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Predictors of Upcycling in the Highly Industrialised West: A Survey across Three Continents of Australia, Europe, and North America

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Abstract: Upcycling, as a way to reutilise resources, offers a promising alternative to production and consumption based on virgin materials. Despite the growing academic and industrial interest in recent years, there is a lack of large-scale cross-country or cross-regional studies that systematically investigate influencing factors for consumer upcycling behaviour. By drawing on social psychological theories of interpersonal behaviour and planned behaviour, this study investigated predictors of upcycling behaviour in five highly industrialised countries of three continents: Australia, Canada, Germany, UK, and USA. Results showed that intention and perceived behavioural control (confidence in abilities) were the most important factors for upcycling. Theoretical and practical implications from this study are discussed in the context of efforts to scale up global upcycling.

Keywords: circular economy; scaling up; social psychology; sustainable behaviour; sustainable consumption; upcycling

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1. Introduction

Mass production and consumption based on the use of virgin materials have been the mainstream practice for decades across industrialised countries. However, this linear system of take, make, use, and dispose is not sustainable due to limited resources and ever-increasing waste. Global recycling rates remain low–9% in 2015 [1]. More importantly, recycling is often regarded as 'down-cycling,' as traditional recycling processes often degrade the properties of waste materials, resulting in reduced quality and value by, for example, using additives or mixed materials [2]. Upcycling, on the other hand, is a promising approach to resource reutilisation or recovery because, through the creative reprocessing of used or waste materials, an old product/material can gain a second life as a new product/material of equal or higher quality or value than the compositional elements [3,4]. For industries, it is a sustainable practice that not only reduces environmental impacts, but also reduces material costs and creates new employment opportunities [5]. For individuals, upcycling is a sustainable consumption behaviour that could contribute to psychological and financial well-being [6].

Despite these benefits, upcycling remains a niche practice in both the production and the consumption domains. Researchers, in their attempts to rectify this situation, have been looking into technical and business solutions, and have produced an increasing number of publications. Among these, some of the most heavily researched areas include how to apply various upcycling approaches to the management of end-of-life plastics [7–10], how to apply upcycling practices in the fashion and textile industry [11–14], and how to upcycle a variety of bio wastes into different types of products [15–18]. Other waste streams have been studied much less frequently, such as those for electronics [19,20], glasses [21], papers [22,23], and woods [4,24].

Research on individuals' upcycling behaviour in the consumption domain, on the other hand, has received relatively little attention. Apart from a few conceptual papers [6,25], only a small handful of empirical research studies have looked into the predictors of upcycling [26–29]. While these reports have provided useful first insights, their focus on particular countries/regions, and their relatively small sample sizes, limit the generalisability of their results. In order to promote and scale-up individual or household upcycling, we do not only need to understand what factors may facilitate the behaviour, but we also need to test the predictive power of these factors across different countries, which could shed light on possible future large-scale interventions. To this end, the present study proposed and tested a theoretical model of the predictors of upcycling behaviour in five highly industrialised countries: Australia, Canada, Germany, UK, and USA. We chose these countries due to a high level of English proficiency and comparable GDP levels—Germany and UK as the top two high GDP countries in Europe [30], and USA and Canada as the top two in North America [31]. The socio-economic similarities across the countries allow for a meaningful comparison on individual levels.

1.1. Upcycling and Circular Economy

Upcycling has been defined in many different ways, such as a process through which the quality/value of the final products is upgraded [10], the creation or creative modification of any product out of used materials in an attempt to generate a product of higher quality or value than the compositional elements [6], and the practice of taking something that is disposable and transforming it into something of greater value [32], to mention a few. Despite the differences in expressions, these definitions all emphasise creative, transformative, and value-adding processes for creating a new product/material out of waste/used materials or products. These processes vary and could take many different forms, such as creative redesign, refurbishment, remaking, remanufacturing, repair, repurposing, reuse, upgrading, and advanced recycling in different disciplines and industry sectors. The latest research on upcycling focused in particular on material-level upcycling (advanced recycling), mostly addressing plastic waste: for example, metal powder upcycling in additive manufacturing [33], plastic chemical upcycling [34–37], agricultural waste upcycling into membranes [38], post-consumer textile upcycling into different polymers or organic compounds [39], and plastic (e.g., polymer, polyester) upcycling with different catalysis [40–42].

Upcycling and 'circular economy' (CE) share conceptual similarities, as both emphasise material circularity [43–45]. However, the two differ in that CE includes design and new product development practices based on virgin materials, contributing to future material circularity, whereas the starting point of upcycling is always used materials, components, or products. Hence, upcycling can be conceived of as a sub-category of CE and is potentially more pertinent to designers, manufacturers, the waste management sector, and creative consumers (or 'prosumers') who deal directly with used/waste products, components, or materials.

1.2. The Theory of Interpersonal Behaviour and Planned Behaviour

This study (cross-country survey) adopted a combination model (Figure 1) based on the Theory of Interpersonal Behaviour (TIB) [46] and the Theory of Planned Behaviour (TPB) [47] in social psychology. These two theories were chosen for their wide applications in predicting different behaviours, such as technology adoption [48], sustainable consumption [49], and car use [50]. The combination model was tested with UK participants and was shown to be able to predict upcycling tendencies [29]. Attitude, social factors, and perceived behavioural control were theorised to predict behaviour (i.e., frequency of upcycling) both directly and through intention. Intention and perceived facilitating conditions were also hypothesised to predict behaviour.

