

On a journey to eliminate waste

Which methodology should product manufacturers and their subcontractors use to apply a zero waste way of thinking when using 2D materials in their products?

Hélène Cheung - Research Proposal

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Research Methods and Professional Development (ACFA7004)

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Introduction

The current shift towards circular economy is an attempt to resolve existing environmental issues which are in the limelight at present. Some scientists warn that more viruses will be released because of the destruction of the biodiversity and the brutal changes in ecosystems (Vidal, 2020). Some others discovered that climate change will not only raise sea levels but free ancient diseases from ice (Bressan, 2021). And before the sea is more the home for plastic than fish (World Economic Forum, 2016) and jellyfish outnumber other living creatures (Fleming, 2019), society as a nature consumer needs a radical change. This realisation may come in the form of the Paris Agreement, Cop 26, the development of an international standard for the circular economy, the Ellen MacArthur Foundation or Greta Thunberg. But it also comes from initiatives of a multitude of individuals like the increasing number of companies adhering to the B Corp accreditation, as well as the growing concerns of consumers over companies' mission. All illustrate this trend.

As part of this transforming society, there is a personal dimension to the reason why this research resonates: a professional one but also a private one. Indeed, it is believed that parenthood changes a woman's value to a conservative one where her priority is to create a secure environment (Lönngqvist, Leikas and Verkasalo, 2018). This view is the emotional motivation for this research: making a positive impact on the future of the planet and for future generations. As a professional involved in manufacturing as well as a mother, there is what could be called guilt of making more and more products creating more and more waste. Indeed waste generated during the production of objects is one to tackle to start making a difference. Waste is actually designed in the product as exposed by Kouhizadeh and Sarkis (2018). It would be interesting to see how it can be designed out. The following example will illustrate this systemic problem. It may seem anecdotal but it represents the common practices in the industry. Processes applied to produce an object from a piece of fabric rely on computer assisted design (CAD) systems. Even though CAD systems optimise the material, they are not as economical with that material as a pattern cutter using an edge to edge technique with a pair of scissors. The efficiency of a CAD system is optimised primarily for time. As demonstrated by Prada's case study published in the National Geographic (Langenheim, 2015), there are still 15% of waste as textile off-cuts while using a CAD system. The leather industry accounts for 25% of the hide being wasted (Carneiro, 2019) and the wood is even worse with 40% being chipped and most of that burned to heat the sawmills (Adi Wicaksono and Ahmad Kadafi, 2020). In the example of the textile industry, it shows that a skilled pattern cutter can adjust the pattern to optimise the material. This technique is time consuming, but it avoids waste. It is used in small scale manufacturing facilities where CAD systems and automation are not implemented but it shows that computing has its limitations.

The example above reveals that manufacturers expect waste at every stage of the production. It is the norm forced upon by technology.

However, historically, it hasn't been the case: tailors, to continue in the textile industry, cabinet makers and leather workers, to use wood and leather again, valued the materials: their approach was quality over quantity. The demand for a mass

market production meant that quantity became the priority. Even though now new brands are positioning themselves as an alternative to mass production, it still remains the main avenue of everyday objects. But efforts are made even by these mass market brands: Ikea are fighting their image of throw away furniture with their buy back scheme (Ikea, n.d.); H&M accept unwanted clothes and use recycled fibres in some garments (H&M, 2020). But these initiatives are focused on the post consumer waste.

As established earlier, a zero waste design eliminates waste at the conception of a product which allows to remove material waste at the manufacturing stage. It is also important to note the complexity of the supply chain and the importance of the accountability of the manufacturers for their subcontractors. Therefore subcontractors should be involved in the process of eliminating material waste at the design stage. The reason for limiting the research to these three materials previously mentioned: fabrics, leather and wood is because they are 2D materials supplied on sheet of a given shape and size and generate off-cuts waste; whereas materials like plastic, metal or glass can be melted and reshaped. With that in mind, which methodology should product manufacturers and their subcontractors use to apply a zero waste way of thinking when using 2D materials in their products?

