



Necessity-driven circular economy in low-income contexts: How informal sector practices retain value for circularity

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ARTICLE INFO

Keywords:

Necessity-driven
Circular economy
Recycling
Low-income contexts
Emerging markets
Sustainability

ABSTRACT

Low-income informal sector contexts are rife in practices that retain value of materials and goods, but in the academic literature and policy debates these practices are seldom considered as part of the circular economy (CE). This is a major omission in CE discourse, as over 60 percent of the world's employed population is in the informal sector and many of them make their living from circularity practices. Hence, our paper advances a globally covering understanding of CE by focusing on local practices constituting CE in the overlooked contexts of low-income informal markets of emerging economies, and on the motives behind the practices. To that end we introduce the notion of Necessity-Driven Circular Economy, defined as a set of locally embedded and interlinked formal and informal practices aimed at restoring and retaining the value of goods and materials for as long as possible, based on economic necessity and opportunities for income generation. We substantiate this conceptual work with our empirical findings from low-income urban communities in Brazil, India, and Tanzania. This allows us to capture the essential characteristics of necessity-driven circular economy. These characteristics draw attention to the social and cultural embeddedness and the interweaving of consumption and production in necessity-driven circular economy, as opposed to the dominant techno-economic and industry-focused circular economy conceptualizations that are typical in academic discourse and portray developed country contexts. Finally, we discuss conceptual and practical relevance of necessity-driven circular economy and point out its system-level implications for policymakers and businesses.

1. Introduction

The notion of circular economy (CE) is gaining in popularity as environmental problems associated with contemporary linear production and consumption patterns increase. Most research and ideation for new CE models take place in and for developed country contexts (Kirchherr and van Santen, 2019). In low-income contexts of emerging markets, however, the scarcity of everyday resources often pushes individuals to implement resource-conserving innovative practices that retain the value of materials and goods in circulation. These practices are informative for advancing conceptual development of the CE, especially as regards understanding CE in emerging markets and developing countries' context, where in some cases up to 50 % of

economic output comes from the informal sector (Lee et al., 2021). The innovative value retaining practices for materials and goods in low-income contexts often tend to be overshadowed by calls for improved formal organization of waste management (Silva et al., 2019; Troschitz and Mihelcic, 2009), or address the inferior working and living conditions of informal sector waste pickers (Uddin and Gutberlet, 2018), or focus on recycling of single waste categories (Gall et al., 2020).

While proliferating, CE is also a contested concept. CE literature tends to focus on technologically-based innovation (De Jesus and Mendonça 2018). It is often simplified into a business strategy that combines radically reduced waste generation with increased competitiveness, or portrayed as an engineering model, in which materials flow flawlessly from production to consumption, then to collection,

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<https://doi.org/10.1016/j.gloenvcha.2022.102573>

Received 24 November 2021; Received in revised form 9 May 2022; Accepted 25 July 2022

Available online 5 August 2022

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processing and back to production (Zink and Geyer, 2017). Despite the warning against such subverted interpretations of CE (Kirchherr et al., 2017), these approaches ignore the additional organizing or re-organizing that is needed for the collection of reused materials or for the marketing of the goods made from them. Existing conceptualizations of CE do not embrace the socio-economic complexity that makes the circulation systems less predictable. This is especially true in low-income contexts where many informal activities take place in parallel with more formal processes. Already back in 1992, the research on global environmental change called for transitions and restructuring that would *not* threaten the social systems they are meant to serve (Dahlberg, 1992). And still today scholars are often concerned that little attention to local communities and processes, externally imposed development and growth imperative may actually undermine local resilience (Rigg & Oven, 2015). Striving for social justice and resilience calls for taking into account the informal local practices and including low-income community members to decision-making processes on opportunities arising through CE (Kirchherr, 2021).

When shifting to new paradigms to an international scale, it is critical to support understanding and negotiations of what kind of a CE or CEs are feasible and sustainable (Luo et al., 2021). The current academic and policy debates often overlook forms of CE that are intertwined in everyday life in low-income communities and involve a whole range of what we here will call “*necessity-driven circular economy practices*”. In this paper we show that unlike policy and innovation-driven CE in developed markets, in low-income emerging market contexts CE is driven by economic necessity (Preston and Lehne, 2017), reflected in the everyday practices of low-income individuals and self-employed entrepreneurs. Thus, the purpose of our study is to facilitate forming a globally covering understanding of what CE means in practice and discuss what could be the aspired CE models for the future, embracing justice and social equity.

Next, we proceed to review the literature on CE and existing accounts of CE-relevant practices in low-income contexts, and introduce the concept of necessity-driven CE. Then we substantiate our conceptual work with our empirical findings from Brazil, India, and Tanzania by illustrating how different informal practices can retain value of the materials and goods in circulation. Finally, we discuss the systems-level implications of a necessity-driven CE.

2. Literature background

2.1. Beyond the formal circular economy

The CE approach has been established largely through governance and innovation programs in different parts of the world. The European Union, for example, adopted a comprehensive European Circular Economy package in 2015, while in China CE has been part of official policy for more than 10 years (Lieder and Rashid, 2016). On the company level, multiple authors have looked into formal circular business models and evaluated the adoption of circularity (Bocken et al., 2016; Witjes and Lozano, 2016; Urban et al., 2017). Yet the accounts of how the vast low-income informal sector retains value of materials in circulation often remain separate from business and policy discussions on transitions towards a CE. This is a major issue, as it is estimated that more than 61 % of the world’s employed population make their living in the informal economy (ILO, 2018), with waste pickers among the three largest urban informal worker groups (Dias and Samson, 2016). Besides waste picking, other urban informal workers earn their living via street vending and home-based work, engaged in diverse repair, reuse and repurpose activities. And while the scholars admit that the informal

sector in the global south will be an integral part of the CE under any scenario (Gall et al., 2020), the conceptual foundations of CE are still rooted in the realities of the formally organized markets.

