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A STUDY ON CIRCULAR MATERIAL INFORMATION WITHIN SMALL AND MEDIUM ENTERPRISES IN MALAYSIA

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ABSTRACT

Exploring and utilising sustainable materials, currently known as circular materials, is a prominent strategy to shift to a circular economy. Today, Malaysia's manufacturing and design industries have started to develop by-products and second-life waste materials and incorporate them into products. The idea is to maintain the technical and biological resources in the usage loop, preventing them from leaking into landfills. However, understanding the experiential qualities of such materials still needs to be explored. Although existing research indicates an early and active development of circular materials in Malaysia, there needs to be a greater understanding of how users will experience the materials. Specifically, this study investigates the life cycle information of waste materials that is communicated to users. A dataset of a hundred-seventeen product cases indicates that information within the 'resource' and 'end-of-life' phases is dominant. Such information helps frame the message of the materials' sustainability, but the absence of holistic lifecycle information makes the materials' biography less engaging. The findings denote that the material developers have invested in developing or utilising the technical qualities of the materials, but more emphasis on the experiential qualities is needed. An engaging material experience may secure a successful uptake of circular materials in the market.

Keywords: Circular Economy, Circular Materials, Materials Biography, Material-Experience

1.0 INTRODUCTION

Plastic waste has become a global crisis, ranking as the third-highest waste source worldwide (Chen et al., 2021). Its volume increases steeply with population growth and rising consumption. Plastic's versatility makes it ubiquitous – it is found in everything from textiles and cars to manufactured goods and packaging (Locock et al., 2017). Its durability, lightweight nature, and affordability have cemented its dominance across various industries.

However, the current "use and throw" mentality ingrained in the linear plastic economy has led to massive waste accumulation in landfills, severely damaging the environment. Plastic pollution spirals out of control because, despite its near-permanent lifespan, many plastic products are designed for single use. The United Nations Environment Assembly reported in February 2022 that global plastic waste generation nears 300 million tonnes annually. This staggering number highlights plastic's pervasive presence in daily life, demanding immediate change.

Planned product obsolescence, another concept in product design, further exacerbates the plastic waste problem (Zeeuw et al., 2017). Corporations discovered that selling short-lived, consumable goods generates higher profits than durable, long-lasting products. This led product developers to strategically define a product's lifespan and use less durable materials to promote repeat purchases. Consequently, estimates suggest that global plastic waste generation will reach 585 million tonnes by 2020 (Chen et al., 2021).

The COVID-19 pandemic further accelerated plastic waste generation. Plastic, ironically, served as a protector during this emergency, but its post-use impact is problematic. Globally, everyday items like food packaging, shopping bags, online shopping bubble wrap, and personal protective equipment (PPE) like aprons, gloves, and disposable masks are disposed of immediately to prevent viral spread. Additionally, many reusable products, like aprons in salons and prayer mats in shopping malls, were replaced with disposable alternatives to comply with safety protocols (Bahrudin et al., 2021).

Undeniably, efforts to combat plastic waste are underway. Relooping plastic waste and incorporating renewable materials into manufacturing processes can reduce plastic's environmental footprint, a key aspect of a circular economy. However, transforming manufacturing and design practices presents challenges akin to changing social norms. The search for superior circular materials to replace plastic remains ongoing, while consumers accustomed to plastic products must evaluate and compare new materials for adoption.

This study investigates circular material information communicated to consumers by small and medium enterprises in Malaysia. The findings will reveal the ways users are informed about the circularity of materials. Parallelly, the development and utilisation of circular materials within Malaysia's SMEs will be better understood.

2.0 LITERATURE REVIEW

2.1 Circular Economy

The traditional linear economic model of "take-make-dispose" is no longer sustainable, prompting a new approach (Braungart et al., 2007). The circular economy (CE) model offers a promising alternative for preserving Earth's finite resources. It aims to maximise the value of materials within the industrial system for extended periods, minimising waste generation (Ellen MacArthur Foundation, 2019). A crucial aspect of CE is designing products that minimise environmental and resource impact throughout their lifecycle. In essence, as Macarthur (2013) conceptualises it when a product reaches its end-of-life, its raw materials are cycled back into the system for further use.