The concept of zero waste way of thinking is when design is no longer a siloed creative hub but a team interconnected with production managers and suppliers in a system where all the constraints are taken into account to achieve zero waste. This holistic approach described by McQuillan (2020) to zero waste fashion as a basis for eliminating waste of plywood and leather may seem farfetched, but the vast majority of literature about zero waste applies to the fashion industry. A number of pioneers fashion designers aim for a zero waste design; Holly McQuillan, Timo Rissanen, Mark Liu and Julian Roberts; whereas in the furniture sector the only obvious name is Ken Landauer who based his whole collection on zero waste using the sheet of plywood as a unit, approach also recently taken by the architect Henning Stummel. The methods used by these designers create a new problem which can be considered wasteful. Indeed the zero waste design techniques do not necessarily mean reducing the use of material. It can actually consume a lot of fabric, especially Julian Roberts "subtraction cutting" technique. In McQuillan's model, the zero waste design technique sits within a wider consideration with zero waste system thinking being limited by the environment on one hand and society on the other. The circular economy is based on the 3Rs: reduce being the first, then reuse and finally recycle. So even though zero waste is not one of the circular economy fundamentals, it is underlying each of the Rs. So when Ballie and Woods (2015) explain that the fashion industry needs to be circular by design with a holistic approach and circularity to become the company's business strategy, they need to include a zero waste strategy as well, as part of a sustainable supply chain strategy.

This research will be developed in three stages. The first one will constitute the literature review and will inform the contents of the second stage, a questionnaire to manufacturers. Three aspects will be explored in the literature review: the weight of frameworks and standards in businesses decisions regarding manufacturing waste, the manufacturers' views regarding collaborations to tackle manufacturing waste,

and finally the limits of the zero waste design techniques. The latest aspect will allow to explore which other methods should be considered that could be applied to sectors other than the fashion industry. The literature review will lead to the second part: a questionnaire addressed to manufacturers. The questionnaire will permit to check how companies position themselves regarding the zero waste way of thinking and what techniques and technology they would implement to eliminate waste. This quantitative research will lead to a qualitative empirical research in a third part: interviews (or case studies) of SMEs already practicing some zero waste approach to their business model. It will be interesting to see the difficulties they face.

The key variables of this research are: the sector of activity which are intrinsically linked to the 2D materials chosen, and when the businesses who take part in the questionnaire were established. The latter will probably influence the receptiveness to a new business model for a circular one, depending where they are on the journey to be environmentally friendly. The expectation for this research is to have all business participants based in the UK but there might be some businesses from overseas which would bring a different perspective on the research.

The aim of this research is to understand how companies can apply a zero waste way of thinking and start their journey to eliminate their manufacturing waste. After establishing which techniques are available to manufacturers, it would be interesting to see how these techniques can be applied in real business scenarios and how they fit within the businesses strategies to create a sustainable supply chain to fit in a circular economy model. Ultimately, this research should reveal a methodology to apply circular manufacturing (Garza-Reyes, 2019) that can be duplicated in various manufacturing businesses using 2D materials like fabrics, leather and wood.

Literature review

This review puts the basis of the three options mentioned in the questionnaire to manufacturers. These three options approach the solutions to eliminate waste in three logical manners: manufacturers can follow guidelines provided by a framework or standard; they can collaborate to create guidelines in a joint manner; or they can innovate and adopt a methodology to eliminate waste.

Frameworks and standards as a guarantee

There are no legal requirement to eliminate waste for manufacturers. Their legal obligations stop at the management of waste to eliminate pollution. Therefore the following frameworks and standards would be on a voluntary basis.

This part of the research will compare the existing frameworks and standards which take in consideration waste reduction, and particularly the entire elimination of waste. To analyse their scope, several criteria will be looked at:

- the limits of qualification,
- their geographical recognition and whether or not it has an impact on the goal to eliminate waste,
- the way audits are conducted whether they are internal or external, and how the differences identified by Simon et al. (2014) hinder or not the journey to zero waste,
- the importance given by the frameworks and standards to the elimination of waste,

- the guidelines provided and the existence or not of stages until full implementation,
- the degree of which the standards become a positive marketing tool depends on how much consumers understand these standards (Bierma and Waterstraat, 2006).

The Environmental, Social and Governance considerations and what is described as the Sustainability Essentials frameworks and standards which will be analysed are the following: Environmental Health & Safety policy, Corporate Social Responsibility model, Carbon Management policy, Institute of Environmental Management & Assessment with built-in frameworks such as Carbon Disclosure Project reporting framework, Sustainability Accounting Standards Board benchmarking framework, Global Reporting Initiative guidelines, Dow Jones Sustainability Index benchmark, Streamlined Energy and Carbon Reporting legislation, and Global Real Estate Sustainability Benchmark.