Furthermore, many authors are calling for more holistic approaches to examine how CE fulfills the three dimensions of sustainability, and the social dimension in particular (Oliveira et al., 2021). Over-simplistic approaches may lead to unintended consequences (Camilleri, 2019), e.g., endangering the livelihoods of low-income individuals (Härri et al., 2020). For instance, there is documented opposition to waste-to-energy technology from informal waste sector workers in India, as they fear losing the source of their income, namely waste (Demaria and Schindler, 2016). Despite the large investments into improving the municipal solid waste collection in China, overregulation of the sector has led to informal actors competing with the formal system, invalidating the investments (Steuer et al., 2018). Studies comparing waste management systems in developed countries and emerging economies emphasize how these systems are tightly linked to their social and economic contexts, and should build on them rather than directly duplicate new externally-developed solutions (Chen et al., 2010). Often it remains unclear how the implementation of CE can improve social equity and access to opportunities for informal sector (Kirchherr, 2021; Murray et al., 2017; Millar et al., 2019), as formalizing activities tend to result in the unequal sharing of the costs and benefits (Conke, 2018). On the other hand, the research on global environmental change purported the value of growing culture of innovation and revitalization in low-income communities as a means for autonomous advancement of sustainable development (Thorn et al., 2015).

It is noteworthy that empirical CE studies lack a low-income perspective, even though emerging market countries are the source of a large proportion of the world’s materials and the destination of much of the waste produced globally (United Nations, 2019; Zoeteman et al., 2010). Typically, developed countries have high export rates of secondary commodities, while countries with large low-income markets have high import rates of secondary materials and high waste utilization rates (Uiterkamp et al., 2011). Even when CE studies do look at emerging economies like China, most tend to focus on formal CE indicators and activities (Geng et al., 2012) and sideline valuable informal individual or community-level practices that retain value of materials and goods in circulation.

2.2. Informal recycling and other CE practices in low-income contexts

Although low-income contexts are rich in CE-relevant practices, these are rarely linked to CE in academic literature. Reike et al. (2018) refer to CE-relevant activities as R-strategies of different value retention capacity and systemize them through the 10R typology – essentially, a hierarchy of waste prevention and value reutilization options (p. 254). Highest value retention strategies like repurpose and repair belong to the shorter, higher priority loops of CE (R1-3), while for instance recycling is part of the longer loop with lowest value retention potential (R7-9). Practices and activities from low-income contexts are often situated within the shorter loops of the 10R typology (Reike et al., 2018). Thus, understanding how and why these are being implemented can inform envisioning the economic transformations required for a just, inclusive and balanced CE.

Current literature on informal practices in low-income contexts often erroneously labels all practices as “*recycling*”, obscuring the benefits of practices that actually retain the value of materials and goods better than recycling. Nzeadibe (2009) describes informal recycling sub-systems in Nigeria, showing how locals wash aluminum cans (e.g., from evaporated milk) for *reuse* in the preparation of local bean cakes.

Washing the cans adds value to the items when they are resold. Similarly, they *repurpose* beverage containers into graters (by perforation) and *reuse* recovered soles to make new shoes (Nzeadibe, 2009). Although labeled as *recycling* in the original article, these practices are aimed at keeping materials in use for longer and are part of the shorter, higher priority loops of the 10R typology (Reike et al., 2018). Over-simplifications of practices in low-income communities may mislead the policymaking towards adopting new solutions, which might be less efficient in value retention of the materials than the ones practiced by low-income individuals.

More examples of necessity-driven CE practices in low-income contexts can be found in the literature on informal livelihoods, scavenging, and recycling. In low-income contexts these are first and foremost economic activities serving as a basis of livelihood for millions of people (Scheinberg et al., 2011). Several studies come to the same conclusion that income level is a significant predictor for considering waste as an economic resource (e.g., Wilson et al., 2006; Damanhuri et al., 2009). Based on several case studies, Troschinetz and Mihelcic (2009) observe that frugal household economics and the existence of local markets for used materials are influential factors in the sustainable recycling of municipal waste. These markets, as well as informal actors' waste recovery skills and ability to locate customers for the uptake of used materials, are at the very center of necessity-driven CE in low-income contexts. The informal actors' practices illustrate how adding value to recyclables at each step of the value chain helps to create business around recyclables (Jaligot et al., 2016).

Nzeadibe (2009) suggests that although informal waste management should not represent a development goal per se, it is worthwhile to identify the positive aspects of informal recycling for possible development interventions. Studies from various low-income contexts in China, Nigeria, Pakistan, and Indonesia, for example, conclude that the recycling of municipal solid waste is to a significant degree maintained by the informal sector (Asim et al., 2012; Ezeah and Roberts, 2012; Sembiring and Nitivattananon, 2010; Steuer et al., 2018). Waste buyers sometimes also provide other services to households, such as cleaning after parties (Asim et al., 2012). A study from Romania, for its part, reported that some households form direct social connections with informal waste buyers and prefer them over formal waste disposal (Scheinberg et al., 2011). Many waste buyers have well-established "routes", allowing them to organize their work more efficiently than municipal authorities. Despite their valuable contributions, informal sector work often involves severe health, social, and economic hardships, further exacerbated by insults and harassment from middlemen traders (Asim et al., 2012). It remains a major challenge to convince local authorities to recognize the informal sector as beneficial, rather than a mere health hazard (Sembiring and Nitivattananon, 2010). In sum, many studies report that the informal sector is only rarely viewed in a positive light (Do Carmo and Puppim de Oliveira, 2010).

Our literature review above reveals some of the richness of activities aimed at retaining the value of materials and goods in low-income contexts. But while formal and informal systems for local waste management are covered in a number of studies, bridging these studies with CE literature is important for understanding what types of CE exist in various geographical contexts, and how local CEs could be supported. Building on the insights from CE literature and the studies of informal practices in low-income contexts, we develop a definition of *necessity-driven circular economy* as:

a set of locally embedded and interlinked formal and informal practices aimed at restoring and retaining the value of goods and materials for as long as possible, based on economic necessity and opportunities for income generation.

Based on our review of the literature, we see a need to extend the discussion on CE to reflect the global perspective and be sensitive to local socio-economic and environmental conditions. These largely define what forms CE can assume in different places and which activities

are most effective at advancing CE (Levänen et al., 2018). In order to properly understand the potential of the large variety of locally tailored actions that can contribute to CE, empirical CE studies should be more globally balanced. As of yet, diverse informal practices related to repairing, reusing, repurposing and recycling have not sufficiently informed the conceptual development of the CE.