The circular economy aligns perfectly with sustainable development aspirations by addressing the scarcity of finite resources and reducing the mountains of waste-burdening ecosystems (Ghisellini et al., 2016). Its core principles stem from ecological, environmental economics, and industrial ecology. Furthermore, it incorporates other sustainability-driven concepts like "cradle-to-cradle", "performance economy" (Stahel, 2010), and "biomimicry". Integrating "lean" and "green" production principles further optimises material flows by achieving "detoxification" and "dematerialisation"(J. et al., 1995; Joseph Fiksel, 2007). Detoxification refers to eliminating hazardous materials from production processes. At the same time, dematerialisation focuses on reducing the material used per product unit and replacing resource-intensive, non-renewable materials with sustainably harvested and renewable alternatives.

Much research explores strategies to implement the concept of CE by optimising resources from various aspects, such as reducing the use of critical raw materials and design utilising bio-based, recycled materials or substituting them with more advantageous materials (Thilo et al., 2018; Aldo et al. Rosen, 2022). The product life cycle will consider product parts and materials used (Virtanen et al., 2017). Good use of materials at the early stages of a product's development can ensure the materials' end of life is also sustainably handled. Therefore, emphasis on the use of 'circular materials' in the product design industry is essential to ensure the progressive development of a circular economy in a country. The success of the circular economy model hinges on effective material stewardship practices. These practices include take-back schemes, material flow records, and large-scale recycling initiatives that ensure optimal material circulation within the system.

2.2 Circular Materials

Defining material sustainability remains a complex issue due to its dependence on the viewpoints and contexts of various stakeholders. Material industry stakeholders highlight diverse sustainability dimensions, yet they converge on similar core ideas—minimising a material's negative impact on humans and the environment through efficient management.

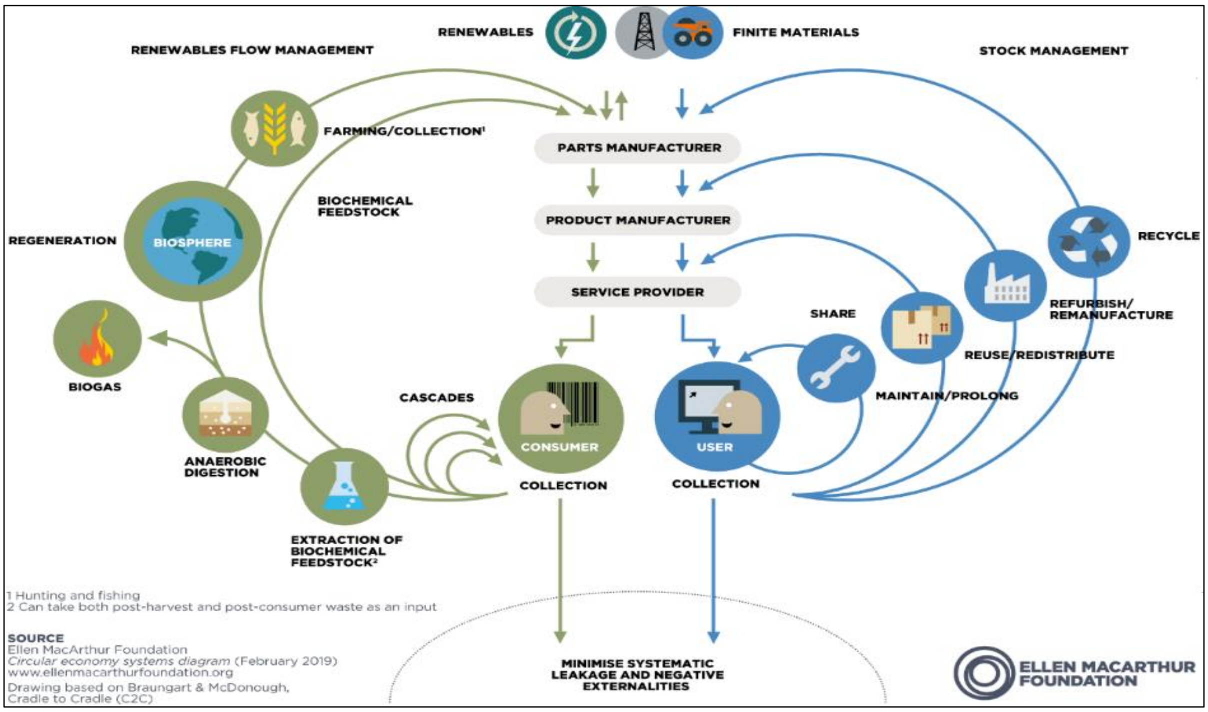

Fig. 1: The Circular Economy System Diagram (Ellen MacArthur Foundation, 2019)
(https://www.ellenmacarthurfoundation.org/circular-economy-diagram)

