LIFE CYCLE ENGINEERING '19
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Assessment of the environmental and cost improvements from extending the use phase of passive durable products

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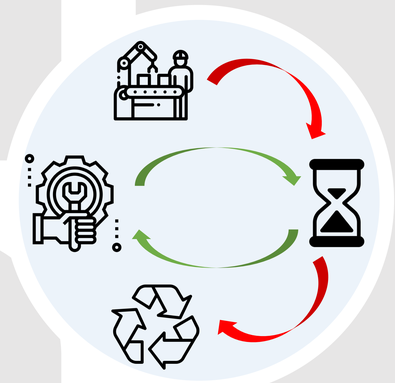
I - Background

In a world governed by intensive product usage habits, shifting to a **circular economy** becomes a necessity to achieve sustainable production and consumption. **Extending the use phase** of products by altering the business model, such as leasing products and offering refurbishment services, is one method to accomplish that. To assess the viability of such a method, environmental and economic implications should be assessed at the same time.

II - Method

The present study uses **Life Cycle Assessment (LCA)** and **Life Cycle Costing (LCC) for the manufacturer** to quantify the environmental and economic benefits of extending the use of five durable and passive products, shown in Table 1.

Application of **LCA** and **LCC** in parallel was made meaningful through dividing the life cycle into the same phases for both methods, as presented in Table 2.



III - Case study

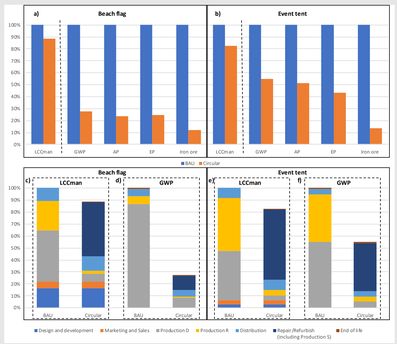
	Product	Functional unit	Circular offering
Company A	Beach flag	1 beach flag used once	Refurbish (used 10 times)
	Event tent	1 event tent used once	Refurbish (used 10 times)
Company B	Bin	2 bins used for 20 years	Repair (change lids twice during lifetime)
	Locker	1 locker used for 30 years	Refurbish (paint doors after 15 years)
Company C	Trash inlet	1 inlet used for 30 years	More modular repair (change the door handle only)

Table 1: The five studied products, their functional unit, and the circular offering implemented

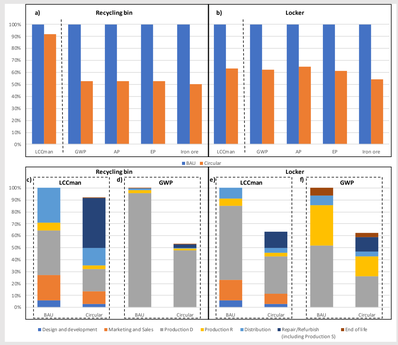
LC Phase	LCCman	LCA
Design and development	• Research and development • Graphic design	
Marketing and sales	• Marketing • Order reception • Sales	
Production	• Administration cost • Product reception • **Product** • **Transport (upstream)** • storage	• **Raw material extraction and production** • **Manufacturing activities** • **Transport (upstream)**
Distribution	• Assembly • Installation • **Transport (downstream)** • Administration	• **Transport (downstream)**
Use	• **Operation** • **Maintenance**	• **Operation** • **Maintenance**
Repair/refurbish	• Administration • Inspection • **Product (spare part)** • **Repair/refurbish** • **Transport (upstream and downstream)**	• **Raw material extraction and production (spare part)** • **Manufacturing activities (spare part)** • **Repair/refurbish** • **Transport (upstream and downstream)**
End-of-life	• **Transport (waste collection)** • **Incineration**	• **Transport (waste collection)** • **Incineration**

Table 2: Different processes included in LCCman and LCA according to different life cycle phases. Text in **bold** represents a common process in LCCman and LCA

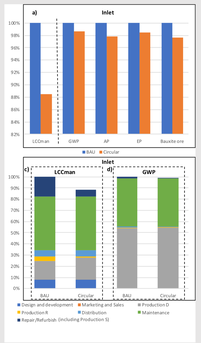
IV - Results



Company A



Company B



Company C

Figure 1: The overall economic and environmental benefits of applying the circular offerings (a and b), and the improvements according to life cycle phases (c,d,e, and f). Production D is the impact from producing the durable component, production R is that from the to-be replaced component, and production S is that from the spare part. Manufacturer's LCC (LCCman) is in SEK, Global warming potential (GWP) is in gCO_2-eq, Acidification Potential (AP) is in gSO_2-eq, Eutrophication potential (EP) is in gPO_4^{3-}-eq, and Iron/Bauxite ore is in g iron/bauxite.

V - Conclusion

Raw material extraction and the production of the durable components in the products caused the highest cost and the greatest environmental impact of the selected products. Thus, extending the life of these components through repair or refurbishment **reduced the environmental impact** of most products (measured as Global Warming Potential) by 45%-72%, **and the cost from a manufacturer's perspective** by 8%-37%.

Another objective of the study is to discuss the degree and level of complementarity and competition between LCA and the manufacturer's LCC. Although the two tools **complement each other** in most respects, there exist some exceptions where they **compete**. This occurs mostly when LCC describes labour costs, while labour is not accounted for in LCA.

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