# Unravelling repurposing

*a taxonomy for a promising circular business model strategy*

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# Unravelling Repurposing - A taxonomy for a promising circular business model strategy

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**Abstract**

The Dutch government and leading academics in the field of circular economy propose that "repurposing", i.e., finding new usages for discarded material, is important to reduce resource usage. Waste collectors, municipalities and start-ups increasingly find ways to develop circular business models, aiming for minimum loss of material integrity. Repurpose is a circular business model strategy which entails using a discarded product or its parts in a new product with a different function.

The aim of this research is to gain a better understanding of this promising but academically underexposed circular strategy by empirically exploring its key characteristics and developing a taxonomy that reflects the scope and potential of the concept. The taxonomy development was based on clustering and comparing 96 case examples using key characteristics and critical factors empirically collected by means of 11 semi-structured expert interviews. The taxonomy was iteratively refined and validated by means of workshops with experts.

This paper proposes a taxonomy and a comprehensive definition for repurposing. The Repurpose taxonomy distinguishes three main categories with increasing levels of material integrity: "Reprocess", "Reshape" and "Recontextualize". The taxonomy provides a refinement of existing circular business model patterns and frameworks for closing material loops strategies. It shows how repurposing may exploit the creative potential of design to fill the gap between reuse and recycling by retaining previously added value with three levels of physical adjustment.

## Literature background

The Circular Economy has been positioned as a potential lever for sustainability and business innovation and sustainable business models and circular business models are needed to facilitate the transition towards a circular economy (WBCSD, 2015; Ellen MacArthur Foundation, 2017). Sustainable business models offer long-term solutions based on sustainable value and pro-active stakeholder involvement, beyond customers and shareholders and including the natural environment (Schaltegger, Hansen & Lüdeke-Freund, 2016). Circular business models are a subgroup of sustainable business models that specifically address the reduction of resource usage by means of circular loop strategies, based on narrowing, closing and slowing resource loops (Bocken, De Pauw, Bakker & Van der Grinten, 2016).

The Dutch government proposed a waste hierarchy based on 9 circularity R-strategies (Potting et al., 2018; Reike, Vermeulen & Witjes, 2018) to minimize resource input and waste (see Table 1). Higher strategies are considered more desirable from an environmental and business perspective and although most strategies have gained attention in the field of the Circular Economy, repurposing remains underexposed.

| | | R-strategy | Usage | Function | Resource |
|---|---|---|---|---|---|
| Smarter product use and manufacture | R0 | Refuse | abandon | same | different |
| | R1 | Rethink | intensify | same | same |
| | R2 | Reduce | intensify | same | fewer |
| Extend lifespan of product and its parts | R3 | Re-use | extend | same | same |
| | R4 | Repair | extend | same | same |
| | R5 | Refurbish | extend | same | same |
| | R6 | Remanufacture | extend | same | same |
| | **R7** | **Repurpose** | **extend** | **new** | **same** |
| Usefull application of materials | R8 | Recycle | new | new | same |
| | R9 | Recover | new | new | same |

**Table 1. circularity R-strategies and position of repurposing (adapted from Potting et al. (2016))**

Repurposing entails the re-use of a discarded technical product or its components in a new function (Sieffert, Huygen & Daudon, 2014; Potting et al., 2018; Kirchherr, Reike & Hekkert, 2017). Repurposing offers eco-effective solutions (Braungart, McDonough & Bollinger, 2007), aiming at maintaining high added-value products on the market as long as possible to ultimately delay recycling or disposal (Bauer, Brissaud & Zwolinski, 2017). Recycling is still very much part of the linear economy and sometimes uses more energy than the production of new materials, (Potting et al., 2018; Allwood, Ashby, Gutowski, & Worrell, 2011) which makes repurposing preferable from an environmental and business perspective.