"Circular materials" refers to materials that meet specific circularity characteristics, regardless of their type. The defining attributes of circular materials can vary depending on the context and assessment methodology. In much research, 'Circular material' is often used interchangeably with 'sustainable materials' and 'eco-materials' to explain the environmental credentials stressed to achieve the Circular Economy. Following the CE diagram, the circularity of materials can be classified into biological resource flow and technical resource flow (see Figure 1). An example of the biological resource flow is food packaging from natural fibre materials. It is expected that the materials will biodegrade at the end of life. In such flow, the nutrients in the material are returned to the natural environment, forming new resources for further harvest. Certain circular materials, such as paper, are worth to be recycled. Hence, for technical resource flow, materials are recycled through a cascading utilisation from high-to-low-value products (Mair et al., 2017). For example, after their lifecycle, plastic mineral water bottles can be turned into recycled plastic products and potentially into composite materials for various applications.

Fig. 2: Aspire Vero green PC made from recycled plastic by Acer.
(https://www.acer.com/ac/en/US/content/series/aspirevero)

As the product manufacturing and design industries progressively pursue the circular economy, various consumables and durable products made of circular materials have emerged. For example, Acer used 30% of post-consumer recycled plastic to produce their Aspire Vero laptop chassis (Figure 2). Besides that, following the principles of CE, the laptop is also designed to be easy to repair, upgrade and recycle. Another example is the ODGER chair of IKEA (Figure 3). The chair embodies an innovative mix of renewable wood and recycled plastic. Both products have a unique visible imperfect texture and are complemented with information that explains the ‘story’ of the materials.

Fig. 3: IKEA's ODGER chair is made of renewable wood and recycled plastic.
(https://www.ikea.com/se/sv/p/odger-stol-bla-00360002/)

2.3 Biographical Identity of Circular Materials

Research has demonstrated that making the products' past identity prominent boosts market demand. This phenomenon is explained by the fact that the narrative of the circular materials induces thoughts about the material biographies, which allows consumers to feel special in owning the product (Polyportis et al., 2022). Through advertisements, websites, or product labels, consumers would be informed of the material's life story, enabling them to trace the circularity of the material used in a product. For example, Adidas and Parley jointly introduced shoe designs made from recycled Ocean Plastic®. Information such as 'the shoe is made with Parley Ocean Plastic®', initially sourced from islands in the Maldives, is stated on their website.

Table 1 summarises the material biographical descriptors identified by Bahrudin (2019). A total of 29 biographical descriptors are identified within the four phases of the material lifecycle. The biographical descriptors enable researchers, designers, and product manufacturers to examine the circularity of materials used through each key point within the four lifecycle phases.

Table 1: Biographical descriptors of sustainable lifecycle

Lifecycle Phase	Biographical Descriptor	Definition	Example of information
Resource	1. Substance origin	Input material types or components of an object	Starch, plastic, paper, fibre, melamine, cellulose
	2. Object origin	The specific objects that the material was embodied into prior to being used	Cassava, corn, yoghurt cup, fishing net
	3. Provenance	The geographical location where the material comes from	United Kingdom (country), Slum of New Delhi (local area), ocean (water)
	4. Procurement source	Individual or establishment from whom the material is procured	Ragpickers, fashion industry, school children, NGOs and volunteers
	5. Material quantity	The specific number of materials or products used to make the materials	11 Pet bottles, 50% recycled materials
	6. Material availability	The specific amount of material resource that is available	2000 tonnes of bamboo production, 2 million cups a year
Production	7. Developer	The originators of the material/product	Rcup, P&G, Adidas
	8. Co-developer	The additional party that jointly developed the	Polish R&D Centre, Parley for the Ocean

