evaluation

Element	Interventions by designers, local authority, government	General interventions
Tools and space	- Design tool hire/rent service - Provide community workshops - Improve community workshops	Improve access to, and facilities and services of public workshops with space, tools, materials, and training for diverse demographic populations
	- Design toolkits for the novice	Design and provide toolkits for novice upcyclers
Materials	- Provide material collection centre or reuse/upcycle centre	Operate a reuse/upcycle centre with a product collection service aligned with usual waste collection service
	- Improve material provision service/system	Design and provide the service model for improved provision of used materials, components and products
Curriculum	- Provide best practice in upcycling - Advance/develop curriculum in art and design	Enrich the curriculum in art and design at schools, colleges and universities to incorporate advanced upcycling skills and knowledge
Workshop sessions, training, events	- Provide skills and knowledge - Provide inductions and training sessions - Design community events and workshop sessions - Organise or subsidise community workshops, training, events	Organise community-based upcycling family events, workshops and training sessions
Competitions	- Provide skills and knowledge - Organise or subsidise competitions	Organise upcycling competitions in schools, universities, communities and industry
Business service	- Provide skills and knowledge - Organise or subsidise specialised business services	Provide advice and consultancy on how to start a business based on upcycling
Handbook/ brochures, social marketing communications	- Design effective communication and demonstration materials in prints or online - Disseminate communication materials - Initiate and/or subsidise communication activities	Design and provide effective communication materials to explain the benefits of upcycling to the general public and industry
Promotion campaigns	- Design effective campaigns (wow experience) - Initiate and/or subsidise communication activities	Design and provide a wow experience as an upcycling promotion campaign
Media demonstration	- Design effective communication and demonstration materials in prints or online - Initiate and/or subsidise communication activities	Produce TV shows and other inspirational media to share the best practices
Tax benefits, subsidies, awards	- Provide upcycling businesses with tax benefits, subsidies and awards	Provide tax benefits and subsidies for upcycling-related businesses
Grants, subsidies	- Provide upcycling initiatives (not for profit) with subsidies, grants and awards - Provide upcycling researchers with grants	Provide grants and subsidies for upcycling-related research and initiatives
High profile projects	- Upcycling projects by popular artists/ designers/makers - Commission projects	Demonstrate high quality and value of upcycling through commissioning upcycling projects by famous artists and designers
Change in government procurement	- Change procurement policy	Demonstrate upcycled goods as a new social norm or standard by changing government procurement policy to favour upcycled goods

6.2 Exploration and evaluation of interventions

This section describes methods and results of the semi-Delphi study to explore and evaluate the interventions, and summarises and discusses the findings.

6.2.1 Methods

The data was collected between October 2015 and January 2016. The procedure, study participants, instruments and analysis are illustrated below.

6.2.1.1 Procedure

The questionnaire was administered via email or in person. A one page study brief and informed consent form were sent to the invited experts (n=52) first. Once the completed consent form was received, a questionnaire was shared with the participant. A preliminary results analysis was conducted of the first 11 responses, and this became the basis for discussion at a subsequent workshop which took place in January 2016 at the University of Bath as an extension of the consortium meeting of the Centre for Industrial Energy, Materials and Products (CIE-MAP). During the workshop, the researcher shared the preliminary results to initiate and stimulate discussions. The first 40 minutes were used for general discussions, the next 70 minutes for discussing each intervention in detail, and the last 10 minutes for card sorting exercises. All discussions were audio-recorded.

6.2.1.2 Study participants

Fifty two experts in the UK were selected on the basis of their expertise in environmental policies, behaviour change, sustainable transitions, sustainable development, social innovation and sustainable design. Invitation emails were sent out to these pre-selected experts, and 12 responded. In addition, 13 experts were identified in the Centre for Industrial Energy, Materials and Products (see Section 3.3.3 for details).

A total of 25 experts responded to the questionnaire. The respondents were 15 males (60%) and 10 females (40%) from the areas of policy (n=6; 24%), engineering (6; 24%),

psychology (3; 12%), sociology (3; 12%), art and design (3; 12%), business management (2; 8%) and economics (2; 8%). Their affiliations included Green Alliance, Greengage, and eight universities including Bath, Cardiff, Leeds, Manchester, Nottingham Trent, Sheffield, Surrey and Sussex. Amongst the respondents, 11 participated in the subsequent workshop: 7 males and 4 females in policy (n=2), engineering (2), psychology (2), sociology (2), art and design (1), business management (1), and economics (1).

6.2.1.3 Instruments

Questionnaire

Instructions for the questionnaire, question presentation style, and rating scales were designed on the basis of proposals by Ziglio (1996) as his book is the latest, most highly cited one providing comprehensive understanding of theory, methods and applications of a Delphi method. In the questionnaire, 15 interventions for scaling-up upcycling (Table 44) and seven instructions (Table 45) were provided.

Table 45 Semi-Delphi questionnaire instructions

No	Instruction
01	Review all interventions.
02	Make comments on any intervention they wish.
03	Rate the level of importance (in terms of its potential impact on scaling-up, on a scale of 1: very unimportant to 5: very important) and feasibility (technical, economic and political feasibility on the scale of 1: definitely unfeasible to 5: definitely feasible) of each intervention.
04	Vote for the most suitable actor(s) for each interventions (among government, local authorities, companies, NGOs, designers, others – specify).
05	Suggest new interventions if any.
06	Select the top 5 interventions they feel are most important for scaling-up upcycling in the UK.
07	Rate their confidence of being accurate in the contribution they have made (very probable: 99-80% confidence of being right; probable: 79-60% confidence of being right; either way: 59-40% confidence of being right; improbable: 39-20% confidence of being right; very improbable: 19-0% confidence of being right; and no judgement).

See Appendix I for the questionnaire rating scale for importance and feasibility.

Workshop

Discussion topics were formulated on the basis of the preliminary analysis. The topics for the general discussions included: a) criteria for sustainable and unsustainable

upcycling; b) scalability of upcycling; and c) potential interventions. The detailed discussions on each intervention covered additional ideas/suggestions, particular usefulness, and potential issues. The card sorting exercises asked the participants to categorise interventions (each written per card) collectively into big, medium and small impact groups, and into short-term feasible (in 2 years) and long-term feasible (in 10 years) groups.

6.2.1.4 Analysis

Simple statistical analysis (mean, standard deviation and frequency) was used for analysing the quantitative data of the questionnaire. The expert discussions during the workshop were reported without interpretation.

6.2.2 Results

6.2.2.1 Importance and feasibility of interventions

Participants were asked to rate the level of importance (in terms of potential impact on scaling-up) and feasibility (technical, economic and political feasibility) of each intervention. Eight interventions (community workshops, materials collection centre, materials provision service, curriculum enrichment, TV and inspirational media, tax benefits for upcycling businesses, grants for upcycling research/initiatives, government procurement change) scored relatively high mean values of above 3.5 out of 5 (*SD*=.71~1.11). Five interventions (novice tool kits, community events, upcycling business consultancy, effective communication materials, commissioned upcycling projects) scored mean values of between 3.0 and 3.5 (*SD*=.96~1.25). Two interventions (upcycling competitions, wow experience) scored relatively low mean values of below 3.0 (*SD*=1.04~1.21) (Table 46).

Nine interventions (community workshops, novice toolkits, curriculum enrichment, community events, upcycling competitions, upcycling business consultancy, effective communication materials, wow experience, TV shows and inspirational media) scored high mean value (above 3.5) with a small standard deviation (*SD*=.78~1.09). Four interventions (materials collection centre, materials provision service, grants for

upcycling research/initiatives, commissioned upcycling projects) scored mean values of between 3.0 and 3.5 (*SD*=.75~1.08). Two interventions (tax benefits for upcycling businesses, changing government procurement policy) scored a relatively low mean value of below 3.0 (*SD*=1.12~1.31) (Table 46).

Table 46 Importance and feasibility of each intervention

No	Interventions	Importance					Feasibility				
		N	Min	Max	Mean	SD	N	Min	Max	Mean	SD
01	Improve access to, and facilities and services of community workshops with space, tools, materials, and training for diverse demographic populations	25	2	5	3.52	.71	25	2	5	3.60	.87
02	Design and provide tool kits for novice upcyclers	24	1	5	3.25	1.15	24	1	5	3.67	1.09
03	Operate a reuse/upcycle centre with a product collection service aligned with usual waste collection service	25	2	5	3.72	1.10	25	2	5	3.48	.96
04	Design and provide the service model for improved provision of used materials, components and products	20	2	5	3.90	.85	20	2	5	3.35	.75
05	Enrich the curriculum in art and design at schools, colleges and universities to incorporate advanced upcycling skills and knowledge	25	1	5	3.72	1.02	25	2	5	3.96	.84
06	Organise community-based upcycling family events, workshops and training sessions	24	2	5	3.33	1.01	23	3	5	4.00	.80
07	Organise upcycling competitions in schools, universities, communities and industry	25	1	5	2.84	1.21	25	2	5	4.12	.88
08	Provide advice and consultancy on how to start a business based on upcycling	23	2	5	3.26	.96	23	2	5	3.65	.88
09	Design and provide effective communication materials to explain the benefits of upcycling to the general public and industry	25	1	5	3.16	1.25	24	3	5	4.04	.86
10	Design and provide a wow experience as an upcycling promotion campaign	25	1	5	2.92	1.04	25	2	5	4.00	.87
11	Produce TV shows and other inspirational media to share the best practices	25	2	5	3.60	.87	25	3	5	4.12	.78
12	Provide tax benefits and subsidies for upcycling-related businesses	22	1	5	3.86	1.08	22	1	5	2.73	1.12
13	Provide grants and subsidies for upcycling-related research and initiatives (not for profit)	25	2	5	3.56	.96	25	1	5	3.20	1.08
14	Demonstrate high quality and value of upcycling through commissioning upcycling projects by famous artists and designers	23	2	5	3.09	1.12	24	2	5	3.38	.92
15	Demonstrate upcycled goods as a new social norm or standard by changing government procurement policy to favour upcycled goods	25	1	5	3.64	1.11	25	1	5	2.84	1.31
		■ High mean value (above 3.5) ■ Low mean value (below 3.0)									

6.2.2.2 Potential roles of various actors to implement interventions

Participants were asked to vote for the most suitable actor(s) for each intervention (among government, local authorities, companies, NGOs, designers and others). Most respondents voted for multiple actors. For example, companies and NGOs (non-governmental organisations)[30] with the expertise of designers might be the most suitable actors for designing and providing toolkits for novice upcyclers. Local authorities partnering with NGOs might be most suitable for operating a reuse or upcycle centre aligned with the existing waste collection and management system (Table 47).

Summarising each actor's potential role, government, local authorities, companies, NGOs and designers were expected to be suitable for 6 to 9 interventions. Government could play a major role in providing tax benefits and subsidies for upcycling-related businesses, providing grants and subsidies for upcycling-related research and initiatives (not for profit), changing procurement policy, and enriching the curriculum in art and design. Government could also initiate the provision of communication materials, commission upcycling projects, and contribute to organising national upcycling competitions.

Local authorities could have a leading role in operating a reuse or upcycle centre, providing community workshops, and organising community events. They could also organise community-level upcycling competitions, provide business advice services, distribute communication materials, and implement (new) procurement policy (favourable to upcycled goods).

Companies (especially start-ups) could play a significant role in providing services for upcyclers to search and buy used materials easily (e.g. online shop), toolkits for novice upcyclers and wow experience for consumers. They (especially well-established manufacturers) could also commission upcycling projects for artists,

30 Non-governmental organisations (NGOs) are not-for-profit, voluntary citizen's groups. They are organised on a local, national or international level to address issues in support of the public good. Their roles and activities include brining citizens' concerns to governments, monitoring policy and programme implementation, relieving suffering, promoting the interests of the poor, protecting the environment and providing basic social services (Hilton and Crowson 2016).

designers and makers as part of their corporate social responsibility, and organise internal and external competitions to collect good ideas for waste management or sustainable production. Companies based on upcycling, in particular, could share their experience and knowledge (in how to start and expand businesses based on upcycling) with future entrepreneurs.

NGOs could play a main role in providing community workshops, organising community events, providing business advices, distributing communication materials and producing informative and inspirational materials through various media. They could collaborate with companies to deliver toolkits for novice upcyclers, and wow experience for the general public. They could support local authorities to operate a reuse or upcycle centre and organise community-level competitions.

Designers could play a primary role in creating toolkits for novice upcyclers, communication materials, and wow experience. Designers (and artists and makers) with practical upcycling experiences, could provide their expertise to enrich the curriculum in art and design, and produce TV shows and other inspirational media. They could also deliver high quality and value upcycling projects for showcase.

Skilled craftspeople and technicians could contribute to improving community workshops (e.g. induction), operating reuse or upcycle centres and services for improved materials provision (e.g. quality rating), organising community events (e.g. demonstrators) or competitions (e.g. assessor), and producing informative and inspirational media. Local communities (including voluntary groups) could also assist main organisers of community workshops, events, competitions and communication materials provision, and share their opinions on toolkits for novice upcyclers with designers. Educational institutions could be involved in enriching the curriculum in art and design, and organising school- or university-level competitions. WRAP (Waste & Resources Action Programme) could be part of operating reuse or upcycle centres or creating communication materials. Communication specialists could be consulted for preparing communication materials or creating wow experience. Design researchers and business consultants could provide their expertise for business

advices. Broadcasters (TV companies) could be part of producing informative and inspirational contents for the general public. Research Councils and Art Council could be the main players to provide grants and subsidies for upcycling-related research and initiatives (not for profit).

Table 47 Most suitable actor(s) for each intervention with multiple choices

No	Interventions	Number of answers on the most suitable actors (n=21~25)						
		Gov	LA	Com	NGO	Des	Oth	Others specified
01	Improve access to, and facilities and services of community workshops with space, tools, materials, and training for diverse demographic populations	3	11	2	10	2	6	Local communities / voluntary groups / skilled craftspeople and technicians
02	Design and provide tool kits for novice upcyclers	1	2	10	8	8	1	Local communities
03	Operate a reuse/upcycle centre with a product collection service aligned with usual waste collection service	4	**20**	3	8	0	2	WRAP / skilled craftspeople and technicians
04	Design and provide the service model for improved provision of used materials, components and products	4	3	12	3	5	1	Skilled craftspeople and technicians
05	Enrich the curriculum in art and design at schools, colleges and universities to incorporate advanced upcycling skills and knowledge	**13**	5	1	0	6	9	Educational institutions
06	Organise community-based upcycling family events, workshops and training sessions	2	12	1	**14**	1	3	Local communities / skilled craftspeople and technicians
07	Organise upcycling competitions in schools, universities, communities and industry	6	7	7	8	3	**13**	Educational institutions / skilled craftspeople and technicians / local communities
08	Provide advice and consultancy on how to start a business based on upcycling	2	7	8	9	3	2	Design researchers / business consultants
09	Design and provide effective communication materials to explain the benefits of upcycling to the general public and industry	9	6	9	11	6	3	Local communities / WRAP communication specialists /
10	Design and provide a wow experience as an upcycling promotion campaign	2	3	10	9	7	1	Communication specialists
11	Produce TV shows and other inspirational media to share the best practices	1	0	5	11	9	7	Broadcasters / skilled craftspeople and technicians
12	Provide tax benefits and subsidies for upcycling-related businesses	**20**	1	1	0	0	0	NA
13	Provide grants and subsidies for upcycling-related research and initiatives (not for profit)	**20**	2	4	2	0	3	Research Councils / Art Council
14	Demonstrate high quality and value of upcycling through commissioning upcycling projects by famous artists and designers	6	3	10	5	9	0	NA
15	Demonstrate upcycled goods as a new social norm or standard by changing government procurement policy to favour upcycled goods	**22**	7	3	2	0	0	NA

■ High number of answers (>12 ≈ over 50% of voters) ■ Relatively high number of answers (>5 ≈ over 25% of voters)

6.2.2.3 Interventions selected as top 5 by participants

Participants were asked to select the top 5 interventions they feel are most important for scaling-up upcycling in the UK (Appendix I). Combining the votes (n=123, 5 votes per voter, 2 votes missing) from 25 participants, the top five interventions were a reuse/upcycle centre aligned with existing waste collection and management system (*n*=16); improved public workshops (15); tax benefits and subsidies for upcycling businesses (14); TV shows and other inspirational media to share best practices (11); and grants and subsidies for upcycling research and initiatives (10).

Table 48 Top 5 interventions

No	Interventions	Votes
01	Improve access to, and facilities and services of community workshops with space, tools, materials, and training for diverse demographic populations	**15**
02	Design and provide tool kits for novice upcyclers	6
03	Operate a reuse/upcycle centre with a product collection service aligned with usual waste collection service	**16**
04	Design and provide the service model for improved provision of used materials, components and products	9
05	Enrich the curriculum in art and design at schools, colleges and universities to incorporate advanced upcycling skills and knowledge	7
06	Organise community-based upcycling family events, workshops and training sessions	6
07	Organise upcycling competitions in schools, universities, communities and industry	3
08	Provide advice and consultancy on how to start a business based on upcycling	6
09	Design and provide effective communication materials to explain the benefits of upcycling to the general public and industry	8
10	Design and provide a wow experience as an upcycling promotion campaign	2
11	Produce TV shows and other inspirational media to share the best practices	11
12	Provide tax benefits and subsidies for upcycling-related businesses	**14**
13	Provide grants and subsidies for upcycling-related research and initiatives (not for profit)	10
14	Demonstrate high quality and value of upcycling through commissioning upcycling projects by famous artists and designers	2
15	Demonstrate upcycled goods as a new social norm or standard by changing government procurement policy to favour upcycled goods	8

■ High number of answers (>12≈over 50% of votes)

■ Relatively high number of answers (>5≈over 25% of votes)

6.2.2.4 Confidence level in respondents

Participants were asked to rate their confidence of being accurate in the contribution they had made. Six options were provided: a) very probable, 99-80% confidence of being right; b) probable, 79-60% confidence of being right; c) either way, 59-40% confidence of being right; d) improbable 39-20% confidence of being right; e) very improbable: 19-0% confidence of being right; and f) no judgement (Appendix I). Eight people (32%) said 'either way', 7 people (28%) said 'no judgement', 6 people (24%) said 'probable', 2 people (8%) 'improbable', 1 person (4%) 'very improbable' another 1 person (4%) 'very probable'. The answers from the participants did not show great confidence of being accurate in their contribution: most answers were neutral or probable.

6.2.2.5 Interventions for short-term and long-term success

Participants were asked to categorise interventions collectively into big, medium and small impact groups, and into short-term feasible (in 2 years) and long-term feasible (in 10 years) groups (Section 6.2.1.3). According to the card sorting exercises, interventions for short-term success (within 2 years) were: a) improved community workshops; b) a reuse/upcycle centre aligned with existing waste collection and management system; c) a service model for improved materials provision; d) community events, workshops and training; e) TV shows and inspirational media; and f) changing government procurement policy. Interventions for long-term success (in 10 years) were: a) curriculum enrichment, b) tax benefits and subsidies for upcycling businesses, and c) grants and subsidies for upcycling research and initiatives (Table 49).

Table 49 Interventions for short-term and long-term success

No	Interventions	Impact			Feasibility	
		Big	Medium	Small	Short-term	Long-term
01	Improve access to, and facilities and services of community workshops with space, tools, materials, and training for diverse demographic populations		V		V	
02	Design and provide tool kits for novice upcyclers			V	V	
03	Operate a reuse/upcycle centre with a product collection service aligned with usual waste collection service	V			V	
04	Design and provide the service model for improved provision of used materials, components and products	V			V	
05	Enrich the curriculum in art and design at schools, colleges and universities to incorporate advanced upcycling skills and knowledge	V				V
06	Organise community-based upcycling family events, workshops and training sessions		V		V	
07	Organise upcycling competitions in schools, universities, communities and industry			V	V	
08	Provide advice and consultancy on how to start a business based on upcycling			V	V	
09	Design and provide effective communication materials to explain the benefits of upcycling to the general public and industry			V	V	
10	Design and provide a wow experience as an upcycling promotion campaign			V	V	
11	Produce TV shows and other inspirational media to share the best practices		V		V	
12	Provide tax benefits and subsidies for upcycling-related businesses	V				V
13	Provide grants and subsidies for upcycling-related research and initiatives (not for profit)		V			V
14	Demonstrate high quality and value of upcycling through commissioning upcycling projects by famous artists and designers			V	V	
15	Demonstrate upcycled goods as a new social norm or standard by changing government procurement policy to favour upcycled goods	V			V	

Big or medium impact and short-term feasible (2 years)

Big or medium impact and long-term feasible (10 years)

6.2.2.6 Workshop discussions

This sub-section describes general discussions on upcycling (i.e. criteria for un/sustainable upcycling and scalability of upcycling) and discussions on each intervention (Section 6.2.1.1) from the workshop. Thematic analysis was used (Sections 3.5.1.2, 3.5.1.3 and 6.2.1.4). See Appendix O for full quotations.

Criteria for (un)sustainable upcycling

Participants explained that sustainable upcycling means that it: a) avoids another purchase of a new product; b) prolongs the life of the products, giving it a second life; c) avoids unnecessary transport and maintains a small local economy (no point in taking low value materials from one end of the country to another); d) does not require any large amounts of energy (to keep the embodied energy low); e) deals with non-recyclable materials; and f) produces products with low environmental impact during usage. They described unsustainable upcycling as the process which involves energy intensive processes or toxic glues, and does not extend the product lifetime for a significant amount.

Scalability of upcycling

A few participants agreed that the current status of upcycling is niche. Some participants argued that businesses (rather than households) might have a better chance to upscale upcycling, considering potential business viability and increasing interest witnessed from many trade shows (e.g. Ecobuild). One participant mentioned that in order to have a significant impact, upcycling should incorporate the concepts of reuse, repair and refurbishment, and other participants mostly agreed with that opinion. Another participant pointed out that making upcycling perceived as something cool and trendy is particularly important as a facilitating condition when scaling-up in households, which was also supported by the majority of participants.

A number of potential issues with scaling-up upcycling were identified. First, there was a sceptical view by some on scaling-up, both as business and as household behaviour. Upcycling as a niche household behaviour could remain as non-

commercialised activity, and equally, in households, the majority of general public could be indifferent to upcycling for incompetence in their skills as well as inconvenience and inefficiency of upcycling in contrast to purchasing mass-produced products. Second, there could be potential conflicts with existing regulations (e.g. no safety guarantee for the reused components), especially for electronics or furniture repair or refurbishment. There was, however, also a counter argument that certified testing and warranty could overcome the issues with regulations. Third, there could be a rebound effect since companies might like to take back products earlier than the end of useful (or functional) lifetime of the products for more potential profits out of them. Equally, some consumers might also like to give products back to manufacturers earlier than the end of useful lifetime as an excuse to buy a new one.

Intervention 01: Improve access to, and facilities and services of community workshops with space, tools, materials, and training for diverse demographic populations

One participant suggested that a community-driven, bottom-up approach is an appropriate starting point. Some argued that supporting community workshops, however, may not be effective especially when there is a lack of awareness or interest by the general public. Others said that community workshops can be truly effective only if there is already a community; otherwise building or establishing a community may be a prerequisite condition. One participant raised the issue of limited utility and usability of existing workshops. The issue of limited funding sources to support community workshops was mentioned by another.

Intervention 02: Design and provide toolkits for novice upcyclers

A few participants mentioned the elements of toolkits as essential hand tools and instructions for guidance (or ideas, manuals, etc. as printed materials or an online platform like iFixit). One suggested that it could be available in community workshops. Some recommended that guidance or ideas on how a certain product or packaging could be upcycled should become producers' responsibility. One concern by others was that toolkits may not be effective alone (as skills development without raising interest). They explained that many novice upcyclers may end up damaging existing

products (rather than improving them) even with the help of toolkits due to their lack of skills and experience.

Intervention 03: Operate a reuse/upcycle centre with a product collection service aligned with usual waste collection service

One participant said that reuse or upcycle centres could help people (potentially upcycling-based entrepreneurs) get affordable, good quality (or guaranteed) materials. Another argued that by locating the upcycle centre at the existing waste and recycling centre, consumers' current behaviour could be easily changed. Potential high effectiveness and efficiency in a system level by linking consumers' used material supply and professional upcyclers' commercialisation was also mentioned by another participant. Some suggested that benchmarking of existing reuse/upcycle centres (run by the local authorities or third sector organisations) should be the starting point to initiate a new centre. One recommended a halfway house between a recycling centre and a charity shop as a new upcycle centre. Others had concerns about potential rebound effect (i.e. encouraging consumers to use products for a short period of time and give them away).

Intervention 04: Design and provide a service model for improved provision of used materials, components and products

A few participants argued that this intervention could lead to good supply of used materials for upcycling-based SMEs which require a large quantity of certain materials. Some explained that this service, or system, could be differentiated from the reuse or upcycle centre which is more of a collection point. Many suggested that the design should be based on the lessons learned from the existing business models, and the local needs. One said that innovative financing schemes could help the actual design and development of the model. Some raised the issue of difficulty in processing almost random, used materials, components and products (in terms of cleaning and standardising). Potential legal issue was mentioned by one.

Intervention 05: Enrich the curriculum in art and design at schools, colleges and universities to incorporate advanced upcycling skills and knowledge

A few argued that upcycling should a default process of design (i.e. how products are designed and made in the first place) and central aspect of design education in secondary schools and universities. Some especially recommended early year education (nursery, preschool). Some others suggested that upcycling education should go beyond art and design subject: for example, engineering education for remanufacturing industry was mentioned. Creativity and well-being framing for education was recommended by one. Design for modularity and reparability as an important part of design education in higher education was suggested by another. One concern by some was that education is a slow process change, and there is no guarantee that it will actually lead to change.

Intervention 06: Organise community-based upcycling family events, workshops and training sessions

Some participants said that getting multiple funders and partners might help make events happen. Others explained that benchmarking existing events to see what worked and what did not may help future organisers (e.g. local authorities or NGOs) design, plan and organise new events, workshops and training sessions. One argued that the use of more widely understood terms such as reuse, repair and refurbish rather than upcycling might be able to attract more people.

Intervention 07: Organise upcycling competitions in schools, universities, communities and industry

A few participants suggested that competitions should be part of school curriculum. One recommended an upcycling festival. Another argued that funding upcycling competitions could be the role of the Design Council.

Intervention 08: Provide advice and consultancy on how to start a business based on upcycling

Some participants suggested that start-up centres, incubators, university career centres, and business schools should provide advice and consultancy on upcycling

businesses. Regarding contents, best practice guidelines and exemplars were proposed. One stated that upcycling-business advices could be easily integrated into the existing SMEs support. Another argued that advices would be more effective for start-ups rather than established businesses as start-ups are in a "fluid state of establishing a business".

Intervention 09: Design and provide effective communication materials to explain the benefits of upcycling to the general public and industry

One participant argued that effective communication is "easy win" with the successful example of Love Food Hate Waste campaign. Some recommended that the communication materials should aim for changing culture, triggering interests and raising awareness. Some others proposed the use of new digital media such as YouTube in addition to traditional paper-based materials. One suggested that messages should be specific rather than generic. Another recommended telling a good story such as 'cardboard to caviar'.[31] Pitching money saving aspect was suggested by another. Another suggestion was that messages could also be linked to the 'peak home furnishing' (IKEA 2016) (e.g. upcycling as a way of changing house interior styles or redecorating the house). Information campaigns alone, however, were viewed as ineffective by most participants. The explanation was that information can only influence people or change behaviour for a short period of time unless the changed behaviour becomes a habit. The difficulty in measuring actual impact of the information (not just the number of people who receive the information) and monitoring actual behaviour was also raised as an issue by one.

Intervention 10: Design and provide a wow experience as an upcycling promotion campaign

A wow experience is a combination of fascination, pleasant surprise and desire (Section 6.1.2.1). One participant recommended physical shops (e.g. pop-up stores) and exhibitions (not 'one-off'). Another suggested wow commercial products selling

31 "Waste cardboard boxes from local businesses are shredded and given to farms and equestrian centres to be used as horse bedding. When the stables are cleaned out, the waste is fed to worms in a composting pit. The fattened worms are fed to the sturgeon which will produce caviar. The Green Business Network, a non-profit making organisation for environmental projects, is behind the cardboard to caviar scheme." (Carter 2003)

on the high street. High cost (for designing and creating the wow experience) and a relatively small audience (unless repeated regularly in many areas), however, were mentioned as potential issues by some.

Intervention 11: Produce TV shows and other inspirational media to share the best practices

Most participants agreed that television and popular media could have significant, long-term impact on public perceptions. Many also agreed that any television programme could contribute significantly to creating a long-term trend (or setting new norms) when it is aired on a regular basis for several years. Some recommended the involvement of high profile designers (e.g. George Clarke, Kirstie Allsopp). Some others suggested high profile projects (i.e. dealing with social and economic issues on top of environmental benefits such as ex-armed forces refurbishing their own houses). The use of new digital media (e.g. YouTube, Pinterest) and word-of-mouth of opinion leaders were suggested by some. One recommended celebrity involvement, but another disagreed because celebrities often appear on different shows not necessarily with their own beliefs or lifestyle commitment. The difficulty in measuring the real impact was mentioned by one.

Intervention 12: Provide tax benefits and subsidies for upcycling-related businesses

A few participants suggested tax on materials and energy use. One proposed reductions in VAT of repaired, refurbished or upcycled products. Another recommended grants or favourable loans for upcycling-related businesses. Benchmarking other subsidies (e.g. renewable subsidies) for detailed information about implementation was suggested by another. There was one positive view on this intervention, linking it to the circular economy package at the EU level (European Parliamentary 2016). Most, however, agreed that this intervention is politically unfeasible in the UK at present, considering the high uncertainty with Brexit and increasing national debt. Another concern by one participant was the fact that upcycling is often regarded as competing with recycling industry (rather than complementary).

Intervention 13: Provide grants and subsidies for upcycling-related research and initiatives (not for profit)

A few participants suggested investigation into how to upscale upcycling, and business cases to make upcycling more attractive and profitable for future research. Some argued that the future grant and subsidy opportunities might be in the context of waste management and circular economy, and dealing with items difficult to recycle (or more costly). One concerned that upcycling research may not be top priority of research in sustainability, climate change or low carbon future due to its relatively small foreseeable impact.

Intervention 14: Demonstrate high quality and value of upcycling through commissioning upcycling projects by famous artists and designers

A few participants suggested that commissioned upcycled projects should be widely communicated to reach a bigger population (e.g. exemplar in communication materials, documentary show, pop-up exhibition) as part of awareness raising and culture changing activities. Some participants recommended ordinary goods as a result of the commissioned projects (rather than luxury or art piece) as they could encourage more people to do the same.

