

# CIRCULAR ECONOMY AND CONSCIOUS CONSUMPTION: A LIFE CYCLE ASSESSMENT OF PRODUCT REPURPOSING IN SAUDI HOUSEHOLDS

**FAISAL A. OSRA**

Professor, Civil Engineering Department, College of Engineering and Architecture, Umm Al-Qura University, Makkah, Saudi Arabia. Email: faosra@uqu.edu.sa

## Abstract

This study aims to explore the concept of product repurposing as a strategy to support the principles of the circular economy and conscious consumption among the Saudi households using Life Cycle Assessment (LCA) approach. With the growth of consumption patterns and an increase in waste generation, the need for sustainable household practices that can help increase product lifespan and minimize environmental impact is greater than ever. The paper explores the reuse of textiles, furniture, electronics, packaging and household items and analyzes their environmental, economic and social effects. Based on survey data and LCA methodologies, the study investigates the consumption of resources, greenhouse gas emissions, waste reduction and landfill diversion due to home-based re-use activities in KSA. The results suggest that the reuse significantly helps in reducing materials consumption, prolonging product life and contributing to sustainable development goals that are aligned with Saudi Vision 2030. The factors found to be important in driving repurposing behavior were the economic savings, cultural values, and ethical issues, and the factors found to be important barriers to repurposing behavior were limited infrastructure, awareness gaps and market uncertainties. The study underscores the significance of implementing supportive policies, awareness programs, and design-for-repurposability measures to bolster circular consumption and foster sustainability transitions within Saudi households.

**Keywords:** Circularity; Repurposing; Sustainability; Consumption; Upcycling; Conscious Consumption.

## 1. INTRODUCTION

Sustainable development of consumption is a significant issue. Resources are becoming depleted, global warming and biodiversity loss is affecting future well-being. Saudi households have unsustainable consumption patterns. There is a significant lack of circularity in retaining value in the product. An important way to extend the product life is to repurpose products. The application of 3R, 5R or 7R principles is encouraged. But detailed information about household product re-using is not available in Saudi Arabia. The purpose of this study is to assess the environmental and economic consequences of reusing in Saudi households and to recommend the factors and policies that stimulate the concept of conscious consumption.

## 2. THEORETICAL FRAMEWORK

Some practices for a circular economy are Sufficiency, Circularity, Repair, Reuse, Resale and Upcycling, which contribute to extending the life of products and minimize the extraction of resources. In the context of this, the problem of e-waste is increasing. Repair, upgrade, repurpose and gift can help stretch the life of the household. This is good for society and ecology and can help to break away from the consumption culture promoted

by advertising and financial offers. By giving consumers freedom to choose and making choices informed, the effects of a rapidly changing consumer landscape can be reduced. [1][3]

## 2.1 Circular Economy Principles

Household practices play a critical role in the transition towards a circular economy, contributing to the reduction of resources consumption, pollution and emissions. Resource recovery is achieved by prolonging the life of the product and utilizing existing resources. By moving away from the linear model to the circular, reduce, reuse, refurbish, remanufacture, the economic value is improved and national priorities are given impact. This practice conserves resources, minimizes environmental impact, is in line with Vision 2030 and supports sustainable development as defined by the UN. The management of sustainable consumption is crucial for Saudi Arabia, which is moving towards diversifying its economy, and is a responsibility of all members of society. [1][4][5]



**Figure 1: Circular economy system illustrating sustainable household practices through reducing, reusing, repurposing, and recycling products**

## 2.2 Conscious Consumption and Behavioral Change

Conscious consumption is about knowing the impacts of what you're consuming in society and the environment, and choosing to use less and waste less. It has as its goal shifting attitudes and habits for sustainable development. Consumption reflects cultural norms and targeted policies can promote other lifestyles. Promoting behaviour change through discussions about product repurposing. Several agencies and businesses support the notion of circular-economy strategies and repurposing is a major component of them. Improving social support and knowledge about re-use can increase awareness and impact on practices. [6][7][8]

## 2.3 Life Cycle Assessment Methodology

Life Cycle Assessment (LCA) is a method to assess the environmental impacts of products throughout their life cycle, which includes the concept of circular economy (CE) for sustainable design and extended product life. A complete Life Cycle Inventory (LCI) measures the amount of resource use, emissions and waste associated with re-use. Assessment focuses on CE practices and interactions within the home. Collectively, CE interventions (Reduce, Re-Use, Refurbish and Remanufacture) help to prolong product use and reduce obsolescence. A flexible boundary takes into consideration the variance in consumer behaviour and design, which promotes circularity. Conscious consumption is used to control materials and maintain waste reduction, and repurposing extends the lifespan of products, particularly those such as food packaging and containers for skin care. [1][9][10]

## 3. CONTEXTUAL BACKGROUND: SAUDI HOUSEHOLD PRACTICES

The concept of circularity is becoming more popular in Saudi Arabia, as a part of the Vision 2030 sustainability initiative. The government regulates, taxes and educates on product re-use and waste reduction. This has created a market for remanufactured products.