Lifecycle Phase	Biographical Descriptor	Definition	Example of information
		material/product	
	9. Material development duration	The time spent on developing the material prior to the production	Six months
	10. Cultivation	The process of nurturing and growing the material	The farm relies on rainwater, not irrigation
	11. Material processer	The person / group/company that processed the material	Women's group and the community at a sheltered workshop
	12. Material processing	Procedures to transform the raw material into a product	Cleaned, dismantled, sorted, and removed unwanted materials such as batteries and textiles
	13. Material processing place	The location where the material is processed	Sheltered workshop
	14. Material-to-product producer	The stakeholders that converted the material into finished goods	P&G, Adidas
	15. Material-to-product production	Operations involved in converting the ready-material into finished goods	3D print, solar heating, synthetic binder-free, hand made
	16. Material-to-product production place	The location where the ready material is converted into finished goods	A small village in Tamil Nadu, Zurich, USA
	17. Material-to-product production date	Date indicating production batch	12-Dec-15
	18. Material technical name	The industry and scientific community recognise a name used in production and regulations to identify a substance or mixture.	Polyethene, Polyvinyl chloride, Aluminium
	19. Material trademark name	Official registered material's trademark	Ecothylene®, SpinDye®, SweeetFoam™
	20. Material nickname	Name by which a material is commonly addressed	Matrix-based felt, bio-polymer, plastic
	21. Certification	The verification of a third-party organisation regarding material's	Rainforest Alliance, Fair Trade

Lifecycle Phase	Biographical Descriptor	Definition	Example of information
		cultivation and/or production	
Use	22. Sensorial	The outcome obtained from using the material in the aspect of aesthetic	Patina, random speckled
	23. Technical	The outcome obtained from using the material in the aspect of utility performance	Flexible, water resistance
	24. Endorser	Spokespeople promoting the sustainability aspects of this material/product	Sustainability manager, celebrity
	25. Social benefit	Charitable contribution directly tied to each product consumption	Toothbrush donation for every purchase
End-of-Life	26. Collection process	The process of how the material is reclaimed or will be reclaimed	Curbside recycling, collection from the beach, take back scheme: e.g. Gimme five program
	27. Recyclability	The material's capability to be converted into new material or product	100% recyclable
	28. Compostability	The material's capability of undergoing biological decomposition in a compost site	Compost in an industrial facility
	29. Biodegradability	The material's capability to be disintegrated in the environment	Throw them in the compost pile after they wear out

3.0 METHODOLOGY

Content analysis is a well-established research method for systematically reviewing and evaluating documents. It encompasses both printed materials and electronic formats like computer-based files and internet content (Bowen, 2009). Like other qualitative research analytical methods, content analysis requires a thorough examination and interpretation of data to extract meaning, deepen understanding, and contribute to developing empirical knowledge.

This study collects information on materials from 33 small and medium enterprises that develop products from circular materials in Malaysia for content analysis. The initial dataset was taken from a study by Ismail et al. (2021). Three firms out of the 33 SMEs have been excluded from the analysis because their official website is no longer in operation. The data is collected in text and infographic form from the companies' official websites and social media sites such as Facebook and Instagram. All the collected data from online sources were accessed from 23-30 July 2022. As a result, 117 material information cases were collected. The material information is scrutinised to identify their biographical descriptors. The types and frequency of the biographical descriptor within the information set are highlighted and recorded for analysis.

4.0 RESULTS

This section shows the result of the content analysis. Thirty-one sets of material information describing their products and circular materials used were collected from 30 of Malaysia's SMEs. Table 2 shows the types and frequency of biographical descriptors used in the material information sets.

Table 2: Frequency Used of Biographical Descriptor

Biographical Descriptor	Frequency of Used
Substance origin	32
Object origin	45
Provenance	20
Procurement source	7
Material quantity	13
Material availability	3
Developer	5
Co-developer	1
Material development duration	1
Cultivation	6
Material processor	4
Material processing	8
Material processing place	1
Material-to-product producer	15
Material-to-product production	16
Material-to-product production place	20
Material-to-product production date	0
Material technical name	11
Material trademark name	9
Material nickname	34
Certification	20
Sensorial	4
Technical	27
Endorser	0
Social benefit	16
Collection Process	0
Recyclability	8
Compostability	12
Biodegradability	20

Chart 1 shows the frequency of biographical descriptors used in the material information sets. The chart illustrates the frequency of biographical descriptors used in material information sets, offering insights into the characteristics commonly highlighted in the information provided by SMEs on their website—the chart indicating trends in the information provided about sustainable materials developed by the companies.