Intervention 15: Demonstrate upcycled goods as a new social norm or standard by changing government procurement policy to favour upcycled goods

Many participants suggested basic stationary goods, computers and office furnishing as suitable product categories that upcycled goods can be used. A few emphasised that making the efforts more visible is important. One positive argument was that government procurement change is essential to rebuild trust between the general public and government, and also to reduce direct emissions from the significant government consumption. Many participants, however, expressed their doubts in changing social norms by changing government procurement policy, and in the feasibility due to the cost, bureaucracies and a lack of capacities.

6.2.3 Summary of the semi-Delphi results and discussion

Eight interventions were identified as important, and nine interventions were identified as feasible (Section 6.2.2.1). Three interventions were both important and feasible: community workshops, curriculum enrichment, and TV shows (and other inspirational media) (Table 46). Suitable actors for each intervention tended to be multiple: 12 out of 15 interventions showed multiple suitable actors (Table 47). Top 5 interventions selected by participants were part of eight important interventions (i.e. community workshops, upcycle centres, TV shows, and financial support for upcycling businesses, initiatives and research) (Section 6.2.2.3). Card sorting exercise revealed six interventions for short-term success (in 2 years) and three interventions for long-term success (in 10 years) (Section 6.2.2.5). Two interventions for short-term success (out of 6) were also consistent with important, feasible and top 5 interventions (community workshops and TV shows). One intervention for short-term success was also selected as an important and top 5 intervention (upcycle centres). The rest were improved materials provision (important), community events (feasible), and changing government procurement policy (important). Two interventions for long-term success (out of 3) were consistent with important and top 5 interventions (financial support for upcycling businesses, initiatives and research). The other for long-term success was curriculum enrichment, which was also selected as important and feasible. Combining the questionnaire and card sorting exercise results, six interventions turned out to be less effective in scaling-up upcycling than others: toolkits, competitions, business advice, communication materials, wow experience, and high profile commissioned projects.

Upcycling was considered sustainable only if the process minimises transport and energy consumption, avoids toxic materials, deals mostly with non-recyclable materials, and produces resource efficient products with significant product lifetime extension, avoiding purchase of products based purely on new materials (Section 6.2.2.6). Regarding scaling-up, there were sceptical views both for industry and households as actors due to unproven business viability and mainstream consumers' preference to purchase over upcycling. Potential regulation problems with particular product categories (electronics, furniture), concerning safety of utilising used

materials, components, or products, and rebound effect of shortening useful product lifetimes for upcycling purposes were raised as main issues. A growing interest in industry for material efficiency and upcycling for growth, however, was mentioned as a positive trend. Far-reaching definition of upcycling (incorporating reuse, repair and refurbishment) and creating cool, trendy perception of upcycling were suggested to facilitate scaling-up in households (Section 6.2.2.6).

The discussions on each intervention are not summarised here as they are too many; they are discussed in the next section, linking them to the implications for improving the initial interventions. There were two differences identified between questionnaire results (Sections 6.2.2.1 and 6.2.2.3) and workshop results (Section 6.2.2.6). One was that questionnaire results did not show any importance of communication materials, whereas some workshop participants viewed it as effective in raising awareness and increasing visibility. The other was that questionnaire results suggested that TV shows and other inspirational media are suitable for short-term success, whereas some workshop participants argued that they also have long-term effect on people's perception (if the programme is aired on a regular basis for several years).

Overall, questionnaire, card sorting exercise and workshop discussions showed consistent results to a great extent, regarding the importance and feasibility of each intervention. The consistency in different data sources means that the results are valid. Therefore, six interventions for short-term success and three interventions for long-term success could be a reasonable suggestion for further prototyping and piloting. However, accumulated evidence in interventions for changing behaviour showed that interventions result in different impact (either effective or ineffective), depending on which behaviour, target group, context and way of implementation. The only way to ensure the effectiveness of particular interventions in a given context is to pilot it and evaluate it (Michie and West 2013). Therefore, all results based on the semi-Delphi study should be understood as a stepping stone for further exploration to measure the real impact of the interventions through prototyping and piloting.

6.2.4 Implications for improving the initial interventions

The following sub-sections describe how six interventions for short-term success and three interventions for long-term success could be improved on the basis of the suggestions and recommendations made, and issues raised from the workshop.

6.2.4.1 High priority interventions for the short term

The semi-Delphi study results suggested that there were at least two important and feasible interventions for upscaling upcycling in the short-term (i.e. in 2 years).[32] One was improving access to, and facilities and services of community workshops with space, tools, materials, and training for diverse demographic populations. The other was producing TV shows and other inspirational media to share the best practices.

For the first intervention (community workshops), taking into account the major issues raised (a lack of awareness and interest, prerequisite community development, and limited utility), the following two suggestions are made. First, 'improving access to the community workshops' should mean increasing awareness of and interest in upcycling outside the workshop (e.g. by organising open events, spreading word, participating in local events), and making the environment more friendly and inclusive for wider demographic range of people (including women, children and elderly people). Second, 'improving facilities and services of the community workshops' should mean extending usefulness of the workshops beyond electronics and building a strong community in the workshop (e.g. by creating a collaboration project for mutual benefit between workshop members or participants). This intervention could be best initiated and delivered by local authorities or NGOs, with support from local communities.

For the second intervention (TV shows and inspirational media), many suggestions were made by different workshop participants (e.g. involvement of high profile designers, celebrities and opinion leaders, use of new digital media). One agreement

32 These were selected as important, feasible and top 5 interventions in the questionnaire, and as interventions for short-term success in card sorting exercise.

was that making the show regular for several years is paramount to set new norms and culture rather than creating a passing fad. Considering the issues raised (one-off trend of celebrity involvement and difficulty in measuring impact on behaviour change), the following two suggestions are made. In the case of celebrity involvement, selections should be carefully made, taking into account his/her personal beliefs, identity or lifestyles. In the case of measuring impact, reliable instrument should be identified or developed through a comprehensive secondary research. This intervention could be best delivered by NGOs and TV companies with the expertise of designers.

6.2.4.2 Medium priority interventions for the short term

There were other interventions which are not the highest priority but relatively important and probably feasible for short-term success. They were: a) operate a reuse/upcycle centre with a product collection service aligned with usual waste collection service[33]; b) design and provide a service model for improved provision of used materials, components and products; c) demonstrate upcycled goods as a new social norm or standard by changing government procurement to favour upcycled goods;[34] and d) organise community-based upcycling family events, workshops and training sessions.[35]

For the first intervention (upcycle centres), many suggestions were made by different participants (e.g. becoming materials collection points, a halfway house between a recycling centre and a charity shop, benchmarking existing centres) mostly with positive views. A major issue was, however, the potential rebound effect from shortening useful product lifetimes. Therefore, it might be helpful to have gatekeepers to check the state of the materials, components and products which are entered into the centre. Fixers and upcyclers could also be present in the centre to provide a quick, affordable (or even free) service of upcycling (repair, refurbishment

33 A reuse/upcycle centre was selected as an important and top 5 intervention in the questionnaire, and as one of the interventions for short-term success in the card sorting exercise.
34 Improving materials provision and changing government procurement were selected as important interventions in the questionnaire, and as part of interventions for short-term success in the card sorting exercise.
35 Community events were selected as a feasible intervention in the questionnaire, and as one of the interventions for short-term success in the card sorting exercise.

or redecoration). Based on such suggestions, the intervention could be renamed as 'operate a reuse/upcycle centre with used materials collection and affordable, professional upcycling service within the existing waste management system'. This intervention could be best delivered by local authorities partnering with NGOs.

For the second intervention (improving materials provision), some suggestions were made by the workshop participants (e.g. delivery service for businesses, benchmarking existing models, operating at the local level, using innovative financing scheme). The major issues were identified as difficulty in gaining the quantity and quality of materials and potential legal issues. In order to ensure the quantity, for example, new start-ups (to provide used materials), make partnerships with local waste/recycling centres (or, ideally, new reuse/upcycle centres), local manufacturers and other businesses (to exchange materials), and provide a direct collection service for local households. In order to ensure the quality (cleaned and standardised materials), the companies providing used materials could focus on one or two key materials (e.g. wood, electronics, fabric or packaging). To resolve the potential legal issues, agreements could be made with partner organisations, and certified testing and guarantee could be provided.

Regarding the third intervention (changing government procurement), some workshop participants expressed their doubt in its effectiveness for changing social norms (unsure about direct impact) and in feasibility (due to the cost, bureaucracies and a lack of capacities). In order to ensure the impact on changing social norms, extra efforts might be needed to make the change more visible to the general public (e.g. press releases). Considering feasibility, this intervention could also be considered as one of the first priority interventions to communicate and lobby for long-term success.

For the fourth intervention (community events), many suggestions were made by the workshop participants (e.g. use of different terminology such as creative reuse, repair, refurbish, and redecorate, involvement of multiple funders and partners, benchmarking existing events). No particular issues were raised. This intervention

could be best initiated and delivered through the coordinated efforts of local authorities and NGOs (and other interested partners).

6.2.4.3 Priority interventions for the long term

There were three important and feasible interventions for long-term success (in 10 years). One was the provision of tax benefits and subsidies for upcycling-related businesses. The second was the provision of grants and subsidies for upcycling-related research and initiatives (not for profit).[36] The third one was curriculum enrichment in art and design at schools, colleges and universities to incorporate advanced upcycling skills and knowledge.[37] The Government is a suitable actor for the first two interventions, and educational institutions are most suitable for delivering curriculum enrichment.

Regarding financial incentives for upcycling businesses (or disincentives for businesses based on raw materials), many suggestions were made by the workshop participants (e.g. tax on raw materials, VAT reductions on upcycled goods, special grants or favourable loans for upcycling businesses). This intervention was, however, largely viewed as politically unfeasible in the UK (due to high uncertainty with Brexit and increasing national debt) by participants. Providing evidence of positive socio-economic impact (besides environmental) from other cases (e.g. VAT rate reduction on repairs by the Swedish government (Orange 2016)) may help convince the Government to consider such fiscal policies.

The financial incentives for upcycling research and initiatives (grants and subsidies) could be in the context of waste management or circular economy programmes, aimed at, for example, small-scale demonstration projects or case studies by companies. Whether or not upcycling is important and worth further research and initiatives is an issue to be determined by the Government and Research Councils.

36 Financial incentives for upcycling-related businesses, research and initiatives were selected as important and top 5 interventions in the questionnaire, and as part of interventions for long-term success in the card sorting exercise.
37 Curriculum enrichment was selected as an important and feasible intervention in the questionnaire, and as part of interventions for long-term success in the card sorting exercise.

For the third intervention (curriculum enrichment), many suggestions were made by workshop participants (e.g. early year education, emphasising creativity and well-being benefits of upcycling, education beyond art and design, engineering education for remanufacturing). Major concerns were about the slow process and no guarantee of actual behaviour change. Utilising innovative teaching and learning approaches (e.g. SCALE-UP)[38] may be able to enhance the learning effect in changing behaviour.

6.3 Summary

The main findings and implications for scaling-up upcycling from the interview and survey studies were synthesised in this chapter (Section 6.1.1). Based on this synthesis, the target populations for scaling-up upcycling (Section 6.1.1.1), key approaches to developing interventions (Section 6.1.1.2), and some ideas for interventions (Section 6.1.1.3) were suggested. The initial ideas were mapped onto Defra's 4Es model, and intervention and policy categories, and extra ideas were generated and added to the table (Section 6.1.2). These initial interventions were suggested as design interventions (by designers) and policy interventions (by local authorities and government) separately, but combined to create 15 general interventions for subsequent exploration and evaluation (Section 6.1.3), which also included identification of suitable actor(s).

The 15 initial interventions were further explored and evaluated by the use of a semi-Delphi method. The results revealed the importance, feasibility and suitable actor(s) for each intervention, the top 5 interventions, and key interventions for short-term and long-term success (Sections 6.2.2.1 to 6.2.2.5). General discussion revealed the criteria for sustainable upcycling and scalability of upcycling (Section 6.2.2.6). Discussions on each intervention uncovered issues and particular usefulness, and suggested ideas for prototyping, piloting or implementation (Section 6.2.2.6). Based on the results, revisions and improvements were suggested for six short-term and three long-term intervention priorities (Section 6.2.4).

38 Student-Centred Active Learning Environment with Upside-down Pedagogies is a learning environment specifically created to facilitate active, collaborative learning in a studio-like setting (Wikipedia 2016b)

6.4 Discussion

The prioritised interventions, when implemented, could scale up upcycling in both consumption and production domains. In the consumption domain, buying new products (for both initial and replacement purchases) is the regime at the present time. When the interventions are implemented, the effects may include creating a niche-cluster such as local networks of passionate hobbyists and activists for upcycling and associated activities (e.g. simple repair or reuse, sustainable making and craft). Such a niche-cluster could develop into the niche-regime (e.g. regional or national networks and social movement). Another effect could be on landscape, changing the consumption culture and people's worldviews towards upcycling and associated activities by consumers. The dynamic interactions between the growing niches (e.g. niche-cluster and niche-regime), the changing landscape and the current regime could eventually lead to a new regime of upcycling and associated activities in which mainstream consumers will often buy second-hand products, repair products when they are broken, refurbish and redecorate products when they are old, upgrade products when more functionalities are required, and make new products from used materials when encountering broken or unwanted products, components and materials (Figure 13).

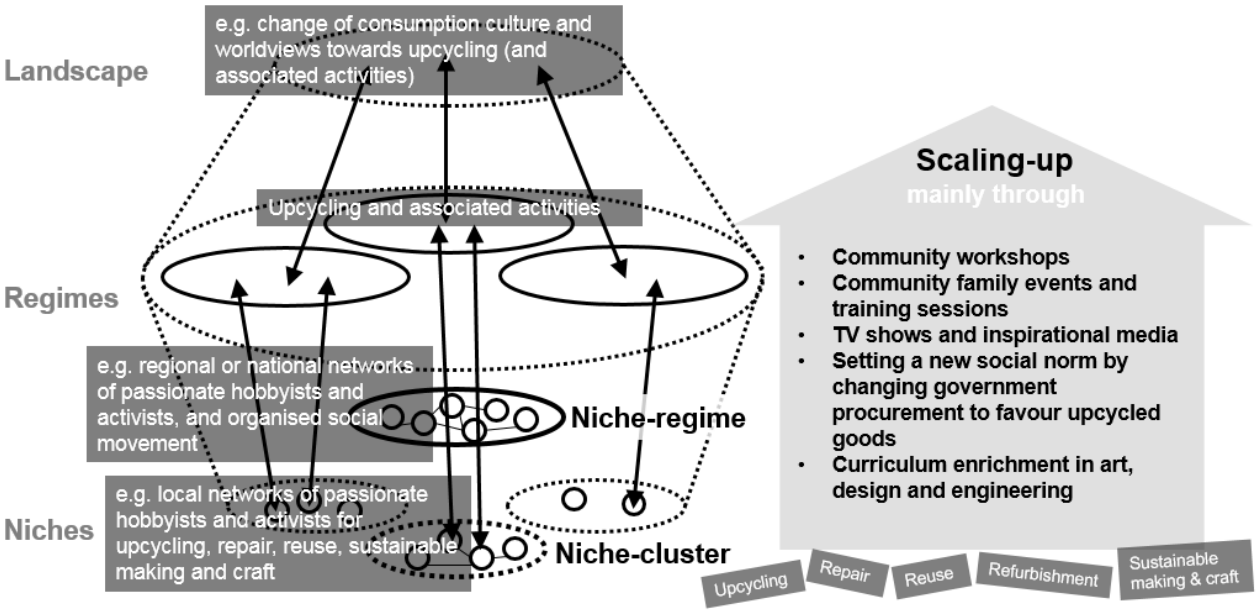


Figure 13 Scaling-up of upcycling in consumption domain

In the production domain, producing new products from new, virgin materials is the regime at the current time. There are, however, already some niche-clusters such as the Ellen MacArthur Foundation that brings together scientists and companies to promote a circular economy for which strategies include greater reuse, repair, refurbishment and remanufacturing. Another niche-cluster is online networks or platforms to bring together SMEs based on upcycling craft such as Remade in Britain. When the interventions are implemented, these niche-clusters could develop into niche-regimes such as regional, national or international networks of companies and academic institutions for industrial symbiosis and knowledge transfer, or retailers for upcycled products on the high street. Scaling-up interventions could also change the production culture and worldviews towards production based on used materials, components and products. The development of niches, along with the changing landscape, could enable the current regime players (i.e. mainstream manufacturers) to adjust their operations such that upcycling becomes a mode of production ('business as usual'), or upcycling-based SMEs to grow sufficiently to provide mainstream consumers with everyday goods (Figure 14).

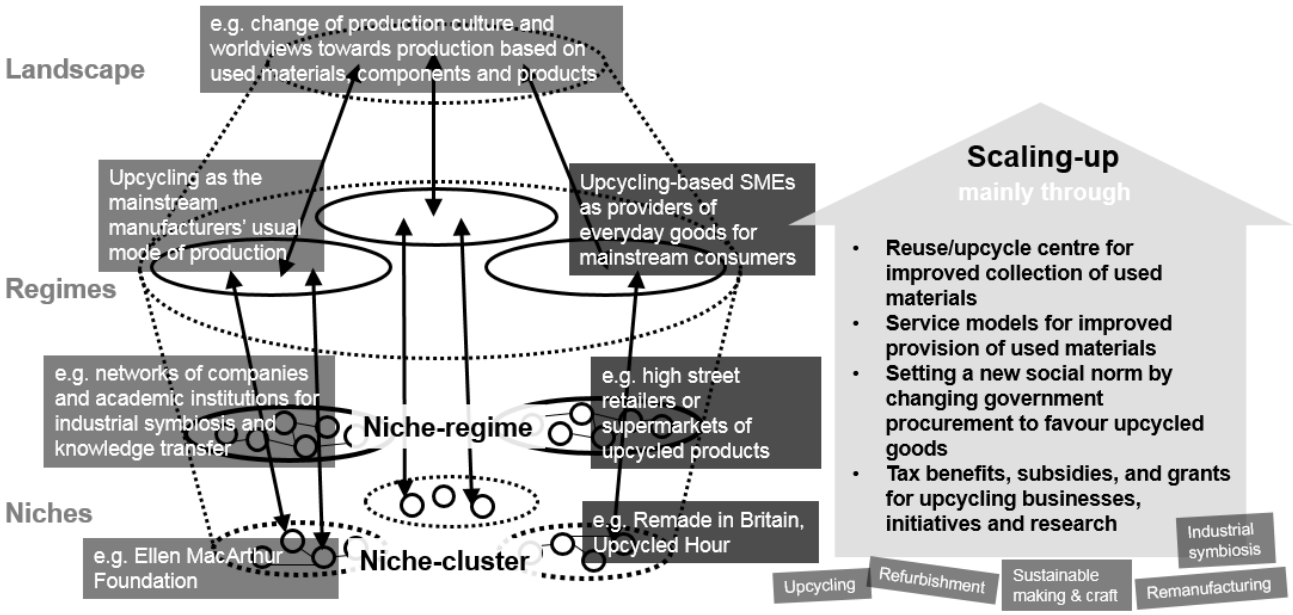


Figure 14 Scaling-up of upcycling in production domain

At the present time, when upcycling is a niche behaviour or practice, 'a spectrum of upcycling' seemingly exists. Some people argue that upcycling is strictly deconstructing waste products and reconstructing them into new products. Others

believe that upcycling is improved (or value-added) recycling through which the quality of materials is often degraded. Some claim that upcycling is any creative process which could give a second life to any used materials, components or products. In order to achieve effective scaling-up of upcycling in both consumption and production domains, the term 'upcycling' needs to be understood and communicated as an umbrella concept which incorporates all understandings within this spectrum. Upcycling is the process of utilising used materials, components or products in such a way that the end products have equal or higher quality or value than the compositional elements. Particular processes (e.g. creative repair, reuse, refurbishment, upgrade, remanufacturing or recycling) should be seen as a means to the end, upcycling. In this way, a greater number of niches can work together to form niche-clusters and develop into niche-regimes, ultimately becoming a new regime.

6.5 Implications

This PhD thesis used an overarching framework based on the Darnton's Nine Principles framework (Section 3.2.2) to understand and influence behaviour for upscaling upcycling. Four later stages of the original framework are not part of this PhD, which are prototyping (with actors), piloting, monitoring (process and outcome), and feeding learning back in after developing and prioritising interventions (Figure 9). Adopting Darnton's approaches, priority interventions could be prototyped and piloted before large-scale implementation. The two high priority interventions for short-term success (Section 6.2.4.1), therefore, should be the first ones to be prototyped and piloted (by any actors aiming to scale up upcycling). The four medium priority interventions for short-term success (Section 6.2.4.2) might also be considered for prototyping and piloting after trying out the two, high priority interventions. Three priority interventions for long-term success (Section 6.2.4.3) should be widely communicated with lobbying activities (if applicable) to influence key decision makers in the Government and educational institutions.

7 DISCUSSION AND CONCLUSION

This chapter reflects on the aim and objectives; draws conclusions; discusses limitations, implications and contribution to knowledge; and suggests recommendations for future research.

7.1 Meeting the aim and objectives

The aim of the research was to develop recommendations for scaling-up upcycling in households and beyond in the UK to contribute to sustainable production and consumption by reducing materials and energy consumption with the ultimate goal of reducing carbon emissions. In order to meet this aim, three objectives were formed. The first was to gain insights into upcycling in the UK, paying special attention to product attachment and product longevity The second was to identify the UK-specific key behaviour factors underlying upcycling. The third was to formulate policy and design interventions for scaling-up upcycling.

In fulfilment of the first objective, semi-structured interviews and a short questionnaire study were conducted (Chapter 4). This first study described the current upcycling behaviour in terms of approaches to upcycling and context for upcycling; listed a number of factors influencing upcycling based on the Triandis' Theory of Interpersonal Behaviour; and revealed the correlations between upcycling, product attachment and longevity.

The second objective was achieved in Chapter 5. Through statistical analysis of the factors influencing upcycling, the key determinants of upcycling were identified and several statistically significant group differences based on demographics were found.

The third study, developing interventions, fulfilled the third objective (Chapter 6). Several initial interventions were generated by the synthesis of the interview and survey studies, as well as idea generation and mapping. Through a semi-Delphi study, to explore and evaluate the initial interventions, important and feasible interventions

for short-term and long-term success were suggested together with ideas for prototyping, piloting or implementation.

7.2 Conclusions

Product lifetime extension is one of the important strands in design research for sustainability. Challenges in product lifetime extension were identified, and upcycling in households was identified as a means to achieve product lifetime extension. Potential benefits of upcycling for sustainable production and consumption were described, and the potential link between upcycling, product attachment and longevity was explored. The lack of past research on upcycling by households, despite the recent growth of interest and potential benefits, was recognised as a research gap in knowledge (Section 1.1).

The scope of research was set to: a) focus on household upcycling; b) understand upcycling as environmentally significant behaviour; c) focus on how to scale up this marginal activity into mainstream everyday activity in households and beyond to make a bigger impact on the environment and society in the UK; and d) approach the study as a multidisciplinary inquiry (Section 1.2). Within this scope, the aim was specified as 'providing actionable recommendations for scaling-up upcycling in households and beyond in the UK to contribute to sustainable production and consumption by reducing materials and energy consumption'. Under this aim, three objectives were drawn (Section 1.3), and they were fulfilled by three consecutive studies (Section 7.1).

At a theoretical level, this research provided the first thorough literature review on upcycling in terms of different uses of the term, state of knowledge, general trend in practice, benefits, drawbacks and barriers, and links between upcycling and product attachment (Section 2.1). On the basis of this review, a number of research gaps were identified, one of which (exploring household upcycling) was used as the starting point for this PhD (Section 2.4). Various behaviour models on environmentally significant behaviour were reviewed, and the significance and usefulness of Triandis'

Theory of Interpersonal Behaviour was considered. Through a review of Triandis' model, a number of concerns were identified, and a combination model between Triandis' model and Ajzen's Theory of Planned Behaviour was proposed as an alternative in order to achieve improved ability to be operational and enhanced explanation power (Section 2.2). Several approaches to scaling-up were reviewed and the suitability of each was evaluated (Section 2.3).

A mixed methods approach was adopted as research paradigm (with pragmatism) and strategy (Section 3.1). Incorporating three stages (semi-structured interviews with a short questionnaire study; survey; idea generation and semi-Delphi study), Darnton's Nine Principles framework was adopted as an overarching framework for investigation of behaviour and interventions (Section 3.2).

At a practical level, the first stage study, on understanding consumer behaviour, generated numerous direct implications for scaling-up interventions, base information to form the subsequent survey study questions, and some observation data to compare to the survey results with a bigger sample (Sections 4.3 and 4.4). The second stage study, on identifying key factors influencing behaviour, provided the crucial information to make important decisions on the foci of scaling-up interventions and target population demographic groups, as well as ideas for scaling-up (Sections 5.3 and 5.4). The third stage study, on developing interventions, provided initial 15 promising interventions (Section 6.1.3), six interventions for short-term success to prototype and pilot (Sections 6.2.4.1 and 6.2.4.2), and three interventions for long-term success to communicate and lobby for (Section 6.2.4.3).

Key findings from the first study included primary materials used (wood, electronics, clothing, packaging), main source of materials (online shops and networks), essential criterial for materials (quality and cost saving), predominant use of home for upcycling, high aspirations for commercialisation and high interest in collaborators or companions (Sections 4.2.1.3 and 4.2.2.6). Key finding from the second study were the statistically significant determinants of upcycling (positive attitude to shape intention and subjective norm) (Section 5.3). Key conclusions from the third study

included the most promising interventions for short-term success such as community workshops, TV shows and inspirational media, upcycle centres, and models for improved materials provision (Sections 6.2.4.1 and 6.2.4.2).

7.3 Limitations

Results and discussions from the interview study, short questionnaire study to investigate the links between upcycling, product attachment and longevity, and the survey study may not be generalisable to the overall UK population due to the sampling method applied and limited sample size. It is especially true for the questionnaire study, as a quantitative enquiry.

Another limitation in interviews was that some questions based on the behaviour model used technical language about each factor instead of more understandable wording (e.g. asking if any "self-concepts" are involved in participants' motivation, instead of, for example, "What sort of people might participate in upcycling?"). This means that potentially more interesting and valid answers may not have been attained. Moreover, some participants may not have been aware of the factors influencing their behaviour.

Other limitations of the short questionnaire study were that estimations and expectations were used to measure product attachment and lifetimes (rather than actual experiences) and that a modified, single item to measure attachment-related variables was used rather than multiple items (due mainly to limited time). This means that the results do not necessarily reflect the reality (i.e. actual attachment and lifetimes), and the complex and multi-faceted nature of the product attachment construct might not have been fully captured.

A limitation of the survey was that data from one of the important behaviour factors, habit, was excluded from the final model because confirmatory factor analysis revealed that the habit items measured more than one construct. Consequently, the

potentially interesting question of what extent upcycling behaviour is affected by habit could not be measured.

Finally, the semi-Delphi results may not be accurate as they are based on the opinions of a limited group of experts. It is possible that different experts could have reached different conclusions and recommendations.

Regarding the aforementioned limitations, future research which aims to achieve more valid and reliable data by applying the same or similar research techniques used, is recommended to:

- interview a larger number of people (probably over 30) with more understandable wording and expressions;
- conduct a questionnaire study on the links between upcycling, product attachment and longevity with a bigger sample (n>100), preferably using multiple items to measure attachment-related variables, and asking about actual experience in a longitudinal study;
- suggest a sound product categorisation that most people can agree with for upcycled goods by, for example, creating upcycled products typology;
- design a survey to predict the behaviour (rather than to explain the behaviour) with two consecutive surveys (with sufficient time interval such as 6 months to a year): the first one with all behaviour factors including the question about habit as the frequency or number of the past behaviour; and the second one asking about the behaviour; and
- use the Delphi method in a more traditional way by conducting a series of questionnaires to fully explore the subject, meticulously evaluate the options, and more confidently reach the conclusion collectively.

7.4 Applicability of the research findings

This research focused on investigating upcycling as a behaviour that requires intervention in order to scale up and providing actionable recommendations to scale up upcycling at different levels in the UK. Due to the justifiably narrow and focused

scope of research, findings from the empirical research are applicable only to the UK context. For instance, any organisations or actors who aim to upscale upcycling in the UK should prototype and pilot six interventions for short-term success, and communicate widely and lobby for three interventions for long-term success. Design researchers, practitioners and educators in the UK, in particular, could focus on community workshops, inspirational media, upcycle centres, models for improved materials provision, community events, and curriculum enrichment. They could co-design new, improved community workshops (and services) with existing workshop members. They could create upcycling-related videos and other multi-media contents and publish them on a regular basis. They could co-design upcycle centres with local recycling or waste centres, and co-develop new models for improved materials provision with local businesses. By working together with local communities, they could design and run community events. Especially design educators could create student projects for upcycling.

Theoretical developments could be applied to other contexts and behaviour domains in any effort involving behaviour investigation and intervention in design discipline and beyond. They include the overarching framework (adapted Darnton's Nine Principles framework) with mixed methods research, the combination model of Triandis' Theory of Interpersonal Behaviour and Ajzen's Theory of Planned Behaviour, and research techniques utilising the Triandis' model and the combination model.

7.5 Contribution to knowledge

7.5.1 Design for sustainable behaviour

Most approaches in Design for Sustainable Behaviour (DfSB) have focused on products or communication information and graphics as a form of intervention to influence behaviour (e.g. Dorrestijn 2012, Lilley 2007, Lockton, Harrison and Stanton 2010, Tang 2010). Investigation into interventions beyond product and communication design (e.g. service design) appears to be relatively lacking. In the meantime, the increasing interest in design as a way of thinking and as an effective tool for policy and service innovation in the public sector (Bason 2014, Boyer, Cook

and Steinberg 2011, European Commission 2012), calls for more general or wide-ranging approaches to design and policy interventions. This PhD exhibited how design can contribute to generating interventions for influencing behaviour beyond product and communication design (e.g. policies and system innovation) in DfSB.

