



The Challenges and Benefits of Developing a Sustainable and Circular Business Model for the Blinds and Shutter Industry in the UK

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Introduction and context

Blinds and shutters have been used around the world for hundreds of years to cover unglazed and glazed window openings although the precise origin and date of invention is unknown. Early examples using natural materials such as bamboo and reeds were developed in the Far and Middle East and slatted wooden 'venetian' type blinds were developed in Persia prior to widespread use across Europe and America. Patents dating from the middle of the 18th century illustrate the development of blind mechanisms and various types of blind (such as roller, slatted, pleated, vertical, panel) made from natural and synthetic materials (including wood, textiles, aluminium, and plastics) are currently available. Both blinds and shutters are used for privacy and contribute to building aesthetics, while shutters (which are usually made from wood or metal) also enhance security. Furthermore the 'correct' use of blinds helps to keep buildings cool in the summer and warm in the winter although what is 'correct' varies according to geographical location and type of blind (opaque,

semi-opaque, roller, slatted, fit-to-window etc.). Changes in weather and climate and a rise in the number of heat waves in the UK (CIBSE, 2015) mean that the importance of blinds is increasing (Swainson, 2016) because correct use contributes to human wellbeing by controlling glare, natural light levels, access to view and interior temperature. This is particularly important for the very young and the elderly who are more susceptible to ill health (and even death) as a result of exposure to high (Lullaby Trust, 2014) or low (Wookey et al, 2014) temperatures, which is not only unpleasant for them but can lead to additional health service costs; furthermore on-going research indicates that the previously described environmental factors can enhance productivity in the workplace (Green Building Council, 2013)

As aids to temperature control and thermal comfort blinds and shutters reduce energy consumption and associated CO₂ and other greenhouse gas emissions. In fact the 'correct' use of blinds can reduce energy consumption up to 15% for double glazed windows and 25% for single glazed windows (Dolmans, 2006) and (Hutchens, 2015). Consequently blind use has the potential to reduce heating costs during the winter and cooling costs during the summer although it is apparent that their benefits are not being fully realised in commercial premises in the UK where the installation and use of air conditioning is increasing (Abela et al, 2016). There are a number of reasons why the full benefits of blind use are not realised including incorrect specification and fitness for purpose, poor understanding of their benefits and associated user behaviour. In their longitudinal study in Switzerland Paule et al (2014) found that users do not move (i.e. raise and lower) blinds regularly or frequently and therefore potential reductions in thermal loss and/or gain are unfulfilled. This same study identified an interesting variation in user behaviour when different control strategies were implemented in that building occupants with motorised blinds moved their blinds far more frequently than occupants with manual blinds. The researchers concluded that this was because the motorised blinds were easier to use than manual blinds.

At a time when the number of heatwaves in the UK is rising concurrently (Abela, 2016) with concern about levels of energy consumption (and associated environmental impact) for both cooling and heating, use of motorised blinds could to be a positive means of encouraging more effective and proactive blind use. However, this type of blind has higher embodied and operational environmental impacts than manual equivalents because these blinds require electrical energy and additional mechanical electronic and electrical components to function. This raises a question as to what overall environmental benefits derive from use of this type of blind: i.e. whether the environmental impact of energy savings exceeds the combined embodied and operational environmental impacts of the products.

At present the majority of blinds are not recycled and many domestic blinds are disposed of with municipal waste where they are either sent to landfill or incinerated in waste-to-energy power stations; many others are disposed of with construction waste and are ground down to form new hard core. The actual quantity of this waste is unknown; in the UK alone however annual sales of blinds exceed £550million (AMA Research, 2014), which equates to between 2.5 and 5 million individual products. Many of these blinds will replace 'unfashionable' or damaged blinds, the majority of which will not be recycled. Considering the annual number of blinds sold, means that a significant quantity of resources is wasted. Furthermore this waste stream will increase concurrently with the potential market growth in motorised and automated blinds.

This paper first assesses the overall environmental impact of motorised blinds and then considers the challenges and drivers for the development of a Circular Economy that includes reuse and recycling for this industrial sector.

Life Cycle Assessment (LCA) of blinds: rationale and methodology

A recent study to assess and quantify the overall environmental impact of manual blind use in a typical UK house showed that, even when energy savings were minimal (5%) and life short (3 years), if recycled at end-of-life the use of blinds had a lower environmental impact than not using blinds. The study also showed that, even with energy saving of 5% when sent to landfill at end-of-life use of blinds was environmentally beneficial as long as product life was at least 5 years (Andrews et al 2015). Although these results are positive they could be misleading: although low levels of blind use can be environmentally beneficial, higher levels of user interaction and thus temperature control are more desirable and, as stated above, can be encouraged through use of motorised blinds.