The following standards will need to be analysed as well: ISO 26000 Social Responsibility, ISO 14000 Environmental Management, BS 8001:2017 Circular Economy, Carbon Trust certification and the B Corp certification.

The interesting view of Cass and Shove (2018) regarding standards for office buildings, as hindering innovation and producing conventional designs highlights the barrier in which compliance to standards and conformity to frameworks can fall into. Therefore a progressive certification recognised by the public would be best suited to reinforce the importance of eliminating waste.

The role of partnerships and collaborations

Partnerships and collaborations allow to work towards a common approach to waste. Collaborations with companies in the supply chain is beneficial especially the suppliers to look for sustainable and innovative solutions to eliminate waste. Banchuen, Sadler and Shee (2017) make a distinction between operational collaborations with the end goal being a costs/quality driven one, and a strategic collaboration with the main objectives being flexibility, delivery and quality which allows for market lead innovations. If the success of a collaboration reside in this choice, it is important to situate the zero waste objective in a strategic collaboration, not reducing it to a costs saving operation. Partnerships with NGOs should also be considered. Indeed Den Hond, De Bakker and Doh (2015) noted that collaborations with NGOs benefit the Corporate Social Responsibility of a company and that informal relationships with NGOs are beneficial to check the strategic fit prior to a formal agreement and partnership. A lot can be said for the focus on an informal human relationship either between companies or with NGOs with a strategic common vision to eliminate waste. In Cabana (2021) book review, two of the six leadership practices for wise leaders as stated by Nonaka and Takeuchi are about communication and bringing people together.

The preference for informal partnerships may increase the risk for diverting from the initial aim, for not showing any accountability and for making product development expensive and difficult to control (Tidd and Bessant, 2018). But being informal it will facilitate less intimidating “ baby steps “ to follow the five stages of innovation implementation (Mariello, 2007): idea generation and mobilisation, advocacy and

screening, experimentation, commercialisation, and diffusion and implementation. The value of the informal collaboration has been demonstrated by Frankel, Whipple and Frayer (1996) to achieve long term successful processes.

To achieve such a meaningful purpose as eliminating waste for the greater good, it is worth noting that informal and strategic type of collaborations have the greatest promise.

Innovative methods to eliminate waste

Lean manufacturing/made to order method applied to the supply chain management as long demonstrated its value while reducing the inventory and the surplus stock that end up devalued and wasted (Melton, 2005). Lean manufacturing is a method used by Digital Native Vertical Brands because they own the data regarding their customers and they own the supply chain (Kevan, n.d); meaning, they only make what they sell.

But this method only eliminates product waste not the materials used in the making of these products, which is what zero waste is about. Therefore the next stage for eliminating waste is adopting a zero waste design technique.

The solution explained by Piper (2019), the zero waste pattern cutting allows for all of the width of the fabric to be used, the length of fabric material is determined by the design because the designer is the pattern cutter as well, understanding 2D and 3D simultaneously. It may be the most frequent used technique but it does not reduce the consumption of material and would be difficult to apply it to other materials with a length restriction as well.

What McQuillan (2020) calls textile form is another zero waste technique where from the fabric weaving emerges the shape of the garment. It goes beyond the 3D knitting technique. The difference with zero waste pattern cutting technique is that the multimorphic textile form is based on technology applied to the traditional weaving method.

It has the same approach to making than additive manufacturing with the shape emerging as the material appears. This approach can therefore be applied to other materials than textile, for instance 3D printed wood. Like McQuillan (2020) with the textile form technique, Jiang, Kleer and Piller (2017) believe that additive manufacturing will change society affecting consumers behaviours and supply chains. It will be interesting to see if the manufacturers taking part in the questionnaire have that in mind.