In DfSB, user studies (or consumer research) have often been exploratory with qualitative methods including interviews and observation (e.g. Kuijer and Jong 2012, Lilley 2007, Zachrisson, Storrø and Boks 2012). Questionnaires (or survey) have been utilised (less frequently than qualitative methods) but mostly without employing behaviour models from psychology (e.g. Cor and Zwolinski 2014, Kobus, Mugge and Schoormans 2015, Tang 2010). The use of mixed methods (e.g. combining interviews and survey) has been rarely used in DfSB (e.g. Laitala, Klepp and Boks 2012, Tang 2010), and none of them is based on behaviour model. This PhD presents the first demonstration of the use of mixed methods based on a behaviour model in DfSB. It showed how the quantitative and qualitative behaviour data (based on the selected behaviour model) can be utilised and linked to design (idea generation) for influencing behaviour.

Darnton's Nine Principles framework (Darnton 2008a) is a general starting point for understanding and changing behaviour based on a comprehensive review of over 60 behavioural change models (Davies, et al. 2014, Prager 2012). It has been used in limited research with topics including recycling (Martin, Ross and Irwin 2015), cyber security (Blythe 2013), preventative services in schools (Macklem 2014) and education for sustainable development (Chauhan, Haigh and Rita 2012). This PhD presents the first demonstration of the use of Darnton's Nine Principles framework in design. More specifically, this PhD critically reviewed the framework, identified the issues (missing details for empirical research), adapted the framework especially suitable for underexplored behaviour (requiring empirical research), and demonstrated how the adapted framework could be used as an overarching framework for behaviour investigation and intervention in DfSB.

7.5.2 Upcycling theory and practice

Upcycling is a relatively new term (Braungart and McDonough 2002, Kay 1994) with varied definitions and practices (e.g. Ali, Khairuddin and Abidin 2013, Bramston and Maycroft 2013, Eder-Hansen, et al. 2012, Emgin 2012, Vadicherla and Saravanan 2014). Despite the rising interest in upcycling manifested by industrial interest along with increased publication levels, no major academic review has yet been presented (Sung 2015). This PhD reviewed upcycling and identified several research gaps. For example, besides fashion and textiles (e.g. Earley 2011, Fraser 2011, Goldsworthy 2009) and plastic recycling (e.g. Czvikovszky and Hargitai 1997, Kreiger, et al. 2013, Munroe, Hatamiya and Westwind 2006), previous research has not paid sufficient attention to public interest such as upcycling craft, hobbies, and home DIY for housewares, furniture and accessories (e.g. Google Images 2016, Instructables 2016, Pinterest 2016). This PhD investigated these understudied areas, in particular, upcycling in households. It explored consumers' approaches to upcycling, context for upcycling and factors influencing upcycling, and explained key determinants of upcycling in the UK. All practical knowledge, implications and proposals (especially promising interventions for scaling-up by different actors) from this PhD would contribute to upcycling practices in the UK.

Past studies regarding product attachment have shown vested interests in product personalisation, mass customisation and participatory design to increase product attachment as design strategies for sustainable consumption (e.g., Chapman 2005, Cramer 2011, Fletcher 2008, Mugge, Schoormans and Schifferstein 2009). Despite the emphasis on consumer involvement in professional design practice, past studies have not paid much attention to design and creation solely by consumers which do not involve professional designers or manufacturers, such as household upcycling. This PhD explored the links between upcycling, product attachment and longevity, and found that determinants of attachment to the upcycled products may be consistent with the ones to ordinary consumer durables, and that irreplaceability may be the most likely consequence of attachment to the upcycled products (which could lead to emotional durability).

7.5.3 Consumer behaviour theory

Triandis' theory of interpersonal behaviour (Triandis 1977) is a pragmatic synthesis (Jackson 2005a) of comprehensive factors to understand behaviour with its wide applicability (e.g. Cotterill, Stoker and Wales 2008, Gagnon, Sánchez and Pons 2006, Salonen and Helne 2012, Tang 2010). However, the original Triandis' model has no clear guidelines for the operational definition of the variables (Araújo-Soares and Presseau 2008), and several adapted models appeared to have varied number of variables with different operational definitions (e.g. Bamberg and Schmidt 2003, Gagnon, et al. 2003, Knoeri and Russell 2014). On the contrary, Ajzen's theory of planned behaviour (Fishbein and Ajzen 1975, Madden, Ellen and Ajzen 1992), one of the widely used models, has parsimony of the model with clear guidelines but with limited explanation power (Bamberg and Schmidt 2003). Taking these into account, this PhD proposed the promising combination model between theory of interpersonal behaviour and theory of planned behaviour for, in principle, its improved ability to be operational and enhanced explanation power.

7.6 Suggestions for future research

Considering the limited, focused, scope of this research, further studies concerning upcycling could be conducted in the future such as:

- Upcycling as practice rather than behaviour based on different theoretical frameworks such as social practice theory (Shove, Pantzar and Watson 2012) to reveal, for example, an upcycling practice typology depending on different skills level, key materials involved, and core meaning of the practice;
- Upcycling as behaviour but focusing on different behaviour domains other than environmentally significant behaviour, such as community participation or mental health;
- Upcycling behaviour as niche, environmentally significant behaviour outside the UK context and comparing the results with UK results;
- Investigation of behaviour and intervention for scaling-up upcycling aimed at the EU level (or even international level); and
- Exploration of a wider cultural context behind upcycling behaviour/practice.

Taking into account the research gaps that were identified through the literature review but not part of this PhD, future research could include:

- A historical study on upcycling as a deep-rooted collective human behaviour;
- Commercial perspectives of upcycling; the profitability of different product categories and scalability of the businesses;
- Measuring the quantifiable positive and negative environmental impacts of upcycling;
- Exploring social benefit aspects of upcycling;
- Investigation into the links between social benefits and larger environmental benefits; and
- Further investigation into service- and system-level design for behaviour change or for sustainable behaviour.

Last but not least, reflecting on the implications of the study, the most interesting future research would be action research on the process of prototyping and piloting the recommended interventions for short-term success in upscaling upcycling. It would aim not only to measure its actual impact on scaling-up but also to report the lessons learned during the process.

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APPENDICES

Appendix A. Pre-interview questionnaire

1. **How many upcycling projects** have you **completed and in progress**? Please indicate the approximate number.

2. Please list your **project** (or **product**) **names** with **approximate start & end dates** and **duration** as much as you remember. (See example answers.)

<Example>

Project/product name	Approximate start and end dates	Approximate duration
Cushion cover	**Somewhere April/2013**	**2 weeks**
Mirror	**August/2013 – September/2013**	**1 month**
Chess table	**March/2014 – ongoing**	**Will be about 3 months**

Project/product name	Approximate start and end dates	Approximate duration

(NB: **If your projects are more than 10, add more table rows** as needed.)

3. Do you use any websites (e.g. instructables, etsy, etc.), forums, blogs, etc. related to your projects? Please list the **names of websites/platforms/forums/blogs** or copy and paste the URLs.

Appendix B. Informed consent form for the interview study

PURPOSE

The purpose of the study is to contribute to the new practical knowledge addition to understanding of emerging behaviour of *upcycling* – creation and creative modification of any product with used/waste materials/products – based on physical resources (e.g. Hackspace, materials and tools) and digital resources (e.g. design software, websites). You were selected as a participant in this study because you have been involved in a number of upcycling projects for and by yourself, which puts you in the best position to answer the required questions in this study. Before you sign this form, please ask any questions on any aspect of this study that is unclear to you.

PROCEDURES AND DURATION

During the interview, you will be asked to answer to questions related to your personal experiences in upcycling with various resources involved. All the questions are open-ended questions such that there is no right or wrong answers. It will take approximately 60 minutes to complete the interview. All conversations will be recorded for the purpose of data collection.

RISKS AND DISCOMFORTS

The study intends to exclude any undue physical or psychological harm to any participant. Notwithstanding, if you feel any unusual stress, embarrassment, loss of self-esteem, or any other kind of psychological discomfort at any point of participation, you are not bound to continue your participation.

BENEFITS AND/OR COMPENSATION

The interview results will be shared with you after analysis.

CONFIDENTIALITY

You will remain completely anonymous and no records of the interview will be kept with your name on them.

VOLUNTARY PARTICIPATION

Participation in this study is voluntary. If you decide to participate, you are still free to withdraw your consent and to discontinue participation at any time without penalty.

AUTHORIZATION

You are making a decision whether or not to participate in this study. Your signature indicates that you have read and understood the information provided above, have had all your questions answered, and have decided to participate. Nothing in this consent shall be construed as being legally binding.

Name of research participant	Date

Signature of participant

Appendix C. The summary of CAQDAS (Computer Assisted Qualitative Data AnalysiS) packages

The following summary is based on Silver and Lewins (Silver and Lewins 2014).

The summary of CAQDAS packages

Software	Data	Architecture and user interface	Functionality
ATLAS.ti	Plain and rich text, native PDF, images, audio, video and geo data	Distinctive 'quotation' structure: quotations from different types of data can be linked as rhetoric structure / mimicking traditional ways of interacting with text and going beyond paper and pencil scribbling and annotating	The network editor as a central workspace / various analytic functions / embedded visualisations / file compatibility / mobile app
Dedoose	NA	Web-based (platform independent, without install, upgrade or maintenance issues) / easy to learn the basics with visual accessibility / additional features accessed via other workspaces	The focus on mixed methods data integration and analysis / code ratings or weights
HyperRESEARCH	Text, images, audio, video	Modular tool architecture enabling new tool add-ons / supporting a case-based structure for comparative analysis / the case card as an architectural centre	Simple clicking and dragging coding / case filters / report builder / theory builder / code-map device for visualisation / cross-platform working (Mac and Windows)
MAXQDA	Text, images, audio, video	User-friendly interface (clear and uncluttered)	Complex visual tools and functions supporting mixed methods analysis / joint displays bringing together both qualitative and quantitative data / report builder / mobile app
NVivo	Text, images, audio, video, social media data, profile-style metadata, direct import from survey websites, PDF	Nodes (thematic codes) and attributes (e.g. socio-demographics) structure / similar to outlook interface / folder system	Focus on qualitative analysis functionality (e.g. systemic handling of codes) / query functions / visualisations using dynamic charts
QDA Miner	Texts, PDF, images, geo data	NA	Fast processing of large datasets / compiling and formatting reports / add-on text-mining functionality
Transana	NA	NA	Cross-platform working / lacking some tools for text analysis but strong for visual analysis

Appendix D. Mini questionnaire study to decide on item for each variable

21 PhD students in the School of Architecture, Design and the Built Environment, Nottingham Trent University (based on convenience sampling) responded to the questionnaire in April 2014. The questionnaire asked respondents to choose their best description among the given items. When the given items were not satisfactory, the respondents provided alternative descriptions. The most frequently answered item was chosen as one generally agreeable description. In the case of product attachment, the most frequently answered item was combined with the definition of product attachment. See the below table for the variables and items with the number of answers.

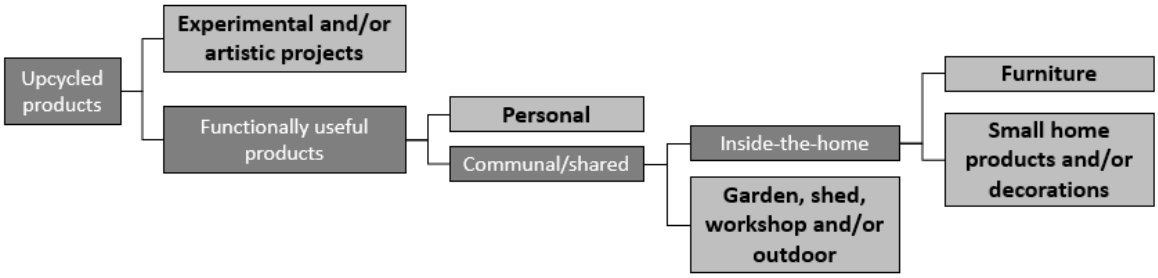
Variables and items provided with the number of answers

Variables	Items (number of answers)
Product attachment	I am very attached to this product I made. (4) This product has special meaning to me. (9) This product is very dear to me. (1) I have a bond with this product. (3) Other (4)
Determinant 1 of product attachment : self-expression	This product reflects who I am. (6) Other people can tell by this product what kind of person I am. (2) This product fits my identity. (3) This product suits me. (4) This product says a lot about me as an individual. (4) Other (2)
Determinant 2: group affiliation	This product indicates that I am a crafter/maker/upcycler/hacker. (9) Through this product I feel connected to other crafters/makers/upcyclers/hackers. (5) Through this product I belong to the group of crafters/makers/upcyclers/hackers. (4) Other (3)
Determinant 3: memories	This product reminds me of people or events that are important to me. (7) This product makes me think back of someone or something that has happened. (2) I see this product as a reminder of certain people or events. (2) Through this product I think back to certain people or events. (4) Other (6)
Determinant 4: pleasure	I enjoy this product. (4) It is a pleasure to use this product. (3) I feel good when I use this product. (11) Other (3)
Consequence 1 of product attachment: disposal tendency	I would like to get rid of this product. (7) If it was possible, I would sell this product. (3) I expect to have this product in possession for a short time. (3) I will soon discard this product. (1) Other (7)
Consequence 2: product care	I am careful about this product. (4) I take good care of this product. (8) I treat this product properly. (3) I handle this product in a careful way. (6)
Consequence 3: expected product longevity	I hope that this product will last for a long time. (13) I want to use this product for a long period of time. (8)

Consequence 4 of product attachment: irreplaceability	This product is irreplaceable to me. (6) Even a completely identical product cannot replace this product for me. (1) For me, another identical product will not have the same value. (4) For me, this product is different to other products of this type. (6) Other (4)

Appendix E. Product categorisation and a list of products with categories

The first criterion for categorisation was the key aim of the creation: (1) experimental and/or artistic projects (including experiments, one-off demonstration, or artistic expression) and (2) functionally useful products (including decoration purposes). Functionally useful products were again categorised on the basis of personal or communal/shared products. Communal/shared products for functional usefulness were further categorised by where the product is used: (1) inside the home, and (2) garden, shed, workshop and/or outdoor. Furniture is separated from other small home products and/or decorations among the inside-the-home products for its relatively large number.



How the upcycled products with attachment were categorised

On the basis of the above categorisation, the upcycled products with attachment were classified as on the table in the next page.

Product category and product items of the upcycled products with attachment

Product category	Product items	
Experimental and/or artistic projects	Black box	Canon hack development kit
	Eye of the internet (art piece)	Henk, the god of technology (art piece)
	IKEA lamp drone	Log-carved
	Pedal power generator	Raspberry pi project
	Relay sockets	RevSmoker (art piece)
	Sculpture	Tour robot
	USB portable battery charger [a]	
Inside-the-home furniture	Alcove bookshelves	Bed
	CD rack	Cyber bed (bed decorated with computer components)
	Jigsaw table	Nest of tables
	Piano shelf	**Recycling bin** [b]
	Side board	TV stand
Garden, shed, workshop and/or outdoor products	Bird box	Block plane
	Bug box	Climbing plant tripod
	Compost bin	Flower pot
	Patio and path	**Wind chimes** [c]
Small home products and/or decorations	CD clocks	Cyber wall (wall decoration with computer components)
	Cushions	Kettle
	Lamp	Record bowls
	Recycling bin [b]	**Wind chimes** [c]
Other personal belongings	Bikes (n=2)	Jewellery
	Jumper	iMac G4
	Prom dress	**USB portable battery charger** [a]

[a] USB portable battery charger project, according to the respondent, was started as an experimental project but developed into a useful product, and he has been using it.
[b] recycling bin can be considered as furniture or a small home product.
[c] wind chimes can be used both outside and inside of a house: they are outdoor products when used outside, and small home products or decorations when used inside the house.

Appendix F. Websites used for internet survey

Website	Web page	URL
Adafruit	Forums of announcements; ask an engineer!; for educators	http://forums.adafruit.com
Arduino forum	e-textiles and craft; interactive art; product design	http://forum.arduino.cc
CNC machining	Forums of hobby projects; general woodworking	http://www.cnczone.com
Code project	Community – the lounge	http://www.codeproject.com
Craftster	Communities of clothing; crochet; amigurumi; fibre arts; glass crafts; homw sweet home; jewellery and trinkets; knitting; miscellaneous; more art, less craft; needlework; paper crafts; scrapbooking; polymer clay; pottery, ceramics, etc.; purses, bags, wallets; quilting; reusing/recycling/recrafting; sewing; machine embroidery; toys, dolls and playthings	http://www.craftster.org
Etsy	chitchat forum; discussions forum	http://www.etsy.com
Folksy	Forums of craft talk; fancy a cuppa; uncategorised	http://talk.folksy.com
Google community	All things mixed media art!; arts & crafts; DIY and crafts; handmade; crafts; DIY, how-tos and tutorials; crochet for fun; DIY ideas and projects; craftsy; handmade only; handmade by you, crafts, DIY, tutorials, decoration; sewing; handmade artists; art of crafts; DIY & craft; DIY crafty projects; 30 minute crafts; handmade jewellery; crochet; home design; crochet along; etsy shops & shoppers; scrapbooking and paper crafters; sewing on my kitchen table; 3D printing; Arduino; reduce, reuse, recycle; sewing for beginners; fiber arts and crafts; paper crafts; craft patterns; upcycle it; sewing and dressmaking; makers, hackers, artists & engineers; Make: Forum; crafters corner decor; upcycling inspiration; crafting away; embedded electronics projects; geek your home; shiny bikes and new gear; viral upcycle; upcycle 4 good; upcycle, repurpose; upcycling; poof upcycling; antique and flea market travellers; waste no more; upcycle it yourself; recycling fabrics and sustainable upcycled fashion; DIY inspired; recycled interiors; live life for less; creative ideas; crafty corner; paper crafting; handmade giftables; etc.	https://plus.google.com/communities
Hackernews	Ask board	http://news.ycombinator.com
Hackspace	Google forums for Nottinghack; Leicester Hackspace; UK-Hackspace; Cammakespace; London Hackspace; North East Makers; DoEs Liverpool; Hackspace Manchester; Chester Hackspace; Lancaster and Morecambe Makers; Leigh Hackspace; Hack:OLDHAM; Build Brighton; Reading Hackspace; SoutHACKton; Surrey and Hampshire Hackspace; Dors et Constructorium; Make Bournemouth; Oxford Hackspace; Swindon-hackspace; Cheltenham Hackspace; Birmingham Hackspace; Salop Hackspace; Make: Bromyard; Sheffield Hardware Hackers; York Hack Space; Selby Hackspace	https://groups.google.com/forum
Ibuildit	Forums of workshop projects and furniture; home improvement	http://www.ibuildit.ca
Ifixit	Answers forum	https://www.ifixit.com
Instructables	art forum; craft forum; community blog forum; green forum; resources forum	http://www.instructables.com
Netmums	Chat rooms of seasonal chat and arts & crafts; house & garden; general coffeehouse chat	http://www.netmums.com
Raspberry Pi	Forums of general discussion; off topic	https://www.raspberrypi.org/forums
Screwfix	Community forums of builder's talk; eco talk; just talk	http://community.screwfix.com
thingiverse	Groups of engineering; Arduino; Raspberry Pi; Gamer Makers	http://www.thingiverse.com

Appendix G. Socio-demographic questions and answer options for survey

Category	Question (answer options)
Gender	What is your gender? (male; female)
Age group	What is your age? (under 30; 30 to 49; 50 and over)
Nationality	What is your nationality? (British; other – specify)
Region of residency	Which region do you live in? (East Midlands; East of England; London; North East; North West; Northern Ireland; Scotland; South East; South West; Wales; West Midlands; Yorkshire and the Humber)
Ethnicity	What is your ethnic group? (White-British; White-Irish; White-any other White Background; Mixed-White and Black Caribbean; Mixed-White and Black African; Mixed-White and Asian; Mixed-any other Mixed background; Asian-Indian; Asian-Pakistani; Asian-Bangladeshi; Asian-Chinese; Asian-any other Asian background; African; Caribbean; Any other Black/African/Caribbean background)
Employment status	Are you employed? (Yes-employed: full time; Yes-employed: part time; Yes-employed: self-employment; No-retired; No-a student; No-unemployed)
Occupational area	How would you best categorise your main occupational area (or study area if you are a student?) (business, finance, management and marketing; creative arts and design; health service; hospitality, leisure, sport and tourism; manufacturing; sales and retail; science, engineering and technology; public and social service; teaching and education; other – specify)
Education level	What is your highest level of education completed? (primary school; secondary school; further education or vocational training; higher education – undergraduate, Master, PhD)
Annual household income	What is your approximate annual household income? (under £20,000; £20,000-£40,000; £40,000-£60,000; £60,000-£80,000; £80,000-£100,000; over £100,000; I don't want to say.)

Appendix H. Recoding of responses to binary nominal data

Items	7-point scale ordinal and multiple-option nominal data	Binary nominal data
Frequency	(1) never – (2) less frequently than once a year – (3) about once a year – (4) about once every six months	(0) relatively less frequent
	(5) about every three months – (6) about once a month – (7) about once a week – (8) more frequently than once a week	(1) relatively more frequent
Perceived facilitating condition items (reverse data) (e.g. "A lack of information")	(1) to a very great extent (problem) – (2) to a great extent – (3) to a fairly great extent – (4) to a moderate extent	(0) there was a problem
	(5) to a small extent (problem) – (6) to a very small extent – (7) not at all	(1) there was no problem
Attitude items (e.g. "un/pleasant")	(1) unpleasant – (7) pleasant	(0) unpleasant (1) pleasant
Intention / subjective norm / personal norm / role beliefs / perceived behaviour control items	(1) strongly disagree – (2) disagree – (3) somewhat disagree – (4) neutral	(0) no
	(5) somewhat agree – (6) agree – (7) strongly agree	(1) yes

Appendix I. Semi-Delphi questionnaire rating scale for importance and feasibility

Category	Scale (Likert-type)	Description
Importance	1 – very unimportant 2 – unimportant 3 – neutral 4 – important 5 – very important	NA
Feasibility (technical, economic and political)	1 – definitely unfeasible	- Cannot be implemented - Basic research needed - Unprecedented allocation of (the most suitable actor's) resources would be needed - Definitely economically unacceptable (i.e. Cost exceeds benefits) - Politically unacceptable
	2 – probably unfeasible	- Some indication that this cannot be implemented - Major research and development effort needed (the most suitable actor's existing resources are inadequate) - Large scale increase in (the most suitable actor's) available resources would be needed - Probably economically unacceptable - Major political obstacles
	3 – may or may not be implemented	- Contradictory evidence that this can be implemented - Indeterminable research and development effort needed (the most suitable actor's existing resources may be inadequate) - Increase in (the most suitable actor's) available resources would be needed - May or may not be economically acceptable - Political obstacles
	4 – probably feasible	- Some indication that this can be implemented - Some research and development still required - (the most suitable actor's) available resources would have to be supplemented - Probably economically acceptable - Some minor political obstacles
	5 – definitely feasible	- Can be implemented - No further research and development required - Necessary resources (financial, labour, etc.) are presently available (for the most suitable actor) - Definitely economically acceptable - No major political obstacles

Appendix J. Interview techniques and the fit with the first study

The following table summarises the main characteristics of different interview techniques (based on Robson 2011, pp. 285-295) and describes the fit with the first study to understand behaviour and consumers.

Interview techniques and the fit with the intended study to understand behaviour and consumers

Technique	Main characteristics	Fit with the study
Structured interviews	- Do not fit easily into flexible design studies - More likely to contribute to a fixed or multi-strategy design - Content analysis is commonly used	No, this study needs flexibility for probing when applicable (especially for clarifying meanings behind short answers)
Semi-structured interviews	- Have considerable freedom in the sequencing of questions, in their exact wording, and in the amount of time and attention given to different topics - Most appropriate when the interviewer is closely involved with the research process (e.g. in a small-scale project when the researcher is also the interviewer)	Yes, this study is small-scale when the researcher is also the interviewer, and it needs flexibility.
Unstructured interviews	- Non-standardised, open-ended and in-depth - Not an easy option for the novice - Interviewees speak freely in their own terms about the set of concerns plus anything else they wish to talk about	No, certain questions need to be answered, which requires certain extent of structure, and it is not recommended for the novice.
Non-directive interviews	- The direction of the interview and the areas covered are totally in the control of the interviewee - Used widely in therapeutic settings - Initiated by the client/interviewee - Not appropriate for research	No, it is not appropriate for any research.
Focused interviews	- Allow people's views and feelings to emerge - Give the interviewer some control - Investigate a particular situation, phenomenon or event - Situational analysis is prerequisite - Demand considerable experience and skill on the part of the interviewer and great flexibility - Widely used in a group setting	Yes, it could have been used after an observation study as situational analysis. But the observation study is not feasible for practical issues within a limited time frame, and it is not recommended for a novice interviewer/researcher.
Telephone interviews	- Substantially quicker and cheaper than face-to-face interviews - Worth considering in situations where lack of resources precludes carrying out an adequate sample of personal interviews - Need to be relatively short (usually less than 30 minutes) - Have lack of visual cues (e.g. non-verbal responses)	No, this study needs at least 30 minutes up to one hour to cover all the questions.

Internet-based interviewing	- No travelling, no hire, and no transcribing costs - Enable participants to reflect on their responses - Concurrent several interviews are possible - No interviewer effects - Great difficulties in obtaining a representative sample - Can take too long, resulting in a loss of involvement and problems in completion - Missing non-verbal cues - Possible effects of impersonality in cyberspace are not currently well understood	No, this study should make sure that participants have upcycling experiences and they answer all questions.
Focus groups	- Group interview or open-ended group discussion which can be highly structured, semi-structured or unstructured - Typically extend over at least an house, possibly two or more - A highly efficient technique - Extreme views tend to be 'weeded out' - Relatively inexpensive and flexible - The number of questions covered is limited - Facilitating requires considerable expertise to manage the process - Conflicts may arise between personalities - Confidentiality problem	No, the questions to be covered are many, and the study requires individual answers rather than group discussion or group decision, as the whole PhD research is about individuals' behaviour and individual attitudes, motivations, etc. behind the behaviour. The technique also requires considerable facilitating expertise.

Appendix K. Survey data collection approaches comparison with the requirements for the second study

The following table summarises the strengths and weaknesses of different survey data collection approaches in resource factors, questionnaire issues, and data quality (based on Robson 2011, pp. 244-245), and describes the requirements for the second study to identify key factors influencing behaviour.

The comparison of approaches to survey data collection with study requirement

Aspect of survey	Postal questionnaire	Internet surveys	Face-to-face interviews	Telephone interviews	Study requirement
Resource factors					
Cost	Low	VERY LOW	High	Low/Medium	Cost should be very low as there is no funding
Length of data collection period	Long	SHORT	Medium/Long	SHORT	Data collection time should be short for the limited time
Distribution of sample	MAY BE WIDE	MAY BE WIDE	Must be clustered	MAY BE WIDE	Wide sample distribution important to have geographic representativeness
Questionnaire issues					
Length of questionnaire	Short	Short	MAY BE LONG	Medium	Medium length is desirable
Complexity of questionnaire	Must be simple	MAY BE COMPLEX	MAY BE COMPLEX	MAY BE COMPLEX	Could be complex
Complexity of questions	Simple to moderate	Simple to moderate	MAY BE COMPLEX	Short and simple	Could be moderately complex
Control of question order	Poor	Poor/Fair	VERY GOOD	VERY GOOD	Question order does not matter
User of open-ended questions	Poor	Fair/Good	GOOD	Fair	Open-ended questions are not required
Use of visual aids	Good	VERY GOOD	VERY GOOD	Not possible	Visual aids are not required
Use of personal/family records	VERY GOOD	VERY GOOD	Good	Fair	Personal or family-related demographic data collection is required
Rapport	Fair	Poor/Fair	VERY GOOD	Good	Rapport is not required
Sensitive topics	GOOD	Variable	Fair	Fair/GOOD	Sensitive topics are not included
Data quality issues					
Sampling frame bias	Usually low	Variable	LOW	LOW (with random digit dialling)	Sampling frame is based on the previous study
Response rate	Poor/Medium	Poor/Medium	Medium/VERY HIGH	Medium/High	Response rate does not matter
Response bias	Medium/High	Medium/High	LOW	LOW	Unbiased response is desirable
Control of response situation	Poor	Poor	GOOD	Fair	Response situation does not matter
Quality of recorded response	Variable	Variable	GOOD	GOOD	Quality response is desirable

Note: Grey cells are highlighted to show the approaches meeting the study requirements.

Appendix L. Selection of Hackspaces

The following table shows how the selection of Hackspaces was made on the basis of the information retrieved on 6th of May, 2014 from the UK Hackspace Foundation and each google group forum, with the criteria of accessibility and activeness.

Selection of Hackspaces based on accessibility and activeness

Area			Name	No.	Accessibility to forums	In/activeness* (number of posts)	Selection decision
England	East Midlands	Derby	Derby Makers	1	No	Inactive (13 posts)	No
		Nottingham	Nottingham Hackspace	2	Yes	Very active (2856)	Yes
		Northampton	NortHACKton	3	Yes	Active (384)	Maybe
		Leicester	Leicester Hackspace	4	Yes	Active (313)	Maybe
	East of England	Chelmsford	Chelmsford Makerspace	5	Yes	Inactive (36)	No
		Cambridge	Makespace	6	Yes	Very active (1517)	Yes
		Hitchin	Hitchin Hackspace / North Herts Makers	7	No	N/A	No
		St. Albans	Herts Hackspace	8	No	N/A	No
		Colchester	Colchester Maker Space	9	Yes	Inactive (34)	No
		Ipswitch	Ipswitch Hackspace	10	Yes	Inactive (21)	No
	Greater London		London Hackspace	11	Yes	Very active (7926)	Yes
			Deckspace	12	No	N/A	No
			South London Makerspace	13	Yes	Inactive (0)	No
	North East England	Newcastle upon Tyne	MakerSpace	14	Yes	Very active (1750)	Yes
	North West England	Liverpool	DoES Liverpool	15	Yes	Active (884)	Maybe
		Manchester	HACMan	16	Yes	Very active (1318)	Yes
			Madlab	17	No	N/A	No
		Preston	Preston Hackspace	18	Not found	N/A	No
		Chester	Chester Hackspace	19	Yes	Inactive (5)	No
		Lancaster	LuneLab Makerspace	20	No	N/A	No
	South East England	Brighton	Build Brighton Hackspace	21	Yes	Very active (2291)	Yes
		Reading	Reading Hackspace	22	Yes	Very active (1641)	Yes
		Southampton	So Make It	23	No	N/A	No
		Surrey	Surrey and Hampshire Hackspace	24	Yes	Active (449)	Maybe
	South West England	Bristol	Bristol Hackspace	25	Yes but not available	N/A	No
		Exeter	E-Space	26	Yes	Active (138)	Maybe
		Bournemouth	The Dorset Constructorium	27	Yes	Inactive (86)	No
		Penzance	Open Shed	28	No	Closing down	No
		Oxford	OxHack	29	Yes	Active (514)	Maybe
		Swindon	Swindon Hackspace	30	Yes	Active (263)	Maybe
		Birmingham	fizzPOP	31	No	N/A	No

	West Midlands	Shropshire	Shropshire Hackspace	32	Yes	Inactive (30)	No
		Newcastle-under-Lyme	Potteries Hackspace	33	Yes	Active (304)	Maybe
		Coventry	TekWizz	34	Yahoo group	Inactive (0)	No
		Malvern	Malvern Hackspace	35	No	N/A	No
	Yorkshire and the Humber	Leeds	Leeds Hackspace	36	Yes	Active (586)	Maybe
		Sheffield	Access Apace	37	No	N/A	No
		York	York Hackspace	38	Yes	Active (284)	Maybe
Northern Ireland		Belfast	Farset Labs	39	Separate	Active (186)	Maybe
Scotland		Edinburgh	Edinburgh Hacklab	40	Yes but not accessible	N/A	No
		Aberdeen	57 North Hacklab	41	No	N/A	No
		Moray Firth	The T-Exchange	42	Yes but not accessible	N/A	No
Wales		Cardiff	Hackspace Cardiff	43	Yes	Active (160)	Maybe
		Swansea	Swansea Hackspace	44	Yes but not accessible	N/A	No

Note: Grey cells are highlighted to show the workshops with high accessibility and activeness.

