Title: Recycled Fashion

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Abstract
Globally, the textiles industry is worth over $1 trillion, ranked the second biggest global economic activity for intensity of trade, and employs approximately 26 million people. Moreover, it contributes to 7% of world exports, supporting a number of developing, small and industrialised economies as well as individual incomes around the world. The fastest growing sector in household waste is Textiles. Over the last ten years, discounting and low retail prices in the UK have led to 60% increase in sales of clothing, with a resultant 90% rise in textile waste from the consumer. Between 2-3% of UK municipal solid waste contains textiles and shoes. In the UK, it is estimated that consumption of textiles is now 24.16m tonnes, on average 35kg per capita, producing around 3.1 million tonnes of CO_2, 2 million tonnes of waste and 70 million tonnes of waste water per year - with 1.5 million tonnes of unwanted clothing ultimately ending up in landfill with the associated methane and greenhouse gas emissions (DEFRA 2006, Madsen et al 2007, University of Cambridge, 2006). The UK government, through DEFRA, took action to "identify, understand and address sustainability impacts from products, services and materials consumed and used in the UK" (DEFRA 2008b). They have set out to examine ten product areas with high negative impact on the environment; textiles/clothing is one. We present findings from research conducted for the Centre for Remanufacturing and Reuse on end of life (EoL) management of corporate wear as part of a project funding for the Clothing Roadmap scheme, to be presented to the Government. Site visits and interviews were conducted with a textile recycler in London and a corporation providing corporate wear to examine and understand their End of Life management approaches. Some of the issues raised were: the daily shipment of some 22500 kg of clothing overseas, the seasonal nature of the clothing disposal, the detailed market knowledge required for effective reuse, the necessity for customer relationships and the need for clear government policies to support and regulate the legitimate collection and use of waste. This research aims to explore remanufacturing opportunities for the industry at the end of the lifecycle of clothing. From literature review conducted, reuse of clothing causes the least impact on energy use and appears to be the most environmentally and socially friendly approach to sustainability efforts (Madsen et al, 2007). Remanufacture of clothing is currently practiced but at niche market levels, for it to have a broader impact, it needs to gain entry into the mass-market retail arena. Our goal is to understand how designers, manufacturers and retailers may work together in a remanufacturing process and to propose a new product development method for sustainable consumption of fashion. We, therefore end the paper by reflecting on implications for the potential mechanisms of the supply chain integration and how the large multinationals may become engaged.

Keywords: textile recycling process, fashion value chain, reuse and remanufacture, socio-economic development.

1 Waste management

Defining 'waste' is complex which the Chartered Institute of Wastes Management (CIWM, 2009) explains arises from which perspective it is viewed: waste may become the raw materials for another. Waste is regulated and is categorised according to methods for their handling, disposal and tracking: household, commercial, industrial, clinical and hazardous (CIWM 2009). The US Environmental Protection Authority (EPA) identifies three distinct types of waste that are nationally tracked: municipal solid waste (MSW), hazardous and radioactive waste (Kumar and Malgeant, 2006).

National and international waste policies, along with environmental concerns, have been drivers behind corporate social responsibility policies and waste management programs, in particular, End of Life (EoL) Management programs. The new EU Waste Framework Directive 2008/98/EC, published in the Official

Journal of the European Union in November 2008, needs to be transposed into UK Law by December 12 2010 (DEFRA 2008a) with the following issues pertinent to textiles:

- Encouragement to apply the 'waste hierarchy' – preference to eliminate waste at source, then, to reduce, reuse or recycle waste and if impossible or impracticable, disposal in a responsible manner.
- Minimum recycling rate of 70% industrial (50% municipal) waste by 2020 by all EU member states.
- Major principle is the 'polluter pays' principle: costs of waste are borne by the holder of waste, the previous holders or by the producers of the product from which the waste arose.
- Certain waste ceases to be waste – if become the raw materials for further development to bring economic or environmental benefits and thus end of waste specifications and criteria have to be developed.
- Separate collection is encouraged to maximise any value that can be gained from recycling and recovery.
- Article 29 of the directive discusses 'waste *prevention* programmes' which it directs member states to have established by no later than 12 December 2013. Moreover, this should work with Article 28 (waste *management* programmes) to analyse current waste management programmes situations in member states. It recommends that measures should be devised to improve reuse, recycling, recovery and disposal of waste. For the waste prevention programme, member states should develop and describe measures and indicators for the waste prevention. The aim is to "break the link between economic growth and environmental impacts associated with the generation of waste". Annex IV of the article lists a number of examples of these measures and *promotion of creditable eco-labels* is one such measure (that can affect the consumption and use phase)

1.1 End of Life (EoL) Management

EoL Management considers "activities required for retiring a product after the user discards it after its useful life", resulting in financial gains and new marketing opportunities (Parlikad and Macfarlane, 2004). Financial gains are through saving on landfill taxes, credits for diverting waste from landfill and revenue through selling waste as raw materials for another process; new marketing opportunities through eco-labels indicating green credentials of a product or company (Rubik and Frankl, 2006). Some eco labels indicate EoL management credentials for a product and some textiles and apparel companies have developed closed loop systems that incorporate EoL principles, this will be discussed later in the paper (Sinha, Hussey, 2009).