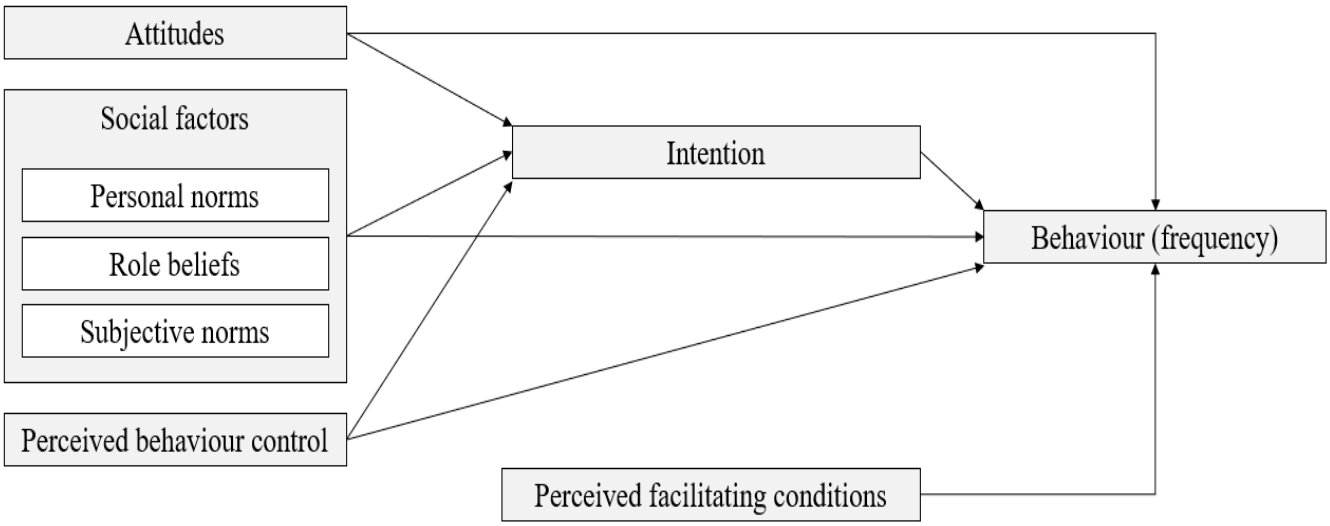

Figure 1. Theoretical model (combination model between TIB and TPB adopted from the UK study [29]) as a starting point of this study.

Attitudes are defined as the overall evaluation of performing a behaviour [51]. Social factors include personal norms, role beliefs, and subjective norms. Personal norms refer to the feelings of personal obligation to perform the behaviour [48]. Role beliefs are beliefs about the appropriateness of the behaviour regarding one's social roles [50]. Subjective norms are the perception made by one's important social circle that the behaviour is correct, appropriate, or desirable [29]. Perceived behavioural control is the individuals' perceptions about how much control they have over performing the behaviour—i.e., confidence in their abilities to perform the behaviour [51]. Intention is the intention to perform the behaviour. Perceived facilitating conditions refer to factors that the individual perceives as being conducive to carrying out the behaviour, such as whether they have the knowledge, skills, and materials needed for upcycling [3].

2. Materials and Methods

2.1. Procedure and Research Instrument

The online survey was conducted in April 2021 using an online participant recruitment platform, Prolific (https://www.prolific.co/ (accessed on 11 January 2023)), for sampling, and Google Forms (https://www.google.co.uk/forms/about/ (accessed on 11 January 2023)) for survey administration, and targeting consumers from the three continents of Australia, Europe (Germany and UK), and North America (Canada and USA). The survey began with an introduction explaining what upcycling is and what the survey was about. Then an attention test and a nationality question were asked (screening). The main survey questions are listed in Table 1. Most questions are from the previous study with the UK participants, and they are a proven instrument demonstrating high internal validity [29]. One new question has been added regarding the COVID-19 pandemic situation, as "Did COVID-19 pandemic situation affect how often you upcycle items?" with answer options of: (i) yes, I became engaged in upcycling 'less' frequently; (ii) no; and (iii) yes, I became engaged in upcycling 'more' frequently. At the end of the survey, demographic information was collected (gender, age group, occupational area, and employment status) to see if there are any group differences based on the demographics. The online survey (structure and questions) was designed and developed on the basis of the previous UK study [29], which was rigorously piloted, pre-tested, and validated by specialists in consumer study and quantitative social research. The adapted version used in this study was further reviewed and validated by the authors, who have experience and expertise in quantitative consumer research and social psychology. Upon completion of the survey, the responses were recorded on Google Forms and respondents were provided with the unique code in

order to be paid for their participation in the study (£0.38 for 3 min for survey completion based on £7.65/hour—under the minimum living wage in the UK, as a token of thanks).

Table 1. Factors, questions, and answer options in the survey.