By considering the impact of blinds in a domestic context both the earlier and this study differ from many others, which are based on commercial premises. This research also differs from 'carbon footprint' studies which, as the name suggests, only consider the impacts of carbon and its

equivalents and consequently are less accurate than Life Cycle Assessment (LCA). LCA includes hundreds of material, gas and liquid inputs and outputs including emissions to land, air and water, the impact on ecosystems, resource supply and human health. The study of a refrigerated display cabinet comparing the results of a carbon assessment and more comprehensive Life Cycle Assessment found that, in the case of the LCA, the embodied impact of the cabinet is proportionally far higher than that in the carbon study (Bibalou et al, 2013).

This paper now builds on the earlier study and compares the impact of motorised blinds with that of the manual blinds. This study is again a screening LCA created with SimaPro software and the Ecoinvent database and hierarchical (average) weighting set. The functional unit in the model is the same, namely one average house with 7 blinds that cover a total of 14.5m²; annual average annual energy consumption for space heating is 60% of the total of domestic energy use (although it varies according to external temperature), which is calculated as 11,160 kWh per household (DECC, 2013) and (DECC 2015).

In the earlier study four different types of blind were reverse engineered and modelled (a blackout roller with 100% polyester fabric, a wooden venetian, an aluminium venetian and a vertical blind with polyester vanes); the environmental impact of each type was calculated and the totals averaged to reflect that fact that different types of blind are generally installed in individual houses. This preliminary new study concentrates on one single popular type of blind however - a motorised roller blind – and the Life Cycle Assessment is based on the following parameters and variables:

- Fabrics: 3 typical fabrics - 100% polyester, multilayer blackout; 72% PVC / 28% glass fibre composite blackout; 64% PVC / 36% glass fibre composite screen. Typically the blackout blinds reduce thermal loss during the winter and night while the screen blinds reduce thermal gain and improve visual comfort during the day.
- User interface: 2 types - a 'wand' control attached to the blind mechanism and a separate remote control
- Electrical / electronic components: 2 types: size and specifications vary according to whether they are part of the 'wand' or the 'remote control' based system. The inputs, outputs and results for these two complete systems are averaged
- Batteries: Systems are battery operated rather than hard-wired (for simple installation). Both systems use Li-ion rechargeable batteries. Battery charge lasts for 6-12 months depending on level of use and so the model includes electricity input for 1.5 charges per year.
- Battery life is limited and in the model they are replaced once every 5 years.
- Energy savings: again energy savings of 5%, 10%, 15% and 20% are modelled. However it is expected that average energy savings will be higher than those for manual blinds because user interaction with and levels of movement of motorised blinds are higher than that of manual blinds.
- Product life: in this and the earlier study product life was set as 3, 5, 10, 15, 20 years.
- End-of-life scenarios: E-o-L scenarios are also the same as those in the manual blinds study and represent a best and worst case scenario namely all parts recycled and all parts sent to landfill.

The overall environmental benefits of recycling manual blinds at end-of-life have already been demonstrated in the prior study and the results are described above; however many blinds are disposed of before components reach the end of their functional life and so the new study also includes reuse.

- Reuse and replacement: some components deteriorate as a result of direct exposure to sunlight and fabrics can fade and/or discolour and as the most visible part of the blind, customers are most likely to want to replace fabric when they redecorate. A fabric 'refresh' (replacement) every 5 years is therefore modelled.
- Good quality blinds that are not misused or abused can last for more than 20 years; all components other than fabric and batteries are therefore reused once (at 5 years), twice (at 10 years), 3 times (at 15 years), and 4 times (at 20 years) over product life.
- Results for the reuse models are compared with results for complete product replacement.

Results

The earlier LCA of the manual blinds showed that the roller (with 100% polyester blackout fabric) had a lower environmental impact than the other three types of blind when sent to landfill at end-of-life; when recycled at end-of-life the overall impact was also comparable with that of the wooden venetian and lower than that of the metal venetian and vertical blinds.

Roller blinds are the most popular type of internal motorised blind in the UK, which is why they were selected for the study; as their name suggests however, blackout blinds blocks out light and may not be used during the day. Therefore in addition to the 100% polyester blackout blind both a composite screen blind (made from PVC + glass fibre) that is designed for daytime use and a directly comparable composite blackout blind were included in the model. In this case the impact of both composite fabrics was higher than that of the polyester; the blackout composite fabric had the highest overall impact due to greater overall materials content and a higher percentage of PVC than the screen composite. The results for the three fabrics were combined and averaged to reflect a typical mix of blind types and fabrics in a domestic interior.

Predictably the environmental impact of the complete motorised blinds was higher than that of the manual blinds because of the additional components, the impact of which was determined by both the mass and type of materials and manufacturing processes associated with the various electrical and electronic components and product casings, batteries, energy input for charging and transport. The benefits of reuse and recycling were apparent despite the fact that the batteries had to be recharged at least once a year and were replaced every five years.