EoL management involves five product recovery strategies aimed at recapturing value: repair/reuse, refurbish, remanufacture, cannibalisation and recycle (Kumar and Malegeant, 2006); the textiles industry undertakes all. Textile recycling, an ancient practice dating back to Ancient Egypt, has always been market driven, and can recover between 93-98% of the textile waste collected (Brill 1997, Hawley 2004, DEFRA 2006). Oakdene Hollins report (DEFRA 2006) refers to the textile recycling industry as 'secondary textiles industry' and, from the literature reviewed, provides the first diagrammatic representation of the flow of materials through the secondary textile industry which it notes sorts and distributes used textiles into some 140 different grades, with four main categories:

- Re-use and reselling: either transported to markets (often to the African continent but also to Europe and Asia), often referred to as the second hand markets, or may be resold in the UK through retail shops (considered the 'cream' of used textiles), referred to as 'vintage'. The clothing is also sometimes reused and redesigned into new items of clothing.
- Wiper Grade - material suitable for use as rags and wipers with little or no further processing and generally sold in the market or to industrial cleaning businesses.
- Recycling Grade - material suitable for pulling (knitted items) or shredding into fibres (woven items) for use in new end products. Shoddy may be used in a range of other industries for their fire retardant properties, eg automotive, aircraft or bedding upholstery, yarns for knitting are used for reprocessing as knitted garments.
- Waste - material that cannot be resold or recycled which is disposed to the waste stream. Textiles that end up in landfill are usually soiled or unusable because they are not the right type of fibre mix or are torn and unsellable.

1.2 Sustainability impacts of fashion

A life cycle analysis of the clothing development process indicates the significant part played by the consumer in textiles waste management (DEFRA 2006, Tukker et al, 2006, University of Cambridge, 2006, Birtwistle and Moore, 2007, Madsen et al, 2007 and Forum for the Future, 2007) and the subsequent exponential rise in the export of clothes to overseas markets (Rivoli, 2005, Mhango et al, 2005, Hawley, 2006, Claudio 2007). Whiles there has undoubtedly been advantages for the destination markets, specially in Kenya and Tanzania – the largest importers of UK and USA second hand clothing respectively (Rivoli, 2005, Field, 2007), this has exasperated an already difficult situation faced by the domestic manufacturing industries and entrepreneurs (Baden et al 2005, Sinha, 2007). Moreover, second hand clothing markets are declining due to increased cheap imports from Asia resulting in increased land filling – legal or illegal- and the associated problems and impacts (United Republic of Tanzania, 2003, Mero et al 2008). In a reaction to this, 14 countries in Africa, as well as some countries in Latin America and Caribbean, are banning imports of recycled clothing or making it bureaucratically impossible to import (Dupin, 2003).

Notwithstanding the economic development problems, it appears that reuse of clothing has the lowest impact on the environment. Woolridge et al (2006) conducted research to quantify the energy used by reuse/recycling and whether this resulted in a net energy benefit when compared with using virgin cotton. The energy footprint was quantified using a streamlined life cycle assessment and they found that "for every kilogram of virgin cotton displaced by second hand clothing approximately 65 kWh is saved, and for every kilogram of polyester around 90 kWh is saved." (Woolridge et al 2006, p.94). The conclusion was, therefore that the reuse and recycling of clothing results in a reduction in the environmental burden when compared to purchasing new clothing made from virgin materials. Ethical and environmental issues have increasingly concerned the fashion consumer's psyche. The umbrella organisation for fashion designers with ethical practices, Estethica, has grown from about ten companies to between 20-30 over the past two years of showing at the major fashion weeks (this year it was at London Fashion Week and was the site of the public launch of the Clothing Roadmap). Some of the companies use remanufacture practices, eg Junky style label, officially launched in 1997, deconstruct used garments and convert them into a new, unique garment. However, this approach is niche marketing and the sustainability impact at this level is small. Our question is: would this be possible to achieve on a mass market level?

1.3 Closed loop systems and remanufacturing

The traditional 'open' system consists of a primary supply chain with forward flow from raw materials, through manufacture to final EoL disposal of the post-consumer product. When coupled with additional supply chains that collect EoL products during the process and reprocesses them into secondary sources, replacing the primary resources in the forward supply chain, the chain is 'closed loop' and the system is typically modelled as transformation processes and materials flows (Matthyssens et al 1994, Kumar and Malegeant, 2006, Yang et al 2009). Remanufacturing is a closed loop system and has been defined as "the process of disassembling, cleaning, inspecting, repairing, replacing, and reassembling the components of a part or product in order to return it to 'as-new' condition"; sometimes termed 'upward remanufacturing' to include the end use of the remanufactured product or component: "the process of disassembling, cleaning, inspecting, repairing, replacing, and reassembling the components of a part or product in order to return it to as-new condition and incorporate it into a new, or "next generation" system, this might require new features be built into the product during remanufacture" (Nasr and Thurston, 2006).

Remanufacturing converts waste into a resource providing new business activities, generating jobs and finance, and diverts waste from landfill resulting in significant reduction of energy use and carbon emissions and is currently practiced in various industries such as automotive and aerospace. Kumar and Malegeant (2006) note that a major problem with remanufacturing is the uncertainty in timing, quality and quantity of returns, balancing returns with demand, disassembly, reverse logistics, materials matching requirements, routing uncertainty, and processing time uncertainty. Sundin (2004) proposed a Remanufacturing Property Matrix (RemPro) which relates all steps in generic remanufacturing process (inspection, cleaning, dissambley, storage, reprocess, reassembly and testing) with the preferable product properties (ease of verification, access, handling, separation, securing, alignment, stacking, wear resistance). Building on this and previous research and literature regarding the fashion supply chain and design process (Frings, 1991, Stecker, 1996, Sinha 2000, Burns and Bryant, 2001, Jones, 2005, McKelvey et al 2008), we considered the issues regarding remanufacturing fashion in the light of the literature reviewed to date, some of which we present below:

- Managing the supply/value chain is challenging.
- Unpredictable supply of second hand cloths.