Factor	Questions (Items) and Answer Options
Attitudes	How much do you agree or disagree with the following statements? To me, taking part in upcycling is 'good'. To me, taking part in upcycling is 'pleasant'. To me, taking part in upcycling is 'worthwhile'. (a) (1: strongly disagree–5: strongly agree)
Perceived facilitating conditions	To what extent do you think: 'access to tools' has facilitated your upcycling? 'used or waste products, components, or materials available' have facilitated your upcycling? 'teachers or helpers' have facilitated your upcycling? 'skills and knowledge' have facilitated your upcycling? 'inspiration' has facilitated your upcycling? (1: not at all–5: to a very great extent)
Personal norms (social factor 1)	How much do you agree or disagree with the following statement? I would 'feel guilty if I was not upcycling', especially when used materials are available and would become waste otherwise. Upcycling 'reflects my principles' about using resources responsibly. It would be 'unacceptable to me not to upcycle', especially when used materials are available and would become waste otherwise. (1: strongly disagree–5: strongly agree)
Role beliefs (social factor 2)	How much do you agree or disagree with the following statements? Upcycling fits my role in 'my family'. Upcycling fits my role in 'my community'. Upcycling fits my role in 'my friendship/support networks'. (1: strongly disagree–5: strongly agree)
Subjective norms (social factor 3)	How much do you agree or disagree with the following statements? Most people who are important to me think that 'I ought to' upcycle. Most people who are important to me 'expect' me to upcycle. Most people who are important to me 'would approve' of me upcycling. (1: strongly disagree–5: strongly agree)
Perceived behavioural control	How much do you agree or disagree with the following statement? For me upcycling would be possible. If I wanted to, I could upcycle. Upcycling would be easy for me. (1: strongly disagree–5: strongly agree)
Intention	How much do you agree or disagree with the following statement? My likelihood of upcycling is high. If I have the opportunity, I will upcycle. I intend to upcycle. (1: strongly disagree–5: strongly agree)
Frequency of upcycling	Approximately how often have you upcycled items in the past five 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)

2.2. Respondents

After data cleansing (deleting those responses that failed the screening), a total of 1744 responses (351 in Australia, 353 in Canada, 341 in Germany, 349 in the UK, and 350 in the USA) were processed for analysis. See Table 2 for demographics of the survey respondents.

Table 2. Demographics of the survey respondents (n = 1744).

Demographic Factor	Category	Frequency (Percentage)
Nationality	Australia	351 (20.1%)
	Canada	353 (20.2%)
	Germany	341 (19.6%)
	UK	349 (20.0%)
	USA	350 (20.1%)
Gender	Female	885 (50.7%)
	Male	834 (47.8%)
	Others (non-binary)	25 (1.4%)
Age group	Under 30	785 (45.0%)
	30 to 49	781 (44.8%)
	50 and over	178 (10.2%)
Employment status	Full-time employment	811 (46.5%)
	Part-time employment	353 (20.2%)
	Self-employment	170 (9.7%)
	Not currently in employment [1]	410 (23.5%)
Occupational area	Business, marketing, sales, and management	443 (25.4%)
	Science and engineering	425 (24.4%)
	Teaching and education	267 (15.3%)
	Creative arts and design	153 (8.8%)
	Healthcare, public sector, and laws	128 (7.3%)
	Student, homemaker, retired, and unemployed	152 (8.7%)
	Others [2]	175 (10.0%)
	Missing	1 (0.1%)

[1] Note here that some of those who are not currently in employment selected their occupational area based on their previous job. [2] Other occupational areas included accounting, administration, beauty, cleaning and maintenance, communication, construction and property management, consulting service, creative writing and editing/proofreading/publication services, customer service, delivery service, entertainment, farming, financial services, food and beverage services, gardening, hotel/accommodation services, human resources, logistics, military service, mining, NGO and charity work, real estate, security, sports, tourism, translation and language services, transportation service, and veterinary and animal care service.

2.3. Data Analysis

The data analysis was divided into two phases: first an exploratory and then a confirmatory phase. In the first phase, we examined the general trend in the data, as well as the predictors of upcycling intention and upcycling behaviour. As the Kolmogorov-Smirnov Sig. values for all variables were 0, suggesting a violation of the assumption of normality, and the scores for all variables were strongly skewed, non-parametric tests were used for this phase. The tests included: (i) descriptive statistics for general trends in data; (ii) an independent-samples Kruskal-Wallis test for group differences in upcycling behaviour; (iii) a Spearman's rank order correlation for exploring bi-variate relationships; and (iv) a logistic regression for testing the predictive powers of the main variables for upcycling behaviour.

In the second part of the analysis (the confirmatory phase), we examined the parameters between the variables in a holistic way using path analysis. The theoretical model, as shown in Figure 1, was evaluated and compared to a series of other models based on the logistic regression results and model modification indices. We used a number of different model fit indices for model comparison. Specifically, model chi-square goodness of fit, one of the most commonly used global fit indices in Structural Equation Modelling, was used. A non-significant chi-square test result indicates that the model-implied covariance matrix equals the population covariance. However, chi-square goodness of fit is highly influenced by sample size. With a large sample such as the one in our study, chi-square statistics often come up as significant [52]. Hence, following Kline's [53] recommendations, we also used Comparative Fit Index (CFI; good fit ≥ 0.95, acceptable fit ≥ 0.90) [52], Standardised Root

Mean Square Residual (SRMR; good fit $\leq$ 0.05; acceptable fit $\leq$ 0.08) [54], and Root Mean Square Error of Approximation (RMSEA; good fit $\leq$ 0.05; cut-off value = 0.06, and upper limit = 0.07) [55]. Generalised least-square (GLS) was used to evaluate the models due to the non-normal distribution of many of the variables.

3. Results

3.1. General Trends in Data

Most respondents reported positive attitudes towards upcycling, generally agreeing that the behaviour was "good" (92.9%) and "worthwhile" (85.3%). Perceived behavioural control was also high, with 78.1% of respondents either agreeing or strongly agreeing that upcycling was possible for them. The frequency of upcycling varied from never (5.5%) to more frequently than once a week (2.9%), with the highest percentages occurring in the categories of about once every six months (20.4%) and about once every three months (21.2%). Regarding the impact of the COVID-19 pandemic, the majority (61.4%) answered that it did not make any changes in terms of how often they engaged in upcycling. However, the second most frequently selected option was "Yes, I became engaged in upcycling 'more' frequently" (28.8%) due to the pandemic situation (Tables 3 and 4).