Whereas repair, refurbish and remanufacturing focus at the original functional value of a product, repurposing often entails new value creation with a minimum loss of material integrity. Examples cited in literature include transforming wind blade parts into building structures (Leahy, 2019; Bank, Arias, Gentry & Al-haddad, 2018), turning old smartphones into parking meters or educational applications (Zink, Maker, Geyer, Amirtharajah & Akella, 2014; Li et al., 2010), and EV car batteries into energy storage systems (Schulz, Bey, Niero & Hauschild, 2020; Richa, Babbitt, Nenadic & Gaustad, 2017). Other examples from practice include transforming old truck tarpaulins into fashionable bags, iconic building floors into high-end furniture, and national railway timetables into trendy office supplies. Repurposing is popular among industrial design and artists (Reike, Vermeulen & Witjes, 2018), and has potential as a business model strategy for sustainability in the transition to a circular economy (Lüdeke-Freund, Gold & Bocken 2018; Sieffert et al., 2014). However, repurposing of technical materials is less used than other circularity strategies (Reike et al., 2018) and remains understudied in business model literature (Lüdeke-Freund et al., 2018; Kurt, Cung, Mangione, Cortes-Cornax & Front, 2019). Moreover, there is a range of academic interpretations of repurposing, for example with regard to various levels of product integrity (Sihvonen & Ritola, 2015), various strategic goals (Bauer et al., 2017), or its multiple linkages to other R-strategies (Coughlan, Fitzpatrick & McMahon 2018; Lüdeke-Freund et al., 2018; Kurt et al., 2019).

Therefore, the aim of this paper is to provide insight in the main characteristics of repurposing as a business model strategy and to propose a comprehensive definition and taxonomy for this promising, but academically underexposed, circular strategy.

## Research design

After exploring relevant literature, a qualitative research approach was used that consisted of two stages. In the first stage key characteristics and critical factors were derived from interview data and literature. In the second stage the key characteristics were used to collect more than 100 empirical cases of repurposing that formed the basis for the development of a taxonomy for repurposing.

*Expert interviews*

The main method of inquiry is based on expert interviews and data collected from academia and practitioners involved in circular economy business modelling and design strategies for technical materials. To get a broad representation from science and practice, 11 experts were selected that varied in background, sector and role. The interviewees included experienced senior business consultants, business owners, CEO's and professors with a solid background in product design and/or business modelling (see Table 2). The interviews had an average length of 45 minutes and covered the following topics:

- definition and characteristics of repurposing
- critical factors
- examples of repurposing

| Nr | Interviewees |
|---|---|
| 1 | Professor in product design |
| 2 | Founder Circular Business Consultancy |
| 3 | Senior Sustainability Consultant |
| 4 | Founder Circular Business Consultancy |
| 5 | Founder Circular Design Company |
| 6 | Founder Circular Design Company |
| 7 | Founder Circular Business Consultancy |
| 8 | Senior Consultant Manufacturing Industry |
| 9 | Senior Consultant Waste Management |
| 10 | Founder Circular Design Company |
| 11 | Professor in Circular Business |

**Table 2. interviewees expert interviews**

### *Data analysis*

The interviews were audio-recorded, summarized and transcribed ad verbatim with the consent of all participants. Software for qualitative data analysis (MAXQDA) was used to assist qualitative data analysis. The analytical process consisted of three stages, constituting open coding, axial coding and selective coding (Strauss & Corbin, 1990). Using a pattern-matching logic for explanation building (Eisenhardt & Graebner, 2007), key characteristics, critical factors in value creation and delivery processes and examples of repurposing were identified.

### *Taxonomy development*

To develop a taxonomy, more than 100 cases were initially collected from literature, university archives, web search, and the interviews. The cases were archived in a database by means of the following variables: origin, characterisation of resource, application, characterisation of physical production, business model aspects, Impact, sources/more information.

All cases were subject to a critical reflection by the researchers with regard to acceptability of repurposing case examples in this research. Only examples related to a scalable business model and industrial design were accepted, e.g. artwork, Do-It-Yourself or one-offs were excluded. This led to a (growing) database with 96 cases in April 2021.

