Revisiting upcycling phenomena: a concept in clothing industry

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Abstract
Purpose – The purpose of this study is to review the literature and practice of upcycling. In particular, the objective of this study is threefold: to comprehend the concept of upcycling and, subsequently, understanding the prominent terminologies used in the literature; to understand the process of upcycling and problem associated with it; and to review current literature and practice of upcycling for clothes.

Design/methodology/approach – A scientific literature review procedure proposed by Mayring (2002) was adopted to select and screen the paper that comprises the following steps: material collection, descriptive analysis and material evaluation.

Findings – Upcycling literature has witnessed significant contribution in the past one decade. The paper has identified various terminologies and definitions such as recycling, down-cycling, upcycling and redesign, which are used in the literature.

Research limitations/implications – The present study may help the scholars to understand the current state of literature. A practitioner of upcycling can use the findings to improve and standardise the existing process.

Originality/value – The process of redesigning is one of the important steps in upcycling, which comprises ideation, reconstruction and fitting. The limitation of redesigning is variability in size and pattern. This can be overcome through various techniques such as craftsmanship, time, innovation, provenance, desire and narrative.

Keywords Literature review, Clothes reuse, Redesigning, Reverse value chain, Upcycling

Paper type Literature review

1. Introduction
Textile and clothing industries involve different processes right from spinning to the finishing of final garments. Each process tries to add some value to the product. This is a highly labour-intensive industry and a huge source of employment (Alkaya and Demirer, 2014). In fact, after food industries, the textile industry has been considered the second largest industry in the world, with consumption of nearly 10 per cent energy. Unfortunately, many hazardous chemicals are used and emitted in the garment manufacturing processes. Many firms have taken initiatives to reduce the harmful effect of toxic chemicals. But, a significant minimisation seems difficult to achieve (Kuo et al., 2014). In addition, the estimated consumption of textile-based goods is approximately 30 million tons per year. The situation is alarming because the disposal rate has also subsequently increased. This might
pose a threat to the environment because discarded garments will ultimately go to landfill or incineration. However, environmental degradation can be controlled by avoiding the entry of virgin (new) raw materials by closing the loop based on any of the three principles: reduce, reuse and recycle (Chen and Burns, 2006; Kuo et al., 2014). This will also indirectly help in providing employment by increasing job opportunities in reverse logistics field (Hawley, 2006).

The reverse side of the value chain consists of mainly three processes: collection, sorting and processing. The collection is the process of getting back discarded products from the consumer. Sorting is responsible for inspection and categorisation of the product according to its quality/type (Rogers and Tibben-Lembke, 2001). Processing involves different activities such as repair, washing, redesigning etc. to restore functionality and enhance the utility (Abraham, 2011). Each process of reverse logistics in detail is explained in the next section. Despite the growing importance in practice, the academic literature on upcycling still appears fragmented. Surprisingly, the extant literature revealed that no study so far has captured a literature review in the area of upcycling. Therefore, this paper is an attempt to understand the upcycling or redesigning process by reviewing and synthesising the existing literature and practices. An effort has been made to review, categories and analyses relevant 52 papers published in the field. The remaining paper is structured as follow: Insight of reverse logistics process is briefed in Section 2. Details of the research methodology are presented in Section 3. Upcycling and redesigning are discussed in Section 4. Section 5 has the discussions of papers. Section 6 contains the conclusion along with future research.

2. Background

2.1 Collection

Collection of waste and used products is not something new. Consumers habitually throw away products after usage. Traditionally, collection of these products was done by scavengers and rag pickers. Recently, formal models have been built by firms to recover waste and used products (Besiou et al., 2012). This can be attributed to the increasing awareness about their harmful effects on the environment. In developed countries, it is mainly done by charity organisations (Tojo et al., 2012), whereas in developing countries it is still done by local vendors who exchange the used clothes with utensils (Abraham, 2011). People who are involved in these kinds of work are from marginalised and poor families (Oldenziel and Weber, 2013). In many regions, government authorities have also taken responsibility of collecting disposed clothes. Clothes collection percentage, however, is much lower as compared to other products such as paper, plastic and glass (Woolridge et al., 2006). If the collection of products is not done in a right manner and at the right time, then it cannot become a part of a closed loop chain (Morana and Seuring, 2007). Hence, there should be more locations to collect used products (Atasu et al., 2008). In the UK, the textile collection bank collects as much as 170 tons of clothing per week (Botticello, 2012). It has been highlighted that manufacturer-driven collection is better than third party collection (Hong and Yeh, 2012). Participation of voluntary or charity organisations in collection depend on the amount of value they get back from the collection. Value of returns from old product depends upon the condition of products donated by consumers (Wojanowski et al., 2007). In addition, an incentive-based system can make the collection more efficient. It has been found that collection can be done effectively during promotional offers or through third parties. The former ones are better and cost effective (Das and Dutta, 2015). It has been observed that collection through retailers is not profitable, and they were not able to collect a high quantity as compared to third parties (Hong and Yeh, 2012). In most of the cases, third parties include charity organisations or non-government agencies that do this on a
voluntarily basis. It has been found that collection point near consumers can help the consumer travel less distance to return the product, which makes their task easier. Most of the time consumers prefer to return products near their home or at other convince centres such as gas stations and 24-hour convenience shop (Min et al., 2006). The product can be easily and efficiently collected if there is a system for consumers’ to return the product. There are many structured collection practices for commercial products as compared to consumer goods. For example, a collection of metal products is more established than that of glass (Akcali and Cetinkaya, 2011).