Appendix M. Qualitative analysis approaches and fit with the first study

The following table summarises the characteristics of different qualitative analysis approaches (and Robson 2011, p.467, based on Bryman 2012, p.582) and describes the fit with the first study on understanding behaviour and consumers.

Different qualitative analysis approaches and fit with the first study

Approach	Description	Fit with the study
Quasi-statistical approaches	- Uses word or phrase frequencies and inter-correlations as key methods of determining the relative importance of terms and concepts - Typified by content analysis	No, the study should not lose full, rich data.
Grounded theory approach	- A version of thematic coding where the codes arise from interaction with the data - Codes are based on the researcher's interpretation of the meanings or patterns in the texts - Used to develop a theory 'grounded' in the data - Can be used very prescriptively following rules laid down by founders of the approach, or as a general style of analysis using a specialised terminology for different types of coding	No, the study does not intend to develop a new theory; rather it starts with a particular theory (Triandis' theory of interpersonal behaviour).
Thematic analysis	- A generic approach not necessarily linked to a particular theoretical perspective - All or parts of the data are coded and labelled - Codes and themes in the data can be determined inductively from reviewing the data and from relevance to the research questions, previous research or theoretical considerations - Themes serve as a basis for further data analysis and interpretation - Makes substantial use of summaries of the themes, supplemented by matrices, network maps, flow charts and diagrams - Can be used on a purely descriptive or exploratory basis, or within a variety of theoretical frameworks	Yes, the study requires the analysis which is descriptive and/or exploratory within the selected theoretical framework.
Narrative analysis	- An approach sensitive to the sense of temporal sequence that people detect in their lives and surrounding episodes and inject into their accounts - Focuses on 'how do people make sense of what happened?' than 'what actually happened?' - Life history research as a prominent location for the application - Relates to the life span, accounts relating to episodes, and interconnections between them	No, the study does not focus on temporal sequence of life span or episodes; it rather requires more generic and flexible approach to analyse a wide variety of data.

Appendix N. Full quotations from interviews

The following table shows the full quotations on what kinds of materials (or components or products) they use for upcycling from 23 interviewees.

Full quotations on upcycling materials (*n*=23)

Theme (n)	Age (gender)	Participant answers
Wood and furniture (8)	Under 30 (2 Females & 2 Males)	- Female02: "pick up furniture in a car boot, even broken bits to make up new things like a coffee table that I showed you at the end of the pictures, it's actually two chairs. […] just wood stuff." - F06: "I use mostly woods, so recycling old pallets and used plywood." - Male03: "So when I did my jigsaw table I told you about. What it was that when we moved in, I've been meaning to get a coffee table for a while, and I was at the village fete, helping my parents out there they are having a barbeque every year and I had a big box to try to find interesting things, and there was a table, I brought it home and the table was a bit big so I cut the top into four jigsaw pieces and added new lags. […] mostly wood work. […] Probably that's the core of what I am doing. The table, workbench, basically woodworking projects." - M11: "all sorts of bits of wood"
	30 to 49 (1F)	F05: "Sometimes wood."
	50 and over (3Ms)	- M04: "it's mostly wood." - M10: "wood. Wooden pegs or matches. Sometimes bits of materials if I need to use it to cover things." - M12: "I normally use wood."
Anything I come across (5)	Under 30 (1F & 2Ms)	- F02: "I use anything I come across to make stuff." - M11: "anything lying around really." - M13: "just anything in my hands really. I live near garages, so they have tires and stuff. And I've taken one of those and cut it down, and get some pipe pips, and screw them up, and I use them to put it on new shoes. […]"
	30 to 49 (1F & 1M)	- F04: "I did have a plan to make a dragon. It's big like 5 to 10 foot long dragon. But I have not found a thing that will spark it to generation. I've got an umbrella, an old dead umbrella nobody can use it anymore, I've got an old hack's wrenches to use for claws, things like that, but I haven't got the one thing that will be the start but everything else will grow around. But I have all the stuff in my loft to be waiting for that time. When all these things I've picked up from the floor can come to flourish in a new life as a dragon." - M05: "all sorts of really. I sort of find myself looking at products thinking how I can make something out of it. So I use everything from bin bags, plastic bottles, state agency signs, train tickets, measuring tape, playing cards, ya, all sorts of different things."
	50 and over	NA
Metal (5)	Under 30	NA
	30 to 49 (2Fs & 1M)	- F04: "nuts and bolts, or bits of metal" - F07: "metal and wires and stuff with copper, so anything that comes along" - M09: "metal, plastics, fabrics, anything that I need to use."
	50 and over (1F & 1M)	- F08: "I use aluminium and upcycle some of previous art work." - M12: "I sometimes use metal and plastics and electronics."
Electronics (4)	Under 30 (1M)	M11: "electronics mainly, I would say"
	30 to 49 (1F)	F04: "I use printed circuit board"
	50 and over (1F & 1M)	- F08: "At the moment, I've been making jewellery for the upcoming exhibition and that is from recycled data cabling, so computer cabling and electric wiring I have a big store of that, which I acquire from the company who gave it to me about 2 years ago when I was working on my MA." - M12: "I sometimes use metal and plastics and electronics. […] I always save my electronics bits because my background is electronics engineer."
Fabric (3)	Under 30 (1F)	F02: "cushions out of t-shirts […] cushions and blankets and that kind of stuff."
	30 to 49	- F05: "mainly fabric."

	(1F & 1M)	- M09: “metal, plastics, fabrics, anything that I need to use.”
	50 and over (1F)	F03: “I work with fabric, different kind of fabric, I like a range of texture”
Packaging (3)	Under 30 (2Ms)	- M06: “I mostly use storage things […] just like the containers, boxes, shelves.” - M07: “I use a lot of paper cardboard, glue, bamboo, stuff like that.”
	30 to 49	NA
	50 and over (1F)	F03: “I saved packaging and used that.”
Anything required for the project (3)	Under 30 (2Ms)	- M03: “depends on the project, really.” - M11: “and anything lying around really. It depends on what needs to be done.”
	30 to 49 (1M)	M09: “metal, plastics, fabrics, anything that I need to use. […] there’s really no limitation to materials.”
	50 and over	NA
Plastics, glass, watches and jewellery (3)	Under 30 (1M)	M08 – waste from glass industry: “this one is cork, chemistry beaker and glass. This is like a waste from the glass industry because the bottom is not very even. They can’t sell it so these become waste. And they are from one of the biggest glass manufacturers in the world. They have like tonnes of bottles they can’t sell. They normally will melt and cast them again, but they nicely offered us, gave us some bottles with defects.”
	30 to 49 (1F)	F04 – watches and jewellery: “I use watches, and bits of old jewellery and things like that.”
	50 and over (1M)	M12 – plastics: “I sometimes use metal and plastics and electronics.”

The following table shows the full quotations on where or how to get materials for upcycling from 23 interviewees.

Full quotations on ways of acquiring materials (*n*=23)

Theme (n)	Age (gender)	Participant answers
Online shops and networks (7)	Under 30 (1 Female & 3 Males)	- Female02: “sometimes online, ebay or gumtree.com. pick up things from there… or freecycle. It’s another one. A lot of people who don’t want to sell it, just want to get rid of it, put it on freecycle.” - Male03: “so, most of the things I’ve done recently, parts came from freecycle, freegle,… freegle is… it used to be called freecycle which is much better name and is a sort of yahoo group. It’s an international loose group of organizations, so you join up for the local yahoo group and people post “I have such and such for free.” “I want such and such for free” what they want is usually hilarious. “I want a car!” “I want a computer!” ya, giving away things they don’t want anymore… that’s where I found the door for the workbench or at the fete… I don’t go there very often, but when I am helping my parents, I can find [something].” - M06: “I bought i-Mac G4 for 10 pounds from ebay. […] the piano was from freecycle for free.” - M07: “I’ve got some stuff from freecycle.”
	30 to 49 (2Ms)	- M02: “Second hand things from ebay as well sometimes.” - M09: “usually I use internet. There’s a shop online.”
	50 and over (1M)	M12: “electronics, I normally get from ebay or from Farnell [Electronic components online shop].”
Anywhere everywhere (6)	Under 30 (2Fs & 1M)	- F01: “just collecting things.” - F06: “from all kinds of places. […] I look out for stuff that are on the street like lots of people put stuff outside the houses, for people to collect. So I’ve got a lot of stuff from there, like neighbours leaving things out and I am walking passed, and picking up things useful. I am looking at skips and those places where the buildings are renovated.” - M13: “just like wherever someone has thrown away really. I’ve never really found a lot near home actually because it’s suburban area. But here in city, if you go to back alleys, then people just throw everything away.”

	30 to 49 (2Fs & 1M)	- F04: "wherever I go, I am always keeping my eyes on the floor, because there's all sort of things you find, people have just lost or disregarded. I found [showing things to the interviewer] that old nuts and bolts and that piece of plastic thing, just on the ground while I was walking two days ago. And I just pick things up and collect them." - F05: "either it's stuff lying around, maybe my housemate, she just bought and doesn't want it anymore, or like… I don't know… various places like… I don't think I ever pull something out of the garbage can but I would if I saw something that was good enough…" - M02: "Anywhere everywhere really."
	50 and over	NA
Skips (6)	Under 30 (1F & 1M)	- F06: "I am looking at skips" - M13: "And there's a dump out of the street. I found even a humidifier. I mean a good one. You know, big one with a refrigeration and heat pumps."
	30 to 49 (3Ms)	- M02: "I also used to work at the university and the things like… things been thrown away, what they consider it as waste from the project, I would go through the skips and find things there. And they are brilliant. Some stuff are amazing. So yes, the materials that are being… before moving out of the space, the materials are all over." - M05: "some of them are freely available for the… for example, I found state agency signs from the skips, sort of bins around the town, where just people discard them." - M09: "those are from the street, from the bins, from the skips […] I know it sounds weird, but I look inside the bins and especially when there is construction, I look inside the skips, trying to see if there is any material I can reuse. and sometimes those materials look useful and I just take them."
	50 and over (1M)	M04: "I get them from skips usually. I quite often also collect things from people who get rid of them."
Broken or unused items (4)	Under 30 (3Ms)	- M06: "they are just rubbish. They are just free. I just use… my own consumables." - M07: "it's probably just excess on stuff that I may have bought for another purpose." - M11: "something I have already."
	30 to 49	NA
	50 and over (1M)	M04: "some of the things, the child swing is actually something we had it in our garden, but it had fallen apart. And I used the steel poles for that."
Charity shops and other local shops (4)	Under 30 (1F & 1M)	- F01 – charity shops: "charity shops" - M03 – charity shops: "Charity shops occasionally."
	30 to 49 (1F & 1M)	- F05 – local shops: "sometimes the offcut from the fabric shops. The cutoff edge of the curtain or something. And they say… you know they try to sell it, but nobody buys then they throw away. So before that happens I will buy it for a pound." - M05 – local shops: "Other ones like… lamp shades out of plastic bottles and the local café, one of the waitresses very kindly stored them for me and gave me a big plastic bag full of them."
	50 and over	NA
Given by people (3)	Under 30 (2Ms)	- M07: "if someone has something that they are obviously not using and they don't want, and I see some potential in it then I will ask them if they want to get rid of it." - M11: "other stuff… where I get originally is being donated by somebody"
	30 to 49	NA
	50 and over (1F)	F08: "some are given to me."
Car boot sales (3)	Under 30 (2Fs)	- F01: "car boot sales […] mainly, we go to car boot sales" - F02: "sometimes in the car boot sales"
	30 to 49 (1M)	M02: "so, big source of my materials are carboot sales. […] But probably the carboot sales are the main supplier of second hand parts. Carboot sales and hackspace."
	50 and over	NA
Building site (2)	Under 30 (1F & 1M)	- F06: "those places where the buildings are renovated."

		- M03: "And… in future, not yet, I plan to be going around and sort of looking at building sites and asking "do you need that wooden pallets?" but I don't really have a space to do that at the moment."
	30 to 49	NA
	50 and over	NA
Hackspace, local factory, recycling centre (3)	Under 30 (1F & 1M)	- F06 – recycling centre: "There's a place called 'Brighton wood recycling centre' that sells used woods for cheap. And I get any particular sizes of woods I need from there. And they are really good prices." - M08 – local factory: "this one is cork, chemistry beaker and glass. This is like a waste from the glass industry because the bottom is not very even. They can't sell it so these become waste. And they are from one of the biggest glass manufacturers in the world. They have like tonnes of bottles they can't sell. They normally will melt and cast them again, but they nicely offered us, gave us some bottles with defects. […] we contacted the glass manufacturer. And the cork, we contacted the biggest cork manufacturer. We've got some of the parts in this space [shared, community workshop garage], so we've got basic parts here."
	30 to 49 (1M)	M02: "Hackspace, donations to hackspace. […] But probably the carboot sales are the main supplier of second hand parts. Carboot sales and hackspace."
	50 and over	NA

The following table shows the full quotations on why to choose particular materials for upcycling from 23 interviewees.

Full quotations on material selection criteria (*n*=23)

Theme (n)	Age (gender)	Participant answers
Project requirement (8)	Under 30 (1 Female & 3 Males)	- Female06: "I try to be quite strict about not just picking up stuff that I don't need for the particular projects. Because everything needed for my projects is on the hallway of my flat, and my partner is annoyed by keeping stuff like that. So I picked up something recently from the neighbour's house, and that was like old flooring, because I wanted to turn that into a workbench. And it's like quite thin and quite strong." - Male03: "What specific thing that I am looking after. The tables, I was looking for a coffee table and I found a coffee table and I thought I could do and it turned out to be big so I adapted it. The workbench I was waiting for three months to find the right bit of material on the freecycle." - M07: "it's almost entirely functional. I don't usually tend to think much about how things look. It's more what fits the structure and it has the kind of mechanical properties. I guess the bamboo lamp, I chose it because it's attractive material I like. But ultimately, it's just something I had it in my hands and it fitted the purpose I wanted. With more effort I could make it better but, my materials choice is usually driven by functions." - M11: "It depends on what kind of thing it is. For example, we've got that old CRT monitor that we want to make it into our arcade machine. So we pretty much built the whole thing around that. So, we did have to get the material, wood and so on, to fabricate around it. So, that's the kind of thing we are talking."
	30 to 49 (1F & 1M)	- F05: "it has to be applicable for the goal. So I look at the goal, what do I need?" - M09: "not particularly. The criteria will be like depending on what I want to build. […] and depending on what the material will be used for. […] it's purely case-by-case based."
	50 and over (1F & 1M)	- F08: "obviously a lot depends on what I have in stock and what I am aiming to do with the materials at any one time." - M12 "when you are choosing electronic components, you choose the components that are appropriate for the job. Each electronic component has got its own set of characteristics so if you are designing something you sort of are roaming through your box of bits and find the most appropriate things. You know things fit with any range values that

		will handle the amount of power, will handle voltage, things like that. […] it really comes down to when you are reusing the piece of wood. What the wood is going to be useful for, whether it requires the soft wood or hard wood. […] So, depending on what you are doing, whether it is a shelf that you want it to look nice, or whether a shelf in a garage you don't care what it looks like, or a shelf in home, you obviously want it to look nice."
Potential value (5)	Under 30 (1F & 2Ms)	- F01: "Or I sometimes see the potential in things that it might be in a bit stated or a bit of over repaired. (2:53) I can see the potential in it. And yeah, go for it." - M11: "sometimes… you might see something and that would give you an idea. So, perhaps something that is somewhat inspiring? That might be the criteria. […] Or something that might have function." - M13: "Value is other thing. I knew a refrigerator, I lifted it up to see if it's heavy, because you can tell the type of unit, if it's heavy, then there's refrigerator, that kind of system costs you some hundred pounds to buy. That's a lot of money. […] I see things, compressor, electronics, and I see if it's repairable, is it something that I can pick up and repair? Is it something I can pick up and strip outside off? is it smashed into pieces yet? […] so I see, quality, value, and can I clean it? Is it recoverable?"
	30 to 49 (2Fs)	- F05: "And I don't take crap. Sometimes I will go to my way a little bit. I will use lower quality stuff than I normally would if I can fix the quality gap by working on it more?" - F07: "I found these (metallic button-shape screws) from an old lamp, and I found them very beautiful, I keep them, and I will use them some way. So anything like that, this is how I see and mentally visualise use examples, then I take it and use it for that purpose."
	50 and over	NA
Financial saving (4)	Under 30 (1F & 2Ms)	- F01: "we go to car boot sales simply because we're moving a house, we don't have a lot of money for furniture, so we are just going to car boot sales and picking things up for a pound and just making things our own really." - M03: "Mostly I tend to find something cheap or free or second hand and build on to it with new materials." - M11: "it's usually price-led. So, I am not going to, if I am upcycling, whole point is to make something, repurpose it, I don't want to cost too much, so it would be price-led really."
	30 to 49 (1M)	M09: "sometimes you've got something in your head, and you don't want to go to the shops, or don't have money for it, then you are looking into a bin for particular items. And that can be a piece of MDF, or old copper tubes, or whatever you want to build something with. It can be like an electronic component. You get an old computer and just extract a fan for a project, something like that."
	50 and over	NA
High quality (4)	Under 30 (1F & 1M)	- F02: "I prefer to use things that are solid wood. So I don't tend to pick up anything that's sort of veneered, so anything that's made of cheap board or MDF (medium-density fibreboard) that's got like pretended on the top, so I use it, I just prefer to use anything that's solid which means I can sand it down and paper tape it? Properly. That's it, really." - M13: "obviously I check the quality. […] I take it for quality. If the wood is rotten, mould, then I can't clean up. I can dehumidify it."
	30 to 49	NA
	50 and over (1F & 1M)	- F03: "I had a very expensive dress which was given to me by a friend. It didn't fit me. It was velvet. The fabric was nice but the design was bad. [..] the decisions are to do with colour, texture, or the person who wants that." - M04: "it has got to be clean, it's got to be reasonable size, and in good condition."
No criteria (4)	Under 30	NA
	30 to 49 (1F & 1M)	- F04 – collect things not knowing where to use: "I would never know when I am going to need it or what it might be useful for. So, I collect them with the intention of one day making something with them. But I

		know what I want to make when I know what I want to make. I will have all the bits then hopefully." - M02 – start with materials, not the other way around (+ given to me): "I think more of my projects are defined by the materials I have rather than choosing materials for the projects. So solar power charger for example, I was given maybe 15 small solar panels and I needed to use them. I have them, and I don't want them to go to the waste. So I was thinking what can I do, what I can make that I use these and also what other people would like. So I did it as kits so that other people can make as well at the hackspace. So more of my process has got this thing: what can I make out of it rather than the other way round."
	50 and over (1F & 1M)	- F03 – given to me: "I had a very expensive dress which was given to me by a friend." - M10 – just trying to do varied range of things: "not really. I just try to do varied range of things from a rocking chair to a little bench, little garden benches, and tables. I do quite a range of things. […]"
Something I like (3)	Under 30 (1F & 1M)	- F01: "It's just something that I like. Because I am a creative person. I kind of see things I like." - M03: "mostly I kind of look at things on a… I guess I find things on an individual basis. I look at something… it's what catches my eyes"
	30 to 49 (1F)	F07: "I just like pretty things. smallest things really."
	50 and over	NA
Easy to handle (2)	Under 30 (1F & 1M)	- F02: "I tend to use wood because it's easily paintable. And I can make it into something completely different. Easy to saw, easy to stick, easy to turn into anything that I want really." - M06: "something that I can use without many tools. Something like cardboard or plastic because it's so easy to cut and so easy to fix."
	30 to 49	NA
	50 and over	NA
Miscellaneous (3)	Under 30	NA
	30 to 49	NA
	50 and over (2Fs & 1M)	- F03 – depends on the person who wants it: "the decisions are to do with colour, texture, or the person who wants that." - F08 – depends on what I have: "obviously a lot depends on what I have in stock" - F08 – unrecyclable: "I guess I pick up the things which are generally not recyclable with the exception of aluminium and copper which clearly are." - M04 – relatively unused: "for most purposes, it has to be relatively unused. Builders, they buy big piece of sheet of plywood and then they cut the big bit off and then the rest of it might be 2 feet wide, could be quite long, but they actually can't use that because it's too small to make any use out of. So they throw it to the skip. As long as it's not covered with rubbish, then I would take it, if I can find it."

The following table shows the full quotations on what to do with the end products after upcycling from 23 interviewees.

Full quotations on what to do with the end products after upcycling (*n*=23)

Theme (n)	Age (gender)	Participant answers
Use for home or myself (15)	Under 30 (3 Females & 5 Males)	- Female01: "we save them for in our house. So, at the moment, we kind of upcycle them we leave them in our garage and will go into our home." - F02: "a lot are in my house. So I usually pick up stuff that we tend to need" - F06: "all pretty much functional stuff. Coz I made like furniture, and storage and stuff like that. So yes, kind of stuff that I can put it in my flat for particular purpose." - Male01: "okay, so, the trellising is the… it goes on the fence […] And the patio, obviously is for dining in the summer." - M06: "they are not good enough to give to someone. They are primarily for my own use."

		- M07: “these are all for my own usage.” - M11: “and our arcade machine for example that is sort of attraction for this space here. Sort of a piece of central piece. Equally, if you did that kind of thing at home, then just for fun, I suppose. Just entertainment, I think for other times. A friend of mine, he recently got an old stereo system like 1950s one, and took all the bits out of it and redid that with using Raspberry pi and now it’s streaming radio system. So, it’s that kind of thing. At the end, you might not necessarily have a purpose for it, but it looks good and it has sort of feature you would want to see in your home or vehicle or whatever.” - M13: “everything I do is… because of attention deficit, I have a real trouble in finishing things, so I always felt like my stuff is not really good enough to give to someone else. […] I never really thought about giving it to someone really.”
	30 to 49 (2Fs & 2Ms)	- F04: “the printed circuit board stuff, I kept some, two of the biggest projects for us.” - F05: “most of my projects are for myself so far.” - M02: “things have been done either for myself or for people I know.” - M09: “I usually use them inside of my house, I use them inside of my workshop, I use them in my day to day life. If I don’t use it, then give it to someone or put it back into a bin? Or kick it on the side and try to use some of the parts of it.”
	50 and over (1F & 2Ms)	- F03: “sometimes it’s practical stuff. I built a fence from the old fence wood materials from neighbours.” - M04: “I use it myself, most often I use it myself.” - M12: “sometimes I make pieces of furniture for myself. I have at home some lovely Parana pine and it’s very scarce these days. If you look at this wood, it’s big, thick, long and very heavy, and very strong. And I’ve been carrying this about for 20 years, because I won’t throw it away. It’s too good. And I am going to make some cabinets for my Hi-Fi for music and television and things like that. So, I hope to get into that project in the next year or two now. So I save this wood, very precious, it’s very nice wood. It was a bed that I made years ago because I wanted a bed to fit in a particular room, particular corner of the room.”
Give to family or friends (8)	Under 30 (1F & 1M)	- F02: “anything that I decide I don’t want then send it to family or friends and I do that a lot.” - M13: “I do jobs for other people. I repair computers and laptops. I recycle stuff for that, like sound card.”
	30 to 49 (2Fs & 1M)	- F04: “I’ve given some pieces to friends. We made a piece for a couple when they got married.” - F05: “I would give something to somebody if I thought it is relevant for them.” - M02: “things have been done either for myself or for people I know.”
	50 and over (2Fs & 1M)	- F03: “prom dress was for my daughter.” - F08: “the items that I have been making with the data cabling are bangles and bracelets and I am going to sell them for the first time. And I’ve shown, and given a couple to people as a birthday present.” - M04: “I usually give it away.”
Sell to others (7)	Under 30 (1F & 2Ms)	- F01: “So I made a lot of cushions with them and little bunting, and bags, handbags, little purses and stuff. And those things I actually do sell. Do quite a lot of craft shows around Christmas time. Christmas decoration and things. and I’ve also got a folksy account. Folksy is like a craft-based website where you can sell your own. It’s same as etsy. But it’s just based in the UK. And I sell all my craft bit on there as well.” - M07: “I have been wondering about making things for the purpose of selling them because you know, a couple of times, people have seen the things I’ve made, and then they said, oh, you could sell these on Etsy or whatever. And really that’s just I haven’t put an effort to investigate how feasible it is.” - M08: “at the beginning of the project, our aim was to start production here, but we faced some legal issues, like selling the products, because we can’t trust the parts, it’s like products go to the recycling centre, such as broken kettles, and broken toasters, and we disassembled them, we can’t trust

		them. And we can't say where it comes from. So if we sell it to somebody, like the kettle, then we are responsible for all the safety issues because we can't say that these parts are from so and so manufacturers. This is a big problem for this project."
	30 to 49 (2Fs)	- F04: "I do sell my upcycled jewellery. […] I use etsy, and I go to certain craft fairs around about." - F05: "I do have an etsy shop. But I haven't sold stuff there yet."
	50 and over (1F & 1M)	- F08: "the items that I have been making with the data cabling are bangles and bracelets and I am going to sell them for the first time." - M10: "I only sold the bowls at the moment. I am not selling the rocky chairs at the moment. If I can find a market for it in this place, I will try do it."
For a faire, exhibition or performance (3)	Under 30 (2Ms)	- M08: "we haven't sold anything. We did many exhibitions with this kind of project but we didn't sell them. And we decided to stop the project for our financial issues." - M11: "our arcade machine for example that is sort of attraction for this space here. Sort of a piece of central piece."
	30 to 49	NA
	50 and over (1F)	F03: "Black box was for the maker faire in Newcastle. […] I did performance once."
Just for fun (2)	Under 30 (2Ms)	- M11: "and our arcade machine for example that is sort of attraction for this space here. Sort of a piece of central piece. Equally, if you did that kind of thing at home, then just for fun, I suppose. Just entertainment, I think for other times." - M13: "ya, I usually do things for sort of pleasure in doing it. […] I do it as a hobby, for fun, I do it as I like it. I mean, I did IT support, and I've always been fixing things and making things. And that was all about fixing things and problem solving. And that's all about engineering, it's a problem solving."
	30 to 49	NA
	50 and over	NA
Part of degree project (1)	Under 30 (1M)	M01: "The raspberry pi project, that's electronics project, umm, it's a prototype for some running some computer software that I am trying to write as part of my degree."
	30 to 49	NA
	50 and over	NA

The following table shows the full quotations on when to upcycle items from 23 interviewees.

Full quotations on usually when to upcycle (*n*=23)

Theme (n)	Age (gender)	Participant answers
Anytime that suits me (11)	Under 30 (1 Female & 4 Males)	- Female06: "I work full time. So I do it at weekends. Generally during the summer. I don't have much space to work in my flat, so I do it outside the garden, more like at the patio. So I don't get a lot done during the winter really." - Male03: "usually at the weekends I guess because I work full time. That really depends on what I am doing and when I am doing. It depends on what I doing at the time being." - M06: "if I feel like I have the chunk of time, a block of time, and there is no distractions, then I can dedicate my efforts into tinkering, into doing something. If I know that I have something other more important, then I am not even starting, because if I have a little time before I open the computer, before I open the browser, before I open the previous notes, it's just taking too much time. So I know that I need to have an allocated chunk of time with no distraction. Only then I can start working. […] it's on weekends." - M07: "whenever I have free time, really. So, historically, it's mostly weekday evening because weekends are, well I have time to go and socialize. Weekday evening often I find something I do to keep myself entertained, I make things for the fun of making things as much as for what it is I end up with. It's more productive than watching TV it seems."

		- M11: "just when I get spare time."
	30 to 49 (2Fs & 2Ms)	- F05: "it's when I can just find around my work." - F07: "during week days." - M05: "I work when I am able. I am sort of juggling a family life and so forth." - M09: "I usually work in the evening. Mostly after work or weekends."
	50 and over (2Ms)	- M04: "any day that suits me really. Coz I am retired, so I can work during the week. Usually I am busier with the family at weekends. So it's the other way around for me. It's usually weekdays when I am working on things. […] probably more in the afternoon." - M10: "when I can, coz I am working in the shop. So it totally depends on when I can get to do something. Probably about a couple of days a week to do it. In the evening after the work."
All the time (3)	Under 30 (2Ms)	- M03: "It's something that I've always kind of been used to doing I guess, from my parents kind of told me to be using recycle [reuse, refurbish] as much as possible, and I kind of always have." - M13: "I am thinking about it every day."
	30 to 49	NA
	50 and over (1F)	F03: "I realised that I've done it thorough all my life. So it is not specific thing I set time to do, it's I need something, want something, have urge to make something, my first thing is… do I have anything here I can use around me? Building whatever it is. So, it's kind of, I guess I do it all the time. Even when I am cooking, I take something that's left over, and turn it into something else."
When responding to a particular event (2)	Under 30	NA
	30 to 49	NA
	50 and over (2Fs)	- F03: "One was in response to a particular event, by curiosity club team, so we've done something outside, and respond to that was how can we make it to the maker faire. So that was the challenge. So that's where we started internal dialogues and dialogues with other people to talk about what I can do for it. And then I made a box, the box was constructed out of plastic I saved from work." - F08: "actually doing the work itself it depends on what events are coming up such as exhibitions."
When I am triggered, I feel like it, or there is need (5)	Under 30 (1M)	M03 – when triggered by the wanted materials: "some cases it's what I have been meaning to do for ages and I managed to get the materials […] I think it's mostly finding the materials. It's… I don't often go out and buy new bits and pieces. But when I find something that I want to do something, "ohh, have that!" so, that has been the driver for the last a couple."
	30 to 49 (1F & 2Ms)	- F04 – when I feel like it: "whenever I feel in the mood for it. It's definitely hobby rather than anything else. So it's just when I got time, and I feel like it. […] because it's quite random when I do it. I don't have any particular time that I spend on it." - M02 – when I feel like it: "I am self-employed. So I don't have anyone telling me exactly what to do. So, when I am interested in something, I will just do it. And it doesn't matter; there's no set time when I have to do these." - M03 – when there is need: "Some cases, it's need"
	50 and over (1M)	M12 – when I feel like it: "I am retired, so I do it anytime. Sometimes 2-3 o'clock in the morning if there isn't any loud work or noise involved with machines or things like that."

