The pursuit of an ethical, circular, and sustainable fashion sector: the Cartiera case study

P. Morone[1], E. Imbert[1], G. Yilan[1,2]

[1]Bioeconomy in Transition Research Group – Unitelma Sapienza University of Rome, 00161 Rome, Italy
[2]Department of Chemical Engineering, Marmara University, Göztepe Campus, 34722 İstanbul, Turkey
[3]

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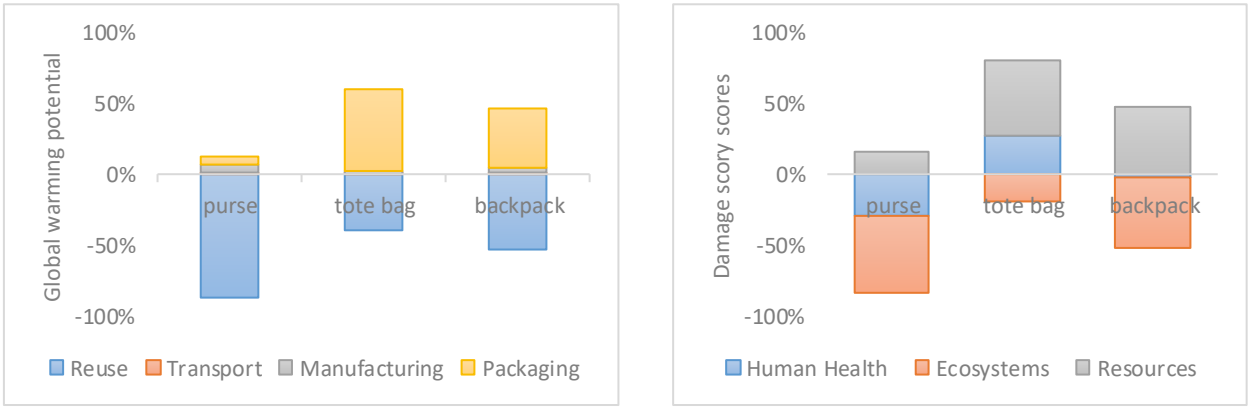
Presenting author email: j.first@somewhere.edu

The fashion industry is one of the most polluting sectors, ranked just after the oil, as it involves an extremely long supply chain with significant consumption of raw materials, energy, and water, as well as the use of chemicals at various stages of the life cycle of products (Jacometti, 2019). These environmental impacts have been magnified over the last decades by the rise of the *fast fashion* phenomenon, i.e., the demand for disposable clothing at low prices (Anguelov, 2015; Li et al., 2014; Singh, 2017; Turker & Altuntas, 2014). The associated rapid growth in demand prompted the shift of production towards emerging or developing countries with low labor costs and workplace abuses (Fletcher, 2013), raising questions of social sustainability along with environmental sustainability. These trends have brought the issue of sustainability of the fashion sector to the core of public attention, calling for a transition from *fast fashion* to *sustainable fashion*. The leather industry is no exception to such trends, facing new tendencies on production and consumption patterns due to society concerns (Joseph & Nithya, 2009). Consequently, the leather industry has started to address the main environmental concerns rising through the production processes, with a special focus on the activities associated with water consumption, wastewater treatment, solid-waste recovery, and toxic chemical exposures (Hu et al., 2011), as well as the social concerns associated with the shift of production towards emerging or developing countries with (mostly) unethical labor force conditions.

Against this background, this study is centred on a social enterprise (namely Lai-momo) producing leather accessories using leftovers from fashion companies' production chains. Lai-momo is a sustainable and ethical fashion enterprise carrying out an ambitious and innovative pilot project named Cartiera, which pursues the integration of migrants and asylum seekers in the recovery of primary materials otherwise destined for disposal, and in the production of leather products with a minimal environmental impact. To this end, an integral part of this study is the adoption of the life cycle assessment (LCA) methodology (defined by ISO standards 14040/14044) to measure the environmental impacts of such leather products. In their publication, Corona *et al* (2019) indicated that the LCA was the most used framework to assess the circularity of products and services, and concluded that the LCA is a potentially useful tool for measuring circularity. Even though some studies reported the environmental impacts associated with the specific processes throughout the life cycle of leather products (Yu et al., 2021), the literature is still very limited in terms of the availability of inventory data especially for waste treatment and recycling activities. Additionally, as Navarro *et al* (2020) mentioned in their extensive review, it is of utmost importance for leather industries to address environmental research and innovation with an LCA type of approach for long-term sustainability. As a result, the lack of inventory for life cycle thinking with ideas on long-term strategies is another drawback for leather industries. This study aims to provide an environmental analysis including the case-specific inventory to calculate the impacts associated with the leather industry.

A comparative LCA of three main types of leather bags was conducted in this study. The selected bag types were a small size purse, a tote bag, and a double-zip backpack. The life cycle environmental impacts for each type were calculated via adopting a gate-to-gate system boundary (from the transportation of leather leftovers to the production of valorised bags including the packaging) and considering one kilogram of the leather bag produced as the functional unit. The inventory data regarding the comparative analysis was collected from the ecoinvent database (v3.01) and input to the software program SimaPro (v8.1.1.16). The environmental impacts were calculated via the ReCiPe (H) Midpoint and Endpoint methods (v1.12). The selected impact and damage category results were provided in Figure 1 for Climate Change (also known as GWP), Human Health, Ecosystems, and Resources.

The analysis of the climate change midpoint category scores showed that the use of leather leftovers saved the environmental impacts (i.e., having negative contribution) while the packaging materials affected the scores in the opposite direction (i.e., creating a burden). For the small purse and backpack types, the results indicated that the impacts of reuse surpassed the packaging phase, and created an overall score ensuring the environmental savings. However, the tote bag scores did not reveal environmental savings underlining the need for the introduction of more sustainable packaging options (Fig. 1a).



(a) (b)

Fig. 1 Environmental impacts regarding midpoint (a) and endpoint (b) category scores

The interpretation of endpoint scores demonstrated that the resources and ecosystems damage category scores had the same tendency for each bag type; namely, a negative effect on the ecosystem quality due to materials used for packaging and savings for the resource utilization due to the reuse of leather leftovers. However, the effect on human health differed according to the bag type produced. Correspondingly, the tote bags underperformed for overall damage scores, similar to the climate change results. The main reason for this shift from the positive to the negative side is mainly due to the high environmental burdens associated with the packaging materials (Fig. 1b).

In conclusion, our study results revealed the reuse of leather leftovers is an important aspect to improve environmental impacts and to steer the fashion sector towards more circular and sustainable practices. Nevertheless, the contribution of each life cycle stage should be carefully examined to ensure the positive impact generated by one stage is not shadowed by the others, such as the negative contribution of packaging materials in our case. Accordingly, we anticipate this study to be the initial point for more sophisticated analyses of full life cycle stages of leather revaluation among other potential sectors via adopting cradle-to-grave or even cradle-to-cradle boundaries to create a more ethical, circular, and sustainable fashion industry.

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