The public-private program concentrates on religious guidelines for conservation and waste problems. Scholars emphasize the importance of hygiene and recommend repair and maintenance for prolonging the life of products and minimizing waste. The focus of national definitions for circularity is on reduce, reuse, refurbish and remanufacture. [11]

### 3.1 Social and economic factors that influence the re-use of products

The economic and cultural factors are affecting the circular economy practices in Saudi Arabia. Cost reduction is a concern to more people in a less wealthy economy. The reuse is supported by a strong appreciation of reuse and a religious and ethical framing. Also, there are differences between urban and rural re-use behaviours. [1][2]

Changing culture is a longer process than it is to create new practices. The importance of addressing current frameworks: the importance of economic conditions affecting the need to adopt practices, particularly for consumers in lower income situations. [12]

### 3.2 The state of policies and institutions in the community.

Policy Landscape and Institutional Support. Waste minimisation in the Saudi homes has been supported with regulations and programs to induce action, which have yielded economic, environmental and social advantages. The new waste management strategy is part of the National Waste Management Programme, which is based on Saudi Vision 2030 and the Saudi Green.

A National Circular Economy Strategy is being drafted, with regional strategies focusing on repair and refurbishment, and reuse programmes by the Saudi Standards, Metrology, and Quality Organization (SSQO). [13]

## 4. METHODOLOGY

Circular economy concepts are becoming important in Saudi Arabia as it put efforts into major practices in the product life cycle. But waste production is significant and needs a systematic approach to it. Household product repurposing, which extends usage and reduces waste, is prevalent. Motivation and convenience of different practices have a substantial impact on frameworks of product-related behavior change in the country. There are numerous policies that support repurposing and waste reduction policies, which underline the relevance of Saudi households in evaluating the applicability of circular economy and repurposing of 12 commonly repurposed items. [2][1]

### 4.1 The scope and the system boundaries

Household recycling schemes are intended to make use of items for household consumption. A life cycle assessment (LCA) analyzes the environmental and economic effects of these practices on products in Saudi Arabia. The environmental aspect covers life cycle inventory (LCI) and impact assessment, culminating in indicators that show how much resources are used and how much emissions are produced from the products gained from repurposed household products. Saudi Vision 2030 promotes product durability and well-being in households. [1][14]

### 4.2 These are the tools used to gather the data (The means of obtaining data).

Home surveys play an important role in assessing re-use. Although they can be expensive and time consuming, they will give reliable data. The national online survey collected data on household characteristics, repurposing furniture, clothing, electronics and packaging and waste awareness. Saudi adults of age 18-70 were the target population, and 421 valid questionnaires were collected between 25 August and 5 October 2021. [15]

### 4.3 The importance of Life Cycle Inventory and Impact Assessment

Maximum gains can be realised by copying and sharing resources, but careful planning is required to prevent inefficiencies. A life cycle perspective is essential to minimise the negative impacts of production and reuse. Five product classes in Saudi households were chosen for repurposing: Textiles, Furniture, Electronics, Cosmetics Containers, and were subjected to a Life Cycle Assessment, which was performed to assess their environmental and economical impacts. The analysis showed that there were significant differences in impact by impact category. The re-use of re-use affects the re-plication of the re-use practice. A broad selection of options promotes more innovation than a narrow selection of options. These results are used as an input to develop strategies for promoting re-use and product life in Saudi Arabia. [2][16]

### 4.4 Assumptions and Limitations

Life Cycle Assessment (LCA) is a method that assesses the environmental impacts and resources consumed by products and services, from cradle to grave, according to the ISO 14 040. This encompasses the extraction, processing, transportation, production, distribution, marketing, use and disposal of raw material. LCA encompasses a range of

analyses that cover material and energy consumption, boundaries (such as energy and water) and a range of assessments that cover the total emissions and land use. Social sustainability and economic importance are also assessable factors in addition to the environmental factors. Within urban frameworks, “sectoral–sectoral” and “sectoral–demands” approaches are used with indicator-based approaches on economic and resource metrics. The socio-economic analysis of eight case studies shows the City of Stockholm's diversity. [17]