The following table shows the full quotations on how often they upcycle items from 23 interviewees.

Full quotations on frequency of upcycling (n=23)

Theme (n)	Age (gender)	Participant answers
Depends on the project (7)	Under 30 (2 Females & 2 Males)	- Female01: "depends on what craft projects I am doing. Because I've been doing craft, knitting, crochet, sewing, and it depends on what project is, sometimes I upcycle things, and sometimes I buy things new." - F02: "depends on I've got in really. If I find something that I like, I work on it until it's finished, and it would be so over lunch or any evenings, or if I just need a break. Sometimes I have more than one thing at the same time, and

		sometimes I don't do anything for a couple of weeks and I pick up something new. I won't pick up anything I don't like. So if I don't see anything, I won't, I won't do." - Male01: "in terms of the raspberry pi thing, electronics, that's taking a long, long time, a year or so. In terms of things to do with woodwork, it's very quick coz it's easy. It's hard to make mistakes, if you are with something like electronics. […] So, it's completely different: electronics takes long time; woodwork takes not very long at all." - M03: "It's one of those things I generally get into it and finish it and then not do anything for a while and then pick up something else and finish it and then move on. So it's in fits and starts rather than every weekend type of thing."
	30 to 49 (1F & 1M)	- F04: "Probably a couple of times a week, for an hour or so. I tend to have a specific project that I do that I spend longer on over a shorter space of time. If I have got a project, I will spend hours a day for a week or so. But if I haven't got a project on the go, I might not touch for days on it." - M05: "It really varies. […] it varies so much. Well, the majority of my work is admin and correspond to projects. The actual making has been about maybe 10% of my work? And I sort of work more or less 40 hours a week. […] when I am really intense in making, I was working for 2 weeks non-stop making. When I got my drawing machine, I just demonstrated machine, non-stop for a period of days."
	50 and over (1F)	F08: "depends on what I am actually making. I realized when I was preparing my display for the next week library exhibition, I haven't got very many of the wider bangles and I thought I must make some more because I know that they are already sold really because people have shown their interest in them. But I only have limited amount of time. So I started yesterday to cut up some more of wires […] I tend to work over 2-3 weeks depends on what time I have in between doing the other things that I am doing."
All the time (4)	Under 30 (1M)	M13: "it was definitely 2-3 days a week, when I was studying. I was always working on something. Whether it's upcycling or based on something new. Now I am working, I have less time to actually work on projects […] Maybe 1.5 hours a day… maybe about 4.5 hours a week?"
	30 to 49 (2Ms)	- M02: "It's kind of… I don't know, all the time? So, I go to the Hackspace, at least one probably two nights a week, and probably one day in a weekend, every month. So, it's something like that. So one day, maybe, two or three days a week for a certain amount of time." - M09: "you can count 80% of every evening during the week. […] They will be probably 4 days a week. Sometimes, at least one of the two days of the weekends."
	50 and over (1M)	M12: "4-5 days a week? 4-6 hours a day. So maybe I say 30 hours a week, something like that."
Spread over a long time period (2)	Under 30 (1F)	F05: "not often a lot. They tend to be spread out through a very long period of time. It's mostly a hobby. So, it's kind of… I do want to make something, then I start looking out for materials I can use for, and I usually gather those over a few months, and then kind of do the work in fits and starts. If I've got a day for a weekend, I spend a day working on it. Or, spend a couple of hours in the evening, but it's usually spread out… like not particularly organized... It's pretty much always ongoing but not that frequent."
	30 to 49	NA
	50 and over (1F)	F03: "I probably spend four full days actually taping and measuring and testing. If I just sat down to do it, it probably takes about a week. The dress, for example, a month, but it was because I do something and I sit back and think 'what do I do next? Should I do this or that?' I have to find another fabric. So that took me about six months. But it's not every day. It's interwoven into my life."
Depends on the job situation (1)	Under 30	NA
	30 to 49 (1F)	F05: "It depends on how my work is going. If I have no contracts, then I have been here up to 5 days a week for probably… up to 9 hours each day. If I do have work maybe once or twice a month for 5 to 7 hours each. It's, you know, unless you can be paid for, it's hard to justify, what am I doing? Playing with like rubbish?"
	50 and over	NA
Once a week to	Under 30 (1F & 3Ms)	- M06 – once a week: "once a week? 2 hours a day? It is relaxing."

once a year (5)		- F01 – once a month: "usually one project every month? But at the moment, probably about three projects a week." - M11 – once every three months: "I'd say at least one every three months. I would say that. Over the year, a couple of every other six months. Not massive amount but depends on what scale we are talking. They are perhaps bigger projects… but some are bits and bobs." - M07 – once a year: "Looking at this list, it's about one a year. These are the best kind of examples I am thinking of. One or two more, given that the first one was in 2007. It seems to be about one a year."
	30 to 49	NA
	50 and over (1M)	M04 – twice a year: "well, probably not that often. I mean I would think probably I do about 2 things this year, perhaps."

The following table shows the full quotations on where to upcycle items from 23 interviewees.

Full quotations on usually where to upcycle (*n*=23)

Theme (n)	Age (gender)	Participant answers
At home (not specified) (7)	Under 30 (4 Males)	- Male06: "I have all the equipment. I am able to make all times. And I have a workspace. And everything is within my reach." - M07: "I've been making things since before Makespace existed. So mostly I just do it at home with kind of whatever tools I have." - M11: "either at home" - M13: "it's usually at home."
	30 to 49 (1F & 1M)	- Female05: "for a long time, I used to do that at home, when I had a flat that I was sharing" - M05: "at home"
	50 and over (1M)	M12: "inside my house."
Hackspace or Makerspace (6)	Under 30 (4Ms)	- M01: "Almost always, either in Hackspace, here, because of all the tools are here […] for the past about a year, so I probably come here maybe twice a month? Not very often. I live about an hour's drive from here so commute to come here so I am not here every day like a lot of people." - M03: "I do some stuff down in the Hackspace." - M07: "So, until the Makespace existed, it was my home. And it still is to an extent, I still do kind of simple stuff that won't generate much mess at home. But when I am working on something more involved I tend to be here especially just because of the access to tools, the stuff like lathe and cutters, they are incredibly useful." - M11: "in Hackspace."
	30 to 49 (1F)	F05: "So now, I use Hackspace, because now I have a room instead of a flat. So the less room I have, the more I work at the Hackspace."
	50 and over (1M)	M12: "here at Hackspace."
Bedroom, dining room, living room, office room or workshop room at home (5)	Under 30	NA
	30 to 49 (1F & 2Ms)	- F04 – living room: "my living room." - M03 – office room: "my office when I do stuff indoors. And the office used to be a bedroom and I keep all my tools in the clothes cupboard because the shed is less secure." - M09 – workshop room: "It's inside of my house. I got a little room that can be used as a bedroom and I converted it into a workshop."
	50 and over (1F & 1M)	- F03 – dining room: "Sometimes I do it in my dining room." - M10 – bedroom: "I do have in my bedroom."
Shed or garage (6)	Under 30 (2Ms)	- M01: "or at home in my garage, coz it has got a work bench, so either that." - M03: "I have a little shed in the back garden."
	30 to 49	NA
	50 and over (2Fs & 2Ms)	- F03: "I have a shed […] and I have sewing machine, table, and bed. I have equipment so that I can play music and video or play videos or DVDs." - F08: "I do have a studio in the garden in my home. I store all my materials there."

		- M04: "I have a workshop because our house has a built-in garage, but we don't keep the car in the garage, we just use it as a workshop." - M12: "in my garage"
Studio or workshop (outside home) (3)	Under 30 (1M)	M08: "yes. This is our workshop in London and we have another in Paris. My associate lives in Paris and I live in London. So, he comes here or I go to Paris or we work through Skype."
	30 to 49 (1F & 1M)	- F07: "yes, my sometimes workshop." - M05: "at my studio […] I really like it when I am doing it in my studio where I have my tools and sort of things."
	50 and over	NA
Patio (2)	Under 30 (1F)	F06: "I don't have much space to work in my flat, so I do it outside the garden, more like at the patio. So I don't get a lot done during the winter really."
	30 to 49	NA
	50 and over (1F)	F03: "Sometimes I do it in my patio, under sunlight, it's bright and warm."

The following table shows the full quotations on with whom to upcycle items on what occasions from 23 interviewees.

Full quotations on with whom to upcycle (*n*=23)

Theme (n)	Age (gender)	Participant answers
Just myself (17)	Under 30 (6 Males)	- Male01: "always by myself, coz it's sort of… none of my family or friends are kind of interested in that kind of thing." - M03: "mostly, in terms of actually physically doing things, I am doing it on my own." - M06: "I am doing this primarily on my own. I wish I could have someone close to me who is sharing similar interest but it's very difficult to find people with similar interest. Of course, I am on the London Hackspace mailing list and Cambridge Makespace mailing list. But they are busy, they have their own schedules, and it's very difficult to coordinate and find a suitable date." - M07: "most of the actual making is by myself. And a number of the projects I have made have been inspired by stuff other people have done. And I got a lot of ideas from reading stuff I found on instructables and various blogs." - M11: "has been traditionally more by myself. And now I get involved in this Hackspace, I do a lot more with other people, groups of people, getting involved in doing things together." - M13: "it's usually me. I'd love to work with someone who is more experienced in electronics. […] I've always been a hacker, I've always been putting things together. So I've always been looking on the websites or forums."
	30 to 49 (3Fs & 3Ms)	- Female04: "nobody else. Just me and him [husband] pretty much." - F05: "by myself. I try to involve people but it doesn't usually work." - F07: "I work on my own." - M02: "Generally, I am probably most productive when I am on my own." - M05: "traditionally, on my own" - M09: "yes, just by myself."
	50 and over (2Fs & 3Ms)	- F03: "I often do it myself." - F08: "it tends to be just me." - M04: "mostly by myself." - M10: "I do all by myself which I like. Nobody can interfere with me or tell me what to do." - M12: "if I am home, I work on my own, if I am here at Hackspace, I work with whoever else is around. It depends what the project is and how many people are required."
Local experts (6)	Under 30 (2Ms)	- M03: "There are a couple of things that I consulted with people about or ask questions about. […] people at the Hackspace and people on the internet." - M11: "now I get involved in this Hackspace, I do a lot more with other people, groups of people, getting involved in doing things together."
	30 to 49 (2Ms)	- M02: "Generally, I am probably most productive when I am on my own. But it's… I learn a lot from other people, and I ask people for help on things, and

		people give me help. Sometimes I help other people. […] generally I work on my own. But I use a lot of other people's resources." - M05: "but the project done more recently I had my assistants. So I work with fabric artists for a couple of years to do sort of fabric projects, and also […] end of last year, I brought some assistants making a big Christmas structure. […] I get volunteers to help build things. It's like passing on skills, getting people involved in making process, which I enjoy."
	50 and over (1F & 1M)	- F08: "Occasionally if I need to do something much more constructional which I don't have the ability to do myself then I will seek out local artist or craft person to be in partnership with me." - M12: "if I am here at Hackspace, I work with whoever else is around. It depends what the project is and how many people are required."
A partner (3)	Under 30 (2Fs)	- F01: "with my boyfriend." - F06: "my partner works on projects as well. We don't do a project together but we both work on anything at the same time really."
	30 to 49 (1F)	F04: "nobody else. Just me and him [husband] pretty much. […] He is very good at spotting what will look right in different places on the panel, but it was my original idea and I have a lot of input into, I collect all the stuff, I get the ideas on what I want to make, he helps me make them and make them as nice as possible. I love it, it's nice to do things together."
	50 and over	NA
Other family members (2)	Under 30 (1M)	M03 – father: "people at the Hackspace and people on the internet. Mostly. Occasionally my dad [that I am asking for consultation]. He has done a lot of things himself."
	30 to 49	NA
	50 and over (1M)	M04 – daughter: "Yes. Occasionally, I do things with my daughter. I've got one daughter who lives with us and other daughter who lives quite close by. So, I do that with them sometimes."
Expert friends (2)	Under 30 (1M)	M08: "I initiated by myself but then we [me and my friend] worked together."
	30 to 49	NA
	50 and over (1F)	F03: "if I hit something and I need something really precise and I have a good friend very good at wood working and she helps me to make a frame to mount 6 ipods."
People online (2)	Under 30 (2Ms)	- M03: "[responding to the question, "What kind of people did you consult?"] People at the Hackspace and people on the internet. Occasionally my dad. He has done a lot of things himself." - M07: "A couple of things I had, sort of active discussions with people who have more experience than me. Where there is any information that I was lacking, I would talk to people mostly online who knew what they are doing."
	30 to 49	NA
	50 and over	NA
Depends on the project (2)	Under 30	NA
	30 to 49 (1M)	M02: "totally depends on the project."
	50 and over (1F)	F03: "It depends on what I am doing."

The following table shows the full quotations on 'economic benefit' as one of the perceived benefits of upcycling from 14 interviewees (out of 23).

Full quotations on 'economic benefit' as one of the perceived benefits of upcycling (*n*=14)

Age (gender)	Participant answers
Under 30 (3 Females & 5 Males)	- Female01: "I think at the moment, it's the cheapest option for us to get furniture and things for a home. […] It's the cheapest way for us to furnish our house, but still have something that's nice. […] Because I can't afford things from John Lewis or whatever, I kind of want to make something nice but not spend all the money." - F02: "I don't earn a lot of money, so it's nice to pick something up, so five pounds, and make it look like something which is worth 65 pounds by painting it really nicely." - F06: "You don't really need to pay a lot of money for someone else to do something for you. You can do it yourself."

	- Male01: "The garden trellis and plant things are… (for) cost? We've had some fence put in the garden, and it's lots of bits of wood leftover and to buy one would cost the money but if it's there for free, then, you want to do it anyway." - M03: "It's cheap or free. So you can save a lot of money by repairing or recycling things." - M06: "It saves a lot of cost. The cost is low. […] It has some commercial potential if I am very successful with the project, then there's an opportunity to market it and sell with profit." - M07: "I started doing it primarily because of the cost and convenience because often I find I can improvise materials for something when you could buy a material that is quite simpler and it's quite a bit more expensive. And I can find often something may be for different purpose but a lot cheaper, but it still does what it is I want to do. And at the same time, it's also true that the things that you have are effectively free." - M13: "(upcycling is for) spending less money."
30 to 49 (2Fs & 1Ms)	- F04: "I can sit and make things some people like to buy." - F05: "It's like, first of all, you pay less money. […] maybe you need to do something you can buy it. You have money for it. But you are not really sure like 'Do I need A, B, or C? What are the qualities of the things I need to buy?' Like you don't really know what you are doing. You need to have like… test run on some junk version first?" - M09: "(upcycling is for) just saving your money. […] People don't try to make their life harder. […] the interest means you want something and you don't have money but you still want it so you try to find alternative way of getting it. And for you actually being able to have what you want is cooler than not having it even if it's like from bins and you had to make it by yourself."
50 and over (1F & 2Ms)	- F03: "When I was teaching with a very small budget, and you could buy a screen or make one which is much cheaper." - M10: "If you throw away an old dress or an old shirt, use it for a cover or make a pillow case, make it covers for something or armrest things. […] If you make things, they are going to be cheaper (than buying a new one)." - M12: "It will save people's pockets."

The following table shows the full quotations on 'environmental benefit' as one of the perceived benefits of upcycling from 13 interviewees (out of 23).

Full quotations on 'environmental benefit' as one of the perceived benefits of upcycling (*n*=13)

Age (gender)	Participant answers
Under 30 (5 Males)	- Male01: "Things are not being in landfill. That's the big one. […] I think not throwing things away… is a good enough reason." - M03: "It's really about reusing what you have instead of throwing away and getting a new one. I live in consumer culture and I throw things away and get new ones occasionally. But I quite like to be able to get something second-hand and something somebody else has thrown away because they didn't want it anymore, and make use of it." - M06: "It's also very environmentally friendly. […] It saves environment." - M07: "I suppose there's environmental benefit in that. Reuse is more ecological use of material. […] It saves materials. […] I see kind of creativity and resourcefulness in doing stuff in a cheap way as something positive." - M13: "(upcycling is for) reduction of waste."
30 to 49 (2Fs & 2Ms)	- Female04: "I like the fact that the things are difficult and dangerous to recycle won't be taken to China to be taken apart. Because I know the life cycle of printed circuit board and its end of life is not pretty. I'd like to keep it out of landfill and out of putting heavy metals and so on back in to the water table. […] I know that eventually down the road the stuff that I made will end up in a tip somewhere, but hopefully by that point, there will be means of recycling them than shipping them by truck road out to China." - F05: "The benefits are, well, clearly we use less resources, if the products of those resources are reused. So you extract whatever it is, you create a product and you use it once and that's the current model. But if you use it more times then it's even better. […] in a way, it's a bit saving the world. You know it doesn't make much difference with one drop in the ocean, but if there is a movement, that's trying to make difference. And more importantly, there's a movement." - M02: "[upcycling is] trying to keep things out of landfill. […] You know plastic bottles. You can recycle them. The electronics and technology we use are very mixed. So it's a lot of energy to reprocess that and also environmentally bad. [Therefore, by upcycling] you can possibly reuse things as long as you can. That makes sense." - M05: "I think that's just not wasting materials."

50 and over (2Fs & 2Ms)	- F03: "Deep down inside, I am quite sure, it has something to do with that one thing I don't like is things are wasted. It just seems silly to waste stuff." - F08: "I don't like to see waste in any form. To me the important thing is environment and how much we can put it back into landfill." - M04: "I think it reduces the amount of waste, because you can reuse things." - M12: "The world is finite. […] We cannot just go chopping down forests willy-nilly, because we need a piece of wood. Somewhere in a skip, there's a piece of wood that's going to be cut off and put onto the fire. That is effectively going to be thrown away. So I would like to see […] a building site where tearing all buildings apart and putting tonnes of wood to skips, that wood getting taken off and reused."

The following table shows the full quotations on 'fun and enjoyment' as one of the perceived benefits of upcycling from 9 interviewees (out of 23).

Full quotations on 'fun and enjoyment' as one of the perceived benefits of upcycling (*n*=9)

Age (gender)	Participant answers
Under 30 (2 Females & 3 Males)	- Female01: "Because I am a creative person, I just really enjoy doing it. […] You have this stage where you just enjoy doing the actual manual work, I quite enjoy that. […] It's kind of a fun thing to do on Saturday or Sunday afternoon really. […] It's just issues of hobby and fun thing that we like doing." - F02: "I just really enjoy it. I do it for my hobby than anything else." - Male03: "I enjoy it." - M06: "[upcycling is for] just enjoying my time. […] It's always about challenges which are fun, joyful, and creative." - M07: "[the motivations for upcycling are] the practical reasons for doing things, and the fact that I have always made things for the enjoyment of making things. […] This is kind of what I enjoy doing."
30 to 49 (1F & 2Ms)	- F04: "It's fun. I love the fact that it's fun. […] I have fun making it. […] The most fun I had is with making this kind of necklace. I just love looking through my boxes and boxes of junks and, 'now which piece will be exactly right for this one?' and finding it. It's such a lovely feeling when I get the exact piece for it. That's my main motivation because it's fun, to be honest." - M05: "The creative process is… this is fun, when you are getting to know how to make things." - M09: "You do it because you like it. It's all purely based on interest."
50 and over (1F)	F03: "I just like to design or shape of something. […] Sometimes it's just a challenge, which is fun. It's like playing. […] I get really happy when I solve a problem. It's really fun. […] It's the thinking process that is so fun behind something."

The following table shows the full quotations on 'feeling good' as one of the perceived benefits of upcycling from 8 interviewees (out of 23).

Full quotations on 'feeling good' as one of the perceived benefits of upcycling (*n*=8)

Age (gender)	Participant answers (*n*=8)
Under 30 (2Ms)	- M03: "I think where the whole ethos of upcycling is… it's useful." - M13: Upcycling makes me feel good because you think it's something there wasn't worth for someone and I've created something worth out of it."
30 to 49 (1F & 3Ms)	- F04: "I just like the idea of making use of something that doesn't work anymore in a different way, whether it be something artistic or slightly more practical. […] Generally I feel nice warm glow because it's sort of knowing that this stuff is getting a second life, sometimes second life, sometimes 3rd or 4th life because I don't know what it has been before." - M02: "I see everything as material. I hardly ever see anything as waste." - M05: "(upcycling is for) finding value in things commonly thought of as rubbish." - M09: "Often you make something working that was previously not working? That means that object got a purpose in life […] It's like you make it live a bit longer."
50 and over (1F & 1M)	- F08: "I like to feel that I can produce something new from old materials." - M04: "It's nice to just build and make use of things."

The following table shows the full quotations on 'product personalisation' as one of the perceived benefits of upcycling from 7 interviewees (out of 23).

Full quotations on 'product personalisation' as one of the perceived benefits of upcycling (*n*=7)

Age (gender)	Participant answers
Under 30 (3 Females & 1 Male)	- Female01: "[upcycling is for] also getting things the way we wanted. […] I don't want things in my house that everyone has in their house. I want something different and unique. It's got my personality stamped on it." - F02: "I find that you can have something completely unique if you do it yourself. […] doing some different things a bit, sanding it up and making it a bit different. And then you end up with something which is completely unique nobody's got. […] for example, I can put whatever different colours of paint I want on a table or that kind of thing, just making something into that's mine." - F06: "I got stuff from freecycle, freegle, and free sections of gumtree and recycling centres, things like that. And if it didn't look like what I want it to, I just kind of cut bits off, or painted it, or turned it into something a bit more interesting. […] I take something free, and make it more of what I wanted it to be. […] It's far more interesting to have something that you changed it somewhere and made it to have your personality." - Male07: "I know there is this kind of movement of deliberate aesthetic of reusing things for the fact that something you can look at it and see it's obviously a reused item, and I guess I quite like that."
30 to 49 (1M)	- M09: "When I started making clothes, it was because I wanted to wear my own clothes. I wanted to express my individuality."
50 and over (1F & 1M)	- F03: "You sometimes upcycle and make it unique. When it's upcycled, it becomes one of kind, and I like that." - M04: "The other TV stand we have at home, I built that when I was 60 because we bought the flat screen TV and we had to find something to put it on. We didn't like any of the designs that we could get. So I made one because it looks nicer."

The following table shows the full quotations on 'learning experience' and 'recognition and appreciation from others' as one of the perceived benefits of upcycling from 5 interviewees each (out of 23).

Full quotations on 'learning experience' and 'recognition and appreciation from others' as part of the perceived benefits of upcycling (*n*=5 each)

Benefit	Age (gender)	Participant answers
Learning experience	Under 30 (2 Males)	- Male03: "I am still distinctly developing skills and I have a lot of work to do to make myself as good as I'd like to be, woodworking thing particularly. […] I know I am not very good at it yet. But I will become better and some of it will be better than the messing up this time. So that you can get it better next time. And that's always part of learning process. […] I learn a lot better by having a project, doing it as best as I can, working out afterwards what I have done wrong, then I will do better next time." - M13: "I can't spend money on clothes and stuff, because that's pointless thing. What you get end of it is you look good for 5 minutes and you want something new, whereas you build something, you learn something, that's positive. It's totally positive. […] I don't see it as waste of time doing all these crazy stuff, because I am learning things. And that's invaluable knowledge."
	30 to 49 (2Ms)	- M02: "My motivation comes from… big interest in how things work." - M09: "I love learning skills and after that sharing these skills. Yes, maybe my biggest motivation is acquiring the knowledge and being able to do whatever I want to do."
	50 and over (1M)	M10: "The more I do, the better I get. So motivation is more to it."
Recognition and appreciation from others	Under 30 (1F & 2Ms)	- Female01: People come into my house and say "I really like the thing you've got here. Really individual and really unique." I kind of did that. So I think that encourages me." - M08: "The positive is that the people from the field, they show interest in what you are doing, so it's nice to see that people recognise your work."

		- M13: "People think, 'oh, that guy repairs things, he's cool, useful.' […] And there's respect from other people. If you create something that has values, there's definitely appreciation for what you are doing and acknowledgement of the fact that it's got value."
	30 to 49 (F1)	F04: "I like wearing my jewellery. I like showing off that I made this. I am very proud of what I do."
	50 and over (1M)	M04: "I like to make things that other people would appreciate."

The following table shows the full quotations on miscellaneous perceived benefits.

Full quotations on miscellaneous benefits as part of the perceived benefits of upcycling (*n*≤3 each)

Benefit (n)	Age (gender)	Participant answers
Improving home (3)	Under 30 (1 Female & 1 Male)	- Female06: "We have a quite small flat, so putting shelves and making storage [by upcycling] helps with that, to keep things organised." - Male03: "Me and my partner are making the home better [by upcycling]."
	30 to 49 (1F)	F07: "When I had my own home, I've always done stuff like that. You know, if my cupboard is a bit tatty then I redecorated it anyway, which is upcycling. Instead of buying new kitchenette, I repainted an old one."
	50 and over	N/A
Being creative (2)	Under 30 (1F & 1M)	- F02: "I think it's good for creativity. That's why I like doing it really." - M06: "(upcycling is to) get creative."
	30 to 49	N/A
	50 and over	N/A
Relaxing (2)	Under 30 (1F & 1M)	- F02: "It's quite relaxing as well." - M06: "I just love to have the relaxation in doing something different. It helps me relax and sooth my mind, focusing on something different for a while. […] [upcycling is] relaxing many times."
	30 to 49	N/A
	50 and over	N/A
Simpler way of making (2)	Under 30 (2Ms)	- M07: "It's convenient and efficient [to make something]." - M13: "Usually when you upcycle, it's less stress, it's simpler."
	30 to 49	N/A
	50 and over	N/A
Empowering (2)	Under 30 (1F & 1M)	- F06: "Instead of looking for particular thing new, I take something free, and make it more of what I wanted it to be. So that's what I found really empowering. You don't really need to pay a lot of money for someone else to do something for you. You can do it yourself. […] I wouldn't call it more desirable but it definitely helps […] your relationship with your objects. You are not being just a consumer, but feeling like you can take over the things that you own or acquire." - M13: "It gives you energy, and you see something, and you think of million things."
	30 to 49	N/A
	50 and over	N/A
For school work (1)	Under 30 (1M)	M01: "The motivation for the electronics is for my degree."
	30 to 49	N/A
	50 and over	N/A
Feeling productive (1)	Under 30 (1M)	M03: "I am an admin; I press buttons and not much thing happens apparently. […] You are in an office with other people, you press button on computers, and occasionally send letters. And it doesn't seem to actually do anything. But I want to make something solid and real and tangible. So that's kind of motivation for doing it as I don't do much at my work."
	30 to 49	N/A
	50 and over	N/A
Tidying things up (1)	Under 30	N/A
	30 to 49	N/A

	50 and over (1F)	F03: "Sometimes it tidies things up."
Stopping me thinking negatively (1)	Under 30	N/A
	30 to 49 (1F)	F07: "Personally, this is psychological one […] It stops me thinking so that I can get into something and I don't think negatively. You know happy to do and getting peace."
	50 and over	N/A

The following table shows the full quotations on social norms affecting upcycling from 23 interviewees.

Full quotations on social norms affecting upcycling (*n*=23)

Social norms (n)	Age (gender)	Participant answers
Environmentally conscious + responsible consumer (10)	Under 30 (1 Female & 4 Males)	- Female02: "I think it's good to, rather than buy something new, upcycle something that can be used again." - Male03: "I think too many people tend to buy something new every time and just chuck it. […] There's only finite amount resources on this planet and we use them too much as it is." - M08: "We wanted to show some alternative ways of producing objects." - M11: "I think we are in a very throw-away society now. And I think it's very important that we think about the environmental impacts, and I think it's very important that we go back to the way things were, you know, some years ago, the war-year generation where they would reuse, recycle and repurpose and upcycle lots of things. You should continue that trend rather than feed this throw-away society." - M13: "I don't agree with waste society. […] You work the job you hate, and earn things you don't need […] so you buy these things you don't need and then you need to look after them? […] It's pointless. I mean, you die at the end of your life. Where are these stuff going to go? Is it going to the tip?"
	30 to 49 (2Fs & 1M)	- F04: "Certainly, in my circle of friends, we all like upcycling, we all like the whole reduce, reuse, recycle ethos." - F05: "There are a lot of people I know at work, all recycling all the time, don't use too much water, don't do your laundry in the day time, etc. My lifestyle is too hectic for that. […] I support them in doing that [upcycling]. But as I said, I am not able to run around and rampage about it. So I do what I can." - M02: "I think that from my kind of beliefs, what I am thinking about how we should act… reusing is better. […] My second motivation probably comes from wanting a bit more quality in the world. Kind of trying to look at the waste that we are creating and figuring out how to deal with that."
	50 and over (1F & 1M)	- F03: "I don't really like stuff thrown away. It upsets me when I see a building demolishes, and there is a perfectly good wood, the wood is not even being burned, it's being thrown into a skip. […] [we should be] not just chucking it away, but do something with it." - M04: "I think it's a good idea to reuse things as much as possible. I actually think it's far too much material wasted in our present society, partly because the cost of labour is very high. […] It's nice to reuse things. It's nice to just build and make use of things."
No social norms (3)	Under 30 (1F & 2Ms)	- F01: "not really [any social norm is related to my motivation for upcycling]." - M01: "No, I don't, personally I don't really care either way. If some people want to do it, then they can do it. If they don't, then I don't listen to other people about it." - M06: "The mainstream society doesn't know much about upcycling. There's no norm established."
	30 to 49	N/A
	50 and over	N/A
Being productive (1)	Under 30	N/A
	30 to 49 (1F)	F07: "You have to show them I am a capable person. […] Yes, I think so [social norm is related to my motivation for upcycling]. More specifically, being productive, not feeling redundant, if you see what I mean. It's being productive. I can do, as most people can do things."