Another approach to zero waste would be to not limit the material to the end form but keep using the material until no more, eliminating the waste. Where additive manufacturing is not an option like for leather, it is worth looking at growing design (Karana, E. et al., 2018) where any waste of mycelium (biodegradable fungal material) can be regenerated in the ecosystem. Or the off-cuts could re-enter the production line to make another product; a sort of internal remanufacture where every scrap of materials is used. Asif et al. (2021) advise for products to be designed for multiple lifecycles, where remanufacturing is not an afterthought but planned from the concept. It would be valuable to think of materials in the same way when the pattern cutting stage is thought with the use of the scraps for other products. As for closed-

loop supply chain (Delpla V. et al., 2021) it would benefit the zero waste design thinking if applied to material rather than product. For instance when a subcontractor ends up with off cuts , these off cuts can re-enter the supply chain for another subcontractor. It would need to be designed in, it is where technology and CAD could expand its use. This strategy would need a network of manufacturers comfortable in working in a collaborative way, who have a geographical proximity rather than operate in a similar industry.

Like a CAD system is a tool to eliminate waste: optimising material, checking how a zero waste pattern cutting fit a body (McQuillan, 2020) and, using off-cuts for an internal diversification or a planned collaboration, blockchain technology has the potential to become the tool to guarantee a sustainable supply chain. A smart contract linked to a blockchain would verify the validation of a certification (Saber et al., 2019) and prove traceability (Pournader et al., 2020) managing risks for nonalignment with a company's environmental mission. However, it is early days for this new block chain technology applied to the supply chain which implies that there are barriers to its adoption. During this research it would be beneficial to assess manufacturers' curiosity for this potential tool of the future to prove their efforts to eliminate waste (Kouhizadeh and Sarkis, 2018).

Methods

As the literature review develops, the approach to the research may get adjusted which will have an impact on the content of the questionnaire to manufacturers. Indeed, at the early stages of this research, the pool function in the social media platform LinkedIn was used to publish three questions, spread on three weeks. No valid data was captured. The two first questions were yes/no type ones and the last one was a multiple choice type with three options. To look professional, the next plan was to publish the questionnaire on an online questionnaire builder with the relationship with the university being obvious to show it has a legitimate purpose. The one chosen is Crowdsignal because it offers the branching function which means restrictions filter the data to only capture data from manufacturers using either of the three 2D materials restrictions. Published on LinkedIn again and shared to Katy Hills, the woman behind Make it British. But still no data. The problem may be the timing when the questionnaire was posted: between Christmas and New year celebrations and then sent to Katy in the new year on a weekday. The other problem may be linked to the difficulties the Omicron variant of the Covid pandemic brought to businesses dealing with staff shortages and more pressing matters. It may not be a bad thing because Make it British is for the vast majority companies working in the textile industry which would have unbalanced the weight given to the three materials selected.

The questionnaire is composed of three tiers which check the validity of the data: if they represent decision makers and influencers or not and let the participant decide to continue or not. But it may be unnecessary because if they bother to open the questionnaire page it is because they want to participate and answer the questions. Having said that, it would be interesting to know why manufacturers chose not to answer the questionnaire. The questionnaire excludes the neutral position of the

Likert scale (weighing 1 to 4) to force participants to take a side regarding their view on waste. But it is important to include a “no opinion” option (Chyung, S.Y. (Yonnie) et al.,2017), weighing 0. The questionnaire exclusively addressed to manufacturers need to have a clear aim from general to specific and no leading questions about how they would tackle the problem within their manufacturing operations.

The analysis will be done in percentage to establish a trend and will include:

- the importance given to the waste problem given by the manufacturers,
- whether or not they would be prepared to work alongside their subcontractors and suppliers to eliminate waste,
- which technique they would consider implementing to achieve this goal
- if they would prefer dealing with their off-cuts (if still generated) internally rather than passing on the problem to other manufacturer to recycle.

It would be interesting to have a broad idea whether or not there is an interest in the new blockchain technology for supply chain management.

The last part of the research is via interviews preferably or case studies done with companies using commercial waste to create their products. The plan is to identify the difficulties these companies encountered: if like Sontha and Tjutju (2021) interviews of European circular startup, the first issue categorised was developing the market and communicating the value of their circular model to the public, and the second issue was the supply chain and the policy challenges. In a similar way, supply chain challenges were noted by Singh et al. (2019) and the difficulties to source the right quantity and quality of material to up cycle. The legislation regarding waste to facilitate up cycling was another challenge noted in both researches for businesses with a circular model. It would be interesting to interview not only start up but long established manufacturers with consistent commercial waste to check if the offer can meet the demand.

The reason for the two methods questionnaire and interviews is to have quantitative data for a broad picture and qualitative data with open questions and gauge which methodology could be implemented and check if there is a common thread.