## **5. CASE STUDIES OF PRODUCT REPURPOSING IN SAUDI HOUSEHOLDS**

In traditional Saudi families, reusing products is a way of life because it is economic, cultural and practical. The investigation examines environmental advantages of reusing and recycles in three major areas—textiles, furniture, and electronics. However, appliances, packages and consumables are also significant but are not as comparable and are not being examined at this time. Textiles are a lively area in which to recycle, whether it's clothing, linens, or curtains. Reuse and upcycling pathways encourage creativity and experimenting in use. It is important to have information about current practices to help improve estimates of LCA and identify areas for interventions. [18] Household consumption of textiles calls for investigation. More than 40% of the total number of households surveyed (7.4 million) bought textiles in the past year because of COVID-19, and another 40% picked up second hand textiles. Of these, approximately 30% and 40% actively worked to change the items, with a prevalent use of upcycling. [1]

### **5.1 Textile reusing and upcycling**

The waste generation is one of the largest sources in Saudi Arabia, accounting for approximately 12% of the MSW, which is mainly due to textiles. Clothes are frequently thrown out too early and more than 50% of the population purchases new clothes every month. Apparel expense is approximately 17% of the monthly expense of households. The use of re-use and upcycling of textiles can increase the life of textiles and contribute to a circular economy. While repurposing fell out of fashion, it became more popular during the pandemic as coping strategies. Others have adopted a “more from waste, less from new” mindset in their homes, ensuring their clothing is made up of the maximum amount of pre-owned textiles, as well as being aligned with sustainable living. As a result, the reuse of fabric and upcycling has come into vogue. [19][20]

### **5.2 Furniture and Household Goods**

Furniture, electronic and textile items are often repurposed for use in the Arab household. There are practices that help to move these items to be reused. Lots of people around the country are doing this with furnishings. According to a survey, in 2018, 39% of households extended the use life of furniture. [2]

### **5.3 Electronic Devices**

With the advent of the digital lifestyle, information and communication has become more readily accessible via devices. This delivery of rich media requires equipment with more

performance, such as smart phones and tablets. Consumer electronics sustainability is becoming a concern; there are a lot of investments to be made in the field of eco-technology to manage their usage and reduce negative impact. Electronics make up a significant part of the family budget and environmental concerns. Restricting consumption and encouraging reuse, resale and sharing are the key aspects of life cycle sustainability. [21][22]

#### **5.4 Packaging and Consumables**

Saudi households produce a lot of materials with single use and a short lifespan, such as food packaging and consumables. This includes dry food packaging, sanitary products, paper towels and facial tissues, diapers, cotton pads, dishwashing sponges and disposable razors. These can be integrated into a circular economy in a variety of ways, especially with regard to material recycling and integration with other practices of life extension [23]. Convenience, cleanliness, and hygiene are usually stronger motives for re-using than are motivations. However, there are a number of households who try to extend the useful life of consumables or find new uses for packages [24].

### **6. ENVIRONMENTAL AND ECONOMIC IMPACTS**

In Saudi Arabia, Life Cycle Assessment (LCA) was used to assess the costs of resource use, waste and product re-use for textiles, furniture, electronics and consumables. Typically, re-use reduces material use, energy use and emissions, but the effects of re-use are small on the overall scale of waste. It can make a significant contribution to divert waste from landfill and can be expanded to a national level to improve impact. Paybacks of less than one year are financially viable, but a wider analysis is required for reusing. The consumption of the present is a strong sign of an ultra consumerism, rooted in social and religious convictions. [16]

#### **6.1 The use and emissions of resources**

Reducing the use of resources and greenhouse gas (GHG) emissions is the goal of household reuse of used products, even in the life cycle stages that are sometimes overlooked. The four case studies demonstrate notable effects of textile related practices and of furniture refurbishing. On the whole, the use of the resources is reduced in the activities of the households. Some areas exhibit smaller impacts or net increases under GHG emissions' repurposing. Recycling and re-manufacturing increase impact for some products, but there are various actions to conserve resources, particularly textiles, and packaging has limited re-use opportunities. [25]