	50 and over	N/A

The following table shows the full quotations on roles affecting upcycling from 23 interviewees.

Full quotations on roles affecting upcycling (*n*=23)

Roles (n)	Age (gender)	Participant answers
Occupational roles (8)	Under 30 (1 Female & 4 Males)	- Female01: "I don't think I have to use any of it in my work. But you know things like choosing colours and things I do in XXX [employer company], choosing colours and choosing finishing, choosing shapes, so they are kind of design aspect and starting of things. I think it's relevant." - Male01: "As a student, um, yes, because there's no way of doing this otherwise. I guess you could buy all the parts but it would costs a lot of money, and… take a lot longer." - M08: "Like… this is what I do. […] I am just doing what I like to do and things I am good at. This is my job to design objects." - M11: "I think that comes down to work because again work doesn't want you to spend so much money. You then have to think about… ok, sometimes easier way to solve a problem is to throw money on the problem, whereas you have to maybe think about it in a different way. Through my work, you don't just […] throw a computer away. If I can actually repair or upgrade it, and then it doesn't have to be thrown away." - M13: "I think, as a student, yes, because it's kind of like you want to do new things, doing new cultures."
	30 to 49 (1F & 1M)	- F04: "I used to make PCBs. And as my job used to be lab technician, I know what goes into them and I don't like the fault of that coming back out in anything other than a controlled way. […] Certainly, when I worked for the company I used to work for […] trying to improve the environmental impact they made." - M05: "I suppose partly as a student, you can't afford expensive materials."
	50 and over (1F)	F08: "Certainly the exhibitions I had had sustainable art themes which are the centre of my art. […] I am also a singer and I am in a theatre production, and then you have to remake things for productions. […] We had to produce some costumes from other things. To me that was upcycling."
Relationship roles (6)	Under 30 (2Fs & 2Ms)	- F02: "I think I am quite family-oriented. So in the sort of new few years, me and my partner would be thinking of having kids, and I will become sort of the mother figure in my house. So, I think it's always good to be able to make, do and mend, when it comes bringing up family in and also teaching your kids to do the same thing really." - F06: "Now I live with my partner, so a lot of stuff I am making useful are for both of us. […] My mom asked me to make her a nice chalkboard for her kitchen and things… and I am planning to do it. I guess having these skills I've got are useful for my relationships. Am I am definitely happy to help things like that." - M03: "My partner gets the use out of the things that I make. And I design some of the things for her. The coffee table, I built it so that she can fit her knees underneath the table; she's only about 3 foot tall." - M07: "When I made this bamboo lamp, and my girlfriend liked it. She thought it was quite a neat idea and I made one for her as a present."
	30 to 49 (2Fs)	- F04: "At home, as a health keeper and wife, I guess I just try to keep things, make, do and mend as possible rather than go out and spend lots of money on new whatever it is." - F05: "I think there is some role, cultural thing in that I was a housewife for a long time. This was my previous relationship where I did most of the stuff. […] I wanted to be able to do fix anything, fix any problem, and not spend money. […] So, most of the time I took the form of doing DIY at home, or building things. […] It's a desire for efficiency and not wanting to say, "Actually, can I have some money?" as a housewife. You know, you don't get paid. [It is the mind-set that] 'actually, I don't need your money. I am going to do it myself.'"

	50 and over	N/A
No roles (5)	Under 30 (2Fs & 1M)	- F01: "No, I don't think so [no role is related to my motivation for upcycling]." - F06: "Not really [any role is related to my motivation for upcycling]." - M06: "Not really [any role is related to my motivation for upcycling]."
	30 to 49 (1M)	M09: "Well… in relation to work, there's absolutely no correlation between my work and building things."
	50 and over (1M)	M12: "Not really. No, I don't think so [no role is related to my motivation for upcycling]."
Organisational member role (2)	Under 30 (2Ms)	- M03: "In Oxfordshire, there is an organisation that runs annually during May all weeks. All sorts of artists and makers and designers around Oxford, they open their doors to public and show off what they do. And this year first time, Hackspace has participated in it and one of things we did was build… I built a trebuchet. […] There's Hackspace doing things to make the Hackspace more well-known and well-subscribed because we don't have enough money to move to another place we would like more, and also make Hackspace work better." - M11: "When I first started, I didn't really know what to expect, and Hackspace has been in the UK since 2009? And another chap started online group to get this going and I joined that group 2 years ago, and now I am forefront of that."
	30 to 49	N/A
	50 and over	N/A

The following table shows the full quotations on self-concept affecting upcycling from 23 interviewees.

Full quotations on self-concept affecting upcycling (*n*=23)

Self-concept (n)	Age (gender)	Participant answers (*n*=23)
No self-concept (4)	Under 30 (1 Female & 2 Males)	- Female02: "No, I don't think so. I don't really do for any sort of self-image or anything." - Male01: "That doesn't bother me too much." - M03: "I don't think so. Not hugely. It's… not consciously anyway. […] I don't see it as the core part of my self-image. I probably wouldn't phrase that way."
	30 to 49 (1M)	M09: "I don't really do upcycling to define myself, like this is who I am."
	50 and over	N/A
Environmentalist (3)	Under 30 (1M)	M13: "The engineering I am doing is like whole recycling into it, solar panels and stuff. It's like I want to build buildings work with the environment they are in. So much of the building we build now are like we keep the outside out? And keep inside in? I want to connect it with outside. The outside is beautiful. I want to embrace it. I want to use it, I want to respect it, and it doesn't damage or damage as little as possible. That's kind of my ethos."
	30 to 49 (1M)	M05: "I guess so. I suppose I always like to be resourceful. And I have strong views about ecology and consumerism and capitalism."
	50 and over (1F)	F08: "I guess I am pretty boring about it particularly these days. I am sure many people are tired of hearing me saying, 'Oh, I mustn't throw that away. Oh, I am going to store that for future use and development."
Maker (3)	Under 30 (1F)	F06: "I think it [self-concept] definitely has some effects on it. Ya, I think as kind of everyone involved in maker and Hackspace culture, it's basic reflect of personality. In a circular way, it affects the personality as well the way they see things and therefore the way they interact with people."
	30 to 49 (1F)	F05: "I think that my self-concept is… more about being a maker and being a problem-solver."
	50 and over (1M)	M12: "Everything just goes wrong. So I tend to build things so they can be easily repaired, and tend to over-engineer things. Make it twice strong as it used to be because I am a maker not a mender, if you see what I mean. I'd rather be making something than mending something."
Problem solver (2)	Under 30	N/A
	30 to 49 (1F)	F05: "I am from North America, I am from Canada. […] We… I think we are kind of solution-oriented. […] I think that my self-concept is… more about being a maker and being a problem-solver."
	50 and over (1F)	F03: "It's part of me as problem solving. Sometimes it has nothing to do with making anything or upcycling something. […] It's about making connections and

		linking people together. So it's about putting things together. It's about making connections and problem-solving."
Rebel (2)	Under 30 (1M)	M13: "I've always been like a bit hippy. […] I grew up in suburban area in Surrey which is a nice place, luckily went into a nice school, and in my heart, it's subversive, or rebel, or independent."
	30 to 49 (1F)	F04: "There's still bit of, I suppose, a stigma that it's not a real jewellery made of something scrap. But I don't care. I've never been the one for following social norms. So that kind of thing doesn't bother me."
	50 and over	N/A
Creative person (1)	Under 30 (1M)	M13: "I have great ideas, loads of great ideas all the time. So many of them are sitting on the shelf so long, and half done. And it's like oww… the thing! […] I am left-handed, so that's supposed to be more creative. […] I think my attention deficit in a way, it does do have a lot of creative energy."
	30 to 49	N/A
	50 and over	N/A
Christian (1)	Under 30 (1M)	M13: "I am a Christian as well, so that's part of why I am recycling, upcycling things. This is like your God has given us this awesome planet, and I don't want to abuse it, I want to have stewardship, I want to treat it with respect. […] Being a Christian, that stewardship thing, that's something I always agree with."
	30 to 49	N/A
	50 and over	N/A
Steampunk (1)	Under 30	N/A
	30 to 49 (1F)	F04: "Yes, certainly the steampunk self-image. […] I like wearing my jewellery. I like showing off that I made this. I am very proud of what I do. So I like to make it as part of me. Yes, I suppose a lot of part of my persona is what I do, upcycling."
	50 and over	N/A

The following table shows the full quotations on 'satisfaction' as one of emotions experienced through upcycling from 15 interviewees (out of 23).

Full quotations on 'satisfaction' as one of emotions experienced through upcycling (*n*=15)

Age (gender)	Participant answers
Under 30 (2 Females & 6 Males)	- Female01: "I thought I was kind of satisfied that what I've done looks good […] It's satisfying and you are pleased with your achievement." - F06: "It's just satisfaction really. I made something, now I can use it. And it's like….I did it and it's pretty cool." - Male01: "Really pleased, because something like Raspberry pi thing that I am working on for uni, umm… it's taking a long time." - M03: "Once I finish something, even if it's not perfect, I am really glad that I finished it." - M06: "I feel joy, satisfaction, a sense of achievement. I think about the final outcome which is positive." - M07: "The kind of satisfaction of having made something for yourself." - M11: "I think there's nothing better than creating something. Creating from maybe bunch of bits and bobs and at the end of it, you've got something physical, tangible products. You might start off as an idea, you might get just bits and bobs and create something out of that, that's just fantastic!" - M13: "Satisfaction. Definitely satisfaction and contentment. […] Relief in a way. It's kind of relief because you feel like… I finally actually finished it."
30 to 49 (1F & 3Ms)	- F04: "I feel very positive when I am doing any of my projects. I feel generally speaking very content when I am working on them." - M02: "When I am finished with it, I am kind of relieved and happy. […] I am pleased that the stress has gone. In the general project, you start with an idea, you quickly get to a point where you have an idea or concept and maybe a prototype, and then, the huge amount of effort is going from that first prototype or that first forged idea to actually something that you are pleased to release it that other people can't make it." - M05: "I suppose there's a moment of magic where you transform whatever from recycling bin, rubbish bin, into something transported. I like that sort of feeling. […] I get a lot more pleasure from work with my hands and build things." - M09: "You get better satisfaction by building something yourself than going to buy one in a shop. […] It means that the feelings you get from the shop is really ephemeral; it lasts really short

	amount of time. But when you build something, and you use it, then it can always increase all the times."
50 and over (3Ms)	- M04: "I think it's nice to make things and see them finished. When you do it from the things you've got for free, it's even nicer. […] You feel pleased with being able to do so. I just feel pleased. I finished it. I don't have to work on it." - M10: "[upcycling] gives me self-esteem to do things more?" - M12: "I guess I get a feeling of satisfaction. This is something I did. […] I find it very pleasant to make things. I really do."

The following table shows the full quotations on 'frustration' as one of emotions experienced through upcycling from 14 interviewees (out of 23).

Full quotations on 'frustration' as one of emotions experienced through upcycling (*n*=14)

Age (gender)	Participant answers
Under 30 (2 Females & 7 Males)	- Female01: "Sometimes I have a bit negative feeling if it doesn't quite turn out the way I wanted it to, or the process I've done on it… so it might that the spray paint is too bright and it looks a bit handmade… maybe it's not smooth enough. I like it to be quite perfect. So if it doesn't look quite perfect, then I might be a bit disappointed. But it kind of drives me to make it better." - F06: "They can be very frustrating, especially when it goes wrong. And it quite often does particularly if it's that kind of project that I have not worked before. So it can be very frustrating and time consuming." - Male01: "Frustration. Ya, so lots of time, when you are working on the electronics, things don't work, I don't know why, and you have to spend lots of time testing every little bit to see what's going on. […] Frustration is a big one." - M03: "The thing that frustrates me is usually waiting around. Most of the time, when I am annoyed by something, it's because I haven't got most of the materials; I have been waiting for ages and ages and they haven't come up." - M06: "If I am just starting something but then something doesn't work, or if I am just distracted, then I feel bad." - M07: "Any negative is, when I am working on something… probably frustration when it doesn't work properly yet." - M08: "You feel frustration because you have technical issues you have to deal with though you find solutions at the end." - M11: "It can be seen as waste of time, you spend a lot of time and it may not turn out the way you wanted it to. Or there might be a problem, or you might not have enough material for upcycling, or etc. etc. Then, that can be a hurdle, that can be negative." - M13: "I get frustrated when I can't find connectors. It's such a little part and still the whole thing you have to buy it. You get frustrated by money, sort of knowledge, or time – when you spend a lot of time on it and it's gone nowhere."
30 to 49 (1F & 2Ms)	- F04: "I feel, generally speaking, very content when I am working on them unless they are going badly, which case I get frustrated." - M02: "I think I get frustrated when things don't go well, when they are not working. But's that's all part of learning. So you kind of have to learn to live with that. But sometimes I don't learn to live with that. […] People massively underestimate how long that takes and how often you have to rebuild prototypes and you're just gonna have to go through it. But at the end of that, to finish it and say I am happy with that, that's very difficult. Emotional rollercoaster!" - M09: "Negative emotion is… just that it's difficult. It's more difficult to do that way [upcycle], because you have to adapt to whatever you found […] Sometimes it's easier to buy raw materials and form them into whatever."
50 and over (1F & 1M)	- F03: "Sometimes I jump up and down, sometimes I scream bad words, when I realised that I glued something wrong. I made a dress once and sew them together wrong three times. And I was not happy – it's not good to do things three times wrong." - M04: "Sometimes it's frustrating. What you find in a skip is bits of wood that had been rejected, it's because either it's too small or they've got defect. They quite often find the wood that has actually got holes in it, or it has been damaged some way. So, a lot of time it doesn't work. But that's the only frustration I found. […] When you are making things, it's quite often, quite often a bit frustrating, when things don't go right for some reasons. […] You come across a problem that things won't fit together if you are using found materials rather than bought materials."

The following table shows the full quotations on 'happiness' as one of emotions experienced through upcycling from 8 interviewees (out of 23).

Full quotations on 'happiness' as one of emotions experienced through upcycling (*n*=8)

Age (gender)	Participant answers
Under 30 (2 Females & 2 Males)	- Female01: "It's either I am really happy with it or I am unhappy." - F02: "I think because I enjoy it, I am always happy while I am doing it. I don't feel anything negative about it because I enjoy the whole process from going and picking up furniture to painting it, to sanding it, and finishing off. I really enjoy the whole process. Yea, I guess it does make me happy doing it." - Male01: "It makes me really happy when it works and.. but it's very short-lived – it doesn't last very long time because as soon as you made it work and you moved onto the next thing." - M13: "So many times I was frustrated on a half way through, and it makes me feel bad. But actually finish it is like that's awesome. It's what I am really happy with."
30 to 49 (1F & 1M)	- F07: "I don't feel negative when I am working [on upcycling]. I feel absolutely positive because I don't think. I just do, so I always feel positive. Yes, it does make me feel good." - M02: "I could be much happier and more relaxed when project has been finished. […] When I am finished with it, I am kind of relieved and happy."
50 and over (1F & 1M)	- F03: "I get really happy when I solve a problem. […] If it's all going well, I am in a very nice stage of flow. […] I just go in and that's great." - M10: "The positive side of it is if I can make people happy, then I am happy. And I think that's positive side."

The following table shows the full quotations on 'pride' and 'excitement' as part of emotions experienced through upcycling from 6 interviewees each (out of 23).

Full quotations on 'pride' and 'excitement' as part of emotions experienced through upcycling (*n*=6 each)

Emotions	Age (gender)	Participant answers
Pride - a sense of achievement	Under 30 (1 Female & 2 Males)	- Female02: "I guess it's a sense of achievement. I feel like I completed something. That's quite nice. […] More like, you know, like I've done that. That's cool. […] It's nice when you see a piece of furniture and go, 'I am gonna do this with it' and at the end, 'Ya, I did do that, it looks good.' Coz you think I've got the eyes for it, and it works. I guess it's sort of achievement feeling really." - Male06: "I feel joy, satisfaction, a sense of accomplishment. I think about the final outcome which is positive. […] I think I feel a sense of accomplishment. That's the primary feeling." - M13: "It's something I can feel proud of? […] It's feeling of achievement. […] For me, finishing things is a big achievement. I am pleased and proud I guess. I am so proud that I want to say I am so awesome. It's more like just proud of myself that I was able to make it work."
	30 to 49 (1F & 2Ms)	- F04: "I feel generally quite proud of myself. Quite content. Accomplished feeling." - M05: "When I just completed the Christmas tree [made by upcycling], we threw a big party to celebrate. I feel like it was a real achievement." - M09: "It's like satisfied and proud."
	50 and over	N/A
Excitement	Under 30 (1F & 1M)	- F01: "I was always really excited about what's gonna… about the outcome. […] There's that kind of anticipation of quite excitement… I think it's gonna look okay, but I am not quite sure until the end. […] I am excited about what's gonna happen next, how it's gonna look in a room, or whether if I am selling it, whether people are gonna want to buy it. I think it looks good but do people think it looks good?" - M08: "You are excited with your ideas when you start working."
	30 to 49 (1F & 1M)	- F04: "When I complete the project, I kind of get sort of feeling of 'that's that. What now?' I am often looking around and say, 'I've made that. What else can I make?'" - M05: "The feel that… they are my children I suppose. You should put out to the world and see what happens to it."

	50 and over (2Fs)	- F03: "I reconstructed this house, and I was so excited by this house, by the fact that I got it back together again [it was broken before]. […] I was so excited at the end of this 8 hours rebuilding the stupid house." - F08: "Sometimes, I am not that cautious and so things just don't work out because they break […] and you have to accept that. But that's a bit like a life – until you try, you just don't know. So I am always pushing boundaries to see what will work. That's what excites me I suppose."

The following table shows the full quotations on 'angst' and 'sadness' as part of emotions experienced through upcycling from less than 4 interviewees each (out of 23).

Full quotations on 'angst' and 'sadness' as part of emotions experienced through upcycling (n≤3 each)

Emotions (n)	Age (gender)	Participant answers
Angst (3)	Under 30 (1 Female)	Female06: "I don't have previous experience of doing it, then I could just put it off. I guess it's worry that I will mess up and waste time and resources, then I have to find more materials or resources to do it again."
	30 to 49 (1F & 1M)	- F05: "Older stuff, I want to use it, but I don't have that good enough judgment yet, because I haven't been out long enough. I look at it and I think, is it worth? Is it worth the trouble? […] When I use something reused like that as a material, I have suspicion that it's going to fail. And I go through, "Ohh… It's going to fail… it looks like crap…I know. I know. It's going to happen again." - Male02: "I am generally, I am a bit stressed when I have a project that I have to do, and I am always thinking about it all the time. So when I am trying to do other things, it's back of my head. […] Slightly stressed when things are not going well, or when I've got something to think."
	50 and over	N/A
Sadness (2)	Under 30	N/A
	30 to 49 (1F)	F07: "There's an element of sadness. Because when you make something like this one [jewellery], I am not too attached to it. But while I am doing it, and when I almost finish it, then I feel 'I am going to miss that – just working with it.'"
	50 and over (1F)	F03: "Sometimes I feel sad. […] I just remembered the book I read about – constructing theatre. The author was watching directors make live performance and she describes it as a process of being a mother. You take it in and you let it go. And this taking it in and letting it go is always part of that kind of energy that is about upcycling and bringing it into explore, and you have to let it go and you do that. And it can be kind of sad and melancholic, or bittersweet, or whatever."

The following table shows the full quotations on present habits as current activities related to upcycling from 23 interviewees.

Full quotations on current activities related to upcycling (*n*=23)

Activities (n)	Age (gender)	Participant answers
Art & craft (9)	Under 30 (2 Females & 1 Male)	- Female01: "I do a lot of knitting, crochet, lots of kind of sewing projects. […] I do the painting sometimes. […] More in the summer I do more woodwork projects." - F06: "I think it's just kind of general interest in art and creativity. I've always enjoyed arts and crafts. So that's kind of extension of that. Instead of drawing and painting, furniture making, wood working, and planning to make some lampshades with decorative paintings. So, yes, kind of extension of interest in art and craft and applying that to more physical things." - Male07: "I visited a friend in the states, and they had this really nice lamp and I felt I could do one of those. […] So, I set myself a challenge of doing that just because it would teach me a certain amount of stuff about carpentry, and for that, I've got all the materials new from probably B&Q."
	30 to 49 (3Fs & 1M)	- F04: "Yes, I've been always making jewellery and bits and pieces like that. […] I've taken silversmith course a couple of years ago. I've made these three rings from my

		jewellery course, silversmithing. […] Crafting, making things, different types of jewellery. I used to make a jewellery called a knit-wire which is a bit like French knitting, a way of using bobbin." - F05: "Mainly I make lots of things that are not upcycling." - F07: "I draw pretty arty, pencil art." - M02: "Basically I would prefer to make something and do it by myself than to let any other person get involved. So this T-shirt, I made it because I wanted this T-shirt."
	50 and over (1F & 1M)	- F08: "I came to adult education much later in my life and I did my first art degree in 2007. […] I did lots of photography wherever I take my camera. I would take something and I think I just see a shape, and somehow that appears whatever I am doing." - M12: "Woodwork. Metal work."
Hacking, tinkering and digital creation (8)	Under 30 (1F & 4Ms)	- F06: "I was really interested in furniture hacking […] turning an existing object into kind of something else, like modifying it into being more of what you want it to be." - M06: "I primarily focus on online, and digital. I start learning electronics. […] I guess I was doing something and I wasn't even aware that upcycling existed. I was probably playing with stuff, just casually." - M07: "At the moment, I am in the middle of building a remote control plane because that's probably the thing that I am inspired to have longest like… I wanted to have one of those when I was 6 and I found out through Youtube actually. […] I've got this telescope which was just completely broken. And more out of curiosity than anything else, I didn't really know how telescopes work, so, I just kind of took it apart […] I tried fixing it with the knowledge I had and I got it working-ish. - M11: "For a long time, I spend a long time, instead of making physical things, I spent a lot of time online, making web apps and websites and that kind of things." - M13: "I've never been scared to take things apart. I've always wanted to know how a thing works. So I've been on Wikipedia and look up on crazy things. […] Electronics is my main sort of thing. Electronics and computer control. I've done it for years. […] When I was working full time, I bought solar panels, and I was basically building systems to charge phone batteries, charge laptops, stuff like that."
	30 to 49 (1M)	M02: "I've always been taking things apart. […] I learned how to do screen print. And I got a second-hand T-shirt, and I made this at the Hackspace. I've never done screen printing before. And it took me a long time to learn how to make masks and took me ages. But I wanted to do something like it."
	50 and over (1F & 1M)	- F03: "When I was teaching about the theatre stuff, we didn't have a technical person – we didn't have a technician really. […] Because I wanted students to […] consider the whole design things, I've taught myself to use a computer. […] so work, the kind of works I have been having put me in the position where I can play with making and adapting stuff." - M12: "My electronics. Computers."
DIY housework, Repair and maintenance (7)	Under 30 (4Ms)	- M03: "I do a lot of DIY housework, painting and repair, bodging a thing." - M07: "Repair stuff. […] I've been always into bikes since I was young. And if you are a serious bike rider, you have to have certain amount of knowledge about repairs because it's just routine stuff. You need to be able to do your own tires if it breaks." - M11: "When something is broken, I've never wanted to throw it away. If I can fix it and reuse it, I will think about it and I will never just throw it away. I think I've done it all my life." - M13: "I've once had money for a nice bike and it got stolen. Since then, I've used quite rubbish bikes […] It's fairly maintainable, and it doesn't cost that much money than to get a new bike."
	30 to 49 (1M)	M02: "Things like fixing my bike last week. I bought a second hand bike ages ago and I fixed a few things on it. And now it's working. […] I would always do that."
	50 and over (1M)	M12: "House restoration."
Other environmentally friendly behaviour (3)	Under 30 (1M)	M11: "I've always repurposed things."
	30 to 49 (1F)	F04: "I like to try everything environmentally neutral as possible. I buy books second-hand. I am looking for ways and means of setting up in practice of low impact way as possible."

	50 and over (1M)	M12: "I've always been reusing stuff at home."
Collecting things (2)	Under 30 (1M)	M03: "Actually there's tendency among myself and my family to acquire things because they might be useful actually."
	30 to 49	N/A
	50 and over (1M)	M04: "I am trying to collect all the metal. So if I've got something including screws then I collect all the screws and take them to the recycle."

The following table shows the full quotations on past habits as childhood activities related to upcycling from 23 interviewees.

Full quotations on childhood activities related to upcycling (*n*=23)

Activities (n)	Age (gender)	Participant answers
Family-influenced making and DIY (12)	Under 30 (2 Females & 4 Males)	- Female01: "I think that was 6 or 7, and my granny taught me to knit. I used to go to her house once a week and she was always knitting. I always wanted to know what she was doing. She was kind of moving these needles around, and had a ball of strings, and just making these things, and I just found it fascinating. So, when I was 6 or 7, she taught me how to do it, and I made a little scarf." - F06: "My grandparents have a huge yard, really small house and then really enormous yards and garden, and my granddad comes from the farming family. So he came from that ethos of DIY […] he has a huge, huge garage workshop when we were little kids. So I remember he was always hitting like kennels into bits of wood with hammers. It probably had a huge impact on me." - Male03: "My parents were always quite DIY about things. So I… so many things that we've done by ourselves or with friends. […] I can't remember anything specific but remember involved in home repair generally. Repairing rotten woods, fixing doors, fixing plugs, fixing electronics, mending stuff in the garden. […]I think it's something I've grown up doing it. I've grown up expecting to do recycling and second hand and the belief that old things are not bad." - M07: "Possibly, this kind of attitude is something I've inherited from my parents because, I mean, my mom grew up just after the second world war when this was just kind of everyday part of life. Everyone did, everyone improvised things and used whatever materials they had. And she still does. […] So, potentially I might have learned this tendency from her. I guess both my parents are quite practical. They both aren't afraid to take stuff apart and make something new. So, I probably learned to not be afraid of taking things apart and experimenting with materials from them." - M08: "We were like a making family. I kind of always made stuff in my house. As long as I remember, I was cutting stuff, drilling things." - M13: "Build computers with my dad. That was a big part of growing up actually. […] We had an old one and upgraded it all the time. My mom had mice as a pet, and we built, me and my brother built, mainly me, Lego house for mice to run around and do exercise kind of maze thing."
	30 to 49 (1F & 2Ms)	- F05: "My mother made my prom dress for high school. That didn't come up very well. But we made a home-made dress. That's the only time I really remember my mom sewing for a long time, and she did it for me, which was nice. And before that, her mother was like super-chic dresser […] she didn't have that much money, so she would make like a fur coat for herself, and she would fake labels in. […] It's like sewing stuff and putting a Gucci label on it. But she was good enough that she could pull it off and it looked amazing. […] so, it's in my family anyway." - M02: "Mainly my mom wanted me out of the house, and took all the stuff outside, so I got a shed and brought electricity, that's where I used to make stuff. […] My dad was a science school inspector and he used to get a lot of electronic kits to test. He was particularly interested in physics once, and he gave the engineering kit to me. I think that must have pushed me to do it. […] I think it was probably family, or parents encouraging me to be interested in stuff. That's probably where it comes from." - M05: "My mom was a knitter and she sews […] I grew up with seeing hand skills and that's part of inspiration for me?"
	50 and over (2Fs &1M)	- F03: "My mom taught me how to sew and cook, and she sewed me one dress and then I just took patterns. There was one pattern and I looked at another pattern,

		and 'Oh, I like that dress and I like that sleeve,' and then I put those two together. So that was my first making really. Just sewing things. […] My dad made things or fixed things a lot. He made me hold nails and hammers. […] So I grew up with the things he made. […] My brother is also very handy in making things. […] I think it has been the environment rather than doing it so much." - F08: "My father was an engineer, and he had a garden shed the way men do. And he used to show me how to make things. And I think that's where my early interest probably began." - M10: "Go-cars. My dad used to make little go-cars."
School making and drawing (8)	Under 30 (1F & 1M)	- F01: "I was doing a lot kind of things in a nursery school, like lots of collage stuff, where you get papers, bits of pastels and sticking things. […] And kind of art and technology at school. I really enjoyed those subjects. That's probably what led me into being and doing product design in uni." - M03: "I had a good, reasonably good education in woodworking and stuff at school."
	30 to 49 (1F & 2Ms)	- F07: "When I was at school, I was around 7 or 8, anyway, I was very good at art. And I painted, it was life size picture of a native American chief with a feather dress." - M02: "I also remember entering the competition for primary school, for school children, up to 18 […] I entered into it for three years when I was in primary school, when I was 8, 9 and 10. So you are given the challenge, and you have to make something to compete that challenge. And I remember that very vividly, kind of making things. One of them was to get five nails from one side of the table to another table, one metre one, and me and my friends built mechanics, crane." - M09: "I was like 15 and I was learning to be a carpenter."
	50 and over (2Fs & 1M)	- F03: "In college, I did 2D drawing class and 3D design, but they were really basic stuff. Conceptual rather than actual making. I did ceramics. I did that in college for a semester." - F08: "I did little bit of art at school." - M12: "I guess I have a childhood memory of making radios. And this was when I was at school. When I was about 14 or 15, it was taught in school those days. […] they taught woodwork and metal work."
Always building and making (6)	Under 30 (1F & 2Ms)	- F02: "I've always been quite creative as a kid, when I was growing up, not anything in particular, but I was always building stuff out of boxes and that kind of thing, when I was a kid." - M07: "I have made things ever since I can remember as a small child. I have been doing making simple stuff." - M13: "I was always making things."
	30 to 49 (1F & 1M)	- F04: "I've always done stuff with my hands. […] I've always been handy with making things. […] - M02: "When I was 8, I was bought multi metres for my birthday and when I was 11, I was bought to shed, because I was making a mess in a house – I was making things."
	50 and over (1M)	M04: "I made a telescope when I was 16. That's an enormous telescope which is like a reflective telescope with a mirror. So I made a mirror, I made tubes, and built the mounting for it. I also built electronics those days. I built various things. I built oscilloscope, radios, things like that when I was a child."
Taking things apart (4)	Under 30 (4Ms)	- M01: "Not really making stuff but breaking stuff? So, things like… with old hoover or something but before throwing it away, take it all apart and see how it works." - M06: "I was always disassembling everything. If anything was broken down, I just used the screwdrivers to see how it works inside." - M11: "I've always broken things to see how they work. And I've managed to get them back together most of the times." - M13: "The first thing really was, as a kid, taking everything apart, power socket or whatever I could find, and see what's in it. […] I've never been scared to take things apart."
	30 to 49	N/A
	50 and over	N/A
Always reusing, fixing and upcycling (3)	Under 30	N/A
	30 to 49 (1F & 2Ms)	- F04: "I used to like, I still do like, old science fiction called Blake's 7. It's around the 80s I think. And I remember making one of the guns from that. I used cardboard roll and integrated circuits, chips, used to come with long, thin tubes. I remember

		getting some of those, hacking them up with hacksaw, layering them around the barrel, around the paper tube, to make this gun. And it looked really good compared to… very much like the original one. […] I was using things for a different purpose that wasn't originally meant for and repurposing them as such. I've been upcycling all my life and I didn't realise!" - M02: "I think I have always taken apart things and use them to make other things. So I don't think there has ever been a time when I suddenly went, 'Ohh, I could use this one as waste resource to do this!" - M09: "My first upcycling project, if I remember it correctly, must have been the moment that I took a red brick and a chisel and hammer, and formed the brick into a little sofa."
	50 and over	N/A
Playing with toys (3)	Under 30 (3Ms)	- M07: "I had quite a lot of Lego, when I was a child. A lot of lot of complete kits. It's like a whole box full of individual parts but I did not have all the precise pieces to do something so that probably taught me a lot about improvising things if I didn't have a particular part I needed." - M11: "Rail control cars… that's one thing I spent a big time with. Scale electric cars. […] You can pull them apart and make different shapes. And when the cars broke then you will have to repair them. […] The earliest thing as making things… I would say it's Lego, really. You know, everybody had Lego. I loved the stuff. I had normal blocks to make a house or whatever. I think that's probably the first making memory that really sticks in my mind." - M13: "Lego. I used to play with Lego a lot. I used to get Lego Techniques and stuff for Christmas […] I used to do that. It was quite fun."
	30 to 49	N/A
	50 and over	N/A
Media-inspired making	Under 30 (1M)	M07: "I think I made a lot of stuff as a child with paper and cellular tape and strings. There's Blue Peter type stuff."
	30 to 49 (1F & 1M)	- F04: "I used to like, I still do like, old science fiction called Blake's 7. It's around the 80s I think. And I remember making one of the guns from that." - M05: "Sort of Blue Peter and Tony Hart, all those sort of 70s art making programmes. They were the culture of 70s? I don't know. That maybe is the part of it."
	50 and over	N/A

The following table shows the full quotations on 'lack of competence' as one of barriers to upcycling from 10 interviewees (out of 23).