2.2 Sorting
Sorting is one of the main activities, which influence the future path that a collected product will follow, i.e. reuse, recycle or incineration (Jayaraman et al., 2008). Sorting is a very complex process and sorting should be done as soon as possible, so that maximum value can be extracted out of the waste. The process of sorting can be combined with processing or even with pre-processing stages (Moise, 2008).

Proper sorting facility significantly helps in improving the efficiency of the supply chain. Hence, its location should be decided meticulously. There are several questions that need to be answered before setting up sorting facility, for instance, “at which is location should the sorting centre be opened” and “which collection centre should be linked to the sorting” (Beamon and Fernandes, 2004). This decision is also associated with the cost incurred to set up facility for sorting operation. In the case of higher transportation cost, decentralisation is done to reduce the cost, while in the case of higher inventory cost, centralisation is preferred (Abdallah et al., 2012). Many times, charity organisations also ship unsorted garments to developing countries because of cheaper sorting facilities at those locations. It is always advantageous to remove unwanted products from the loop as soon as possible. So sorting can be done alongside collection. In this situation, handling becomes easy but no extra cost will be incurred on transportation of unwanted materials (Moise, 2008).

Sorting of clothes is a very subjective process and requires a lot of standardisation. This can be done in two stages; at the first stage, waste and valuable should be differentiated. At the second stage, usable clothing products can be sorted as per type or style. The waste can be decomposed into the fibre through recycling process (Crang et al., 2013). Owing to subjective nature, the destination of the collected products totally depends upon the skill of persons involved in sorting process. On the basis of the sorters’ judgement of the waste can be used as second-hand products or converted into rags or wipers for cleaning purpose (Botticello, 2012). In most of the cases, sorting is done manually. Higher quality products are sold in the local second-hand shops, while inferior quality products are shipped to East Europe, Asia and Africa. The products which cannot be reused are moved to the energy generation units for incineration. Efforts taken during initial stage such as elementary sorting at collection point can reduce waste. Proper indication on the collection bin can further help the customer to rightfully drop used product. However, sorting is labour-intensive and expensive. Hence, technology should be developed to make it more efficient and cost effective (Ekstrom and Salomonson, 2014).

2.3 Redesigning/upcycling
Recycling may be considered the use of the material properties (e.g. as a fire retardant non-woven material in a mattress spring cover; Morley et al., 2009). Down-cycling may be conceptualised as making an inferior product or broken down into raw material.
However, several scholars proposed various definitions of upcycling. These include the following:

- through upcycling value/quality of the product is improved by making a superior product. (Dervojeda et al., 2014);
- giving new value to materials that are either discarded, or are not being used anymore” (Fletcher and Grose, 2012); and
- repurposing lower-value items such as a neck scarf to create a higher-value end use item, such as a wrap skirt or halter top (Janigo and Wu, 2015).

Upcycling of clothes creates interest in consumers along with increasing the life of the product. Fashion trends for clothes are fast changing, where particular design or style become outdated after a certain time. Hence, it is important to develop an interest for old clothing products. This can be done by redesigning outdated fashion products (Armstrong et al., 2015). The redesigning will reduce dependence on natural resources and enhance reuse of items by increasing their aesthetic value. Different used products such as hospital textiles, work wear, defence uniforms and vintage items can be used to redesign new products. Upcycling is an effort to achieve better or same functionality of the product by minimal consumption of raw material and energy. Upcycling is also a way to give new life to the product that is on the verge of discard (Heiskanen and Jalas, 2003; Harris et al., 2016).