Table 3. Descriptive statistics of variables/factors (n = 1744).

Factor	Items	Mean	SD
Attitudes	Good	4.50	0.65
	Pleasant	3.86	0.90
	Worthwhile	4.29	0.79
Perceived facilitating conditions	Access to tools	3.71	0.98
	Used or waste products, components, or materials available	3.68	0.95
	Teachers or helpers	2.70	1.22
	Skills and knowledge	3.75	1.01
	Inspiration	3.90	1.05
Personal norms (social factor 1)	I would 'feel guilty if I was not upcycling'	3.48	1.17
	Upcycling 'reflects my principles'	3.94	0.98
	It would be 'unacceptable to me not to upcycle'	3.44	1.17
Role beliefs (social factor 2)	My family	3.23	1.09
	My community	3.13	1.12
	My friendship/support networks	3.02	1.12
Subjective norms (social factor 3)	Most people who are important to me think that 'I ought to' upcycle.	2.72	1.12
	Most people who are important to me 'expect' me to upcycle.	2.34	1.15
	Most people who are important to me 'would approve' of me upcycling.	4.11	0.89
Perceived behaviour control	For me upcycling would be possible.	4.10	0.85
	If I wanted to, I could upcycle.	4.18	0.85
	Upcycling would be easy for me.	3.40	1.04
Intention	My likelihood of upcycling is high.	3.64	1.05
	If I have the opportunity, I will upcycle.	4.02	0.92
	I intend to upcycle.	3.87	1.02

Table 4. Frequency of upcycling and impact of COVID-19 pandemic (n = 1744).

Category	Answer Option	N	Percentage (%)
Frequency of upcycling	Never	96	5.5
	Less frequently than once a year	183	10.5
	About once a year	248	14.2
	About once every six months	356	20.4
	About once every three months	370	21.2
	About once a month	320	18.3
	About once a week	121	6.9
	More frequently than once a week	50	2.9
Impact of COVID-19 pandemic	Yes, I became engaged in upcycling 'less' frequently	170	9.7
	No	1071	61.4
	Yes, I became engaged in upcycling 'more' frequently	503	28.8

3.2. Group Differences in Upcycling Behaviour

An independent-samples Kruskal-Wallis test showed that there was significant difference in upcycling behaviour across different countries, x2 (4) = 24.366, $p < 0.001$. Pairwise comparisons demonstrated that respondents in the UK reported a significantly lower frequency of engaging in upcycling compared to those in Germany, standardised x2 = −3.725, adjusted p (adjusted by the Bonferroni correction for multiple tests) = 0.002, and in Canada, standardised x2 (1) = −4.150, adjusted $p < 0.001$. Respondents in Australia also reported a significantly lower frequency than their Canadian counterparts, standardised x2 (1) = −2.998, adjusted $p = 0.027$.

Significant differences were found across different age groups, x2 (2) = 16.429, $p < 0.001$. Pairwise comparisons showed that the 50+ group reported a significantly higher upcycling frequency than the under 30 age group, standardised x2 = 4.051, adjusted $p < 0.001$, and a higher frequency than the 30–49 group, standardised x2 = 3.220, adjusted $p = 0.004$. However, this difference needs to be interpreted with caution due to the relatively small sample size of this age group (n = 178) compared to the other two groups (each with over 700 participants).

Even though the Kruskal-Wallis test reported a significant difference by gender in upcycling behaviour, x2 (2) = 7.732, $p = 0.021$, pairwise comparison showed that the three groups (i.e., men, women, and non-binary) did not differ from each other after the p-values were adjusted by the Bonferronic correction for multiple tests. In terms of occupation, the Kruskal-Wallis test was significant, x2 (6) = 17.076, $p = 0.009$, but the only significant difference was observed between participants in the creative arts and design field and those who did not have a full-time job (e.g., students, homemakers, retired, or unemployed), standardised x2 (1) = 3.169, $p = 0.032$.

3.3. Explaining Predictors of Upcycling Intention and Behaviour

Figure 2 gives the Spearman's rank order correlation across all items. An inspection of the table showed that most items under one variable had medium (r = 0.30 to 0.49) to large correlations (r > 0.50) with one another. However, there were some notable exceptions. For example, "teachers or helpers" as a perceived facilitating condition was only weakly correlated with "access to tools", another facilitating factor. Similarly, the subjective norm "important social circle expects me to upcycle" was only weakly correlated with another subjective norm item, "important social circle would approve of me upcycling". The small correlations of some items suggested that they might have limited predictive power for testing our theoretical model. The most important role of these correlation coefficient values was to identify which items could represent the variables in the theoretical model: in other words, which items have the highest correlation coefficient values with upcycling behaviour. These items (single item from each variable/factor) were then used in the subsequent analyses for our main purpose of testing the predictors of upcycling behaviour (Tables 5 and 6).