- There must be an efficient take- back system.
- Problems of material flows and high inventory systems.(Sundin, 2004)
- Large involvement of labour than technology. (Sorting, disassembling, re-designing)
- Sorting and preparing cloth pieces for re-manufacturing takes more time than unusual, which adds extra costs to the business.
- Lot of effort should be put in disassembling the garment.
- Issues with durability and difficulties in disassembling. (Depend on stitch type and quality of seam)
- Difficult to sort and disassemble, quality issues and poorly designed products would make remanufacturing too expensive.
- Cheap and low quality garments make the re-manufacturing impossible.
- Problems of developing unique patterns for individual cloths captured.
- How to make the re-designing and cutting process effective and efficient?
- Large-scale remanufacturing may be uneconomical in developed countries.
- How to maintain the low cost advantage?
- Is global sourcing still a solution?
- Need of efficient planning methods and tools which help minimal cost adaptation for remanufacturing process
- Use of lean or mass production systems are practically impossible with remanufacturing.
- Requirement of a flexible manufacturing system.
- Requirement of innovation and creativity to optimise the remanufacturing process
- Reuse often involves with cleaning and transport which are environmentally unsustainable.
- Government policies
- How to compete with the existing market as it continues to falling price of new products and short life cycles.
- Long lead times may be inconvenient for retailers and customers.
- What are the strategies to access the marketplace – Attract the retailers and buying public

1.4 Examples of remanufacture in fashion

The first step in remanufacturing is the process or method by which a company collects used products. Known as 'reverse logistics' (Seitz and Wells, 2006), the product 'take back' process can potentially account for a significant part of the total costs of any closed-loop supply chain (Kumar and Maleagean, 2006). Three categories of product take back systems are as below:

1.4.1 customer pays system

Teijin, a large multi-national company with over 150 fibre, fabric and fashion companies manufacturing a type of polyester fibre that can be broken down and remade back into polyester fibres. A network of companies such as AEON and Uniqlo in Japan and Patagonia in the USA make use of this technology. Teijin calls this network their *'eco-circle'* system and they have developed a number of types of polyesters suitable for a range of different uses such as garments, uniforms, building supplies, stationary (ecocircle 2009). All recycling takes place at Teijin's Japan plant, costs for returning garments to Teijin are borne by the retailers who collect the garments. Patagonia takes back clothing in stores (customers may drop them off or mail them back) and transports back to Japan and Teijin as part of their Common Threads Garment Recycling programme (Patagonia, 2009). Patagonia has a range of products that is in this eco-circle, not every product that they sell is in this range. The Japanese clothing retailer AEON also set up a take back system for clothing that bears the EcoMate label certified by the Japan Apparel Industry Council as "a commodity adopting design conducive to recycling", ie, it identifies if the clothing can be recycled (p 12, AEON, 2004).

1.4.2 collection box (analogous to the public recycling bins)

The AEON group have taken the principles of eco-circle a step further and have developed a stand alone retail concept (Self and Service) that is based on an EoL management system for the clothes that they sell. The store partners up with Nakano Inc., the leading used-clothing recycler in Japan to collect and sort the clothing. Their initial idea has been to take back only clothes with the EcoMate logo but they are now developing a system to collect clothing not bearing the EcoMate logo (p 12, AEON, 2004). The idea of collecting the clothing is to send to Teijin or to export to second hand markets.

Nike, the athletic wear company, has entered the area of sustainable design and are doing so in partnership with two types of companies. To collect products, they entered into a strategic alliance with the National Recycling Coalition (NRC), a non-profit organization, to undertake the logistics of collecting

used tennis shoes to recycle them; a long term goal being to develop at least one collection centre per state. Nike has also worked with McDonough Braungart Design Chemistry (MBDC) to develop ecologically intelligent product design by identifying environmentally harmful substances in the making of the waffle soles of the shoes. Focusing primarily on Nike's global footwear operations, Nike and MBDC identify materials that meet or exceed the company's emerging criteria for sustainable design, designed to either be metabolized by nature's biological systems at the end of a product's useful life or be perpetually recovered and reutilized for new products, ie flow in closed loop cycles - the foundation of our concept of their Cradle to Cradle Design SM (McDonough & Braungart, 2002).

1.4.3 combine collection with other transportation

Second hand clothes are collected and transported to the textile recycling plants both publicly and also as part of a system in the CSR policies of companies. The system of transporting by tankers overseas is routine in the second hand market trade but Rivoli (2005) has raised the issue that this might become another area of competition in the USA as many tankers come from China packed with garments destined for the USA and return empty. The Chinese manufacturers may realise the financial gains to be made from the second hand market trade and begin to require the return of their tankers to have bales of second hand clothing to enter the secondary textile industry (Kumar and Malegeant, 2006, Nike Environmental Responsibility, 2004).