In what follows, after introducing our materials and methods, we proceed to offer descriptive accounts of reusing, repurposing, repairing and recycling in Brazil, India, and Tanzania to illustrate necessity-driven CE in low-income contexts and the broader characteristics that pertain to it.

3. Materials and methods

In order to empirically illustrate the necessity-driven CE practices in low-income contexts, we will draw on data we collected from urban low-income settings, or more precisely selected slums of Belo Horizonte in Brazil, Kanpur in India, and Dar es Salaam in Tanzania. We applied multi-sited rapid ethnography (Halme et al., 2016), to explore the phenomenon of informal CE through the practices of low-income individuals constituting it. These locations were selected because they were cities with significant low-income populations (specifically living on less than purchasing power parity adjusted 5 euros a day), they

Table 1
Interviewees and observation locations.

Description	India	Tanzania	Brazil
In-depth interviews	5 (paanwallah/ seller of traditional local snack, factory worker, driver, women leather workers, housewife)	12 (1 waste trader, 2 female & 1 male heads of households, 1 job seeking youth, 2 school children, 2 teachers, 2 entrepreneurs, 2 community workers)	10 (housewife, school children, community leader, waster picker, teacher)
Expert interviews	3 (Journalist, packaging company representative, manager of worker training programs)	4 (1 workshop with entrepreneur women; 1 roundtable with local authorities; poverty expert of a local NGO; development researcher)	12 (anthropologist, 2 journalists, favela sociologist, communication sociologist, radio manager, micro credit manager (NGO), ecodesigner, city waste manager, packaging Industry representative, paper company manager, grocery store owner)
Ad hoc interviews	11 (raddiwallah, households, 2 teachers, sellers at markets)	40 (sellers at marketplaces, teachers and households, local authorities)	10 (waste pickers, radio journalist, households, workers at community association, teacher, librarian)
Observation locations	15: 1 household, 2 schools, 3 markets, mall & food bazaar, shops, pharmacies, temple, slum area (including inside house), women leather workers' "factory", raddiwallah, street life.	8 (2 schools, 2 households, 2 markets, 1 waste dump, 1 small industry area) in 3 neighbourhoods of Dar es Salaam (Kurasini, Tandeka and Keko).	8 (2 favela households with children, 4 associations: a recycling center, community development, a play club and a capoeira club, 2 schools - public and private).

Table 2
Necessity-driven CE practices identified in Brazil, India, and Tanzania.

Observed practices					Descriptive codes
Practice type	Practice description	Country	Who	Why	Descriptive themes
REUSE	Reusing plastic bags as storage solutions off the floor (hanging on the wall)	BR	Low-income families	Flexible storage due to lack of space	“Making-do”
	Reusing newspaper for storing fruit, fish, etc.	IN	Street vendors	Cheap material for preventing damage	Resourcefulness
	Using jute to make packaging sacks and bags combined with other scrap material	IN	Street handymen	Means of livelihood	
	Reusing standard plastic “buckets” for collecting water, buying flour, cereals etc.; for storage at home, as table or chairs	TZ	Low-income families, self-employed entrepreneurs	Easy to reuse; convenient standard size for trading	Value of everything – “no waste”
	Selling wood pieces and similar for building housing out of recycled materials	TZ	Self-employed entrepreneurs	Means of livelihood	
	Selling second-hand clothes from Europe & USA	TZ	Self-employed entrepreneurs	Means of livelihood	Business, numerous raddiwallahs in Indian cities
	Selling collected materials for reuse to vegetable markets, food sellers (to be used as food cups) and to factories (to be burned for energy)	IN	Raddiwallah [informal sector middleman]	Business, numerous raddiwallahs in Indian cities	
	Re-selling old newspapers, booklets, advertising brochures, old office paper for use in the market (e.g. wrapping food, making food sachets).	TZ	Traders in open markets	Cheap material for wrapping, packaging	Lack of money Can’t afford new Time-consuming; Space for CE practices
	Opening retail packaging and selling in smaller units, so sellers often need materials for re-packaging.	TZ	Self-employed entrepreneurs	Customers can’t afford to buy in large quantities	
	Reusing old office paper, searching for paper from garbage for writing at school	TZ	Children at school	Cannot afford new notebooks	
Making handicrafts from pieces of fabrics, plastics, etc.	BR	Handicraft organizations	Small profit, community (social) activity for women		
REPAIR	Repairing sandals, leather products, chairs (using scraps of old materials)	IN	Street handymen	Means of livelihood	No official work space;
	Repairing electronics and home goods; seamstresses repairing clothes. Often working from home.	BR	Self-employed entrepreneurs	Means of livelihood	
	Repair services for goods and clothing	TZ	Handymen in workshops, streets	Means of livelihood	Space for CE practices
	Repairing and producing furniture from recycled materials collected at ASMARE cooperative	BR	Members of ASMARE	Means of livelihood	
REPURPOSE	Repurposing various kinds of packaging that could be used in daily life: plastic bottles, cardboard boxes.	BR	Low-income families	“Free” solutions for everyday life	Resourcefulness
	Making food cups from newspaper	IN	Street vendors	Convenient serving	
	Teaching children how to be resourceful, e.g. different ways to reuse PET bottles at home	BR	Teachers in schools	Teaching on “recycling topics”	Resourcefulness;
	Making ovens out of barrels	IN	Street handymen	Means of livelihood	
	Making ovens out of barrels	TZ	Handymen in workshops or along the streets	Means of livelihood	Imperfect solution
	Making chairs out of car tires	TZ	Handymen in workshops or along the streets	Means of livelihood	
	Making water containers from plastic containers by adding a nozzle	IN	Street handymen	Means of livelihood	“Making-do”; Lack of money Imperfect solution;
	Improvising “coolers” made out of plastic bag, cardboard and ice	TZ	Fishmongers in markets	Keeping fish fresh without electricity	
	Using branches and tarps for roofing	IN	Residents of shantytowns	Using free materials for building homes	
	Assembling equipment for cooking and agriculture	IN	Street handymen	Means of livelihood	
RECYCLING	Collecting paper, plastic, and metal from households and streets to be sold by weight to middlemen	IN	Waste pickers	Means of livelihood	Time-consuming More time than money;
	Half-formal sorting of valuable materials for recycling to national and international industries	TZ	Waste pickers	Means of livelihood	
	Collecting recyclable trash door-to-door and on the streets Storing and sorting of collected waste in recycling “cells” at ASMARE cooperative	BR BR	Waste pickers Waste pickers	Means of livelihood Means of livelihood	Space for CE practices