#### **6.2 Reduce Waste at Source and Landfill Diversion**

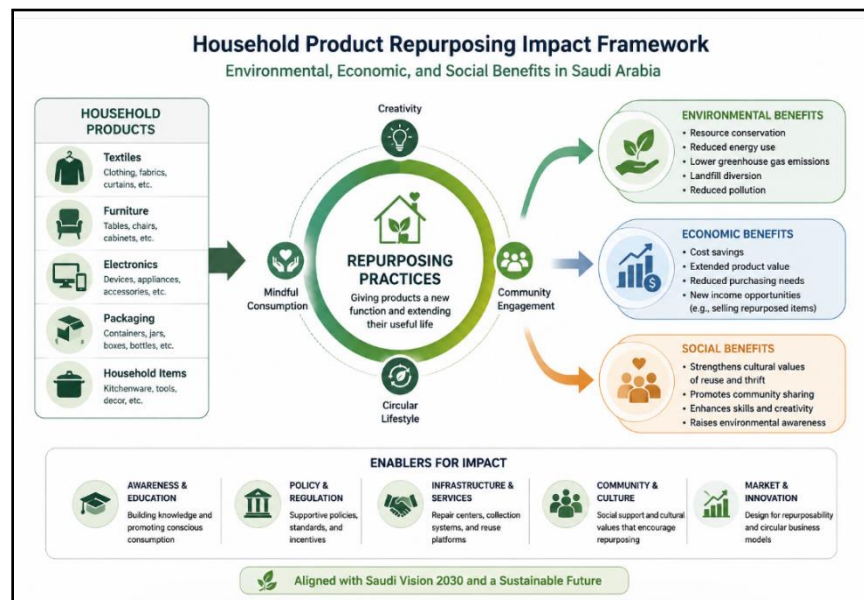
Case studies demonstrate landfill diversion happens when people repurpose products that are no longer being used, thereby decreasing waste generation and entry into landfills, through the KSA. The 12 cases had a total lifetime diversion of 280 kg, which is an average of 155 kg per household. When viewed as a whole life cycle, the last three



cases resulted in the avoidance of 836 kg in landfill - 473 kg per household. The automotive seats study shows very little diversion at the household level.

### 6.3 The economic implications for Households and Markets

There are significant economic impacts of reusing practices. The use of second-hand products also saves money to the household, however, repurposing may lead to a decrease in the market demand for the product, as well as to inefficiency. This analysis looks at the various economic impacts in the following areas: saving rather than buying new; amortisation of repair costs; consumption effects of second-hand alternatives; pricing of resources; and impacts on the manufacturers. The average amount of money spent by households per month on the reuse of textiles is SAR 558 and SAR 72 saved. The cost of homemade textiles is SAR 37, repairs average SAR 247 per year. Furniture installations can be as low as SAR 170 compared to new ones at SAR 4,800. The second-hand electronic market is booming in Saudi Arabia, but privacy concerns are limiting the sales of smaller devices. The second-hand market is impacting new unit demand, according to data.



**Figure 2: Framework showing the environmental and economic impacts of household product repurposing in Saudi Arabia**

## 7. SOCIAL AND BEHAVIORAL DIMENSIONS

Economic, cultural and structural factors influence repurposing practices of product reuse. The readiness to re-use depends on the socio-economic status and the valorisation need for waste perception of individual. Repurposing preferences are related to attitudes towards second-hand goods and attitudes towards waste reduction policies. Educational activities and controlled collection are vital to production of reusable materials. Reuse and repair varies between urban and remote areas, and income and remanufacturing

possibilities. These factors highlight the need for specific policies and campaigns promoting awareness and commercial opportunities. [1][6]

### **7.1 Attitudes, Norms, and Knowledge**

Saudi consumers' repurposing behavior has been investigated because of the complex blend of cultural elements, attitudes, and practices that influence repurposing behavior. The drivers behind the circular economy are economic, cultural and psychological. Basic economic knowledge and resource conservation have been shown to increase re-use in surveys and interviews, although there are barriers to many householders. Socio-cultural factors include cultural appreciation and Zaharanc dimension, highlighting social value of discarded items, and advocating their preservation or recirculation by reusing them. [26]