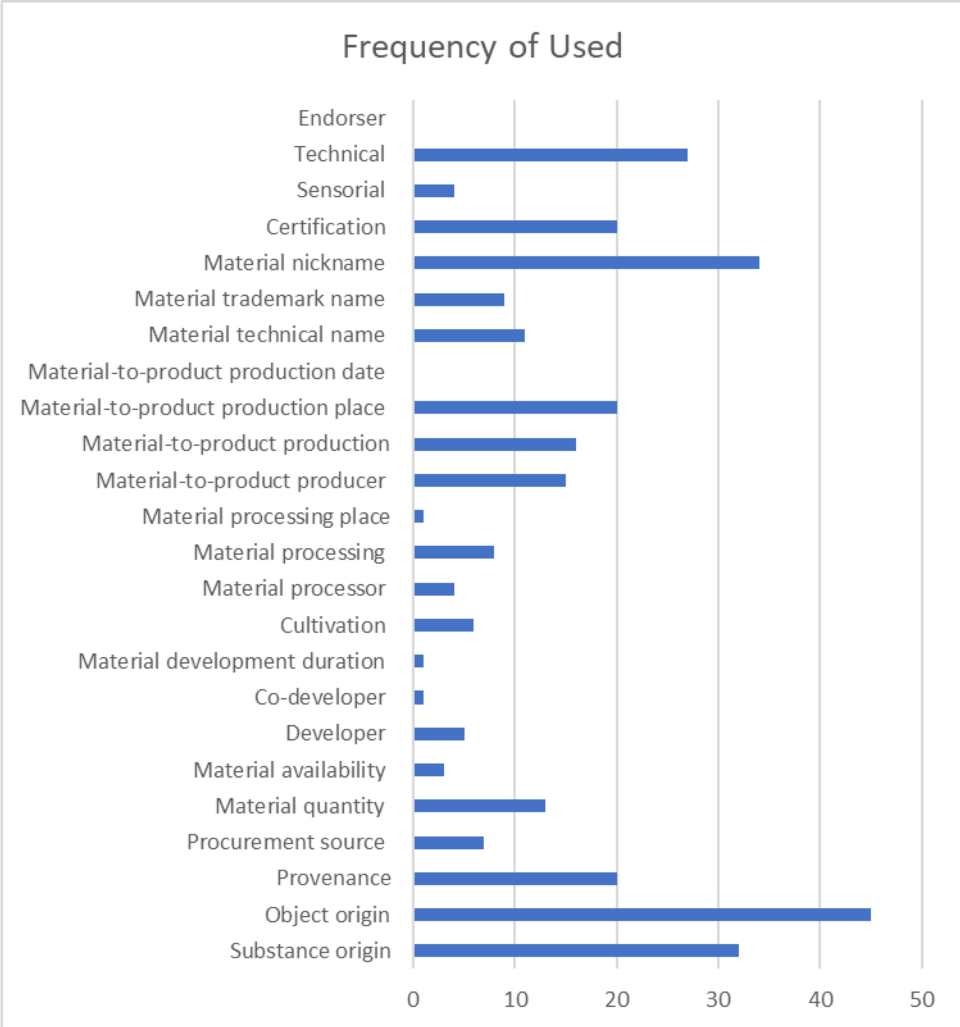

Chart 1: Frequency of biographical descriptors used in the material information sets

The biographical descriptors are then tabulated in the four phases of the product lifecycle. Figure 4 illustrates the high and low existence of descriptors in each lifecycle. In total, the biographical descriptors in the dataset are concentrated within the resource and production phases.

In the resource phase, most firms stress object and substance origin information. For the descriptors, most firms inform that they are utilising recycled materials and bio-based materials in their product. More than two-thirds of firms specify the object origin of their products, such as recycled plastic, recycled firehose, discarded PVC advertising banners, recycled paper, and used kimonos identified in the study. For substance origin, materials such as jute, corn starch, cotton, palm fibre, wheat lignin, and pineapple fibre were identified in one-third of the firms. Information on provenance, procurement source, material quantity, and availability descriptors in the information set is scarce.