represented a diversity of geographical contexts (i.e., continents), and the research team had access to these locations (including the possibility to work with scholars familiar with local languages and contexts). Data gathering trips to the three cities lasted between three to four weeks and were made consecutively over a period of five months, with breaks in between to allow for cumulative learning. The original broader focus of the research was related to packaging, mass communication, and primary education in low-income contexts. Based on background research and pre-study, observing the lives and activities of informal sector individuals was recognized as a means for richer exploration of informal practices revolving around keeping materials and goods in use for longer periods of time.

The data were gathered by six researchers, two for each location. One of the two team members was from the country concerned. In addition, the teams had fixers/guides, assistants, and translators with a close familiarity and knowledge of the local culture. This team composition ensured a richness of perspectives and researcher triangulation. Primary data was gathered through interviews and observation in a total of 31 locations, including recycling stations, slums, markets, shops, factories, households, and schools. The research team members applied purposive sampling and interactive shadowing to reach out to low-income individuals involved in activities prolonging the life and use of materials and goods. The interviewing followed an unstructured approach with the emphasis on encouraging the respondents to talk (Rowley, 2012), avoiding topics that made respondents uncomfortable. For instance, due to the informal lifestyles, many respondents did not possess official papers and often could not recall their exact age. When interviewing, the researchers sought to maintain a conversational style helping the informants to talk about their life, especially regarding circular practices as their work or part of their daily life. The questions were tailored according to the location and the interviewee. Key questions centered on the observed circularity practice(s), collecting more details about the practice(s) and the motivation for the practices. Often, questions related to personal situations, immediate family and networks, sources of livelihood, expenditures, daily struggles (e.g., water, food, hygiene) and longer-term challenges (e.g. no access to the formal job market). As shown in Table 1, the data comprised 27 in-depth interviews, 61 shorter ad hoc interviews, 19 expert interviews, about 1,200 photos, extensive video material, and a range of secondary background documents. The large data set collected from different primary and secondary sources allowed for data triangulation and a comparative assessment of data from different sources (Silverman, 2003).

Upon returning from our data gathering trips, the interviews were transcribed, translated, and analyzed by all researchers using NVivo, a qualitative data analysis software. The data was coded in two main rounds: The first inductive data analysis and the second theorizing round. In the first round of coding, we identified practices for prolonging the use and life of materials and products; CE practices. The most frequent categories of such CE-practices turned out to be reusing, repairing, repurposing, and recycling (Table 2). In the second round of coding, we scrutinized these practices in light of existing CE research to both reflect on the motivations and underlying characteristics of CE in the low-income contexts. It turned out that the omnipresent motivation was related to economic necessity in different forms from saving money to earning livelihood through waste collection. This led us to the key observation of economic necessity as a driver for CE practices, and eventually motivated us to coin the concept of necessity-driven CE.

4. Results

4.1. Necessity-driven CE practices identified in Brazil, India, and Tanzania

Seeking to advance a more nuanced understanding of CE in these contexts, we will next describe our findings of four types of CE-practices, or the “R”-strategies (see Reike et al. 2018) of *reuse*, *repurpose*, *repair* and *recycling* in these settings. Analyzing our findings from low-income contexts against the different value retention strategies (the “Rs”) introduced by Reike et al. (2018), we found features idiosyncratic to CE in low-income and poor communities.

Table 2 contains a detailed overview of CE practices we identified in the low-income settings we studied, followed by a description. In addition, Table 2 provides a brief analysis of the actors engaging in these CE practices, and the main motivations for the practice.

4.1.1. Reuse and repurpose

In each studied locality in India, Tanzania, and Brazil we observed widespread reuse of containers (plastic or metal). These containers are washed and then reused for carrying/storing water, liquids, grains, or charcoal. In Tanzania the use of plastic buckets is so widespread that they have become a standard measure in the sale of flour, cereals, etc.

The repurposing of different items is also widespread and creative. Simple ovens are made out of barrels, and water containers are made from regular plastic containers by adding a nozzle. There are hundreds of “micro-businesses” that either specialize in making different household items (e.g., ovens) or agricultural tools out of recycled materials, or simply sell pieces of wood and metal scrap for similar purposes (manufacturing out of recycled materials).

Scraps of different materials (e.g., leather) are reused for making packaging or products for sale in combination with local traditional materials and fibers. For example, jute is a long and soft vegetable fiber that can be spun into strong threads. It is one of the most affordable natural fibers available, and India is by far the largest producer of jute in the world. Together with leather scraps, jute is used for making bags, packaging, for keeping containers cool or fruit fresh, etc.

In Brazil we observed the repurposing of plastic bags as storage solutions in favelas, to keep goods off the floor. Many homes in favelas have scarce furnishing and lack of space is a serious issue. Shelves or chests of drawers are a rare sight. Instead, personal hygiene items (e.g., toothbrushes), important documents and other things are hung on the wall in plastic bags. Some primary schools in Brazil explicitly engage in teaching children about resourcefulness. For example, children are taught how to repurpose PET bottles to serve as plant pots, helping to prevent the spread of dengue fever by reducing insects’ access to still water (Fig. 1).

In shantytowns people will often reuse whatever materials they can find, as many homes are made of tree branches, tarps, pieces of old furniture, etc. In India newspapers have a long life. One of their most prominent uses is for packaging in local markets: newspapers are used for wrapping and packaging fruit (transportation, storage), or made into small sachets for selling spices, grains, etc. Newspapers are also used as food cups because they can be made into a convenient serving size cup. Once no longer usable, it is burned during cooking.

On food wrapping, a shopkeeper (Kanpur): “*You don’t touch the Paan [a popular Indian snack] by hand. The customer’s hands don’t get stained. Many other shopkeepers are doing this. It is now very popular in the best shops.*”

The same practice was observed in Dar es Salaam, where old newspapers and office paper are widely reused for the packaging of food.