3. Method

A scientific literature review procedure proposed by Mayring (2002) was adopted to select and screen the paper that comprised the following steps:

- **Material collection:** The collection of material is well defined and delimited based on the profiling approach. Profiling technique has been applied to the initial pool of papers selected on the basis of keywords. “Upcycling”, “redesign”, “remake”, “reuse”, “repair”, “refurbish” and “sustainable” have been used as primary keywords along with secondary keywords such as “textiles”, “clothing”, “apparel”, “fashion”, “garment” and “retail”. Literature profiling has been completed using different attributes such as author’s network, publication years and journals. Each paper is defined as a unit of analysis (Porter et al., 2002).

- **Descriptive analysis:** Different criteria were set to perform a descriptive analysis of collected materials. Temporal distribution of paper has been analysed to find out trends. The papers were further analysed on the basis of its distribution across different journal. This was done to avoid biases of journal specific paper search.

- **Material evaluation:** Research papers have been analysed and interpreted to understand the process of redesigning and upcycling in depth. The process of theory building exercise helped to identify various aim, actors, problem and solution to the upcycling, and proposed a conceptual framework.

QSR NVivo 10 was found to be very useful software for analysis. Nodes have been created for each category, and corresponding notes were made in the same. Multiple nodes were made for each research paper. To further analyse, these nodes and heading were entered in text format in MS Excel. The methodology used has been discussed with different researchers to check the credibility of steps undertaken. This approach has helped us decrease the risk and increase the validity of right selection of scientific article (Reim et al., 2015). This leads to a proper and comprehensive review of the literature.
4. Descriptive analysis

In total, 52 papers have been reviewed. Increasing trends have been found in terms of publication. In the past five years, the rise in the publication has been sharper than that in the previous years. Out of the 52 selected papers, 9 papers were from the year 2012. The subsequent year, 2013, stands second in terms of the total number of papers (Figure 1).

Upcycling or redesigning has been taken into account by two kinds of journals. The first type of journals published papers from clothing and textile domains. The second type of journals was focused on the subjects of operation and supply chain management. The list of main journals that published papers in the area of redesigning and upcycling has been summarised in list of main journals:

(1) Type 1: Textile and clothing journals
   - International Journal of Retail and Distribution Management
   - Textile: The Journal of Cloth and Culture
   - International Journal of Clothing Science and Technology
   - Clothing and Textiles Research Journal

(2) Type 2: Operation and supply chain management journals
   - European Journal of Operational Research
   - International Journal of Production Economics
   - International Journal of Production Research
   - Journal of Cleaner Production
   - Production Planning & Control

It has been observed that, mostly, quantitative papers were published in the operation and supply chain domain. These papers have attempted to design some mathematical or statistical models to derive a conclusion. Textile and clothing journals have mostly published conceptual papers.

5. Upcycling process

Redesigning may be considered one of the important steps in the upcycling process. The process of redesign is to add value to discarded or used products. The original idea of the redesign is based on the technique of pattern making and draping (Lapolla and Sanders, 2015). The extent of redesign can vary from adding minor details to complete transformation of
clothes. A minor change can be made by adding decorative trims, new embroidery or prints. Also, by complete transformation, a dress can be remade into ladies’ tops or children’s garments. The scope of redesign to the garment can be decided on the basis of its structure, fabric and quality (Janigo and Wu, 2015). Design thinking is an iterative process and consists of inspiration, ideation and implementation steps. Any design process jumps back and forth between these steps, particularly inspiration and ideation (Earley and Andersen, 2014). For the process of redesign thinking, inspiration and ideation can be clubbed together, as separate inspiration and ideation are required for each individual product. However, implementation steps can be broken down into reconstruction and fitting. So the process of redesign consists of ideation, reconstruction and fitting stages (Figure 2).

Redesigning is a time-consuming process as it takes a huge time to find the appropriate transformation of particular products. The limitation of redesigning could be variability in size, pattern, fabric and the colour of used product (Keith and Silies, 2015). Small size and complicated pattern of fabric from the discarded product cannot be easily accommodated in a new product design. Further, each fabric has different material properties and colour. Material properties and colour of fabrics are important criteria for its use in the new product. However, these limitations can also be considered as an opportunity for redesigning process as the size and pattern of each fabric retrieved from the used product is distinctive. This provides a unique design solution for new and improved products. To convert limitation into opportunity, redesigning process requires excellent skill to achieve perfection. Further, a substantial amount of time is needed to achieve the desired output. Each part of the used product is unique, which needs to be handled individually to maximise utilisation. An innovative approach is also needed to tackle unpredicted quality and quantity of discarded products offered for a redesign. It is impossible to run the continuous process of redesign, with a limited supply of input. In the fast-changing fashion world, the previous season’s fashion becomes precious. Hence, it is important to retain its provenance. This can be achieved by upcycling or redesigning old products with improved aesthetics or/and functional properties. Narrative of the upcycled product is another important factor, which increases its saleability. Narrative of the product’s previous life could be an important marketing strategy (Keith and Silies, 2015). Deschamps et al. (2016) also highlighted the need of upcycled brands to retain the history of the product (Figure 3).