The taxonomy was iteratively developed, refined and validated in various workshops:

- Two card-sorting sessions, one with researchers and one with experts clustering cases by means of 6 profile diagrams based on the critical factors identified in the interviews.
- Two round-table discussions with researchers to 1) develop the taxonomy based on the clusters found and 2) classify all cases and refine the taxonomy
- Online workshop with experts to validate the taxonomy

## Results

With regard to the circular economy business model (CEBM), we found a number of key characteristics and critical factors based on the interviews and exploration of characteristics in available literature.

### *Key characteristics*

The characteristics that distinguish repurposing from other circularity strategies are particularly related to two aspects. Hence, we propose that repurposing typically involves a change of the value proposition and retention of value that was added in previous usage and production processes (see Table 3).

| | Characteristics | Interview & Literature |
|---|---|---|
| **Change of value proposition** | New context (e.g. new target audience, new market) | 1, 2,10<br><br>(Sihvonen et al., 2015; De Hollander et al., 2017; Bauer et al., 2017; Whalen, 2019) |
| | New function (e.g. new goal, new application) | 2, 3, 5, 6,7, 8, 9, 11<br><br>(Sieffert et al., 2014; Kurt et al., 2019; Potting et al., 2017; Bauer et al., 2017) |
| **Value retainment** | Objective physical integrity (e.g. material destruction, eco-effectiveness) | 1, 2, 3, 5, 6, 7, 8, 9, 10,11<br><br>(Bauer et al., 2017; Allwood et al., 2011; Mestre & Cooper 2017; Braungart et al., 2007) |

| | | |
|---|---|---|
| | Subjective emotional integrity (e.g. personal attachment, culture, historic value) | 7, 10, 11 (Sieffert et al, 2013) |

**Table 3. characteristics based on change of the value proposition and value retainment**

### *Critical factors*

With regard to critical factors for repurposing, two main categories emerged from the data which are related to complexities in repurposing value creation and delivery processes:

- Cross-sector collaboration
- Resource availability

| | Critical factors | Interview |
|---|---|---|
| **Cross-sector collaboration** | **New integral logistics processes** (e.g. new cross-sector forwarding and reverse logistics) | 1, 3, 6, 7, 8, 9, 10 |
| | **New partnerships** (e.g. new revenue models, launching customer, new channels, new competences) | 1, 3, 4, 6, 7, 8, 9, 10, 11 |
| **Resource availability** | **Quality** (e.g. consistency, complexity, uniqueness, functionality) | 4, 5, 6, 7 |
| | **Quantity** (dis)continuity, timing/synchronicity, feedstock scalability, visibility & accessibility | 1,2, 3, 5 7, 9 |

**Table 4. critical factors based on cross-sector collaboration and resource availability**

Although limited resource availability decreases options for upscaling the business model, some interviewees mentioned that, typically for repurposing, limited resource availability may also create opportunities for valorisation with 'limited editions'. However, this also carries a risk of a rebound-effect (Zink & Geyer, 2017), for example by replacing popular discarded products or components by virgin material.

### *Taxonomy for repurposing*

Based on these characteristics, critical factors and a cross-case analysis of 96 cases, a taxonomy for repurposing is proposed, consisting of three main categories: Reprocess, Reshape and Recontextualize and four related categories (see Figure 1).