Another method that could be informative is the Delphi method which in the time constraints would be difficult to achieve especially during these current times of social distancing. However, it may be beneficial to have experts in recycling, circular economy and supply chain interviewed, despite the fact that interviewing experts may balance the results towards a more theoretical approach to the problem rather than the empirical purpose of the selected methods in two phases.

Results

The results of the questionnaire will be quantitative data to compare manufacturers opinions about a zero waste way of thinking in percentage. If enough data is collected it would be interesting to differentiate the results by materials to notice if the manufacturer using textiles are more equipped to tackle the waste challenge. It would be expected as most of the literature regarding zero waste is in the sector of the fashion industry.

Regarding the interviews, it will follow Canary (2019) how-to. From the transcripts, the main concepts will be extracted. They are expected to be technical, economical,

creative, financial, cultural and skill based. Common themes and connections between themes will be organised. The analysis should highlight some common theme (deductive analysis) and also tell informative relatable stories (inductive analysis).

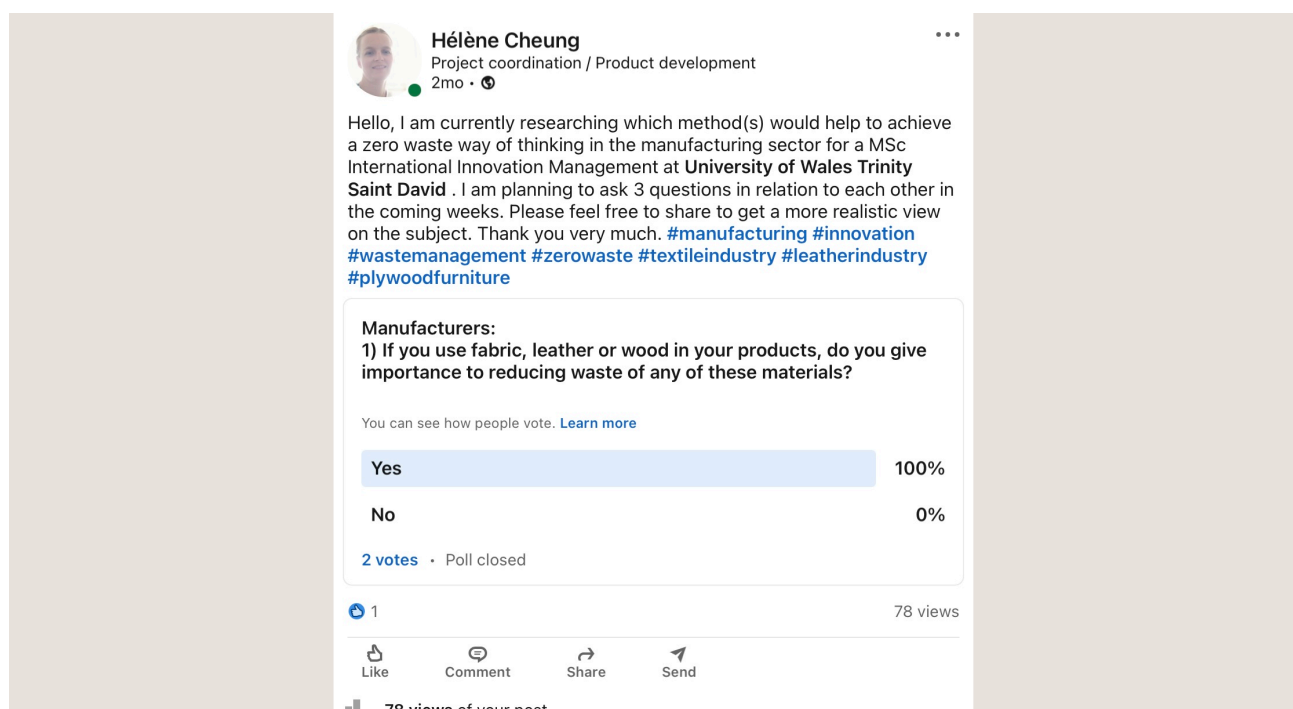
Evaluation

This research is an empirical research where theories and previous studies are the base. The objective of this research is to apply a methodology deducted from the questionnaire to manufacturers and what they would implement to minimise waste, as well as deducted from interviewed companies already applying a circular model to some degree. The methodology should be suitable to existing manufacturers, that is why the questionnaire is address to them to evaluate their drive to eliminate waste in their operations processes to make products and start their journey towards a circular economy. The risks are that the results of the questionnaire may show that manufacturers are not interested in eliminating waste meaning that a transferable methodology would become unnecessary. In this case, the literature review and the interviews would become a guidelines for future manufacturers rather than a methodology to adapt existing manufacturers and their subcontractors to a zero waste operation.