Full quotations on 'lack of competence' as one of barriers to upcycling (*n*=10)

Age (gender)	Participant answers
Under 30 (2 Females & 4 Males)	- Female01: "I think it's learning the skills I need to do a good job. I think that only comes with trying and error." - F06: "Developing skills mainly. […] I don't have previous experience of doing it, so I could just put it off. I guess it's worry that I will mess up and waste time and resources, then I have to find more materials or resources to do it again. And I am just not good enough to finish things." - Male01: "Learning electronics…it's hard. And coding as well. The computer code is very hard when nobody is teaching you." - M07: "You can't make something if you don't know how to, how it works." - M11: "I think it has been gaps in my knowledge, so… I have to go and spend a long time either looking how to do a particular thing, or finding someone who does, learning what they know, those kind of things, most of the times." - M13: "Just amount of knowledge? Sometimes it's knowledge gap? Like if I want to build something really complicated, especially electronics, it's like… you buy some chips and you have no idea, and end up blowing up half of chips a couple of times, and miss something important, and you just didn't know."
30 to 49 (1F & 1M)	- F05: "Older stuff, I want to use it, but I don't have that good enough judgement yet, because I haven't been out long enough. I look at it and I think, 'Is it worth? Is it worth the trouble?' […] [sometimes] when I do start working on it [used materials], then 'Ahh… I should have waited… I should have got the new stuff.' So part of that is just skill, having better judgement. […] I don't have that judgement."

	- M05: "This is fun, when you are getting to know how to make things. And then you realise, no, this is hard. You think you should have learned some skills, and some works. It's not that fun. […] also how to clean them all and process them so that they can be made into something else? […] There are some traditional skills dedicated to certain materials, whereas if you are taking something not supposed to be made into something else, you have to adapt existing skills and make up new skills or techniques to work with that material."
50 and over (2Fs)	- F03: "My lack of ability on what to do next. Or if I make a mistake, and I think why didn't I think that through, you know, I should have measured that!" - F08: "The difficulty for me is always how I can physically use the materials if there's a structure like wood and metal and copper. Because I am not very good at that. So I have to find craftpeople who have empathy with my idea to be able to move it on."

The following table shows the full quotations on 'problems with materials' as one of barriers to upcycling from 8 interviewees (out of 23).

Full quotations on 'problems with materials' as one of barriers to upcycling (*n*=8)

Age (gender)	Participant answers
Under 30 (2 Females)	- Female01: "I found it a bit frustrating when I started a project and then I realised I need something I don't have at home, then I have to get on a car and go to Hombase, so being in a queue to get a sandpaper or something." - F02: "I found it quite difficult to upcycle [when] I used quite cheap paint, and just anything I can get my hands on really, so it would take quite a long time to do stuff, coz you just have to put more coats of paint on, because it isn't really good paint."
30 to 49 (1F & 2Ms)	- F05: "If I could make everything using reused material, or free material, I would. But the quality is just not good. It's possible that I could find better sources. But I don't know where to look though really. […] I could just go down on the street, go into the store and just pick what I want. Or I could like… sort of digging somebody's grandma's closet or like garbage or at some recycling depot and take forever." - Male02: "The thing is you are constrained by the physical limitation of what you've got as materials, so say the solar power charger, I specifically have these solar panels, so I have to work around that. And they had to fit in: they had certain voltage, which meant that, first of all, it didn't work because the voltage didn't add up to the right number, so I had to use more of those. So you are limited because your material is limited. […] say, you take a motor that is second handed, it's nearly always there's right size shaft on the meter or whatever, then you need to make the thing connects it to the other thing you are making. Whereas if you just bought something you knew the outputs of it, you could just buy one with the right size shaft, rather than going through the whole process of making one yourself. I think with all kinds of waste materials, you have to go through the process of figuring out how to change it to connect to other things." - M05: "I think some barriers are… just generally you don't know where to get the materials from. […] Where do you get like 200 state agency signs? […] or where do you get 2000 plastic bottles? […] the hardest thing is material, that's one barrier."
50 and over (1F & 2Ms)	- F08: "I really have to look at materials before I work. Sometimes, I am not that cautious and so things just dong work out because they break." - M04: "Finding things to fit together is actually always the biggest problem. So sometimes you have to go out and buy something. […] One of the barriers is hard to get the materials. If there was some effort to put into recycling [reclaimed] materials, it would make it easier. […] A lot of wood gets to landfills which could actually be reused. But the problem there is it's quite labour intensive to sort it. In fact, there is a second-hand wood shop in Brighton. I've been there. But the wood is actually nearly as expensive as new wood really. […] And also what it has is a lot of shuffling ply which is all covered with cement." - M10: "Sometimes it's really annoying if you need things you can't get, and sometimes it's expensive to go and buy things that you need to upcycle things."

The following table shows the full quotations on 'lack of space' and 'social situation and cultural perception' as part of barriers to upcycling from 7 interviewees each (out of 23).

Full quotations on 'lack of space' and 'social situation and cultural perception' as part of barriers to upcycling (*n*=7 each)

Barrier	Age (gender)	Participant answers
Lack of space	Under 30 (3 Females & 3 Males)	- Female01: "I think one main reason is because I didn't have a space. I didn't actually do the projects because, A, I was living at home, and B, I didn't have anywhere to put bits of furniture because I was living at home. […] I think space is the main problem I had. Mom and dad didn't like things like lots of paintings lots of craft stuff around the house." - F02: "When we first got together, we didn't really have… we didn't have any room to do it for one […] We didn't have a big space like for putting the tools out and painting that kind of thing." - F06: "I guess it's because I didn't have the resources to be able to? I was in a shared flat, so I didn't have anywhere to store the project." - Male03: "The first sort of major project, the barrier was that we didn't have the space. […] Getting a tool was not particularly a problem, although getting all the tools is again a matter of space. […] Whether they are upcycling or whether they are building things from new takes a lot of room. […] If I had a room, I could do a lot more. […] It's space and time thing more than anything." - M06: "If I had more space then I could put all stuff. I could use the space to have more of all the equipment and materials. But my flat is small, it's limited. So I quite often say it's not worth my time and worth my effort actually to keep all the stuff. So I often throw things away immediately. So if I had enough storage space, then I would be more inclined to do something with waste." - M07: "For a lot of stuff I make, the space you would like to work in is a limiting factor. So, I say I would love to build electronic car but if you don't have a garage or somewhere, you can't do it. Probably I tend to pick projects that I can do with the space available to me. Certainly, a certain class of engineering anything with precision, there's no substitute to having the right tools. And right tools are very expensive and even quite big and need a lot of space. That's again something that makes space an opportunity."
	30 to 49 (1F)	F04: "I think the space and the equipment. […] Because I do my all stuff in the living room, I either have to clear up in my free time if I need to do something else, or which is more likely is that I just leave everything sprawl over the living room for a week and then can't move."
	50 and over	N/A
Social situation and cultural perception	Under 30 (2Ms)	- M07: "People in my experience unless you are doing it as a kind of aesthetic statement, people don't entirely understand the thinking behind, either that it's weird and eccentric, or they think it's sort of miserly penny-pinching, you know, 'Why do you want to make something out of this when you can buy this from a shop?' […] Outside of the Maker culture […] I think there's slightly negative view on reusing materials." - M13: "I guess it's seen as subversive activity. If you are in the back alley and picking up sort of junk, it's a bit… I always feel a bit awkward about it."
	30 to 49 (2Fs & 1M)	- F04: "There's still a bit of, I suppose, a stigma, that it's not a real jewellery made of something scrap." - F05: "Sometimes if you find a good source of used things, especially materials like furniture, you say, 'Well, this is with garbage, I will take this, and I will make something else out of it.' And then somebody else comes and says 'What are you doing? It's robbery!' It's like that's in the garbage, it's not robbery. But except legally here you are not allowed to pull stuff out." - M09: "It's not really social to actually do that. It's like usually people will look at you, when you take things out of bins or skips. It's not really socially acceptable. […] People often have high negative view on someone in a bin. It's nothing you can do with that."
	50 and over (2Ms)	- M10: "I didn't want to go get anything from the bin and upcycle it at all." - M12: "The kids of today are different to I was a kid. Because I was always making stuff. And kids today don't see any charm, anything to be gained in making stuff,

		because they can just buy one. […] Because of the explosion of South Korea, Taiwan, China, Thailand, all other parts of the world, now everything as soon as you think of it, as soon as you talk about it, someone is making it […] Now you are not restricted by the availability of things. Virtually whatever you want, it's there."

The following table shows the full quotations on 'lack of tools' as one of barriers to upcycling from 6 interviewees (out of 23).

Full quotations on 'lack of tools' as one of barriers to upcycling (*n*=6)

Age (gender)	Participant answers
Under 30 (2 Males)	- Male01: "Having the tools in the first place is definitely barrier." - M07: "Probably any given time, the barriers to what I would make could just be what tools and what equipment I had access to. […] Certainly a certain class of engineering anything with precision, there's no substitute to having the right tools. And right tools are very expensive and even quite big and need a lot of space."
30 to 49 (2Fs & 1M)	- Female04: "I think the space and the equipment. There are still things that I like to upcycle but I can't because I don't have a workshop and I don't have welding gear. And I don't have a laser cutter." - F07: "I keep snapping my drill bits. That's difficult. Or tools, they would help me greatly especially with metal. […] Mostly tools and things like that, that holds me back." - M09: "Sometimes you are required to build something with the tools you don't have."
50 and over (1M)	M10: "If I don't have certain tools and it's very annoying because you have to improvise what you are going to use. So sometimes I get a bit annoyed when I can't find the things I need to do my items."

The following table shows the full quotations on 'lack of spare time' and 'safety issue' as part of barriers to upcycling from 5 interviewees each (out of 23).

Full quotations on 'lack of spare time' and 'safety issue' as part of barriers to upcycling (*n*=5 each)

Barrier	Age (gender)	Participant answers
Lack of spare time	Under 30 (1 Female & 2 Males)	- F02: "If I didn't work from home, I wouldn't have time. […] My partner goes out at 8 o'clock to work and comes back at 6 or 8. Then you don't have much time to do it." - M03: "There's only so much time that I have and I usually try to have a project in mind or something rather than just getting it and hope it to be useful. […] It's space and time thing more than anything." - M13: "Time is a big thing. It's really a big thing. […] It's trade-off between money and time. The more time you have, the less money you need."
	30 to 49 (1F)	F05: "I don't have time."
	50 and over (1M)	M04: "Mainly because I was too busy. I was too busy working."
Safety issue	Under 30 (3Ms)	- M01: "I am 25 now. When you are kind of, I don't know, 15 or something, you can't use all the power tools. You can't use the saws and big drills and everything because of parents." - M03: "Not hugely… [there was a barrier or problem] other than occasional injury. I do keep doing it." - M08: "At the beginning of the project, our aim was to start production, but we faced some legal issues, like selling the products, because we can't trust the parts. It's like products go to the recycling centre, such as broken kettles and broken toasters, and we disassembled them, then we can't trust them. And we can't say where it comes from. So if we sell it to somebody, like the kettle, then we are responsible for all the safety issues because we can't say that these parts are from so and so manufacturers."
	30 to 49 (1M)	M05: "I wanted to do the project with the local recycling dump where people can take rubbish, and I heard that because of health and safety reasons, you can't just go into the dump and find materials. You might get cut by broken glass or something."
	50 and over (1F)	F08: "I tend to put my safety goggles on, and my mask, because some of them you are not quite sure whether they are being contaminated in different ways, and so that's quite an important area. […] You have to be much more safety-conscious about how you use things. Since I've been touching them, I think, 'Is this a good idea? Do I need to decontaminate the product before actually I work with it?' […] Because obviously there are contagious things and materials change."

The following table shows the full quotations on miscellaneous barriers to upcycling from less than 4 interviewees each (out of 23).

Full quotations on miscellaneous barriers as part of barriers to upcycling (n≤3 each)

Barrier	Age (gender)	Participant answers
Lack of interest (3)	Under 30 (1 Male)	Male11: "Having a starting point, and having the drive or motivation? To get started. It's what all you need. I think that's the biggest."
	30 to 49 (1M)	M09: "It's interest. If you use, for excuse, time, material or whatever, in relation to the reasons for not doing something, you are lying to yourself. You started doing things because it's interesting."
	50 and over (1M)	M10: "I didn't' think about doing it then [before the first upcycling]."
Quality issue (2)	Under 30 (1M)	M07: "In some instances if I set myself goal of using something old or something recycled, and it doesn't really work properly, if it doesn't work perfectly, and I think if I had gone to the right materials for this, new materials, it would have worked better. […] Not everything you are using is intended to be for the purpose that you are using it for."
	30 to 49 (1F)	Female05: "Most of time using used materials or something like that, most of the time the product you are able to create from that, is either not very good or not sellable. Those are the problems. If I could make everything using reused material or free material I would. But the quality is just not good. […] Your quality fails and you only find out half way through. And it's like, 'I shouldn't have used it. I should have started new. I knew this was going to happen.' […] Because I will go up to days for sewing something up and it will take forever, and it's like 'This is going to sag really bad on the butt. It's going to be really unattractive. That's because I used the used material!'"
	50 and over	N/A

The following table shows the full quotations on 'having enough space' as one of facilitators for upcycling from 11 interviewees (out of 23).

Full quotations on 'having enough space' as one of facilitators for upcycling (*n*=11)

Age (gender)	Participant answers
Under 30 (3 Females & 3 Males)	- Female01: "Not I've got my house. I've got space that I can put things. I think that's probably the main reason. […] I think the most influential factor is space. Just having kind of a surface to work on, having a workmate or having a big table to work on […] I can't just leave all my craft on the table, because people have to have dinner and so, you can kind of have your own space and leave it how you want it without having to tidy it away." - F02: "Now in this place […] we've got a bit of extra space, and it's only two of us in the house, so we don't have to use the dining room all the time. So, it's nice to have the space to work in. We've got garden as well, which means we've got a room outside to do as well. So I guess it's more of a space thing than anything." - F06: "Once I moved into my own place, I have my room and space to work on these projects. So that's how I am doing it. […] Having space is a big one. The first house I lived in, it was a shared house, I had my own room, and we had like lots and lots of space and we had a big garage, so I did my woodwork in it. After that, I was in a smaller flat without any workshop, but I had a big room and a lounge dedicated to workshop area for working on small projects. And the house after that, there was no space whatsoever, so I didn't work on anything when I was there. It was a very small shared house. […] So that had been a big impact on what I could do. […] I would probably say actually the most influential factor is space because I can always have access to tools in the Hackspace if I need them. And I try not to make the lack of knowledge too much impact. But if I don't have any space that I can store things and be working on it, I can't really do it. So that's probably the most important one." - Male03: "It's space mostly. […] Buzzfeed DIY has some articles about how to turn all the craps into cool stuff. And I've read them and I found that 'I can't do it because we don't have any room here. And we moved, so, 'Ohh, I can do some of those!' […] the most influential factor is space definitely." - M07: "You need all of these things. If you are going to make something, you need space, you need time, you need materials, and you need tools. Because if you don't have all of those things, then you can't do anything."

	- M11: "You probably need bigger things to need more space. So having the space? So having the space is certainly a big bonus now."
30 to 49 (2Fs & 1M)	- F04: "Having a space I can dedicate to all my workshop stuff, all my projects, would be really useful." - F07: "Space, definitely. I mean I can work in a small space anyway. It just means that I couldn't do a large piece." - M02: "I like having my own workshop because I am quite productive there. Because of that hackspace I am quite involved with, day to day running it as a space, as a social area… but I don't get much done there as I could in terms of my own projects and my own kind of what I want to do."
50 and over (1F & 1M)	- F03: "I have my own house to see that I can make my mess and then I can leave it out. I can leave it there till I stop thinking about it. […] The space is really important. Not having to pack up. That's the good thing." - M04: "I think it's useful to have somewhere you can store things. That's quite important. I mean it's useful to have a workshop. If you don't have a workshop then it's more difficult. […] I mean it really requires some storage space. The Hackspace is a possibility but we have really limited storage in a Hackspace so if you have a large bit of wood, it would be a problem really."

The following table shows the full quotations on 'having all the right materials', 'Hackspace' and 'inspiration from people and experience' as part of facilitators for upcycling from 6 interviewees each (out of 23).

Full quotations on 'having all the right materials', 'Hackspace' and 'inspiration from people and experience' as part of facilitators for upcycling (*n*=6 each)

Facilitator	Age (gender)	Participant answers
Materials	Under 30 (2 Females & 1 Male)	- Female01: "Having all the right materials." - F02: "As soon as I start doing properly, and I wanted to make nicer pieces and make it look better. So I bought some nice paint, which meant easier and faster to paint stuff. […] To start with, it's quite difficult to just have really cheap brushes and really cheap paint. It took quite a while. But now I've got some nice paint and nice brushes and better tools just to make it a lot easier." - Male07: "You need all of these things. If you are going to make something, you need space, you need time, you need materials, and you need tools. Because if you don't have all of those things, then you can't do anything."
	30 to 49 (1F)	F05: "If there was source of like used stuff that I could know that it's good quality that is pretty sorted online, I would use that."
	50 and over (1F & 1M)	- F08: "A lot is personal contact with acquiring materials." - M12: "If I need to do a job so and so, it's 7 pm at night, the shops are close, then what am I going to do? What was meant to be 5-minutes job is going to be tomorrow, and some other jobs came along, then I may forget. So it's just handy to have a cupboard full of stuff, nuts and bolts and screws and electrical things."
Hackspace	Under 30 (4Ms)	- M01: "The Hackspace. Without the Hackspace, I wouldn't do it because they have all of the tools here. These here, would cost thousands and thousands of pounds. […] I've got workbench at home with some things, but nothing like what we've got here." - M07: "Obviously, Makespace is a big step-up, before that, I found myself buying tools as I went along, through university and stuff." - M11: "Now the Hackspace exists, so I am starting to do things. They are good because they lower other barriers down. So the tools and that kind of thing. [Before the Hackspace, it was like] there's always someone who knows someone. They've got the tool and then you can do it. It just takes much longer process, whereas in Hackspace, you just make it very easy, very straightforward." - M13: "We have our own space, that's why Makerspace is so good. You just do whatever you like."
	30 to 49 (1F & 1M)	- F04: "I want to re-join them [Makerspace]. Basically all the workshop tools that I don't have would make it easier for me to upcycle things or make things whatever." - M02: "That Hackspace has been very good for me, in terms of access to better tools. So for some of my projects, I needed to weld things, so I used welder there. The laser cutter is amazing. […] I needed the space and also materials around, a lot of screws and nails, and small bits of woods to do what you want. You have to buy some for

		your own, or find something for your own stuff, but generally, there are other bits. It's nice to have access to parts."
	50 and over	N/A
Inspiration from people and experience	Under 30 (1F & 2Ms)	- F02: "I started doing it because my partner's mom ran an upcycling business. […] So she runs this business on the south coast where his family live, doing some repainting and that kind of thing. And she sells in a shop. And I just really enjoyed what she did, I did few bits for her. So for me, go down for a weekend to help her out… was nice to sort of… I've just got really into it. I really enjoyed it." - M11: "Definitely seeing people come down here [Hackspace] and having ideas, that's definitely inspiring me more than whatever has. […] seeing do it online as well. I think that's definitely been encouragement. […] It's really difficult to say what's most important because I think you've got to have the time, you've got to have inspiration. They are really two important things." - M13: "In terms of inspiration, little by little, yes, my dad was inspiration. He is such an idealist, and he doesn't like waste. So that's definitely inspiration."
	30 to 49 (1M)	M02: "I spent a year in Philippines living and working on remote electric application project. And that was very interesting because of the big differences in what people have. So here in the west, it's mainly stuff is cheap, and labour is very expensive, so my time costs lots of money whereas buying a new phone doesn't cost much. In a lot of other countries including Philippines, it's totally the other way around. People's time is not more than anything. And stuff is so much more expensive. […] There's a whole street where people rewind the speaker code for speakers. And in the UK, we don't have to do that. Just buy a new speaker. It's just not worth it, whereas in Philippines, it's employing lots of people to take something that's not fully waste, repair it, and get it going again. So that's definitely formed my opinions."
	50 and over (2Fs)	- F03: "I went to Indonesia once and I was really amazed by the fact that everything was being reused." - F08: "I've been down to the waste recycling plants in Nottingham and Northampton I visited. I interviewed them as part of my own master about recycling, cost of it, and people's attitudes to it. I think that's the influence to me over the years."

The following table shows the full quotations on 'tools' and 'competence' as part of facilitators for upcycling from 5 interviewees each (out of 23).

Full quotations on 'tools' and 'competence' as part of facilitators for upcycling (*n*=5 each)

Facilitator	Age (gender)	Participant answers
Tools and technology	Under 30 (2 Females & 3 Males)	- Female02: "Now I've got some nice paint and nice brushes and better tools just to make it a lot easier." - F06: "And tools, and I've been collecting more tools every time." - Male03: "It's having a space, having tools, that is the real thing I guess." - M07: "You need all of these things. If you are going to make something, you need space, you need time, you need materials, and you need tools. Because if you don't have all of those things, then you can't do anything. […] the most influential factor is having always had tools around. You know when I was living at home I had stuff in my dad's garage and when I moved out it was certain amount of stuff that I bought for myself. Because to a certain extent, everyone has a space and time. And anyone can get hold of materials. […] Having even a fairly basic set of tools, they will let you do so [whatever work you want to do]. So probably the single enabling factor that will… that you will make stuff is tools." - M11: "I think if you've got the right people around you, and you've got the right tools as well, then those difficulties suddenly drop."
	30 to 49	N/A
	50 and over	N/A
Competence	Under 30 (1F & 1M)	- F06: "Knowledge development of… knowledge of techniques." - M07: "If it's not a field that I am familiar with then I will see what I am doing, I will read up and investigate stuff, look at Wikipedia or whatever about how it works. […] I say knowledge hasn't been the limiting factor, but if there is something you don't know, then it won't occur to you to make something. So maybe that's spurious kind of point."
	30 to 49 (1F)	F07: "I see beauty in lots of things, but other people wouldn't. […] Like the screws that I showed you. You know everybody else would probably throw away. But I see them

		beautiful and keep them, use those for something. So it's about what you see, and what you can picture from them."
	50 and over (2Fs)	- F03: "I can see 3-dimensionally in my head, so that makes easier to do things." - F08: "I just feel with many products but not all, I can see a way of changing them to make them to have another life, which seems a good thing to me. […] We all have to be aware much of how to better use our resources and to reuse them. This takes creative time and thought and not everybody is prepared to do that. But I am."

The following table shows the full quotations on 'internet', 'social situation and cultural perception' and 'companions' as part of facilitators for upcycling from 4 interviewees each (out of 23).

Full quotations on 'internet', 'social situation and cultural perception' and 'companions' as part of facilitators for upcycling (*n*=4 each)

Facilitator	Age (gender)	Participant answers
Internet – information + sourcing materials + helping communities	Under 30 (2 Males)	- Male06: "Everything is accessible that I don't see any major barrier stopping me from doing literally anything. It doesn't require much effort to get information online." - M07: "One of the good things about Instructables is that a community of people is around it. There was a time a forum that was quite active and a lot of people who have this kind of technical knowledge, so I took some photos and posted 'I got a telescope, I repaired it and it looks like it. I can tell it is a bit off. But I don't know what to do to it.' And I got some really good information on there about kind of next stage of what I ought to do to get further and so. The next day, I went back to it and applied all of the stuff people have told me and then I got it more or less as good as new, which I wasn't really expecting when I started. […] I had the thought that radio-control plane as the hobby… all the stuff involved is very expensive, fragile, and complicated, and it takes a lot of time and a lot of effort. And all of sudden, I found this channel saying, 'Actually, no, like the part is cheap, you can just buy them on internet.' […] You can make stuff out of foam and glue gun and so that… that opened up a new avenue I haven't realised that it was accessible."
	30 to 49 (1F & 1M)	- Female05: "With the internet now, the things just come to you." - M02: "Internet has been amazing for information. It's really, I've kind of grown up with knowing about electronics as a hobby, and there are a few magazines. […] Some of them are out of prints, because of the internet. It's more interesting, and easier to search and reference things. […] Probably the internet as facilitating thing recently. I've learned so much from it. I've got involved with hackspace because my friends were giving a presentation at London Hackspace, so I looked at what London Hackspace was on the internet, found that there is Nottingham Hackspace. There was only one person, XXX, and I then contacted him, and from there we decided to do more. So I think the internet has certainly in the last 10 years changed how I do, what I do, how I am meeting up with other people, or just wanting to make things."
	50 and over	N/A
Social situation and cultural perception	Under 30 (2Ms)	- M07: "I think within the kind of Maker culture, it's just kind of accepted, you can use whatever material in your hands and make those pragmatic decisions if you are going to reuse something." - M11: "In Stoke, we are quite frugal people. In Stoke-on-Trent area, I am sure anyone would tell you that in the area. And we have this culture of… if we don't want to spend money, we probably would avoid it."
	30 to 49 (1M)	M05: "I think there's a Maker culture going on now which is going to bring back the idea of making things yourself and hacking things, DIY things. It's interesting. It's different from the old craftspeople purely making baskets and things from a scratch."
	50 & + (1M)	M04: "I think it's helpful to have a sympathetic partner. If your husband or wife doesn't like you doing things then it doesn't really work. But she is quite appreciative. She's very keen on birds. So she likes the bird boxes and she likes the TV stand a lot better. [bird boxes and TV stand made from upcycling]"
Companions	Under 30 (2Fs)	- F01: "I quite like doing with someone. A lot of my personal craft project, I don't, I do it by myself. But some of the project that we have been recently, we've been doing it as a couple, because, A: I want something that we do together for the house, and B: it's

		nice to kind of chat while doing a bit of sanding or painting. It's just nice to have a bit of, you know, like activities together. It's nice." - F02: "My partner is the same really. He's quite creative and he knows how to build stuff. So I always learn stuff from him. If I am not quite sure, then he teaches me how to use power tools and stuff. So, it's quite nice. We do some bits of things together, and you know it's quite nice to do things together."
	30 to 49 (1F)	F04: "I'd like more space, but equally I like company of having my husband in the same room tinkering with his project. Because it has nice feeling of… we are both working on stuff we want to work on, and a bit of fellow feeling, camaraderie, that kind of thing. So I like that. When I worked in the Makerspace a couple of times I did, it was nice knowing somebody else just in the next room doing their stuff, and it felt really positive and lots of good energy kind of thing. […] The most important factor is having the space, actually, would I? No. that's tricky one. Given that I do all my stuff in the living room which is small, I guess, having the company is actually more important to me, knowing that somebody else is there also making something."
	50 and over (1F)	F08: "It's finding people who are creative as well as constructional."

The following table shows the full quotations on 'interest and imagination', 'teachers' and 'spare time' as part of facilitators for upcycling from less than 4 interviewees each (out of 23).

Full quotations on 'interest and imagination', 'teachers' and 'spare time' as part of facilitators for upcycling (n≤3 each)

Facilitator (n)	Age (gender)	Participant answers
Interest & imagination (3)	Under 30 (2 Males)	- Male08: "My personal intuition? And interest." - M11: "I think you've got to have the time, you've got to have inspiration. They are really two important things."
	30 to 49 (1M)	M09: "My biggest influence is my interest and imagination."
	50 and over	N/A
Teachers (2)	Under 30 (1F & 1M)	- Female02: "My partner is the same really. He's quite creative and he knows how to build stuff. So I always learn stuff from him if I am not quite sure. Then he teaches me how to use power tools and stuff. So, it's quite nice." - M11: "I think if you've got the right people around you, and you've got the right tools as well, then those difficulties suddenly drop."
	30 to 49	N/A
	50 and over	N/A
Spare time (2)	Under 30 (2Ms)	- M07: "You need all of these things. If you are going to make something, you need space, you need time, you need materials, and you need tools. Because if you don't have all of those things, then you can't do anything." - M11: "When I started at the Hackspace, and when I started being involved with it, I had more spare time. So when I had time, that was a good condition. […] It's really difficult to say what's most important because I think you've got to have the time, you've got to have inspiration. They are really two important things."
	30 to 49	N/A
	50 and over	N/A

Appendix O. Full quotations from the Semi-Delphi workshop

The following table shows the full quotations on scalability of upcycling from 11 participants.