Fig. 1. Reuse and repurpose of containers and bottles in low-income contexts.

Clean new paper is not readily available in Tanzania, often parents cannot afford to buy new notebooks for their children, who have to find paper elsewhere. Many are forced to pick through garbage in order to look for old office paper and reuse it for making notes at school. Cardboard boxes are used in spontaneous street markets as tables, and at home they may be used as storage solutions (Fig. 2). In Dar es Salaam we also found them repurposed as coolers for perishable food:

A fish seller (Dar es Salaam): "...we use big plastic bags with two layers of cardboard inside. This isolates the cold inside the fish. The fishermen put the catch in ice. Also when we buy the fish are in ice. The ice is among the fish inside the cardboard...this way the fish can stay for 4 h. After that we have to fry the fish."

4.1.2. Repair

Repair services were readily available in all the low-income locations we visited. These services are usually conveniently located close to markets and other busy areas. In India, for example, repair "workshops" are found right on the roadside, with tools laid out on the ground. There people can have their shoes, furniture or other household items repaired. In Brazil many seamstresses work from home and offer their services for repairing clothes. Other small businesses that often operate from home repair electronics and furniture. Low labor costs make it cheaper to repair rather than buy new (Fig. 3).

Both in India and Tanzania we observed workshops and carpenters repairing or building furniture out of leftover pieces of wood, wooden pallets, and packaging. In Belo Horizonte in Brazil, the ASMARE



Fig. 2. Reuse and repurpose of plastic bags, newspaper and cardboard.



Fig. 3. Repair tools, services and workshops in India and Tanzania.

cooperative houses a workshop where furniture is fabricated from different recycled materials.

A man reselling pieces parts of the dismantled houses (Dar es Salaam): *“Since this area of the city has to be cleared, and those who receive money are obliged to move, there was a lot of building material that had been taken down from the settlement and sold again. Pieces of metal that are used to make selling boots, sheds etc. were sold at individual prices, That means that the sellers would give a price for each piece depending on its size and its condition. If it had no holes, and could still be used many times, the prices was higher than for worn out pieces.”*

4.1.3. Recycling

In each city we visited the informal recycling sector had its own structure and organization. In some cases, such as Belo Horizonte, the informal sector has in fact had a half-formal co-operative, ASMARE, which stepped in to protect the rights of informal actors and cooperate with the formal municipal system. ASMARE provides waste pickers with their own storage cells where they can deposit what they have collected and come back to sort it later.

Waste picker, member of ASMARE cooperative (Belo Horizonte): *“We used to sell to a middleman, from an association. But it was hard. The police used to treat us like bandits. They used to throw cold water at us, beat us. They said we were getting the streets dirtier. They didn’t see us like they see*

today, they didn’t see that we were cleaning the streets.”

ASMARE also provides legitimacy, helping to reinforce the perception that instead of a nuisance, waste pickers are in fact doing useful work. The waste pickers we interviewed noted that ASMARE membership has helped to improve their self-image. ASMARE works closely with the formal waste management system by collecting, sorting, and transporting recyclables to Sao Paolo’s recycling facilities. The municipality also has partnerships with local favela community leaders for the collection and recycling of construction waste. Favela leaders help the authorities locate dumping grounds for construction waste so that it can be collected and used for manufacturing bricks. ASMARE ensures that waste pickers also collect garbage from narrow, difficult-to-access streets and onwards to official garbage trucks (Fig. 4).

The city of Kanpur is an important center for recycling in India. All larger cities in the country have recycling stations and separate trash bins for different materials, but it seems these are not in use. In Kanpur, recycling is an organized informal business with clearly defined roles between different actors. Waste pickers collect paper, plastic, and metal from private households and from the roadsides. They collect whatever has value and sell it to middlemen – raddiwallah. This means that waste, which has no value and is very light in weight remains on the streets, uncollected. There are numerous raddiwallahs in every Indian city, reselling collected materials for reuse, repair and recycling.



Fig. 4. Recycling as entrepreneurial activities of low-income individuals.

4.2. Characteristics pertinent to a necessity-driven CE

The above-described practices are representations of necessity-driven ways to retain the value of materials and goods in everyday life, for economic reasons. Analysis of these reuse, repurpose, repair and recycling practices has helped us to make sense of *why* and *how* the value is being retained and to show how these everyday practices constitute part of the *economy* in low-income contexts. Necessity-driven CE practices are an integral part of daily life in low-income contexts: for some it constitutes the main source of income (e.g., waste picking, repair), for others it is a frugal way of approaching all daily activities. Inspired by the approach of Banerjee and Duflo (2007) who examine the “economic lives of the poor” to understand the patterns of their earning and spending, we investigated the ways in which economic necessity frames CE practices in low-income contexts. This made it possible to identify *characteristics pertinent to a necessity-driven CE*, which we elucidate below.

The “circular mindset”. CE practices in low-income contexts engender true resourcefulness. In the three countries studied, this is manifested to different extents. In India and Tanzania every little scrap of material is salvaged for reuse and repurpose: for instance, even small pieces of fabrics are used for making protective boundaries around flower beds. It seemed that the extent of reuse and repurpose was lower in Brazil where poverty is less extreme than in the two other countries. Still, cardboard boxes, plastic bags, bottles and other items are all integral part of repurposing practices.

Tolerance towards imperfect solutions. In all locations we observed that certain imperfect solutions simply “worked” in the circumstances, such as hanging up plastic bags for storage purposes – a flexible arrangement in space-constrained homes. In Tanzania car tires make as

benches for community “meeting places”. All these require virtually no additional investment, yet serve the purpose.

Focus on affordability and long-term functionality (not the formal process). Despite the different levels of poverty in the three locations we studied, repair services are widely available in all of them. The value of long-term use for furniture, electronics, clothes, footwear, etc. is sufficiently high to ensure a demand for repair services. These services are provided right on the roadside, because customers expect to have their belongings repaired quickly and affordably. The handymen are inventive in their ways of fixing and matching the materials and spare parts, because affordability and speed of the service are key in competing for customers.