The other danger is to have insufficient number of participants in either or both the questionnaire and the interviews in the time constraints to gather valuable and analysable data. Otherwise this research will stay anecdotal and it will not provide applicable solutions. It is worth noting that the methodology found may be a series of zero waste design techniques and way of thinking which require adjustment to be applied to a multitude of manufacturers; however it might provide a starting point to a consultancy work in the UK.

Appendix 1

LinkedIn poll



Hélène Cheung
Project coordination / Product development
2mo • 1

Hello, I am currently researching which method(s) would help to achieve a zero waste way of thinking in the manufacturing sector for a MSc International Innovation Management at **University of Wales Trinity Saint David**. I am planning to ask 3 questions in relation to each other in the coming weeks. Please feel free to share to get a more realistic view on the subject. Thank you very much. [#manufacturing](#) [#innovation](#) [#wastemanagement](#) [#zerowaste](#) [#textileindustry](#) [#leatherindustry](#) [#plywoodfurniture](#)

Manufacturers:
1) If you use fabric, leather or wood in your products, do you give importance to reducing waste of any of these materials?

You can see how people vote. [Learn more](#)

Response	Percentage
Yes	100%
No	0%

2 votes • Poll closed

1 78 views

Like Comment Share Send

78 views of your post



Hélène Cheung
Project coordination / Product development
2mo • 🌐

Here is the second question to manufacturers for my research for a MSc International Innovation Management [University of Wales Trinity Saint David](#). I would like to establish if there could be a method to implement a zero waste way of thinking within the supply chain. Thank you very much in advance and feel free to share. The more the better! Thanks again!

[#supplychainstrategy](#) [#nowaste](#) [#wastefree](#) [#sustainability](#) [#sustainablemanufacturing](#)

2) If one or more of your suppliers uses fabric, leather or wood, do you make sure they have processes in place to reduce waste?

You can see how people vote. [Learn more](#)

Response	Percentage
Yes	0%
No	100%

1 vote • Poll closed

 Like
 Comment
 Share
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 58 views of your post



Hélène Cheung
Project coordination / Product development
2mo • 🌐

If you have been following the first 2 questions, this is the last one addressed to manufacturers using fabric, leather or wood. I have been posting them within the framework of my MSc International Innovation Management studies to research which methods should product manufacturers and their subcontractors use to apply a zero waste way of thinking when using 2D materials?

[#zerowaste](#) [#wastemanagement](#) [#wastefree](#) [#nowaste](#) [#manufacturing](#) [#manufacturers](#) [#textileindustry](#) [#leathergoods](#) [#woodfurniture](#) [#plywooddesign](#) [#sustainablebusiness](#) [#sustainability](#) [#sustainableproduct](#) [#sustainabledesign](#)

3) If waste matters to both you and your subcontractors, is it a question of:

You can see how people vote. [Learn more](#)

Response	Percentage
An informal check, a dialogue	0%
A verified standard compliance	0%
A collaboration to a solution	100%

1 vote • Poll closed

 Like
 Comment
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 44 views of your post

Appendix 2

Questionnaire to manufacturers - January 2022

<https://hplanethome8644.survey.fm/towards-zero-waste>

Appendix 3

Production managers interview as planned in January 2022

- 1) Companies using waste - two for each of the materials chosen as examples: leather, wood and fabric
- 2) Why have you chosen waste as your raw material?

- 3) What difficulties did you encounter when sourcing materials? What do you think would have helped you to find the materials in the right quality and quantity?
- 4) Would you be interested in standards like the Carbon Trust's one?
- 5) Do you check your subcontractors' practices regarding waste? If so, how?
- 6) Do you have processes in place to minimise waste? If so which ones?
- 7) Is zero waste your goal?
- 8) Do you work in collaboration with other manufacturers within a zero waste way of thinking?
- 9) How do you see the circular economy?
- 10) Are you interested in how the blockchain technology could demonstrate your environmental achievement with transparency across the supply chain?

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