Full quotations on scalability of upcycling from the workshop (n=11)

Theme	Sub-theme	Participant answers
Current status of upcycling	Niche	"It's a bit too niche" "It is smaller, more personalised items."
Opportunities for scaling-up	Business as a better opportunity than households	"I think the thing that drives anything is money. Business viability is always going to be more influential than any kind of worthiness or motivation for environmental reasons which for the general public aren't there at the moment. It's quite a small proportion of people who are motivated enough to do it for the sustainability reasons, while businesses will be actually making a profit, and able to find items that you want because they are good items. They might happen to be upcycled, but ultimately it's about a good product I want at a good price. […] Upcycling can sometimes be irrelevant in terms of the actual consumer demand for that product."
	Growing interest in industry	"If you look at the cradle to cradle certification, it is becoming increasingly apparent primarily in business to business cases rather than business to consumer. They appear in Ecobuild and lots of other kind of trade shows. It gives you an indication that those companies are actually thinking about material efficiency and upcycling."
Facilitators for scaling-up	Far-reaching definition	"Upcycling could supply a reasonable proportion of the global demands for goods as long as upcycling incorporates the concept of reuse, repair and refurbishment."
	Cool & trendy perception	"I think it depends on if people perceive it as something cool or trendy, because when I arrived in the UK, I first of all did not understand why people were so into the British Bake Off for example. […] It can always be that the people can become interested in it and if the time has come for that idea, who knows."
Potential issues with scaling-up	Sceptical view on scaling-up through businesses	"It really seems to me that, often the business case is the exception, rather than the rule. What if upcycling primarily remains as a non-commercialised activity that households do? Maybe that's the way goods and services are provided in the economy and perhaps that is desirable if we are thinking of a shift towards an economy that is ultimately using less resources."
	Sceptical view on scaling-up in households	Fun vs. incompetence and inefficiency: "It's a marketization of practices that could be done at home. I can have fun right. You don't have to let companies do everything in a way. But in the end, I am actually really indecisive whether I would like to do it myself because I know that I don't have the competencies for many products. I would just make it worse. So why not give it to a company, which would be more environmentally efficient than me anyways." / "Upcycling is actually competition with manufacturing. […] And I think we should really think about what is more desirable in terms of efficiency and competences." Inconvenience: "It ties very closely to why companies exist in the first place: to basically make your life easier. We could do everything from scratch, but we don't because it's a hassle, so likewise with our recycling it's easier." / "I am actually a huge fan of division of labour." Trade-offs between upcycling and other activities: "We have to know where to decide, what I want to do myself. If we do upcycling, we must be aware that that takes time and we can't do other stuff."
	Potential conflicts with regulations (for refurbishment)	Electronics: "If you want to upcycle and make it mainstream, then you may have issues with regulations. If you are doing it yourself, I think there is no issues with that. […] But when it becomes mainstream, especially with an electrical stuff, you may have conflicts with regulations." Furniture: "It seems like the issue is if you are selling it. I was just thinking about the Royal Society of the Arts, the Great Recovery Project. They did a thing about furniture and found if you take the fire tag off of the sofa, nothing can be done with it anymore, because then it's not deemed as safe, and they have to throw it in the skip. So there are lots of little things around regulations there. So they are working on a project to try and maybe stamp the fire regulations on the base or inside of the sofa."

		Counter-argument: “British Heart Foundation will actually take electrical equipment and they will refurbish and sell. Presumably they have people there who do the testing.” / “They can test them and then they give you a warranty with the electrical items. […] If they are tested and you get a warranty it will do well I think.”
	Potential rebound effect	“Promoting something like upcycling can actually decrease product lifetimes in the end, because it enables a company to have, for example, trade-ins. So for example, you say, ‘Please Sir give me your phone after one year. Don’t care about the environmental effects. We will recycle. So it’s perfectly circular economy model.’ You may reduce the amount of waste, but in all other environmental matters you would fall far less.” / “Products take-back in the circular economy guarantees that their own materials return. […] But it reduces the lifetime of the product, because if it doesn’t reduce that then there is no way they are going to make a profit.” / “We might be creating a vicious circle here or reducing the life span just to feed the recycling industry.”

The following table shows the full quotations on the discussions on the first intervention, improve access to, and facilities and services of community workshops with space, tools, materials, and training for diverse demographic populations, from 11 participants.

Full quotations on the discussions on the intervention 01: Community workshops

Theme	Sub-theme	Participant answers
Suggestions	Community-driven	“Perhaps it should start at a lower level, at community level or a small group of friends […] and then you do stuff to upscale that towards local authorities […] but I think initially it should be community driven.”
Issues	Lack of awareness and interest	“I have got personal experience of where those things do exist, a lot of people just don’t take them on, even when they are free. So free workshops on upcycling, and like three people turn up, even though it’s widely promoted. So what I think later on, if the demand grows and awareness raises, then this would be really important […] but at the moment the demand to actually take part in those kind of activities largely isn’t present in the population.” / “They [community organisations] are fundamentally run by volunteers in the local community, and they run workshops on, upcycling, bike repair, furniture repair, and things like that, and although they do promote it fairly well in the community […] and they are very low cost […], they are always really poorly attended. Even though they get very good feedback from people who do so, […] they don’t seem to get new people up.”
	Ineffective alone	“Skills development alone is not effective. It’s benefiting current practitioners only.” / “The main contribution might be the sense of community [if it’s implemented alone].”
	Requiring an established community	“If you want to have a large scale transition, I think it’s completely ineffective. I think this is a really effective intervention for when there is already a community in a way. I think within a certain lifestyle group this is essential for the communication and exchange of ideas, but beyond that, I think they will not induce any change for other people.”
	Limited utility	“The existing workshops provide limited utility. It’s male-led and electronics-dominant. It has limited access and usability for wider demographic people.”
	Limited funding	“Who is going to fund it? There are limited funding sources.”

The following table shows the full quotations on the discussions on the second intervention, design and provide toolkits for novice upcyclers, from 11 participants.

Full quotations on the discussions on the intervention 02: Toolkits for novice upcyclers

Theme	Sub-theme	Participant answers
Suggestions	Elements of the toolkits	Essential tools and instructions/ideas/manual/guidance: "What does your toolkit contain? Is it simply tools such as scissors, pliers, whatever, or is it instructions, ideas and a manual or guidance, that kind of thing as well?" / "What is essential?" Fixing toolkits and online platform: "iFixit with toolkits and online platform could be a good benchmarking target."
	producers' responsibility	Humorous upcycling ideas on packaging: "I am wondering if ideas for upcycling could be included on products in the same way as disposal information is given. This is potentially as part of the kind of the producer responsibility. You could dispose of this product in this way, but also you could turn it into something else. So just ideas, it could be relatively humorous, but as a communications campaign for companies, and as a way to reduce their own landfill." / "[…] so this water bottle, that's probably recyclable, and recyclability instructions on it, but they could also have – have you thought of turning it into a flower pot? That kind of, giving people ideas." / "I have seen one or two companies where they have put stuff on, but it has been usually in a humorous way […] something like Innocent." Upcycling suggestions and guidance as a short-term strategy: "Companies may be able to provide upcycling suggestions and guidance for the end of product lifetimes […] It would be suitable as a short-term strategy as this would not challenge the current business model to produce the initial product"
	Link to workshops	"could be part of the workshop."
Issues	Vagueness	"I can't see this at all. I just can't quite picture. I can't see how this would work." / "What do you mean by toolkits?"
	Skills issue (impractical for novices)	"This was years ago, where you could pick your i-pod apart, when they could still be made to come apart, and you could take the battery out and put a new battery in it, I was very proud of myself for managing to achieve that, but in the process of doing it, it still damaged something in the i-pod, and it only lasted for about another year. […] It's, I think, a difficult thing to do, and to feel that you have the confidence to do so."
	Ineffective alone	"Skills development alone is not effective. It's benefiting current practitioners only."

The following table shows the full quotations on the discussions on the third intervention, operate a reuse/upcycle centre with a product collection service aligned with usual waste collection service, from 11 participants.

Full quotations on the discussions on the intervention 03: A reuse/upcycle centre

Theme	Sub-theme	Participant answers
Benefits	Getting the right materials	"We mentioned the problem earlier of actually getting the right kind of materials, to be able to upcycle, which is why potentially it is only going to be craft or very niche. But that's because you can't guarantee materials. […] If you are not aligned into conventional collections and recycling, then it helps mainstream it [upcycling]. It does make it more obvious recycling centres do have facility you can just drop stuff off there first rather than stick it in a bin."
	intercepting current behaviour	"Sometimes literally physically by the guys on the site, saying "Oh, hold on a minute, Madam, you need to put that in there." […] you can intercept and change the path of their behaviour into a different one because it is physically in the same place. […] So they might have been intending to throw those things away, but when they get to the site, the fact that there is another option and that it's nice and clear, and potentially encouraged by the signs, it can change their behaviour at the last minute. […] I think it is quite a powerful one in terms of practical implications."
	Efficiency and effectiveness	"seems more effective if people can simply drop off old items and professionals/charities upcycle and sell them"

Suggestions	Benchmark existing centres	"Quite a few of them around the country have reuse centres in the same location as the household waste or recycling centres. Sometimes it is run by the local authorities, sometimes they are run by third sector organisations. You have it on the same site. That's quite big and quite common around the country. Not all of them, but there is quite a few of them." / "It is happening now around the country but it's not everywhere."
	Halfway house	"a halfway house between a recycling centre and a charity shop where items could be repaired/upcycled"
Issues	Potential rebound effect	"People who are not really interested in upcycling or recycling or generally pro-environmental activities might think like, 'Hey, somebody will pick it up and upcycle and do something nice with it.' So they might not really use it as long as they actually could do, and they just give it away because of convenience. […] So I think that's a bit almost dangerous as much as it can be a great opportunity." / "Can become 'moral offsetting' for those who consume high number of resources?"

The following table shows the full quotations on the discussions on the fourth intervention, design and provide a service model for improved provision of used materials, components and products, from 11 participants.

Full quotations on the discussions on the intervention 04: A service model for improved materials provision

Theme	Sub-theme	Participant answers
Benefits	Good supply for SMEs	"This one could be useful. If you are a small business and you want to upcycle caps of drink bottles and you want a thousand and they will have to be purple for my new clock or something, then a service model provider would be a company whose job is to find that thousand purple bottle tops and provides me with them." / "If someone decided a way of making a steel chair out of a car door, or something, then you are talking bigger business. You could do a one-off and sell it at an arty farty shop for a lot of money, but you want to build it up into this kind of a business, to sell a hundred of these chairs, but you might not be the kind of person who wants to faff around in a car breakage shops, so I want someone who can supply me a hundred of, for example, left hand doors, and someone else could be the supplier of that in theory."
Suggestions	Differentiate from the reuse/upcycle centre	"Previous one was collection, this is more the service and delivery. This is about providing the stuff." / "This is about matching up people who need the materials to make whatever they are making."
	Benchmark existing business models	Mobile phone trading companies: "There is an example in the mobile phone sector. There are a lot of trading companies. They mostly get them for recycling but I think they could also just take them apart and reuse certain parts for upcycling or remanufacturing." National Industry Symbiosis: "National Industrial Symbiosis program of matching was part of International Synergies. It has been dormant for a few years." / "It is what used to be called waste exchange as well. […] basically putting people who got stuff that they want to get rid of that would normally cost them money to get rid of, to someone who might actually want to use it." / "Matchmaking"
	Local level	"will work at the local level." / "Detail models should evolve to suit local needs."
	Funding	"Some innovative financing schemes could help."
Issues	Quantity	"Increasing amount of parts/materials would need to be provided by business, but would be difficult thing to achieve"
	Cleaning and standardisation	"It raises for me the issue of standardised materials and components out of random and possibly dirty materials and components." / "You have got quite a lot of random materials, so that would be very time-consuming for very little profit. […] So again, it's the value of the material that drives a business to do that."
	Legal issues	"Potential legal issues to be sorted out"

The following table shows the full quotations on the discussions on the fifth intervention, enrich the curriculum in art and design at schools, colleges and universities to incorporate advanced upcycling skills and knowledge, from 11 participants.

Full quotations on the discussions on the intervention 05: Curriculum enrichment

Theme	Sub-theme	Participant answers
Suggestions	Early year education	"I think it should start at nursery or inception or that sort of stage when children are more open to things. I think that has been done with recycling. […] But it's going to be generational sort of timeline." / "Kids are usually very creative and I see great potential to facilitate a strong interest in upcycling early on."
	Creativity and well-being framing	"You could teach it or put it in place in the education curriculum as an environmental thing and a green thing, but you could also just bring it in as, creativity and well-being, and there are other ways to interest people in doing these things without having to push a green agenda."
	Upcycling as default design	"I thought the most important bit of that was the design bit, in terms of almost moving to a position where designing from existing materials or waste materials becomes the default rather than something you sort of add on as an afterthought and try and change things. It is almost making the change in how we design things and make things in the first place, and moving the default position of sourcing from raw to existing. Making upcycling the norm or default position of designing and making." / "Can be a central aspect of design education – connecting design theory and practice with commercial considerations."
	Design for modularity and reparability	"I thought you were referring more to people who are going to be product designers. I guess designing products for modularity and reparability so that products themselves have the potential to be upcycled at a later stage, at the end of their first life. Design for upcyclability in the way that you are designing for durability and for reparability. […] I think that would have the potential to increase upcycling at the end of life of the product, considering what components you could keep for what purposes."
	Engineering education for remanufacturing industries	"I think in general in the whole remanufacturing industries, there is a lot of evidence that there is a lack of skills that many manufacturers just don't do the investment because they don't have the people to do it, and you need to have a lot of competences to change your business model in this respect."
	General education for all	"I don't think it should just be art and design, but enable non-creative to get involved in upcycling products from a more practical (+potentially engineering) perspective."
Issues	Slow and no guarantee	"A very slow process and no guarantee that upcycling would become mainstream due to the competing pressures of everyday life."

The following table shows the full quotations on the discussions on the sixth intervention, organise community-based upcycling family events, workshops and training sessions, from 11 participants.

Full quotations on the discussions on the intervention 06: Community events

Theme	Sub-theme	Participant answers
Suggestions	Different language	"A friend of mine runs some reuse workshops [on electronic appliances, mobile phones, laptops] and they are always quite well attended […] Maybe that is the big difference between upcycle and reuse."
	Multiple funders	"Bicester one is funded by a combination of the local authorities, and they have also got grant funding from WRAP (Waste & Resources Action Programme) for some of their activities, and they get a little bit of local sponsorship from businesses, but not very much." / "Existing NGOs, for example in transition movement, will be interested"
	Benchmark existing events	"It's already happening like Re-use network in London." / "I am aware of others where they are just done by the community for the community. So they are always free. People doing it with other people."

The following table shows the full quotations on the discussions on the seventh intervention, organise upcycling competitions in schools, universities, communities and industry, from 11 participants.

Full quotations on the discussions on the intervention 07: Competitions

Theme	Sub-theme	Participant answers
Suggestions	part of school curriculum	"If you educate them, then you can organise competitions at schools, universities, communities, etc. That might be useful." / "could be linked to the curriculum in art and design." / "I guess primarily to focus on educational institutions with local authority support from a national ministry of education."
	Festival	"an upcycling festival could be more fun."
	Role of Design Council	"there could be the role for the Design Council. For funding?"

The following table shows the full quotations on the discussions on the eighth intervention, provide advice and consultancy on how to start a business based on upcycling, from 11 participants.

Full quotations on the discussions on the intervention 08: Business advice

Theme	Sub-theme	Participant answers
Suggestions	Target start-ups (than established businesses)	"If you talk to start-up entrepreneurs when they are in a very fluid state of establishing a business, you impose the idea of circularity and resource efficiency at that point, it is much easier to coach that kind of behaviour than it is to try and graft it into existing business, generally speaking."
	Add-on	"Easily integrated into the existing SMEs support"
	Providers	"Start-up centres, incubators, university career centres also to include colleges"
	Best practices	"Best practice guidelines, exemplars, etc."
	Link to business schools	"It's the kind of thing that all business schools would like as good case studies. They need to have a good narrative like cardboard to caviar, really nice story conveying the right sort of message."
	Approach it as profitability	"I would rephrase that in terms of how upcycling and reuse can contribute to profitability. So it's more what upcycling and reuse can do for me as a business person rather than trying to persuade business people to do upcycling [for environmental reasons]. Flipping it the other way around in terms of how it's approached to businesses."

The following table shows the full quotations on the discussions on the ninth intervention, design and provide effective communication materials to explain the benefits of upcycling to the general public and industry, from 11 participants.

Full quotations on the discussions on the intervention 09: Effective communication materials

Theme	Sub-theme	Participant answers
Benefits	Easy win	"Easy win – campaigns such as Love Food Hate Waste have had a lot of visibility"
Suggestions	Influence culture	"Communications should be part of that cultural change process as a part of getting the idea in people's head that there is a potential second life which is not necessarily the same as the first life items."
	Trigger interests and raise awareness	"Before this becomes worth putting a push on it's got to be, you have got to get people seeking it first, because otherwise the information is not going to be making much difference because people are not looking for it." / "If you first raise awareness, and then you communicate on a broader scale, then it's probably useful [to have communication

		materials], but if you just send out some emails, or send out some toolkits, or communication materials, it might be almost completely useless."
	New digital media	"I would say Youtube is better than handbooks and brochures." / "I think there is quite a bit of stuff online already about how to upcycle lots of different things. If you are seeking it, you can already find a lot of stuff, but the key thing is most people aren't seeking it."
	Specific	"Need to be very specific – a broader behaviour change campaign unlikely to have any impact"
	Good story	"One of the best examples of what would upcycling gets trotted out in a circular economy thinking is the cardboard to caviar. […] It's quite a well-known story […] that ties in a lot of the things that we are talking about."
	Pitch money saving aspect	"Somehow everyone is feeling broke at the moment, and there has been a slight trendiness around making do and being broke. […] There is an evidence that the middle classes are now shopping out of Aldi. So there is a sense that cost saving is now quite acceptable to a lot of people. So pitching this in terms of money saving or thriftiness might be some attraction there to the individual upcyclers as well I think. […] cost savings as in that it would be cheaper to upcycle this item than buying a new one, if it's presented in a relatively trendy way, with the figurehead person, it might be attractive to people."
	Link to the peak home furnishing	"Another big retailer mentioned the fact that we had reached peak home furnishings, so we have too much just right now. […] Upcycling messaging could be kind of latched onto this peak furnishings, kind of 'You don't need more furnishings, but with the furnishings you currently have, how they can be upcycled, changed, reused and so on." / "Or 'Fancy a change? Fancy a change doesn't have to mean buying a new lot. You can change what you've got."
Issues	Knowhow	"I am working with this biggest furniture retailer in the world, and they actually recently became interested in upcycling but they have no idea how to communicate about it, or how to provide their customers information. So for them it's something very new, and they see some potential there, but they don't know how to communicate it."
	Doubt in effectiveness	"I have to say that I get so many emails every day, so many guides and in general communication materials, but it's really difficult to actually say how effective it has been to change my daily behaviour." / "Unlikely to be effective in mainstreaming due to the competing pressures and practices of everyday life." / "Information campaigns alone have shown to not be very effective and need to be aligned with other strategies"
	Short-term effect	"Our research project takes three years, and my supervisor at the very beginning told me it [initial behaviour change] doesn't mean after three years people still change their behaviour again. […] It [monitoring at the point of interventions] would just give you an indication of how effective your research or project was. You can't really take it for granted that they will continue their changed behaviour." / "Until it becomes a habit that lasts forever, it [behaviour change] is just a temporary shift that will be changed back to the original behaviour." / "And you have to be told over and over and over again."
	Measuring the impact	"There is this whole challenge around how you actually measure the effectiveness of communications, and it's really difficult thing to measure the actual impact of what communications lead to. So things like 'We got this number of web hits', 'We gave out these many leaflets', or 'We got these many people coming to our workshops', they are all good to know, but none of those is an indication of whether the behaviour actually changed. You have to follow up with that monitoring of the people involved, or the actual behaviour."

The following table shows the full quotations on the discussions on the tenth intervention, design and provide a wow experience as an upcycling promotion campaign, from 11 participants.

Full quotations on the discussions on the intervention 10: A wow experience

Theme	Sub-theme	Participant answers
Suggestions	Physical shops and exhibitions	"I see some wow things on the internet, things that are upcycled in a way that is so creative that you will think wow. I have never seen them physically on the ground. You see pictures of people that have made amazing things out of little things but they are not mainstream. They are usually sort of one-off things. I see them because I look for things like that, but how you get those in front of the general public is one of the problems."
	Wow commercial products	"I remember when the very first Freitag bags [unique bags created out of old truck tarps] appeared in the market, there was this wow effect because everyone had his own bag, and they are also very expensive. I don't think upcycling is very often related to luxury but it's in the luxury segment, so the wow effect."
Issues	High cost	"I don't know how feasible it is because it seems to me at least quite expensive."
	Effectiveness and efficiency	"Likely to reach only a small audience and need to be repeated regularly in many areas"

The following table shows the full quotations on the discussions on the eleventh intervention, produce TV shows and other inspirational media to share the best practices, from 11 participants.

Full quotations on the discussions on the intervention 11: TV shows and other inspirational media

Theme	Sub-theme	Participant answers
Benefits	Long-term effect	"TV and popular media can significantly influence public perceptions over a longer time scale" / "Yes, consider the impact of the choir and bake off"
Suggestions	High profile designers	"I think this is about getting high profile designers like George Clarke." / "Or Kirstie Allsopp."
	High profile projects	"There is an interesting guy who has gotten involved in a housing project, taking some derelict houses in Liverpool and Manchester, and housing ex-soldiers. We know the problems that veterans have physical and mental health issues, and in that housing project, they refurbish houses that they are going to live in. So those kind of high profile projects, I think could be the sort of vehicle that would actually really raise the awareness, and also raise issues not purely about environmental sustainability but also about social and economic stuff."
	Celebrity involvement	"How you make something that is not mainstream become trendy like the British bakeoff can be done by using famous people. And the key thing is that it is fun and inspirational, rather than it being gritty and worthy, which never works."
	Norm-setting	"The nature of the trend is that it goes down again." / "That's really an issue. We must really tackle the norms underneath it. […] If we raise awareness [for the short-term trend] it would even be negative in the long term because it is not trendy anymore. We should be really careful there."
	Steady, regular show	"It's probably how you keep the ball rolling. […] You've got TV programmes that run for a long time like Saturday kitchen and things like that. So you could do something similar, like Saturday upcycling," / "Or The Great British Upcycling, and keep it rolling for ten or twenty years, why not? If there's real interest from people and provided it was properly framed, then it would not be just trend, it would be entrenched into the culture."
	Connect to existing shows	"Potential to connect with existing programmes (e.g. Britain's empty homes)"
	New digital media	"Youtube channels a good means of communication and so are Pinterest, Life Hacks, Tumblr, etc."
	Word-of-mouth	"If we don't have the money to do actually some TV shows or projects, then we can engage some opinion leaders and just spread the words."

Issues	One-off trend in celebrity involvement	"I think there is a problem that some celebrities are campaigning one year for X and then next year for Y. And it just makes it a one-off trend. So one year it's that, and then it's gone. It doesn't necessarily become a lifestyle."
	Measuring impact	"If Kirstie featured making a certain thing out of fabric or whatever, was there any perceivable change? Were people then going out and buying the cotton that you needed to make something? Is there any way of measuring whether any one actually went and did it?"

The following table shows the full quotations on the discussions on the twelfth intervention, provide tax benefits and subsidies for upcycling-related businesses, from 11 participants.

Full quotations on the discussions on the intervention 12: Tax benefits and subsidies

Theme	Sub-theme	Participant answers
Suggestions	Link to EU Circular Economy	"I think at the EU level, the circular economy framework is really big at the moment, and they have just started the next big framework and research. I think this fits perfectly into this kind of thinking of political agenda. […] I think maybe there is even a momentum at the moment particularly after times of crisis because circular economy is also used as a means to increase economic growth."
	Different pricing	"I don't think you have to subsidies a specific industry. All you have to do is actually to make resources more expensive and labour cheaper."
	Tax on materials and energy use	"Tax on the materials and energy uses would be super effective." / "Having the upcycled products more competitively priced whereas at the moment they are often not. […] If the laptop cases that are made out of raw materials were taxed, and this company didn't have that tax because they are reusing materials, that might equal the balance a little bit more even if it didn't cancel it out."
	VAT reduction	"A reduction on VAT in relation to repaired/recycled products and the materials needed to complete this would be essential."
	Grants or favourable loans	"Grants or favourable loans for companies/NGOs could be useful. Not just upcycling businesses but also businesses of supplying used materials or offering a marketplace for the upcycled goods"
	Benchmark other subsidies	"See renewable subsidies such as FiTs (Feed-in Tariffs) for smaller projects and ROCs (Renewable Obligation Certificates) for larger projects"
Issues	Politically unfeasible	"Unlikely at the moment." / "On the feasibility, probably it's not feasible, not with this government." / "Very hard to get the political consensus on this (i.e. currently politically unfeasible)"
	Not major economic barrier	"Economic barriers probably not the main barrier (as opposed to the time and effort required, specific skills, knowledge or materials)"
	Compete with recycling	"Not sure how you could justify this without providing unfair intention compared with recycled products."

The following table shows the full quotations on the discussions on the thirteenth intervention, provide grants and subsidies for upcycling-related research and initiatives, from 11 participants.

Full quotations on the discussions on the intervention 13: Grants

Theme	Sub-theme	Participant answers
Suggestions	Grants in waste management	"I can see that happening. There are grants in the context of waste managements, WRAP (Waste & Resources Action Programme). Not much money, but there is some money out there and it's important."
	Link to circular economy	"should be linked to wider aspects of the circular economy."
	Research questions	"Research questions for future grants could be… how do you upscale upcycling." / "The business cases to make it attractive to make people put money into it. Is it going to make them money ultimately?"
	Target items	"More appropriate for items that have a high environmental cost to recycle"
	Small-scale demonstration	Suitable for small-scale demonstration projects"
	Professional companies	" More suitable for research by professional companies"
Issues	Less effective and achievable	"Increased attention from research council may be helpful but other areas of sustainability/climate change/low carbon research would take priority as they would be more effective and achievable"

The following table shows the full quotations on the discussions on the fourteenth intervention, demonstrate high quality and value of upcycling through commissioning upcycling projects by famous artists and designers, from 11 participants.

Full quotations on the discussions on the intervention 14: High-profile commissioned projects

Theme	Sub-theme	Participant answers
Suggestions	Align with communication materials, TV shows, and wow experience	"I don't think that's that different to the other, awareness raising, culture changing aspirational projects that we have been discussing." / "potential to connect with existing TV programmes (e.g. Britain's empty homes)
	Position as ordinary goods than luxury	"You have got this installation by a famous artist, which only someone very high could buy. I don't think that would necessarily help. Maybe it will have the opposite effect." / "I remember reading that the 2012 Olympics resulted in less people doing sports because throughout the Olympics people just kind of thought, 'Some people can do things much better than me, why should I bother?' […] So maybe there is a risk of people thinking 'Oh, these are clever, talented artists able to do upcycling. It's not for me. It's for the professional.' So there is always a risk with that."
Issues	Ineffectiveness	"Probably reach a small audience and may not actually encourage participation."

The following table shows the full quotations on the discussions on the fifteenth intervention, demonstrate upcycled goods as a new social norm or standard by changing government procurement policy to favour upcycled goods, from 11 participants.

Full quotations on the discussions on the intervention 15: Government procurement policy change

Theme	Sub-theme	Participant answers
Benefits	Essential in the long term	"Due to the general lack of trust in Government that they do not play their part or take its own advice + public procurement is a significant proportion of spending and emissions"
Suggestions	Basic stationary stuff	"Pens, basic stationary stuff can be easily be [replaced with upcycled goods].
	Laptops and computers	"I think it would be quite easy for the government. For instance, laptops or computers, they need central provision, like centrally regulated type of thing. And every single computer needs to be of the same level of technological standards. So they have to replace all of them." / "I think remanufacturing would be very effective because you could just take all of the computers, remanufacture them, maybe not all of them at the same time, but within two or three weeks you would have them and at higher standards. I think that would be perfectly feasible in my opinion."
	Office furnishing	"I knew a company in London, the guy who owns it is a bit of a hippie and he designed the whole office from reclaimed. He commissioned a designer to design the whole office from reclaimed materials in terms of the desk, lights, and so on. I guess his employees who are not necessarily hippies were exposed on a daily basis to a reclaimed office space whether they liked it or not." / "Do what I do, not what I say sort of thing. If your employer is furnishing the building with upcycled materials or reused materials, rather than everything being new by default, it becomes the thing that you see around you. So actually seeing it happening, seeing other people doing it, whether it's business or other individuals, helps you know. The behaviour becomes more visible in everyday life."
	More visibility	"Sometimes I think about how visible those things are. So the example of the computers, if you go to work and you are working in an office, you don't necessarily know that you are working on a computer that's been prolonged because you are just working on a computer that they gave you when you started. So one of the things is about making these behaviours more visible so that people do realise and that is the norm." / "Buying second-hand clothing from Oxfam is invisible behaviour compared to me putting my recycling out on the street. […] If we as consumers see them [reusing behaviours] happening around then they can become the norm, but often they are not visible so it's quite difficult."
Issues	Doubt in effectiveness	"Effective in reducing environmental impacts maybe, but not sure about influencing 'individual' upcycling" / "Not sure if it will change social norms – may help green image?"
	Feasibility	"Difficult to achieve for cost, bureaucracies, etc. – hard enough to achieve with simpler recycled/low carbon goods" / "Supply chain innovation is difficult to achieve unless linked to relative initiatives/standards (e.g. ISO) and requires all participants to be aware of the financial benefits; and government lacks the capacity to do this." / Extensive lobbying necessary which is tedious and costly."