Engagement in time-intensive practices. The repair “industry” is characterized by resourcefulness in terms of skills and materials, while the value of time appears less relevant for repairmen as compared to getting the service done. In fact, many of the activities we observed were time-consuming in relation to their final value (e.g., making furniture from recycled materials). Making a living out of recyclables is extremely time-consuming: waste picking activities typically take up days. Thus, engaging in time-intensive practices constitutes an important part of necessity-driven circular activities. In low-income contexts often the most readily available resource is time.

The existence of informal hubs reinforcing CE. It became obvious that both formal and informal structures reinforce existing CE practices in the countries studied. For example, the ASMARE cooperative in Belo Horizonte, Brazil, helps waste pickers make a living by providing storage cells, allowing them to do the sorting later. While storage cells are a physical structure, they are also an informal hub where waste pickers meet and interact, an embodiment of living off CE practices. The existence of cooperatives and other formal or informal structures helps to

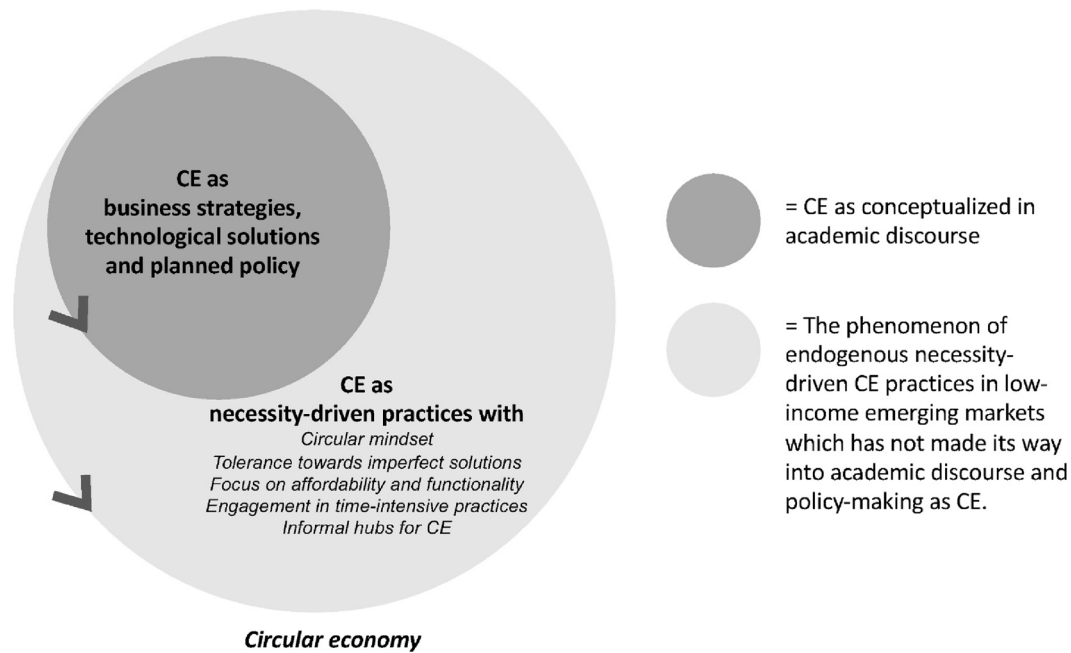


Fig. 5. Enlarging the conceptualization of CE in academic discourse and policy-making in order to include the necessity-driven CE practices in low-income emerging markets.

give legitimacy to the activities of waste pickers and to reduce harassment. ASMARE has improved the lives of many waste pickers in Belo Horizonte: locals increasingly see them as members of society who do “useful work”. ASMARE’s connections to Sao Paulo’s formal recycling facility have given waste pickers greater legitimacy.

We will next turn to discuss how our findings help to build more comprehensive knowledge about the phenomenon of circular economy.

5. Discussion: necessity-driven circular economy and its implications

The starting point for our study was the observation that although low-income contexts are rife in value retaining practices for materials and goods, these practices are rarely framed as CE in academic literature (Gall et al., 2020). Our paper is an endeavour to advance the CE conceptualization and discourse to include forms of CE that are endogenous to low-income contexts, as well as to substantiate this conceptual development empirically. Our work makes altogether three advances to the current CE discourse.

Our first contribution is the expansion of the conceptualization of CE to include also the low-income informal sector circular practices that retain value of materials and goods. As opposed to the current conceptualization of CE emphasizing technology, business and formal policy, we introduce the concept of *necessity-driven circular economy*, and define it as a set of locally embedded and interlinked formal and informal practices aimed at restoring and retaining the value of goods and materials for as long as possible, based on economic necessity and opportunities for income generation. The concept of necessity-driven CE responds to the call for a more systemic approach towards CE (Korhonen et al., 2018), and brings into light a currently underappreciated form of necessity-driven CE taking place in the informal low-income contexts of the globe. This is different from the current conceptualization of CE in academic discourse and policy making, which delves around technological solutions, business strategy and governmental policies that support circularity of materials, motivated by environmental concerns. Such predominant conceptualization of CE originates primarily from developed countries

Table 3
Comparing and contrasting the CEs of developed and emerging economy settings.

	CE in the developed contexts	Necessity-driven CE
Drivers	<ul style="list-style-type: none"> Formal sustainability policies; international agreements; new business opportunities 	<ul style="list-style-type: none"> Economic necessity; shortage of materials; opportunities for entrepreneurial income generation
Barriers	<ul style="list-style-type: none"> Lack of circular mindset: low consumer interest and hesitant company culture; embeddedness in linear systems; excessive reliance on technological solutions; rigid regulations 	<ul style="list-style-type: none"> Insufficient cooperation between informal and formal economic players; exogenously imposed “systems”; lack of quantified impact data from informal activities
Basis	Technologies and innovation	Labour and time-intensive practices
Underlying attitudes	Environmental morality	The “circular mindset” about materials
Orientation towards	Convenience, efficiency	“Making-do” solutions that retain the highest value of materials
Focus on	Standardization	Affordability & long-term functionality
Institutions	Formal organizations, agreements, contracts	Informal hubs and relations
Systems of production and consumption	Separate	Blurred/Merged
Benefits	Impact and efficiency via the scale of technologies; Security and decent work conditions	The default principle of retaining the highest value of materials (reduce, reuse, repair, etc.)
Risks	Downgrading materials and goods with excessive reliance on industrial recycling strategy for reaching scale and large volume	Insecurity, harassment of workers, health risks

context and to some extent from the formal economic arrangements of emerging markets like e.g., China or Brazil.