### **7.2 Areas of opportunity and obstacles to reusing**

Repurposing refers to the re-use and reworking of products with minimal production. Recycling is making new products from original products, with less virgin material. Corks, glass, plastics, wood and paper can be used to create furniture, toys and decor. It involves an approach of less energy consumption and avoiding the usual design procedures, that takes into account the following criteria: size, color, function, etc., using similar materials. [2][1]

## **8. POLICY IMPLICATIONS AND RECOMMENDATIONS**

Development of an enabling economic and regulatory framework is needed to stimulate individual behaviour change and new circles consumption norms. The focus of this study is on: Facilitating design for re-usability; Establishing trusted re-using systems; targeted educational campaign; and economic tools. Easy to build structures and good design increases re-use. Design standards and certifications are significant factors in the stimulation of demand. The institution should be supportive of the safety concerns with re-use products. Collection and quality assurance can be enhanced to ensure consumer safety. E-commerce and local repair services are emerging in Saudi Arabia but there is a need for investments to promote them to meet the regional equity.

### **8.1 Design for Repurposability**

Product development for domestic use as a carrier is a crucial element in the reduction of consumption. Cost and environmental benefits are enhanced by optimized lifetimes and repurpose. The circular economy seeks to prolong the useful life of resources; it should be easy to dismantle them for re-use. Problem of disposal should be avoided by providing a return, resale or repair feature in products. However, many do not have such designs and advertising does not promote re-use of these with seals and restrictive warranties.

### **8.2 The machinery and systems to pick up and return waste, or repair waste**

Good infrastructure is needed to be able to use products effectively. The networks are to be well signposted and will need resources. To boost participation, points can be added for the return of consumables in the value chain. Products that are not in use should be



converted into useful products. Recycling may be available; re-sealable packaging is useful and compatible plastics are a must. When it comes to electronics, collection and repair services are essential because they provide an extra level of reliability for second-hand electronics. It takes consumers being able to see the standards to establish trust. Local repair services can be provided by NGOs in places outside their area of origin. Products should be designed for re-use and for remanufacturing. It may be useful to develop a re-use network.

### **8.3 Activities for raising awareness and education**

Specific campaigns can encourage re-use by Saudi consumers who are looking to gain knowledge. Environmental, cost and ethical consumption should be the focus of the messaging. Introducing Islamic Waste ideas is culturally appropriate. Positive behaviors can be the basis for creating community identities. One of the most important things to be discussed on social media is the sharing of tips on how to re-use. For some product groups, there is a need for specific information on collection services, taking into account urban-rural differences and ethnic diversity. Awareness can be increased and regional storytelling needs be met through knowledge sharing.

### **8.4 The economic dimension of the solution: instruments and regulation**

The role of rules in product reuse is very important, in the reduction of market uncertainties. Some key instruments are economic instruments, regulations, voluntary instruments and public procurement instruments. Economic instruments are used to solve market failure problems and affect consumer decisions and regulations ensure safety. Demand can be created by procurement; and trust can be achieved through voluntary programs. Not even even-use is of interest to consumers, and no proposals for deposit-refund systems are put in place, as with footwear and textiles. Acknowledging campaigns could help to raise market awareness and confidence in the use of repurposable goods.

## **9. LIFE CYCLE ASSESSMENT RESULTS: INTERPRETATIONS AND UNCERTAINTIES**

The benefits of repurposing are numerous – both environmental and economic and social. A life cycle assessment (LCA) of Saudi households reveals that re-use has a significant impact on reducing resource consumption, GHG emissions and embodied energy, and also on reducing landfill waste. It also offers economic and social benefits, further highlighting its contribution to a circular economy. Yet cultural trends and institutional constraints have an influence on these practices. The LCA identifies policy gaps to further improve the repurposing of households, such as design for repurposability, collection systems, education, and supporting economic regulation. [14][10]

### **9.1 Scenario Analysis and Sensitivity**

The assessment looks at the level of re-use in the household, including refurbishment such as furniture painting and repairing, changing household products, and moving items within the household. For these investigations, the classic LCA does not include some

intermediate components and activities that are relevant for Saudi illustrative cases, however. [1][14]

## 9.2 Comparing with the Linear Consumption Baselines

Repurposing in Saudi households can also help to cut energy usage and emissions, as well as save money by extending the life of resources. This highlights the need for product re-use for sustainable development. But in Saudi Arabia, there is a lack of life cycle assessments (LCA) for such products, and there are only a few comparisons made for incontinence materials in three Scandinavian countries.