	AG[1]	AP	AW	FA	FM	FT	FS	FI	PF	PR	PU	RF	RC	RS	SO	SE	SA	BP	BC	BE	IL	IW	II	UF
AG	1.000	0.499**	0.525**	0.226**	0.307**	0.126**	0.213**	0.328**	0.357**	0.442**	0.305**	0.338**	0.268**	0.284**	0.211**	0.126**	0.321**	0.294**	0.266**	0.192**	0.390**	0.401**	0.448**	0.248**
AP	-	1.000	0.545**	0.225**	0.305**	0.163**	0.217**	0.317**	0.340**	0.382**	0.333**	0.421**	0.324**	0.336**	0.227**	0.200**	0.229**	0.308**	0.266**	0.339**	0.434**	0.399**	0.463**	0.263**
AW	-	-	1.000	0.177**	0.314**	0.134**	0.232**	0.289**	0.409**	0.453**	0.375**	0.393**	0.329**	0.308**	0.259**	0.222**	0.288**	0.369**	0.337**	0.350**	0.496**	0.456**	0.532**	0.322**
FA	-	-	-	1.000	0.411**	0.244**	0.389**	0.340**	0.226**	0.246**	0.192**	0.257**	0.157**	0.199**	0.165**	0.108**	0.197**	0.223**	0.181**	0.189**	0.272**	0.250**	0.281**	0.172**
FM	-	-	-	-	1.000	0.209**	0.333**	0.331**	0.294**	0.372**	0.276**	0.339**	0.278**	0.303**	0.224**	0.200**	0.220**	0.307**	0.264**	0.283**	0.378**	0.363**	0.380**	0.276**
FT	-	-	-	-	-	1.000	0.341**	0.174**	0.184**	0.153**	0.182**	0.219**	0.274**	0.312**	0.291**	0.308**	0.084**	0.084**	0.059**	0.110**	0.163**	0.139**	0.173**	0.116**
FS	-	-	-	-	-	-	1.000	0.401**	0.272**	0.318**	0.254**	0.275**	0.263**	0.290**	0.215**	0.184**	0.196**	0.243**	0.216**	0.207**	0.301**	0.312**	0.316**	0.247**
FI	-	-	-	-	-	-	-	1.000	0.277**	0.319**	0.234**	0.309**	0.229**	0.285**	0.159**	0.094**	0.221**	0.285**	0.259**	0.225**	0.324**	0.319**	0.353**	0.205**
PF	-	-	-	-	-	-	-	-	1.000	0.633**	0.700**	0.447**	0.365**	0.377**	0.392**	0.397**	0.280**	0.347**	0.308**	0.305**	0.552**	0.537**	0.576**	0.405**
PR	-	-	-	-	-	-	-	-	-	1.000	0.545**	0.447**	0.389**	0.378**	0.346**	0.312**	0.367**	0.357**	0.328**	0.294**	0.511**	0.510**	0.552**	0.364**
PU	-	-	-	-	-	-	-	-	-	-	1.000	0.433**	0.382**	0.373**	0.400**	0.425**	0.259**	0.348**	0.317**	0.360**	0.542**	0.514**	0.552**	0.386**
RF	-	-	-	-	-	-	-	-	-	-	-	1.000	0.591**	0.576**	0.406**	0.406**	0.265**	0.386**	0.322**	0.403**	0.558**	0.477**	0.543**	0.405**
RC	-	-	-	-	-	-	-	-	-	-	-	-	1.000	0.679**	0.431**	0.413**	0.273**	0.260**	0.221**	0.299**	0.399**	0.374**	0.427**	0.326**
RS	-	-	-	-	-	-	-	-	-	-	-	-	-	1.000	0.469**	0.449**	0.262**	0.285**	0.229**	0.315**	0.411**	0.368**	0.407**	0.286**
SO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.000	0.706**	0.335**	0.195**	0.145**	0.235**	0.346**	0.329**	0.349**	0.283**
SE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.000	0.229**	0.194**	0.118**	0.281**	0.358**	0.322**	0.349**	0.307**
SA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.000	0.280**	0.279**	0.174**	0.291**	0.334**	0.326**	0.162**
BP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.000	0.733**	0.596**	0.610**	0.477**	0.560**	0.404**
BC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.000	0.578**	0.549**	0.452**	0.522**	0.370**
BE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.000	0.603**	0.471**	0.551**	0.446**
IL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.000	0.720**	0.797**	0.547**
IW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.000	0.743**	0.472**
II	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.000	0.528**
UF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.000

Figure 2. Correlation coefficient values for all items (n = 1744): [1] AG: Attitude—Good; AP: Attitude—Pleasant; AW: Attitude—Worthwhile; FA: Facilitating condition—Access to tools; FM: Facilitating condition—Materials; FT: Facilitating condition—Teachers/helpers; FS: Facilitating condition—Skills/knowledge; FI: Facilitating condition—Inspiration; PF: Personal norm—Feeling guilty; PR: Personal norm—Reflecting principles; PU: Personal norm—Unacceptable not to; RF: Role belief—Family; RC: Role belief—Community; RS: Role belief—Support network; SO: Subjective norm—Ought to; SE: Subjective norm—Expect me to; SA: Subjective norm—Approve of me; BP: Behaviour control—Possible; BC: Behaviour control—Could; BE: Behaviour control—Easy; IL: Intention—Likelihood; IW: Intention—Will; II: Intention—I intend; UF: Upcycling Frequency; ** $p < 0.001$ (2-tailed); and □ no shading: small relationship (r = 0.10 to 0.29); ■ light grey: medium relationship (r = 0.30 to 0.49); ■ dark grey: large relationship (r = 0.50 to 1.0).

Table 5. Predictors of upcycling intention (n = 1744).

Variable	Item(s)	Wald	df	*p*	Odds Ratio
Attitudes	To me, taking part in upcycling is 'worthwhile'	35.946	1	0.000 **	1.784
Personal norms	I would 'feel guilty if I was not upcycling'	59.649	1	0.000 **	1.698
Role beliefs	Upcycling fits my role in 'my family'	46.154	1	0.000 **	1.680
Subjective norms	Most people who are important to me 'expect' me to upcycle	12.833	1	0.000 **	1.284
Perceived behaviour control	For me upcycling would be possible	157.895	1	0.000 **	3.692
Perceived facilitating conditions	Available used/waste products and materials	1.709	1	0.191	1.112
	Skills and knowledge	1.832	1	0.176	1.111
	Inspiration	2.063	1	0.151	1.112
Nationality	Nationality	0.086	1	0.769	1.014
	Constant	335.202	1	0.000	0.000

Note: ** $p < 0.05$ (2-tailed).