In addition, we substantiate the concept of necessity-driven circular economy by identification of five *characteristics pertinent to a necessity-driven CE*, which makes our second contribution to CE literature. The characteristics we discern are (1) everyday inventiveness and resourcefulness (the “circular mindset”); (2) tolerance towards imperfect solutions; (3) focus on affordability and long-term functionality (not the formal process); (4) engagement in time-intensive practices; and the existence of (5) informal hubs as structure reinforcing CE. These portray how the “circular mindset” and tolerance toward imperfect solutions (“making-do”) are part of the complex everyday bricolage of low-income contexts, which uses whatever is at hand even with an odd range of resources (Levi-Strauss, 1966). In the context of CE, bricolage is about retaining the value of goods and materials in use for as long as possible. In line with Halme et al. (2012), our results emphasize how the resourcefulness of bricolage is both about the ability and the readiness to identify and deploy the sometimes unconventional means at hand to address issues that the person considers relevant. Fig. 5 summarizes the key take-ways of our work: (1) how the current framing of the CE valid for developed or formal sector contexts excludes the necessity-driven CE omnipresent in the low-income and mostly informal sector contexts, and (2) the different nature of CE in these different contexts.

The motivational basis of necessity-driven CE that we investigate here is different from the combination of environmental and business motivations, implicitly assumed in the current academic literature on CE. Due to the lack of financial resources, in low-income contexts value retaining practices for materials and goods are an integral part of everyday life, instead of an environmentally or policy motivated voluntary choice. Extending the earlier findings of Vergara et al. (2016) and Scheinberg et al. (2011) on recycling, we demonstrate that other CE practices are a source of income too (e.g., repair), or an important source of savings in low-income households (reuse, repurposing). While in wealthier contexts citizens are usually educated and morally persuaded into doing what is termed the “consumption work” – cleaning, sorting, and transporting of recyclables (Wheeler & Glucksmann, 2013), household compliance with waste sorting is not always efficient (Nainggolan et al., 2019) and a general lack of circular mindset is one of the main barriers to CE development (Kirchherr et al., 2018). In low-income contexts these activities are occupations in the informal sector, with specific skills and motivation to maximize the value of goods and materials. There is much that households in high-income settings could learn from the circular mindset, but it is questionable whether that can occur without the economic necessity driver, which pertains to low-income contexts, or without policies that assign high prices to resources.

Further differences between the existing academic conceptions of CE, and those of the necessity-driven CE we introduce here, concern the “R”-strategies of *refuse* and *reduce* (Reike et al., 2018). Both of these are so integral part of lives in low-income households, that they could not be framed in the same way they are usually understood in CE discourse of higher-income contexts, assuming them as voluntary activities of consumers with environmental motivation. In regard to the specific practice of *repurposing*, in the developed settings it is typically performed by producers as a business activity (Reike et al., 2018). Our data challenges this conception by indicating that the wide range of repurpose practices performed by low-income individuals are part of their everyday life. Overall, our findings illustrate that the distinction between production and consumption systems in the low-income contexts is rather blurry. While the dichotomy between production and consumption of the developed contexts has been criticized for stifling sustainability transitions (Geels et al., 2015), learning from the extensive repurposing of low-income contexts implies smarter multi-functional design of goods and packaging by producers to better enable the reuse and repurposing of these in everyday life.

Effectiveness of necessity-driven CE. Our findings suggest that necessity-driven CE is potentially highly effective in retaining value of

Table 4

System-level implications of necessity-driven CE for policymakers and businesses.

Characteristics of necessity-driven CE	System-level implications for policymakers and businesses
The “circular mindset”: inventive everyday solutions in reusing, repairing, repurposing	Innovative systems for supporting cyclical flows of materials and energy and for slowing down consumption rates Policymakers: Policy level support is needed for enterprises that are based on and favor existing local solutions, materials, and paths for recycling, repurposing. Businesses: Supporting existing CE practices requires that businesses reflect on what products and solutions are essential in low-income communities, and how to better maintain their multi-functionality.
Engagement in time-intensive activities	Legalization of time-intensive jobs contributing to CE (some of these are considered “consumption work” in affluent contexts) Policymakers: Municipal-level programs for integrating informal CE activities into formal waste management. Businesses: Developing standards and business models for the integration of time-intensive jobs with advanced technologies.
Focus on affordable end result and functionality, not the formal process	Flexibility toward informal organizing for CE Policymakers: On the municipal level better integration and de-stigmatization is necessary for informal activities in low-income communities. This can be achieved, for example, by affording waste pickers the status of municipal workers, by providing access to certain supplies (safety gloves) and health services to reduce associated health hazards. Businesses: New business models might emerge that facilitate the closer integration of existing informal activities, such as informal repair services, with formal firms, producers of goods.
Tolerance toward “make-do” (imperfect) solutions	Utilization of local solutions and expertise for the design of broader waste management and CE Policymakers: Explicit policies to integrate existing local systems and solutions instead of imposing incompatible, expensive, and overperforming technologies. Businesses: Accepting and learning from local “fixes”; extending the technologies and waste management services of formal businesses to include these solutions and the informal sector in ways that provide reasonable livelihoods for locals.
Formal and informal structures such as hubs	CE institutions, levers for supporting CE practices in low-income contexts Policymakers: Support for existing local cooperatives; focusing on reducing the exploitation of low-income individuals through legal schemes for integrating informal activities with formal businesses; legalizing and facilitating the sharing of equipment and co-working spaces for repair services, or CE activities. Businesses: Exploring opportunities for collaboration with local cooperatives or NGOs for the responsible integration of informal actors; exploring sharing opportunities (e.g. for special equipment) with local entrepreneurs in collaboration with municipalities to reduce the risks of criminal misuse, theft, etc.

materials and goods. Due to lack of financial resources, in the low-income contexts even the shortest loop Rs of *refuse* and *reduce* – the most desirable forms of conserving use of resources according to Reike et al. (2018) – are common, and so are other forms of short or medium-loops. Naturally, our empirical sample is qualitative and illustrative, so we acknowledge the effectiveness questions warrant further research.