The studies concentrate on liquid absorption, indicating that the reuse of the product contributes slightly for sustainability (–5%) in relation to the traditional consumption. It is estimated that 75% of impacts may be due to the use phase. [1][14]

## 9.3 The "uncertainty" component and the "data gaps" component

Life cycle assessment (LCA) accuracy is limited by uncertainty and data gaps. These need to be dealt with through a focus on data quality and completeness. Having principles, as in ISO 14040, there are problems with impact assessment and interpretation. Improving data collection and models is vital for robust LCA results and sustainable design. [10]

Life cycle assessment (LCA) and environmental analysis are the focus of uncertainty and data gaps. Modeling uncertainty with frameworks aims to manage uncertainty, and Monte Carlo simulations quantify the uncertainty of the system. Assessing uncertainty is important in decisions-making. Reliability of measurement uncertainty in environmental labels and sustainability assessments is improved by Standards such as ISO/IEC Guide 98-3:2008. [27]

## 10. IMPLICATIONS FOR SUSTAINABLE DEVELOPMENT IN SAUDI ARABIA

The repurposing of household products in Saudi Arabia is linked to the aspects of economy, social, environmental and national sustainability. Material reuse attitudes are shaped by lifestyle, cultural values, and laws, and are oriented towards frugality and renewable resources.

Policies support waste reduction and encourage learning and sharing of reused knowledge. Saudi Arabia is looking for sustainable development and toward a circular economy as population grows and urbanisation increases rapidly. This change is promoted by the “Vision 2030” program, which shows the benefits of household practices that prolong the life of a product for global sustainability, including Sustainable Development Goals.

## 11. CONCLUSION

Development of a circular economy and sustainable consumption is crucial for the sustainable and equitable global society. In homes, circularity involves activities that help to extend the life of products, helping to ensure that resources are used effectively through

reusing, repurposing and repairing. Life Cycle Assessment (LCA) is used to quantify the environmental and economic impacts of circularity interventions. In Saudi households, the repurposing of products is widely seen, such as repurposing a piece of furniture, fabric, packaging, electronics, and paper.

The three circles of circular economy are covered by handling product repurposing in households: closing, slowing, and narrowing loops. Closing the loop means reconsidering and reclaiming a product's life, with a focus on prolonging its use and promoting the reuse of materials throughout the product's life cycle. Slowing the loop involves practices in managing products at the end-of-life. Closing the loop is about minimizing the amount consumed or the amount used at certain times. [1]

### Acknowledgement

The author extends his appreciation to Umm Al-Qura University, Saudi Arabia for funding this research work through grant number:26UQU4170009GSSR04

### Funding statement

This research work was funded by Umm Al-Qura University, Saudi Arabia under grant number: 26UQU4170009GSSR04

### References

- 1) S. Willskytt and A. M. Tillman, "Resource efficiency of consumables – Life cycle assessment of incontinence products," 2019. <https://doi.org/10.1016/j.resconrec.2018.12.026>
- 2) F. Granström, "Socio-economic evaluation of furniture re-use," 2007. <http://urn.kb.se/resolve?urn=urn:nbn:se:slu:epsilon-s-7071>
- 3) V. Kandpal and A. Jaswal, "Circular economy principles: shifting towards sustainable prosperity," in \*Circular economy and ...\*, 2024, Springer. [https://doi.org/10.1007/978-3-031-52943-6\\_4](https://doi.org/10.1007/978-3-031-52943-6_4)
- 4) N. Daniela Mihaela and S. Mihaela, "The Transition to the Circular Economy through Buyback Programs," 2018. [PDF]
- 5) K. Keshavarz, M. J. Alvarez, and C. J. Garcia, "The role of consumers in transitioning to a circular economy," Circular Economy and Sustainability, 2025. <https://doi.org/10.1007/s43615-025-00617-0>
- 6) J. Macklin (Downes) and S. Kaufman, "How do we change what we can't describe? A comprehensive Framework of User Behaviours in a materials circular economy." 2022. [osf.io](https://osf.io)
- 7) T. Tang and T. A Bhamra, "Understanding Consumer Behaviour to Reduce Environmental Impacts through Sustainable Product Design," 2009. <https://shura.shu.ac.uk/id/eprint/550>
- 8) M. Tanatarova, "Conscious Consumption as a New Form of Social Activity," Вестник КазНПУ имени Абая, 2024. DOI:10.51889/2959-6270.2024.87.3.006
- 9) x. i. a. n. g. x. u. e. zhang, "a new metric-based lca method for assessing the sustainability performance of metallic automotive components," 2012. [https://uknowledge.uky.edu/me\\_etds/15](https://uknowledge.uky.edu/me_etds/15)
- 10) A. Marie Santucci, "A Method for Use Phase Definition as Integrated into an Object-Oriented Approach to Life Cycle Assessment," 2018. <https://repository.rit.edu/theses/9950>
- 11) O. Ahmed Labib, L. Manaf, A. Hamzah Sharaai, and S. Sarah Mohamad Zaid, "Understanding the Effect of Internal and External Factors on Households' Willingness to Sort Waste in Dammam City, Saudi Arabia," 2021. [ncbi.nlm.nih.gov](https://ncbi.nlm.nih.gov)