Table 6. Predictors of upcycling behaviour (n = 1744).

Variable	Item(s)	Wald	df	*p*	Odds Ratio
Attitudes	To me, taking part in upcycling is 'worthwhile'	0.243	1	0.622	0.959
Personal norms	I would 'feel guilty if I was not upcycling' …	5.124	1	0.024 **	1.148
Role beliefs	Upcycling fits my role in 'my family'	1.870	1	0.172	1.094
Subjective norms	Most people who are important to me 'expect' me to upcycle	5.932	1	0.015 **	1.145
Perceived behaviour control	Upcycling would be easy for me	36.575	1	0.000 **	1.517
Perceived facilitating conditions	Available used/waste products and materials	0.962	1	0.327	1.070
	Skills and knowledge	12.509	1	0.000 **	1.265
	Inspiration	4.360	1	0.037 **	0.875
Intention	My likelihood of upcycling is high	69.042	1	0.000 **	2.060
Nationality	Nationality	3.600	1	0.058	0.927
	Constant	156.223	1	0.000	0.004

Note: ** $p < 0.05$ (2-tailed).

Two logistic regression analyses were conducted to measure the effects of various variables on (i) the respondents' intentions to upcycle, and (ii) the frequency of their upcycling behaviour. Predictors of intention were attitude, the three social factors, perceived behaviour control, and the three perceived facilitating conditions. For upcycling behaviour, the same predictors were used, in addition to intention. Nationality was used as a control variable in both models, but no other demographic variables were included due to the negligible differences among groups as reported in Section 3.2. The Omnibus Tests of Model Coefficients showed that the model for intention was significant, x2 (df = 9, N = 1744) = 930.604, $p < 0.0005$). The model explained between 41.4% (Cox and Snell r-square) and 55.9% (Negelkerke r-square) of the variance in the intention to upcycle and correctly classified 81% of cases. Attitude, all three social factors, and perceived behavioural control made statistically significant contributions to the model, but not the three facilitating conditions. The biggest contributor was perceived behavioural control, recording an odds ratio of 3.692, meaning that the respondents who reported higher perceived behaviour control were over three times more likely to report their intention to upcycle (Table 5). The model that predicted upcycling frequency was also significant, x2 (df = 10, N = 1744) = 513.706, $p < 0.0005$, explaining between 25.5% (Cox and Snell r-square) and 34% (Negelkerke r-square) of the variance in the upcycling frequency, and correctly classified 72.3% of cases. Attitude was not a significant predictor, but the three social factors were, along with perceived behavioural control, intention, and two out of the three perceived facilitating conditions. The Odds ratios indicated that intention (2.060) was the most important predictor of the behaviour, followed by perceived behavioural control (1.517) (Table 6).

3.4. Confirming Predictors and Evaluating the Theoretical Model

We further conducted path analysis to confirm the predictors and evaluate the initial theoretical model (Figure 1). Attitude, the three social factors, perceived behavioural control, and nationality were modelled to predict both upcycling intention and behaviour. Intention and three facilitating conditions were also modelled as predictors of upcycling behaviour. The error variances of the independent predictors were allowed to covary. The model fit indices suggested a mediocre fit: x2 (df = 3, N = 1744) = 31.322, $p < 0.001$, CFI = 0.974, SRMR = 0.011, RMSEA = 0.074 (0.052, 0.098).

The second model we tested was based on the results from the logistic regression. Attitude, the three social factors, and perceived behavioural control were modelled to predict upcycling behaviour via upcycling intention. Direct parameters were also modelled from personal norms, subjective norms, perceived behavioural control, and nationality, to upcycling behaviour. Two perceived facilitating conditions (skills and knowledge, and inspiration) were included in the model as direct predictors of upcycling behaviour, but the third condition, availability of materials, was removed from the model. Error variances were allowed to covary among the independent predictors. Model indices showed that this model fitted the data well, x2 (df = 5, N = 1744) = 25.030, $p < 0.001$, CFI = 0.981; SRMR = 0.010, RMSEA = 0.048 (0.030, 0.067), though the model modification indices suggested parameters between the two facilitating conditions to upcycling intention.

A series of modified models were then evaluated by adding the suggested parameters and by dropping non-significant covariates between the independent predictors one by one. The final model that we derived from the analysis showed an excellent fit: x2 (df = 7, N = 1744) = 15.72, $p = 0.028$, CFI = 0.992; SRMR = 0.010, RMSEA = 0.027 (0.008, 0.045). Figure 3 shows the standardised coefficient of the parameters. The model was able to explain 60.5% of the variability in upcycling intention and 36.8% of that in upcycling behaviour. Attitude, the three social factors, perceived behavioural control, and two facilitating conditions all significantly predict upcycling intention. For the actual behaviour, two social factors (personal norms and subjective norms), perceived behavioural control, one of the two facilitating conditions (skills and knowledge), intention, and nationality were direct predictors. In terms of total effects, upcycling intention had the largest total effect ($\beta = 0.383$, $p < 0.001$) on upcycling behaviour. This was followed by perceived behaviour

control (β = 0.264, $p < 0.001$) and the three social factors: personal norms (β = 0.194, $p < 0.001$), subjective norms (β = 0.122, $p < 0.001$), and role beliefs (β = 0.078, $p < 0.01$). The effects of nationality or facilitating conditions were small (β ≤ 0.06, $p < 0.01$).