This exemplifies how existing conceptualizations of CE based on data from developed settings can be complemented and contrasted with data coming from CE practices in the informal low-income settings, in order to build more nuanced understanding of CE in these contexts. While we do not argue that one type of CE is superior to the other one, understanding the different drivers and bases of the CE types allows building a more integrative approach for transitioning towards circularity. Building on the characteristics of necessity-driven CE that emerged in our findings, we contrast it with the CE of the developed contexts (Table 3). Although representing a simplification, this exercise illustrates the complementary natures of the two CE types. The formal CE tends to rely on innovative technologies, and aims to provide convenient solutions and engage participants on moral grounds. Necessity-driven CE, on the other hand, is based on labor and time-intensive practices with the intention to provide affordable “make-do” solutions. Due to its informal nature, the necessity-driven CE encompasses both production and consumption, engendering both benefits (more holistic approach to circularity), and risks (insecurity due to informality). In practice, building on this nuanced understanding above allows us to next discuss the third and final advancement of our study to the CE discourse.

5.1. Re-aligning policymaking and CE innovation with local necessity-driven practices

Given the importance of necessity-driven CE as a source of livelihood and its potential effectiveness in retaining value of materials, it is important to consider designing policies fit for the necessity-driven CE work within the informal sector. We suggest such knowledge should complement the views purporting technology transfer from developed to developing country contexts as the dominant means to improve material efficiency and accelerate green innovation (Singh & Chudasama, 2021).

Our third contribution to CE discourse is the development of system-level implications for businesses and policymakers in low-income contexts. As many studies have demonstrated, reluctance to consider economy-level implications in, for example, formalizing waste management activities often leads to overregulation, conflict and uneven distribution of benefits and costs, endangering local livelihoods and undermining social equity (Conke, 2018; Steuer et al., 2018). We, therefore, highlight that overcoming the current disconnect of many CE policies from the local socio-economic conditions requires linking the CE discourse with locally embedded formal and informal practices. This calls for explicit cooperation between different economic actors (Camilleri, 2020). The ASMARE cooperative in Brazil is a good example of how individual-level informal waste picking practices can lead to closer cooperation between municipalities, NGOs, and local communities in an effort to simultaneously improve waste management, employment of the poorest, and their working conditions.

Building on the five characteristics of necessity-driven CE identified in the above, we outline the following set of system-level measures (Table 4). Supporting the “circular mindset” requires knowledge about existing local solutions, materials, paths for reusing, repurposing, and recycling that are already in place and functioning efficiently, and how policymakers and businesses could reinforce and complement them. Millar et al. (2019) establish that one of the current priorities is to explore and illustrate how CE could improve social welfare, especially since due to global processes CE-oriented policies of the developed contexts may indirectly endanger the livelihoods of low-income communities in emerging economy countries, e.g., in clothing and apparel industries (Repp et al., 2021). Our findings suggest that instead of

replacing the existing endogenous CE practices of low-income individuals with overperforming technologies and methods unfit for context, policymakers could explicitly favor combinations of systems and technologies that integrate the skills of low-income individuals, improving their security, safety, hygiene, and status. For instance, the time intensity of low-income occupations and flexible working arrangements call for supportive policy measures in terms of legalization, integration, and de-stigmatization, access to shared work spaces and innovative business models (e.g., integrating the existing informal repair services). If justice, social equity and access to opportunities are to be improved through CE, as suggested by Kirchherr (2021) and Murray et al. (2017), it is imperative that close attention is paid to local socio-economic settings.

6. Conclusions

Circular economy has captured the attention of governments and businesses worldwide as an easy-to-grasp and promising way of sustainably advancing their economies while responding to pressing environmental problems. So far, however, circularity has been mostly discussed through the prism of formally organized developed markets, overlooking the multiplicity of existing (necessity-driven) practices for retaining the value of materials and goods in diverse global environments. These practices are noteworthy both for advancing circularity, but also for understanding and connecting the socio-economic lives of low-income individuals to political and academic debates on CE. This will be necessary in order to reach a globally shared understanding of what CE means in practice and what might be the aspired CE models for the future. Rather than trying to leapfrog to the waste management systems of developed countries, the focus should be turned to the question of how to enhance locally-tailored broader CE systems, addressing existing injustices, integrating existing necessity-driven CE practices, effective in retaining the value of materials. Furthermore, it should also be recognized that high-income contexts could learn from the circular mindset of low-income contexts we outlined above, essentially engage in “reverse leapfrogging”.

Our study has examined the informal practices of individuals living in low-income contexts, and in this respect has extended the ongoing CE discussion to explicitly include individuals and their practices as part of economy-wide transformations towards CE. Establishing broader CE systems should be more socio-culturally informed. Therefore, more research is needed on the micro-level implementation of CE in the global context, asking how existing informal CE practices are linked with formal systems and how their potential can be increased with policy support and business innovations.

CRediT authorship contribution statement

Angelina Korsunova: Conceptualization, Formal analysis, Writing – original draft, Writing – review & editing, Visualization. **Minna Halme:** Conceptualization, Methodology, Investigation, Writing – review & editing, Visualization, Funding acquisition. **Arno Kourula:** Investigation, Methodology, Writing – review & editing, Project administration. **Jarkko Levänen:** Formal analysis, Writing – review & editing. **Maria Lima-Toivanen:** Investigation, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

This work was supported by Business Finland [40279/09].

Appendix A

Coding scheme for Characteristics of Necessity-Driven Circular Economy.
(For the origin of the descriptive codes see Table 2).

Descriptive code	}	Aggregate code
Value of everything – “no waste” Resourcefulness	}	Circular mindset
Lack of money Can’t afford new	}	Affordability focus
Imperfect solution Making-do (with what is at hand)	}	Tolerance toward imperfect solutions
More time than money Time-consuming	}	Time-intensive practices
Space for CE practices No official work space	}	Informal hubs for CE practices

Appendix B. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.gloenvcha.2022.102573>.

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