Closed loop systems dependant on proprietary chemical recycling methods relies on a particular fibre type. Fashion, however, is made up of a myriad of fibre types suggesting that the sustainability impact may not be as high as might be needed to counter the rise of textile waste. While remanufacturing offers a non-fibre/chemicals dependant solution there are other problems. Our research quest was to consider if a strategic alliance may be possible between retailers, recycle firm and entrepreneurs in destination second hand markets to undertake a remanufacturing process. While much is documented about the supply of fashion (design, manufacture, production and marketing) much less is documented about the textile recycling firms, Rivoli (2005) referred to them as the 'invisible' trade. To begin to explore the concept, we carried out case studies to understand approaches to EoL management by a textile recycler and a corporate wear provider - corporate wear is notorious within the textiles and clothing industry for the lack of EoL management – only about 2% of the corporate wear market (4% of the total UK spend on clothing) escapes landfill.

2 Methodology

We conducted on site visits and in-depth interviews with textile recycler (LMB) and a corporate wear provider (Royal Mail Group) to examine their approaches to EoL management. Each interview was recorded, photographed (where possible) and transcribed. The process was examined and drawn up according to $IDEF_0$ modelling principles where each process is labelled as an activity with inputs, outputs, constraints and drivers the process, (Bin Akasah and Amirudin, 2006). The case studies have been reported in the UniformReuse website (www.uniformreuse.co.uk).

2.1 Results

2.1.1 Textile recycling firm. Lawrence M Barry & Co (LMB), Canning Town, London.

The site visit took place in July 2008, for three hours and was conducted with the manager and director (and daughter and son of Lawrence MBarry), Michelle Goggi and Ross Barry. Established 1985 with three members of staff, it is still a family run business and has evolved into three companies with 170 staff:

- LMB recycling plant,
- Britannia Plant and Engineering Ltd (fabricates the recycling receptacles and conducts mini-sorting),
- LMB Supplies (manufactures and supplies wiper cloths and ecological janitorial supplies).

Figures 1-4 illustrate the process of collection and EoL routes at LMB. For a typical 22.5 tonne container, between 5-12% is waste, of which less than 1% is textile waste. There are three broad phases: collection, sorting and distribution. On average, each item gets handled seven times.

Phase A: Collection - from LMB static banks within the M25 (south east region) to maintain low carbon footprint. They prefer public donations in re-used supermarket sized plastic bags (keeps clothing dry and free from contamination), rather than black bin liners (virgin material) that tend to jam up their conveyor belts. Once into LMB vans, they are weighed on LMB weighbridge, recorded, and reported to the local authority once a month. The council claims their credits and LMB make a payment for the tonnage received. Once weighed, clothes and miscellaneous items are tipped off the back of the van and sorted.

Paired shoes and bags are removed and sorted separately. Other items are de-bagged (if necessary) sent up a conveyor belt to a first floor caged area where all clothes are deposited and stockpiled.

Phase B: Sorting – simultaneous separation of shoes from textiles and decisions for reuse, recycle or landfill are made.

Shoes: Unpaired or unrepairable shoes are sent to landfill as it is not yet possible and potentially very environmentally toxic to recycle shoes. Paired shoes are sorted by gender and age (men's, women's, children's) then by type, and by quality grade 1 or 2. Men's and children's shoes command higher demand, (ladies' much higher turnover – many are unworn, still bearing the retailer's labelling). Shoes with holes may be repaired in the destination countries. Shoes are bundled together in see through plastic (mixed) 30kg bags so that customers can see easily the content of the bag. The sorters need to have good destination market knowledge: eg, heeled women's shoes are sent to Eastern Europe, while African environments require flat shoes. On the wall, vintage style shoes are displayed to inform the sorters to help them identify products for home 'vintage' markets. All goods are hand sorted then thrown into the appropriate shoot to a container on the floor below where bundles are created for final dispatch.

Clothing and any domestic articles: sent down the chute to be separated. This 'rag' sort is a quick sort between reuse (curtains, nets, pillowcases, handkerchiefs etc) and recycling. They are sorted into particular categories and those unsuitable for either are land filled.

Re-cycling - items may be:

Made into shoddy - used for fire retardant properties, eg mattresses and automotives (tested by shoddy manufacturers to ensure appropriate minimum 40% wool),

Re-knitted - pulling machines at external processors take jumpers apart - white jumpers have more value as they can be coloured to the latest trends most directly.

Wipers - LMB Supplies manufacture 16 grades of wiper cloths (from absorbent, stained or torn clothes, eg Tee shirts, sweat shirts, etc).

Reuse items are sorted (slow sort) by a team of trained 'useful sorters' by garment type (not brand labels), placed into one of 160 box/cage categories (eg: light weight polyesters, accessory type items, formal trousers) and 'destination' - warmer winter type clothing going to the mountainous countries, and the lighter weight items being sent to the African countries. Formal garments are graded into types, made into smaller bundles and folded carefully to avoid excessive creasing during the transportation phase, eg, trousers with a crease and turn up command a higher price, leather coats may be sold on, deconstructed and created into new products (if good quality), feathers to Belgium. Damp/wet items are dried before bundling - if bundled when wet, they mould, generating heat and potentially combustible/hazardous as shipments can be on the seas for five or six weeks. Items to be bundled come down the shoot, with the appropriate label explaining exactly what is in the bundle which is bagged up into 45kg bales (or smaller if they are trousers), as they may have to be carried by hand once they reach their destination. The bales are compressed, sealed in plastic and bound to standard dimensions; as one is compressed, the next load will be dropped. Prior to dispatch, the larger bales are wrapped in duvets and sleeping bags to protect and utilise them.