6. Discussion
The combination of materials in clothing products create material recovery problem at the end of its life. Disassembly needs a lot of effort and incurs a huge wastage. Multi-component

![Figure 2. Redesign process](image-url)

![Figure 3. Problems and solutions of redesigning](image-url)
and diverse use of material should be minimised to promote and facilitate disassembly. The strategy of “design for disassembly” could aid methods of material recovery for reuse, redesign and recycling. The success of design for disassembly depends upon three important factors:

1. the selection and use of materials;
2. design of clothes and its parts; and
3. selection and use of seam, stitch, lining and trims.

So design for disassembly should be considered to reduce the required disassembly steps and time (Gam et al., 2011). This effort will also minimise the labour cost incurred on the deconstruction of clothes at the time of upcycling. Hazardous materials should be avoided, and only durable material should be used. Less diversified materials and permanent bound were suggested in place of interlining. Importance of longer stitch and product design for smooth disassembly has also been highlighted by Subie et al. (2009). Earley and Goldsworthy (2015) have emphasised on the “designing for cyclability” to enhance the recovery of the material. Higher value creation can be achieved by increasing the number of consecutive cycles of product usage. Biodegradability, mono-materiality and low energy production are the key attributes to achieve cyclability. Further, proper coordination among supply chain partner enables the efficient redesigning process. Information sharing between producer and re-designer improves the process of upcycling (Kumar and Putnam, 2008). Natural resources are diminishing drastically, while the demand for energy has been surprisingly increasing. In this situation, the phenomena of redesign become important to increase product longevity and durability (Bocken et al., 2014). Products are also redesigned to consider its impact on the environment. However, the success of redesign also depends upon its future market demand and cost of redesigning process (Metta and Badurdeen, 2013).

It has been found that the price of the new product in the market is the main criteria to purchase the used product. If new clothes are available at lower prices, consumers will prefer to buy new instead of second-hand clothes. So, the price of the used product also decides its future. Focus should on how to reduce cost during repairing or redesigning (Zhao et al., 2013; Das and Dutta, 2015). It has also been found that collaborative kind of redesigning facility is more cost effective (Yang et al., 2013). Technical and scientific skills of management people should be used to locate redesign location to remove all valuable accessories from waste. This will help in reusing zipper, logo, labels, etc. with other products (Russell et al., 2010). The location and type of machines/software available at a particular location have also an impact on daily as well as long-term planning. This is another crucial element that enhances the usability of product and influences performance of reverse supply chain (Min and Ko, 2008). The allocation decisions regarding repair operation will determine the success and failure of reverse logistic operations. It has been found that an integrated system is always better and cost effective than non-integrated (Xiong et al., 2013).

6.1 Redesign for textile is defined as new design made out of reused material or production spills

This can be classified as Class I (more stringent) or Class II, depending upon the level of modification. A number of designers practice redesign activities in the textile and clothing industry. Still, the volume of redesign textile is very low and irregular. A small amount of the collection of the discarded item is not suitable for redesign at the industrial level. Out of the total collection, little is found to be suitable for upcycling or redesign (Tojo et al., 2012;
Charitable organisations are involved in various kinds of redesign or remake activities at a small levels, where used clothes are converted into new clothing, or products such as cushions and pillows. For example, adult sweaters can be remade into a pair of pants for children. Some clothing companies are also involved in the remake/redesign activities for their surplus stocks. These companies allow suppliers or intern student to retransform unsold items to new clothing products (Ekstrom and Salomonson, 2014). Uniforms and of office wear in various organisations are changed frequently to stay up-to-date with latest fashion trends. Resultantly, a large volume of clothes is discarded much before their end life. There is a huge scope of redesigning and upcycling for discarded office wear. Various type of modification such as print or embroidery can be incorporated to stimulate the interest of the user (Russell et al., 2010). Redesigning, remaking or reconstruction is associated with slow design as this is meant to save resources for future (Aakko and Koskenurm-Sivonen, 2013). These activities also generate new job opportunities in the areas of tailoring, washing, ironing and mending. Other sector jobs such as handling and transport are also generated out of these activities (Imo and Maiyo, 2012; Norris, 2012). It has been estimated that income earned by the poor handler, cleaner, repairers, re-designer and distributor is almost equal to the partly lost income in tailoring operations. A high-valued collected product such as jeans and trousers are generally reconstructed. Shorts or garments for children are made out of jeans. Woven trousers are converted into elasticised sportswear by attaching tape or strip of knitted clothes. All trims and accessories are preserved for future use (Abraham, 2011). To do all these activities, sufficient skill is required. The lack of proper skill to modify or upcycling leads to the disposal of garments into waste bins (Goworek et al., 2012). Main factors affecting redesigning or upcycling process details are provided:

1. **Aim:**
   - to enhance product durability and longevity;
   - reconstruct into high potential product;
   - repair and remade;
   - increase functional and aesthetic value;
   - increase market value of product; and
   - convert into other garments or products such as pillow cushions.

2. **Actors:**
   - stores that perform minor mending and washing;
   - government machineries that collect and formulate law;
   - charitable organisations that collect and redesign;
   - laundry service that improves the appearance; and
   - volunteers that redesign clothes.

3. **Benefits:**
   - pre-owned clothes are cleaner as chemicals are washed away;
   - a number of jobs such as dealer, trader, tailor, mending, washing, ironing etc. are generated;
   - product life is longer;
   - creates interest among consumers;
Personalising and restoring recovered items is a new consumption trend. Consumers try to purchase remade items to avoid waste and landfills. The processes of remaking and reconstruction prolong the life span of the existing products. A similar initiative has also been taken for furniture. Old furniture is painted and modified for new purposes (Guiot and Roux, 2010), an initiative that is almost similar to that in the clothing and textile industry. Connell (2011) conceptualised that clothing product has two different kinds of life time, i.e. technical and aesthetic. Technical life is the time for which functional property of product is intact, while aesthetic life means time for which consumer has interest in the product. A common way to extend the life time of the product is repairing, altering and refashioning. Many individuals and volunteers derive satisfaction while performing these activities on their own. Restyled and remade clothes are sold as per their market value (Bigsten and Wicks, 1996). By upcycling process, second-, third-, fourth- and a later-generation of product enjoy better value life (Guide and Van Wassenhove, 2009). A number of processes such as shape modification and overprinting are preformed not only for improving value but also to conceal stained and damaged part. Unwanted clothes could be transformed into fashionable items by adopting this strategy (Braungart, 2006).

A number of designers and brands have been working to minimise the environmental impact of fashion goods. Junky Styling, a London-based label was a pioneer in the area of upcycling and sustainable fashion from 1997 to 2012. The label offered “wardrobe surgery” for people to help them get a new look to their garments. Clothes were transformed to Junky Style through made-to-order services. Besides, this label also offered ready-to-wear collections of modified garments. Junky Styling believed that sustainability and ecological awareness can be achieved in consumable and disposable society too (Sanders and Seager, 2009). In practice, various upcycling and redesigning initiatives have been taken up by leading clothing and textile brands.

7. Conclusion
Existent literature revealed that no study so far has attempted to summarise the literature in the upcycling area. Thus, this study could be seen as a significant and unique contribution to the literature. Altogether 52 papers were shortlisted and reviewed, in which 9 papers were from the year 2009, the year-wise distribution of papers depicts increasing trends of publication in the area of upcycling. It has been observed that the main aim of upcycling is to achieve sustainability by increasing the life span of the product and/or its materials. An upcycling process consists of ideation, reconstruction and fitting stages. Complex pattern and design are found to be the main challenges in upcycling. The concept of “design for disassembly” and “design for cyclability” were found to be the strategic foundation to boost upcycling. Multiple sizes, fabric types and colours were found to be other problems. Solution to these problems can be achieved through craftsmanship and innovation. Along with a skill set, the person involved in the redesign process should have the desire and readiness to devote time to it. Retaining provenance and narrative increases the chance of clothes purchase. Upcycling operation is still at the nascent stage, which leads to high cost of operation. Support of government and volunteers can make redesigning process cost effective and successful. Upcycling has various benefits, which includes environmental and...
monetary benefits for the individual. The current paper has also comprehended practice of upcycling done by leading brands. The bibliography and insights provided in the study may be used by future scholars as a ready reference for their research. In future, this can be extended by empirical investigation of upcycling and redesigning process by visiting various organisations. A quantitative study such as model development could also be an extension of the current work.

References


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