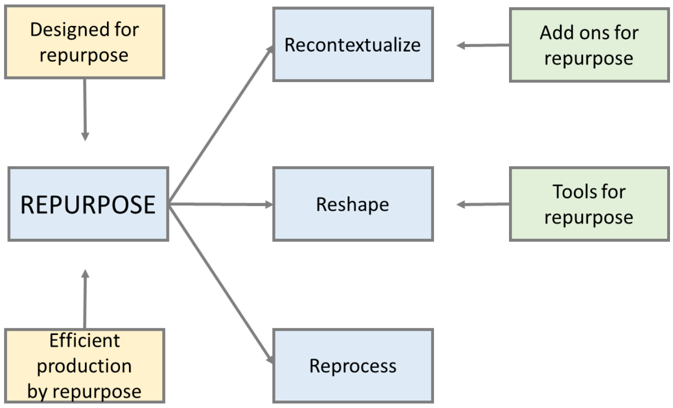


**Figure 1. Repurposing Taxonomy: three main categories for repurposing and four related categories.**

The three main categories – Reprocess, Reshape and Recontextualize – each entail new value propositions with increasing degrees of value retention. In Reprocess the product or its components undergo relatively significant physical modifications, but specific functional and visual properties of components or materials are used for the production of higher-value products. Other than with recycling, with Reprocessing the material of the discarded product or component is still recognizable, for example colorful flip flops produced from waste rubber found on African beaches each being unique and appealing to a sustainability-minded target audience. In Reshape, the product or its components undergo minor physical modifications and are used for a new application inspired by the emotional value related to the unique origin of the product, the original form or appearance of the product or component, and/or the functionality or the properties the product or component offers. An example that uses a combination of these characteristics is a tray made of the national railway timetables, using the color and material properties as well as the emotional value related to the iconic timetables. In Recontextualize the discarded product is used without physical modifications in a new context, however with a new value proposition which is closely related to its original usage. A car battery, for example, may no longer be able to fulfil its original function properly, but is with minor alterations usable in a less demanding context such as electricity storage in buildings.

Additional to the three main categories, four separate product categories were identified, which merely *facilitate* repurposing. For example, "add-ons for repurpose" are products that facilitate recontextualizing of discarded products (for example a cap that makes a spray bottle out of a soda bottle), and "tools for repurpose" facilitate the making of a new product from discarded materials (for example a kit to make guitar picks out of cred-it cards). Additionally, some products were found that were specifically designed upfront for next-life repurpose (Bauer et al., 2017; den Hollander et al., 2017), whereas repurposing production waste is aiming at more efficient processes.

## Discussion

Our research set out to explore repurposing as a promising, yet understudied circular business model strategy.

On the basis of our findings, the following comprehensive definition for repurposing is proposed: *"a business model strategy that applies a discarded product or its components for a function or context, other than its originally intended value proposition, and in doing so retaining value that was added by previous value creation, value delivery and use processes and adding new value".*

The taxonomy reveals the broad scope and creative potential of the repurposing concept and provides a refinement of the strategic options to retain value by applying the cascading and repurposing circular economy business model pattern (Lüdeke-Freund et al., 2018). The results show that this business model pattern is not exclusive for biological cycles, but is also relevant for technical nutrient cycles. The main categories Reprocess and Reshape reflect the creative potential of design to fill the gap between reuse and recycling (e.g. Reike et al., 2018; Mills et al., 2012), and provide promising possibilities to retain value that was added in previous usage or value creation and delivery processes. The category Recontextualize reflects the definition of repurpose by Sihvonen and Ritola (2015) with no or minor adjustments to the original product design.

Our findings suggest that the repurposing categories Recontextualise and Reshape may represent a higher level of circularity then just above recycling in the hierarchy. These categories could be equivalent to re-use, repair, refurbish and remanufacture (Coughlan et al., 2018; Lüdeke-Freund et al., 2018; Kurt et al., 2019) and create new opportunities for additional value creation. This makes repurposing particularly promising for the development of new circular economy business models, either by prolonged use and reuse of goods over time ('slowing loops') or the reuse of materials through recycling ('closing loops') (Bocken et al., 2016). However, since rebound may be a relevant risk in successful repurposing business models, additional research should investigate how, and under which conditions, repurposing could be placed higher on the circularity ladder.

The taxonomy may be used as a framework to study circular economy business models and circular supply chains for each identified repurpose category based on design options and patterns found in state-of-the-art literature. We propose follow-up research by means of in-depth case-studies for each repurposing category in order to identify whether the circular economy business model (CEBM) design options and patterns proposed by Lüdeke-Freund et al. (2018) can also be applied to the various categories in the repurposing taxonomy, or whether additional CEBM design options and patterns are necessary to facilitate the development of business models on a micro-level.

Moreover, each repurposing category could benefit from more in-depth case studies to explore repurpose-specific constraining and driving mechanisms. For example, perceived supply chain risks related to usage of material in a different context play an important role. Further research could focus specifically on the dynamics and mechanisms in cross-sector collaborations for various repurposing categories.

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