Table 1: The environmental benefits of motorised roller blind use in a typical house in the UK

Key: ✓ = impact of blinds + operational energy is lower than not using blinds;
 X = impact of blinds+ operational energy is higher than not using blinds

	product life	5 years		10 years		15 years		20 years	
energy saving	end-of-life scenario	landfill	recycle	landfill	recycle	landfill	recycle	landfill	recycle
5%	complete product replacement	X	✓	X	✓	X	✓	X	✓
	replace fabric and batteries; reuse all other components	✓	✓	✓	✓	✓	✓	✓	✓
10%	complete product replacement	✓	✓	✓	✓	✓	✓	✓	✓
	replace fabric and batteries; reuse all other components	✓	✓	✓	✓	✓	✓	✓	✓
15%	complete product replacement	✓	✓	✓	✓	✓	✓	✓	✓
	replace fabric and batteries; reuse all other components	✓	✓	✓	✓	✓	✓	✓	✓
20%	complete product replacement	✓	✓	✓	✓	✓	✓	✓	✓
	replace fabric and batteries; reuse all other components	✓	✓	✓	✓	✓	✓	✓	✓

The results are summarised in Table 1 which clearly shows that use of motorised blinds is environmentally beneficial as long as they are recycled at end-of-life even when energy savings are as low as 5%; it also shows that reuse of components (other than fabric and batteries which are replaced every 5 years) is environmentally beneficial even when energy savings are as low as 5% and products are sent to landfill at end-of life. It is expected that use of motorised blinds will produce greater energy savings for heating and cooling as consumers interact with and move these blinds more frequently; furthermore, in addition to these increased environmental benefits, use of motorised blinds will lead to more indirect physiological, psychological, and economic benefits as a result of improved temperature control, thermal and visual comfort and fewer medical and health issues.

Although these results illustrate the benefits of motorised blind use the following must be noted: because the environmental impact of motorised blinds is higher than that of manual blinds the associated environmental 'savings' for this type of blind are not as high as those associated with use of manual blinds. Similarly the quantity of resources used for manufacture and operation is greater than those for the manual blinds, all of which highlights the importance of developing a Circular Economy for this industrial sector.

Towards the Circular Economy

The way in which blinds are manufactured and assembled means that disassembly of many components is relatively straightforward; therefore it should be comparatively simple to divert the increasing level of resources away from this waste stream into open and closed materials loops at end of life and to encourage reuse and remanufacture of components prior to that.

Reuse of complete blinds is possible and both unused and used blinds can be found in charity and other second-hand shops and on-line via services such as e-Bay and Free Cycle. More formal and regulated systems for component reuse also exist: for example some manufacturers already enable customers to refresh (replace) fabrics and batteries and therefore to reuse other components. The success of this business model is unknown but it could be developed and supported with additional incentives to engage customers to reuse components on site such as loyalty schemes, lower prices, and speedy fabric replacement. Similarly manufacturers and suppliers could offer a take back service when blinds are replaced; older blinds could then be disassembled and suitable components reused and/or remanufactured. Customers will benefit in various ways such as not having to dispose of 'old' blinds and by having the option of buying economical blinds that include reused/remanufactured components.

It has already been explained that the majority of blinds currently become waste at end-of-life; however the importance of recycling will increase concurrently with increasing use of motorised blinds. At present there is no legislation to support the recycling of manual blinds but the inclusion of electrical and electronic components means that motorised blinds will be subject to WEEE (Waste Electrical and Electronic Equipment) legislation. Recycling will create new business opportunities as the process could be carried out either by or in conjunction with blind manufacturers or by new businesses. Similarly while some components could be reused others can be recycled into the same or other products depending on the materials' properties and suitability after the recycling process.

Conclusions and recommendations

The research undertaken has assessed the environmental impact of battery operated motorised roller blinds in a typical UK house; the results show that, although the overall environmental impact associated with this type of blind is higher than that of manual equivalents, their installation and use is environmentally and economically beneficial because they can reduce energy consumption for heating and cooling and direct costs. Furthermore motorisation has been shown to encourage user interaction and therefore has the potential to enhance thermal and visual comfort and to reduce indirect health-related costs.

At present the majority of blinds are sent to landfill or incinerated and a considerable quantity of materials is lost in the waste stream. While the models illustrate the significant prospective benefits of reuse and recycling current incentives to do so are very limited. The research proposes that, although the environmental impact of motorised blinds is higher than that of manual blinds the inclusion of electrical /electronic systems will foster the development of a Circular Economy for this industrial

sector in order to meet WEEE legislation. In turn this will foster the development of current and new business models that increase levels of reuse and recycling.

This research has only assessed the impacts of internal battery-operated motorised roller blinds and more research is required to gain a comprehensive view of the inter-related impacts of blind use and higher technology products, the development of the Circular Economy and new business models. Future work will involve assessment of different types of internal and external blind types, hard wired and automated systems, and product-service-system models. Nevertheless this research has illustrated the potential benefits of higher as opposed to lower technology products and the potential for a Circular Economy in this industrial sector.

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