- 12) D. Chrisendo, S. Heikonen, J. Piipponen, T. Banafa, "A systematic review of sustainable food systems identifies socio-economic pathways driving food systems transformations," *Nature Food*, 2026. nature.com
- 13) L. Milios, "Advancing to a Circular Economy: three essential ingredients for a comprehensive policy mix," 2018. ncbi.nlm.nih.gov
- 14) c. a. s. t. e. l. l. a. n. i. valentina, h. i. d. a. l. g. o. carme, g. e. l. a. b. e. r. t. laura, r. i. e. r. a. maria rosa et al., "Consumer footprint: Basket of products indicator on household goods," 2019. DOI:10.2760/964701
- 15) R. M. Alqurashi, S. M. Abdalla, A. B. Ammar, I. M. Shatwan, et al., "Food consumption patterns in different regions of the Kingdom of Saudi Arabia: household cross-sectional study," *Food Research*, vol. 2025, Elsevier. <https://doi.org/10.1016/j.afres.2024.100666>
- 16) M. Almansour and M. Akrami, "An environmental assessment of municipal solid waste management strategies in Riyadh, Saudi Arabia: A comparative life cycle analysis," *Sustainability*, 2024. <https://doi.org/10.3390/su16209111>
- 17) S. Hellweg, E. Benetto, M. A. J. Huijbregts, et al., "Life-cycle assessment to guide solutions for the triple planetary crisis," *\*Earth & Environment\**, vol. 2023. <https://doi.org/10.1038/s43017-023-00449-2>
- 18) J. Harris, S. Clark, and M. M. Hassan, "Mapping Circular and Sustainable Fashion, Textiles and Technology Innovation," 2026. arts.ac.uk
- 19) S. Han, D. Tyler, and P. Apeagyei, "Upcycling as a Design Strategy for Product Lifetime Optimisation and Societal Change," 2015. [PDF]
- 20) G. Cardoso de Oliveira Neto, M. Maia Teixeira, G. Luis Victorino Souza, V. Demarchi Arns et al., "Assessment of the Eco-Efficiency of the Circular Economy in the Recovery of Cellulose from the Shredding of Textile Waste," 2022. ncbi.nlm.nih.gov
- 21) M. Kaviul Islam, M. Sharifa Khatun, and M. Mourshed, "An in-depth analysis and review of management strategies for E-waste in the south Asian region: A way forward towards waste to energy conversion and sustainability," 2024. ncbi.nlm.nih.gov
- 22) E. G. Ryen, "An Ecological Framework to Assess Sustainability Impacts for an Evolving Consumer Electronic Product System," 2014. [PDF]
- 23) E. Fiore and S. Barbero, "Assessment tools for disposable and long durability products," 2016. DOI:10.18638/scieconf.2016.4.1.357
- 24) N. A. Mohamed, "Environmental Vision for the Egyptian Dry Food Packaging Case Study of Cocoa packaging," 2016. [PDF]
- 25) E. Hoxha and H. Birgisdottir, "Recycling and reusing a robust solution, or a utopia for lowering the greenhouse gas emissions of buildings? The case of Denmark," *The International Journal of Life Cycle*, 2025. springer.com
- 26) M. Jacoba Stols, N. Cynthia Sonnenberg, and N. Marx-Pienaar, "Female Consumersu27 Motivation and Intent to Dispose of Apparel in an Eco-friendly Manner: A South African Emerging Market Perspective," 2017. [PDF]
- 27) P. A. O. L. O. TECCHIO, "Streamlining Life Cycle Assessment to support Ecodesign through multi-criteria materials selection," 2015. DOI:10.6092/polito/porto/2590356