Phase C: distribution – destination markets or landfill. Overseas markets reached by shipment, usually by a 40 foot container per day, which is around 500 bales, or 400 bales (rest of the space filled with 'shoe sacks'). LMB only landfills textiles if they are heavily contaminated as there will be landfill charges and environmental concerns.

Figure 1: a summary of the textile recycling process at LMB and Co.

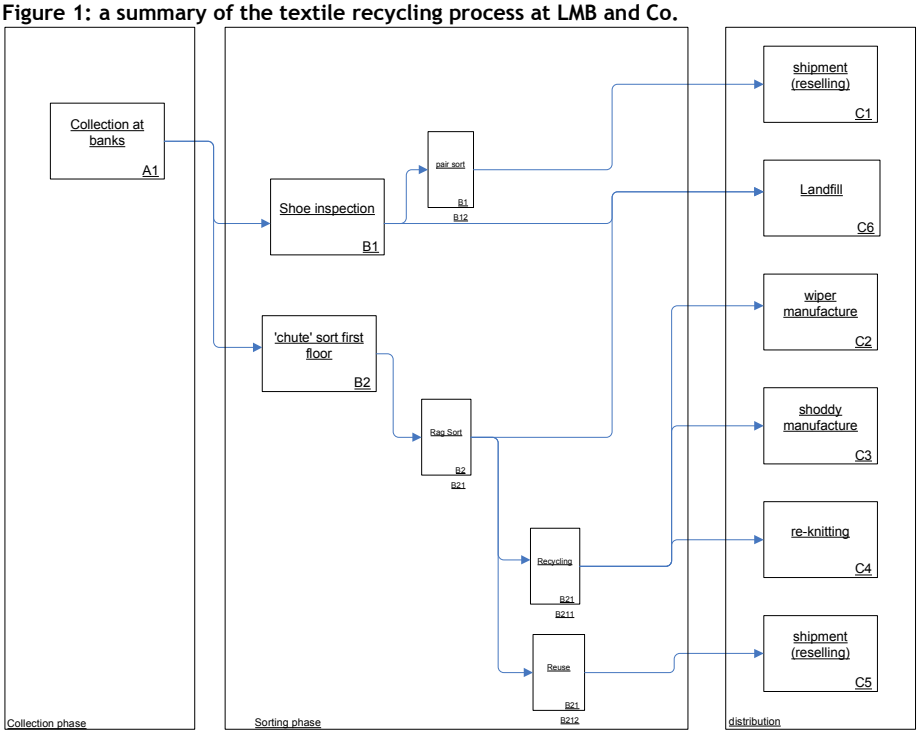


Figure 2: collection phase at LMB and Co.