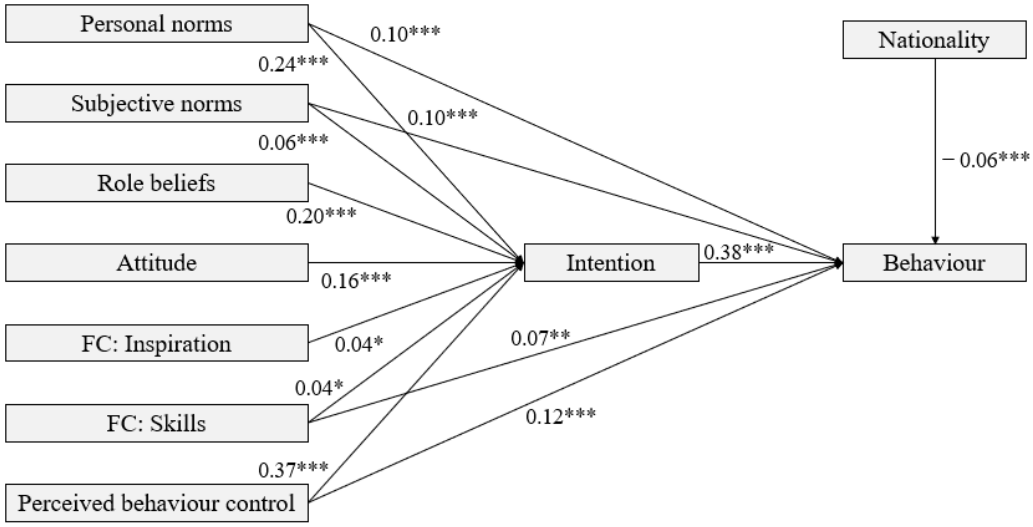

Figure 3. Path model that depicts predictors of upcycling behaviour: Notes: * $p \geq 0.05$, ** $p \geq 0.01$; *** $p \geq 0.001$; FC = Facilitating conditions; PBC = Perceived behavioural control. Error covariance and non-significant parameters are omitted to aid visual clarity.

Based on the logistic regression (3.3. Explaining predictors of upcycling intention and behaviour) and path analysis (Figure 3), a summary model has been created to highlight our key analysis results.

4. Discussion

In order to scale up upcycling, more generalisable data are required to design effective interventions for wider populations. This paper presented our investigation into the causes/predictors of upcycling behaviour in a large-scale, cross-country (and cross-continent) online survey study in the highly industrialised West—i.e., five countries from three continents: Australia, Canada, Germany, UK, and USA. The results revealed the cross-country predictors of upcycling: key predictors of intention and perceived behaviour control (confidence in abilities) followed by social factors (personal norms, role beliefs, and subjective norms). Overall, these results were largely consistent with the previous studies on the causes/predictors of sustainable behaviour [50,56,57]. That notwithstanding, the new theoretical model (Figure 4) is a unique contribution to the body of knowledge on sustainable behaviour. The new model presents a summary of key analytic results, showing the key predictors with the extents of their influences visually and intuitively for other researchers to quickly grasp the common predictors of upcycling. This new theoretical model could be a starting point or an important reference for future researchers investigating similar topics in different parts of the world.

When it comes to the discussion of notable variable/factor analyses, the majority of respondents had positive attitudes towards upcycling, agreeing that it was "worthwhile", which aligns with the literature on sustainable behaviour [58,59]. However, although the positive attitude stimulated high intention, its contribution to upcycling behaviour was not significant. This incongruence between what people consider worthwhile and what behaviours they engage in has been studied as the attitude-behaviour gap [60] and the intention-behaviour gap [61]. In contrast to a previous study in which the gap between attitude and upcycling behaviour was not observed among UK citizens [29], this cross-country study showed the gap. This gap may be due to various contextual factors [62,63] and could be further investigated in the future study.

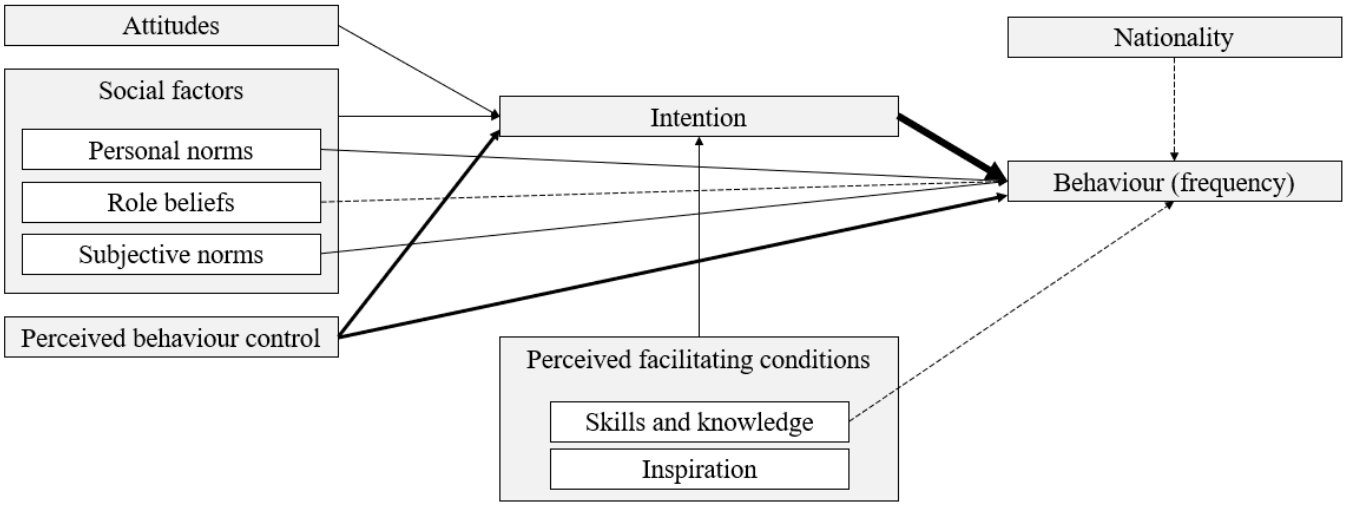

Figure 4. Summary model highlighting the key analytic results (thicker arrows indicating larger influence and dotted arrow with ignorable influence).