Fig. 4: The material biography analysis result is based on the lifecycle phase.

Within the production phase, several biographical descriptors exist in high frequencies. Many firms mainly provide information on material nicknames, certifications, and material-to-product production. For example, Terrae assembled their tees in their partner factory in Kuala Lumpur, Malaysia, using organic cotton and dye made in Bangladesh and certified by Organic Content Standard (OCS). Meanwhile, information on developer, co-developer, material development duration, cultivation, material processor, material processing, material processing place, material-to-product producer, material-to-product production, material-to-product production date, material-technical name, and material trademark name is limited.

In the use phase, most firms only highlight the technical benefits of utilising circular materials rather than the sensorial and social aspects. Emphasis is placed more on a material's functional qualities, such as water resistance, durability, non-toxicity, and moisture absorption advantages. More information is needed to endorse the materials.

The highly used bio-based materials have repeatedly mentioned biodegradable descriptors in the end-of-life phase—firms such as Bejute, Eco Friend, Fuze Ecoteer and Live Cube Global Sdn. Bhd. is a firm that informs its product users of the biodegradability of the materials used in its products. On the other hand, the collection process, recyclability, and compostability aspects at the end-of-life phase should be more emphasised.

5.0 DISCUSSION

Analysis shows a significant need for more detailed information regarding the circularity of materials used by Malaysian small and medium enterprises (SMEs). Currently, most SMEs provide only basic details like "recycled plastic" or generic nicknames for familiarity (e.g., rubberwood, wastepaper).

The utilisation of circular materials among SMEs is in its infancy but is still progressive. Nevertheless, the types of materials in the dataset align with the study in that they indicate scarce recycling activities. Most firms show evidence of utilising more than two types of circular materials in their products. However, as most firms' output is consumer-based products every day, the lack of material information may hinder the uptake of the products in the market. The firms may need to craft stronger material narratives by incorporating descriptors that largely contribute to experiential aspects of circular materials, such as material resource, provenance, material production process, and sensorial. Additionally, using endorsers may solidify the green or circular image of the products. Such information enables a better appraisal, leading to a favourable uptake of the materials in the market.

Despite this, the scarcity of detailed information may hinder consumer acceptance, particularly for everyday products. To improve market uptake, SMEs should consider crafting stronger "material narratives" that incorporate specific details contributing to the experiential aspects of circular materials. This could include information on material sources, provenance, production processes, and sensory qualities. Leveraging endorsements could further solidify the green or circular image of their products. Richer material narratives enable consumers to assess the products better, potentially leading to a more favourable market response.

Our findings suggest that many SMEs in the dataset may be using readily available circular materials to create products rather than developing them from scratch. The data contains limited information on material cultivation and development processes, which is unsurprising considering that many Malaysian SMEs operate as Original Equipment Manufacturers (OEMs) with limited control over material circularity.

The study's results only reflect the information companies present on their websites. This reliance on online content analysis limits the findings, as the information may only partially represent the companies' holistic situations. Future research could incorporate user experience studies to gain a more complete picture. These studies could directly collect feedback on how users perceive information presented in a certain way. For example, a user experience study could explore consumer reaction patterns to information about products made with recycled materials. This approach would provide valuable insights to complement the online content analysis. Future research could also use focus groups with industry practitioners to triangulate these findings. This can provide a clearer picture of the actual breadth of circular material development and utilisation within the Malaysian product industry.

6.0 CONCLUSION

A linear take-make-throw concept is no longer a tenable approach in the production industry. Hence, securing resource flows through developing and utilising circular materials, such as renewable and waste materials, has become an important agenda. This study has found that many SMEs in Malaysia utilise circular materials in their products. The findings indicate an early but positive development that paves the way toward an ideal circular economy in Malaysia. However, the way the materials are communicated to users needs improvement. It is a fact that the adoption of new or non-conventional materials will be subject to users' critical evaluation. Hence, holistic lifecycle descriptors that send an enticing message about the materials' circularity are essential. Additionally, the data shows that the firms are product makers or industries that convert materials into products. However, little evidence portrays that the firms are the developers of the materials.

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