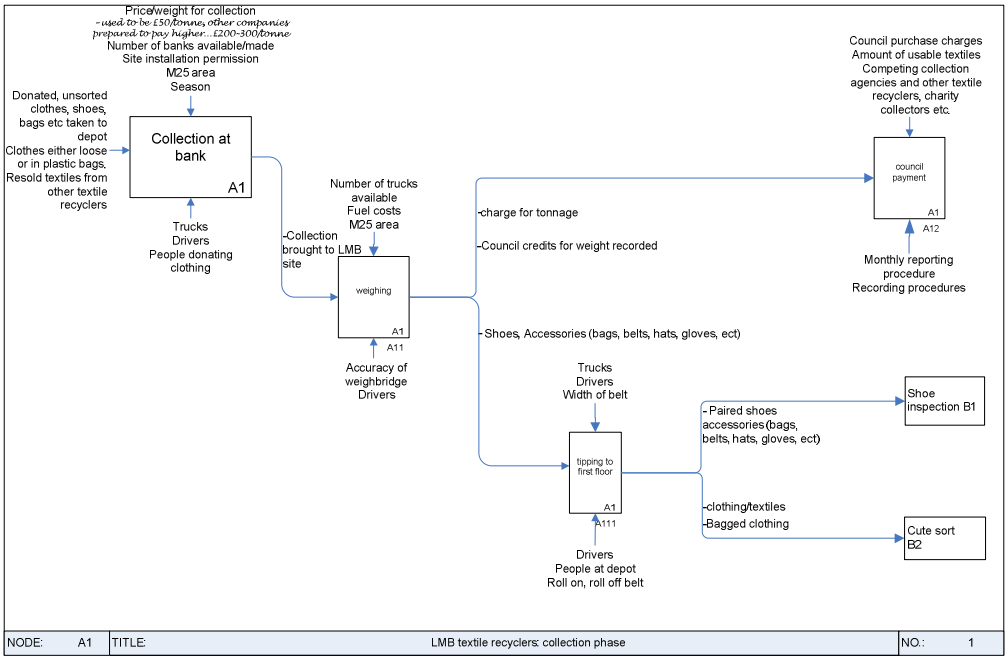


Figure 3: sorting phase at LMB and Co.: shoes

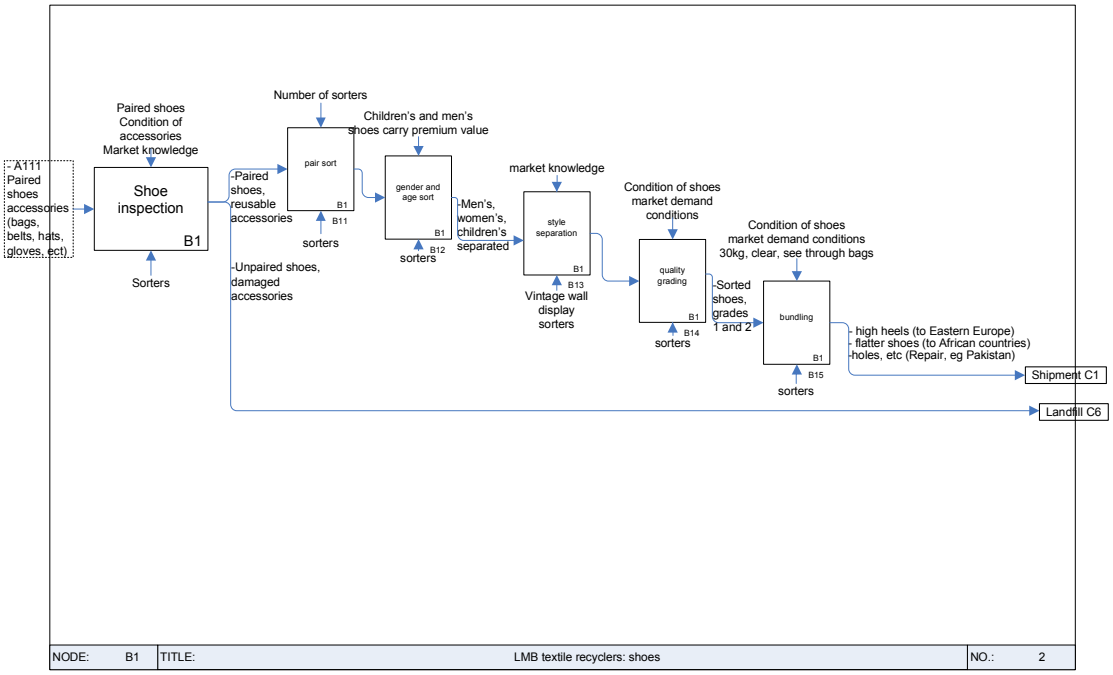
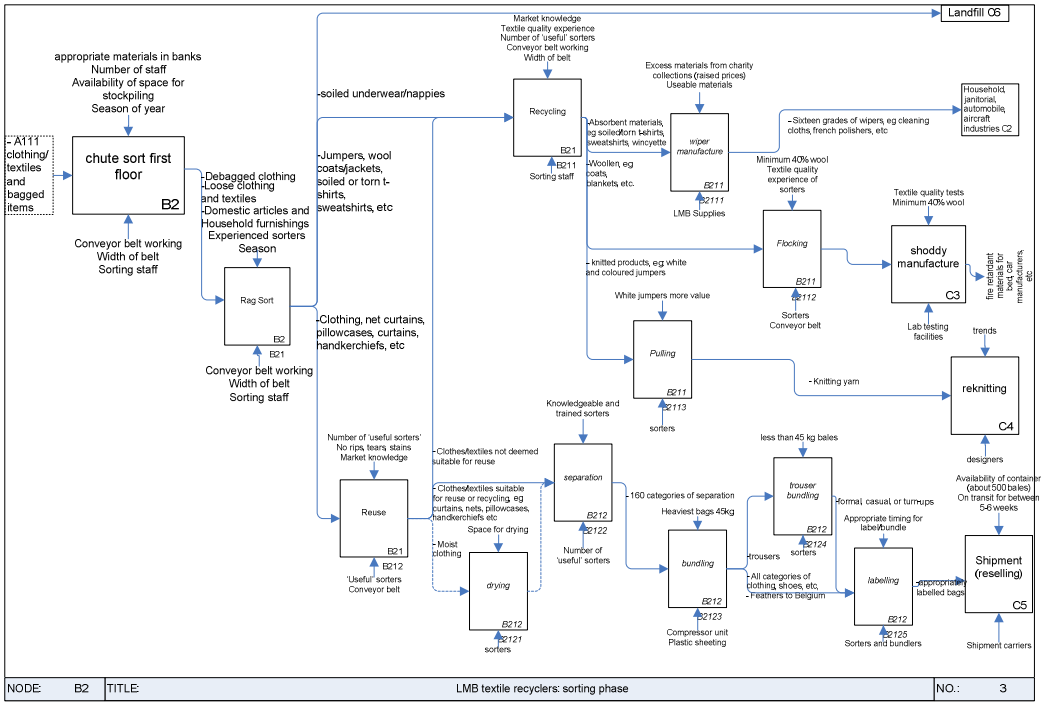


Figure 4: sorting phase at LMB and Co.: textiles products

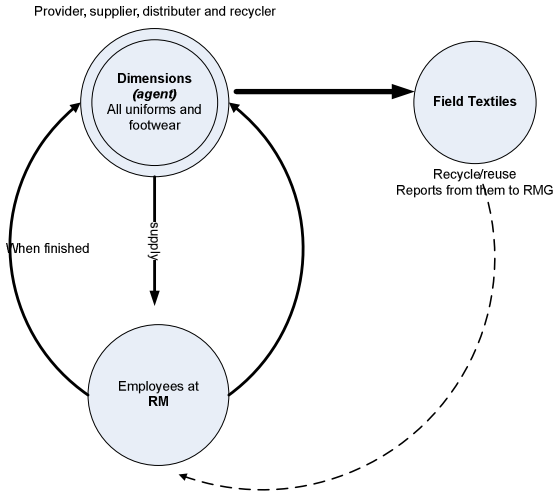


2.1.2 Corporate wear provider – Royal Mail Group (RMG)- Chesterfield

Royal Mail Group is the umbrella organisation for the Royal Mail, Post Office, ParcelForce Worldwide and Cash In Transit (CIT). Employing about 1% of the total UK population they provide about 50 products including high performance, cycle helmets, footwear and cater for sizes XS to XXXL as well as belief systems (eg 100% natural fibres and vegan footwear). They are subject to Public Procurement Law, contract approval takes about two or three years and a contract will last for between 3-5 years (option to extend by another 5 – ie, potentially 10 years). RM works with Field Textiles a recycling firm who also recycle materials for the Ministry of Defence (including warships etc). RM also works with Dimensions as