Perceived behavioural control was found to be one of the most critical factors to motivate/encourage/enable people to intend to upcycle and actually upcycle items. This implies that supporting people as they increase their confidence in their abilities would be an effective pathway to promote and facilitate upcycling behaviour, instead of solely providing external aids (e.g., information, materials, tools, training). In fact, the degree of perceived behavioural control is closely related to the concept of self-efficacy [64,65]. Self-efficacy means that goal achievement is determined by the degree of confidence in one's capacity and capability to manage the performance necessary to achieve the goal. Our findings suggest that improved self-efficacy in relation to upcycling should be one of the priorities for interventions.

Generally, social factors were associated with both upcycling intention and behaviour. The results support the assumption that imposing personal morality and social responsibility would facilitate upcycling behaviour. However, they must be interpreted with caution because this approach would not necessarily promote upcycling behaviour and people's well-being together. Controlled extrinsic motivation (e.g., avoiding feeling guilty about not upcycling materials) would involve a sense of pressure or obligation to monitor and down-regulate certain behaviours [66]. As such, avoidance motivation can be experienced as stressful and could negatively impact people's psychological well-being [67]. This unintended effect of using social factors as a mechanism of interventions should be considered with caution. Further studies could be conducted to investigate the relationship between social factors (and mechanisms based on them) and well-being.

When asked about the impact of the COVID-19 pandemic, the majority of the respondents said it did not affect how often they upcycled, while the second most frequent answer was that they became engaged in upcycling more frequently because of the pandemic. Overall, its influence on upcycling behaviour was either neutral or positive. Although our data did not reveal what drove this shift, one possible explanation is that the COVID-19 outbreak forced people to rethink their consumption in response to its uncertain financial impact. Recent studies have shown that, among the most important shifts during the pandemic were more prudent purchase decisions, which may have increased interest in upcycling [68]. Another possible explanation is that the COVID-19 crisis may have stimulated personal norms as an antecedent of collective sustainable behaviours, i.e., feeling morally compelled and responsible to act [69]. Despite the promising result, questions remain about what aspects of the pandemic specifically led people to continue or commit more to upcycling. Gaining insights into these situational factors will help develop upcycling interventions under similar circumstances in the future.

When it comes to the limitations of the study, this study used an online survey with an online participant recruitment platform, which attracts certain type of participants (e.g., not too old, technology-savvy, looking for extra income). The participants' demographics and their results therefore are not likely to be representative. Future studies aiming to obtain more representative data should try different approaches to sampling (e.g., using a professional research participant recruitment company). The predefined questions (or variables) from the theoretical models were limited. For example, in daily decision-making, people act in accordance with their routines, shaped by contextual factors such as their schedules and the presence of other people, which may promote or hinder certain sustainable behaviours [70]. The psychological needs [71,72] associated with the contextual factors could be another motivation for upcycling. Future studies could consider these contextual factors and psychological needs as well as other variables from alternative theoretical models.

The data we collected and reported on upcycling behaviour included only the frequency of the behaviour. We did not ask about which materials or products they used or what end products they created out of those materials. Depending on the type of materials and the product outcomes, the degree of participation (upcycling frequency) could differ due to the different skills and resources required [73]. Future study could investigate how different demographic groups interact with different material/product types in their upcycling.

5. Conclusions

This study makes unique theoretical and empirical contributions to understanding the underlying mechanism of upscaling upcycling behaviour. The results provide a nuanced explanation of the relative roles that intention, perceived behaviour control, and social factors play in facilitating upcycling behaviour. The paper visualised and highlighted such relative roles in the summary model (a new theoretical model). The analyses provided in this study are important in that they advance our understanding of shared influencing factors (or predictors) across countries and highlight the most important influencing factors in order: first, upcycling intention; second, perceived behaviour control (or confidence in abilities); and then social factors (personal norms, subjective norms, and then role beliefs in this order). They thus offer a direction for future actions/interventions taken/developed/implemented to make changes in people's behaviours on a wider scale (across three continents).

The stakeholders involved in the intervention development (e.g., governmental agencies, policymakers, educators) should give attention to how each of the common predictors could be effectively established. The questions to be addressed around upcycling are, for example, "What are the conditions that increase the individuals' confidence in their abilities to carry on upcycling (i.e., perceived behavioural control [64])?", "What would make people feel morally compelled and responsible to act (i.e., personal norms [74])?" and "How can the awareness of a social circle's expectations be increased (i.e., social norms [29])?" In the broader discussion of sustainability, we postulate that both the initial theoretical model operationalised by the online survey study and the newly suggested theoretical model could be applied to other behaviour domains that are favourable to fostering. Further, this paper advances the understanding of a consumer behaviour alternative to mass production and consumption, as well as how the alternative behaviour could be scaled up by addressing key behavioural factors.

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Informed Consent Statement: Not applicable.

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