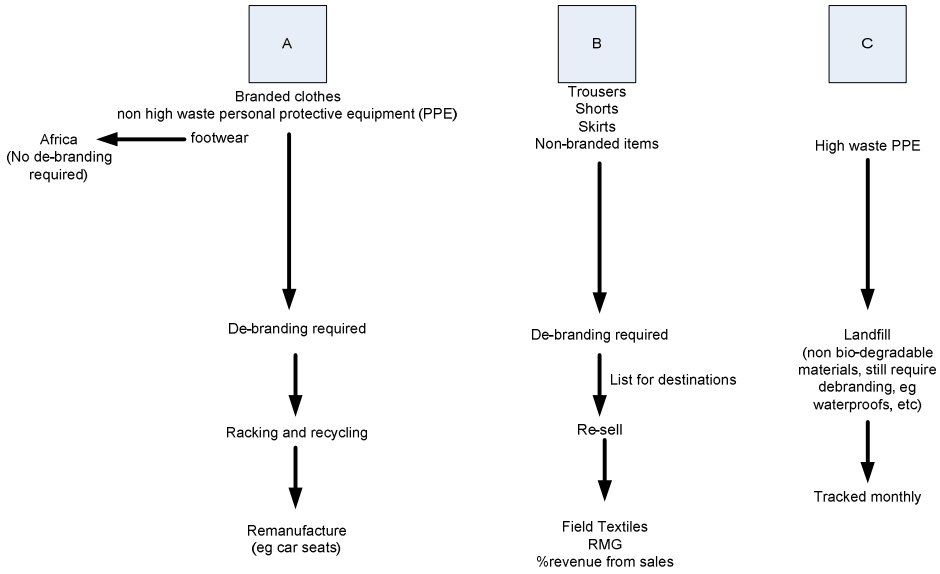
agents to manage procurement of suppliers, distribution and take back of the corporate wear when they need to be decommissioned. See figure 5.

Figure 5: The flow of materials between Field Textiles, Dimensions and RM.



Field Textiles has a mainly automated process, employing minimal staff. Uniforms are brought to the Field Textiles depot by trucks and sorted for de-branding by about 3 people (the labels are cut off the garment thus rendering them unusable). Garments may enter into recycling (depending on the fibre content) or landfill if non bio-degradable. Another ten people rack the garments considered useable. All materials destined for land filled also need de-branding for security. Shoes do not have to be de-branded and (depending on condition) can be sold again. Field Textile track, record and report monthly to RMG about the destinations for all the goods: resell or landfill. Dimensions bar code all products to track from supply, distribution and disposal, implementing a system of disposal through three codes: A, B and C, each route has a separate final destination. A percentage revenue of the sales made through reselling goes back to Field Textiles and RMG. See figure 6.

Figure 6: disposal of corporate wear through the three codes: A, B and C.



RM claim to landfill less than 1% corporate wear collected (0.86%) however; they are looking for ways to improve rates of collection from their employees.

3 Discussion

The process of recycling at LMB was consistent with the literature reviewed (Brill 1997, DEFRA 2006). LMB felt that there was some confusion around the term "waste" with regards to textiles. If the general public donates clothes to a charity shop, it is not waste. If that donation can not be re-sold within the shop, then it becomes waste. To conduct legitimate business in the waste industry, a company needs to register, obtaining a waste carrier licence; failure to do so results in imprisonment or fine. Some companies recycle textiles but do not register, adding to the confusion over the process and destination of textile recycling. Moreover, the discarding of clothing is effected seasonally - before holidays, after holidays, after rainy days, pre-Christmas is very quiet but post-Christmas is very high. Consistent with the literature reviewed, LMB estimated approximately 95% of a collected bin can avoid landfill; below 1% is textile waste, due to being mixed up with household rubbish eg, foodstuff or other waste. LMB suggest clearer public guidelines on what can/cannot be recycled within their bins. The following elements are of interest to remanufacturing process of fashion:

3.1 Market knowledge:

Destination market requirements dictate type of items sent and, consistent with Rivoli's (2005) account, textile recyclers visit destination markets often to get personal experience of demands, eg short skirts may not be popular/worn in Africa. LMB employ sorting staff from destination markets to use their market knowledge.

3.2 Networking:

LMB and RMG had developed networking relationships with various actors in their chains.

3.2.1 Customers:

LMB is proud of the relationships developed with their customers across the world, stressing they was not a charity: LMB buy their goods, sort, sell, whereas charities sell their received donations to merchants, who may not process the goods. A repercussion is that LMB (who purchase goods by the tonne from the London borough councils) find prices driven up from as much as £50 to £200-300 per tonne. There have been instances where Eastern European countries have obtained goods from the UK, created wipers, and then they try to sell back to LMB for redistribution.

3.2.2 Business to business:

RMG works in a network type of relationship with a textile recycler and a sourcing agent.

Polyester tends to be the fibre of choice for the corporate wear companies and it is the most difficult type of fibre to recycle. Having worked with a major airline company for 15 years, LMB now advises them at the conception stage of their uniform with regards to designing with EoL considerations (eg using natural fibres instead of polyester).

Councils: In the last four years LMB have introduced an 'education' arm (set up as a community interest company), which works with the local authorities. LMB's 14 coordinators go into around 600 schools where they provide creative workshops to aid understanding of recycling and reuse, free recycling service in the form of a 'Bertie & Betty Bin's' shaped like monsters, and arrange specific collection days. They pay more per tonne of these goods as there is higher re-use of the goods.

LMB also re-design using in house designers and items that can not be re-used as a garment, selling through their own shop on Brick Lane, the term they use is up-cycling. They work with the local prisons to help develop skills in prisoners for rehabilitation for work and they have also helped new businesses by sponsoring them by giving them access to textile products, once they are more established they sell them the materials they need by weight (www.lmb.co.uk).

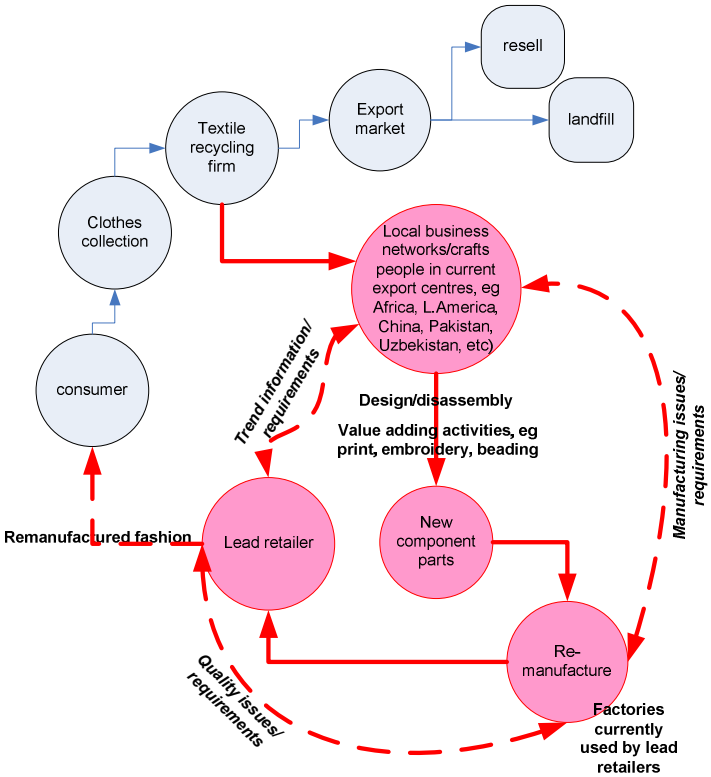
4 Conclusions

As noted, the second hand clothing market raises complex issues. The clothing supply chain is complex, global, characterised by sub contractors in the developing world and the use of migrant workers. Most fabrics for clothing manufacture are bought on global commodity markets. Retailers can buy clothing from known suppliers, through agents or vendors. Determining origin and sustainability credentials of raw materials and stock are key challenges, affecting transparency and the ability to effectively manage impacts across the supply chain, and requires an understanding of the risks involved in the management of the supply chain (ERM, 2007, University of Cambridge, 2006). These issues have often been examined by the value chain approach, extensively in the field of development studies, as it examines the mechanisms of developing trade and production through globalisation and the resulting effects (Gereffi et al, 2001). A 'value chain' is an umbrella term to include various concepts: supply chains, international

production networks, global commodity chains, French *filière* and the global value chain. The value chain concept differs from that raised by Michael Porter (1980), in that the chain of organisations may contain a complete or incomplete set of functions depending on their specialism, raising questions about power, governance and dynamics within the chain; ie how chains are organised and managed. The global value chain approach highlights the relative value of those activities that are required to bring a product of service from conception, through the different phases of production – involving a combination of physical transformation and the input of various producer services – delivery to final consumers, and final disposal after use and focus is on how various functions of a product's (or industry's) supply chain are splintered and globally dispersed (Gereffi et al 2001).

When viewed from a value chain perspective, the apparel value chain is organized around five main parts: raw material supply, (including natural and synthetic fibres); provision of components, (eg yarns and fabrics); production networks (eg garment factories, their subcontractors); export channels (established by trade intermediaries); and marketing networks at the retail level (Appelbaum et al, 1994). Research carried out on particular sectors, eg garment, electronic and agricultural commodities, has provided valuable insights into the role of lead firms in constructing these chains. Lead firms, predominantly located in developed countries, include not only multinational manufacturers, but also large retailers and brand-name firms, playing a significant role in specifying what is to be produced, how, and by whom. Our proposition for remanufacturing in fashion is illustrated in figure 7. The heavy lines depict the remanufacturing process network of textile recyclers, technology providers eg Lectra ® (with latest CAD/CAM pattern cutting/management software), local crafts entrepreneurs in destination second hand market areas and factories supplying clothing to the large retailers. Our intention is to pursue this research by interviewing members of this proposed network to understand the issues raised by our proposition with a view to developing an industry based remanufacturing process.

Figure 7: proposed remanufactured fashion model



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