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Marketing & Technological Challenges in adopting Sustainable Packaging: A Conceptual Framework

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ABSTRACT:
Oriented towards sustainability, this paper presents a systematic literature review on marketing & technological challenges being confronted by organisations while adopting sustainable packaging. Packaging, the 'silent salesman' supports & impacts many of the Sustainable Development Goals (SDG) like SDG 2, 12, 14, etc. Driven by mass urbanisation & consumerism, consumption levels of products & therefore packaging, have increased resulting in voluminous packaging waste. Rising concerns about its harmful impacts has prompted shift towards Sustainable Packaging, which implies 'incorporating the comprehensive objectives of sustainable development to the complete life cycle of packaging, while providing due consideration to Triple Bottom Line approach.' Sustainable packaging faces multi-pronged challenges like lack of an absolute definition, complex material technologies & plurality of actors involved. Using Stakeholder Theory as framework, this study identifies marketing & technological challenges in adoption of sustainable packaging. Marketing challenges identified are: potential source of competitive disadvantage, lower margins, extra communication efforts, redesign causing potential loss of users, lack of demand etc. Within marketing, consumer related impediments are: lack of information about packaging's sustainability, green washing, low willingness to pay higher prices & assumed inferior aesthetics. Technological challenges include lack of technical knowledge & skillset, high technological uncertainty, lack of collaboration in value chain, existing lock-in, inadequate recovery infrastructure, limited raw materials & suppliers, risk of quality failure & non-viability due to scale economies. While further studies are required to detail challenges arising from other factors, this conceptual framework facilitates improved focus in resolving marketing & technological challenges & implementing suitable sustainable packaging.

Key Words: Packaging, Sustainable Packaging, SDG, Marketing, Technology

1. INTRODUCTION

The form, shape & concept of packaging exists because of product (Dörnyei et al., 2023). Product protection is the key functionality of packaging, while keeping product's quality unaltered & safety uncompromised (Han et al., 2018, Dörnyei et al., 2023). However protection is not the only role of packaging, as the discerning consumers & the advancements of society, at large have resulted in its enhanced role & significant usage. Prof Philip Kotler defined packaging as 'all activities of designing & producing the container for a product.' (Kotler et al., 2005), a definition which is fundamentally reflective of packaging's functional pertinences, but not restrictive of its expanded role, per se. Packaging plays an important role in today's society, whereas historically & traditionally it was centred on protection, containment, communication & convenience (Parada et al., 2021, Yam et al., 2005). With advent of newer technologies & advancements, the role of packaging has expanded to preservation, storage, withstanding supply chain conditions, interactive communication, regulatory compliance, brand building & market promotion. These have been resultant of globalisation, mass urbanisation, consumerism, altered societal demographics like nuclear family, literacy, per capita income increase etc. (Saha, 2022).

As a social-scientific discipline operating in the society, packaging ensures delivery of goods to the ultimate consumer in the best intended condition (Lockhart, 1997). It is an enclosure of products or a coordinated systems of preparing goods for transport, distribution, storage, retailing & end use, & a techno-commercial function aimed at optimising costs of delivery while maximising sales (Coles, 2011). Its other features include improvement in shelf life, traceability, and improved brand appeal through novel haptics, aesthetics & user convenience.

The increasing demand of consumer products, have caused voluminous increase in packaging usage & subsequently waste (Maye et al., 2019). The driver for increased usage of packaging has been its quality, performance, low prices of plastics (Geyer et al., 2017), better control over food safety & hygiene (Iacovidou et al., 2019), reduction of food waste (Barlow & Morgan, 2013), changes in household income & size (Thanh et al., 2011), changing consumer habits & the desire for convenience (Hawkins, 2018).

Converse to above, literature highlights harmful effects of packaging & packaging waste, by reflecting upon packaging as a symbol of unsustainable consumption (Hage & Soderholm, 2007), visible excess of contemporary consumption, & ephemeral yet important till it is needed but discarded surplus & waste thereafter (Fisher & Shipton, 2010). Packaging,

a man-made novelty (Persson et al., 2022) certainly has a negative environmental footprint (Morgan et al., 2022) but is a resource & not litter (Dörnyei et al., 2023).

Nevertheless, the avoidance of packaging has detrimental effect on product safety, quality & wastages (Beitzen-Heineke et al., 2017, Williams et al., 2020). Food packaging studies have reflected that packaging total energy inputs are a smaller fraction but play a critical role in ensuring that the other 90% energy inputs to the supply chain are not wasted. (Verghese et al., 2015) i.e. environmental foot print of food is very large as compared to that of packaging (Crippa et al., 2021, Silvenius et al., 2014).

Accepting essentiality of packaging and without any room to eliminate it, the choice converges to make the packaging itself sustainable i.e. sustainable packaging. Sustainability is characterised through three major dimensions- human well-being/ society (people), the economy (profit) & the environment (planet) (Ibrahim, 2022). To achieve sustainability are the UN developed & defined Sustainability Development Goals (SDG's). The seventeen goals of SDG's, categorised within Social, Economic, Environmental & Peace and Prosperity, do not mention 'packaging sustainability' but packaging in connected, inter-related and supports many of these goals. Sustainable Packaging impacts SDG 12 (Sustainable consumption & production) by reducing wastage in supply chain; SDG 14 (Conserving marine resources) by being non-polluting to marine resources or marine life; SDG 15 (Protecting terrestrial eco-systems, environment) by remaining in environment and still not causing pollution of air, land etc.; SDG 2 (Achieving food security) by ensuring wastage elimination and optimal shelf life of food products etc.; SDG 3 (Ensuring healthy lives) through appropriate sustainable packaging to store & transport medicines or smart packaging solutions which communicate when contained material has deteriorated (Bradley & Corsini, 2023).

While Sustainable packaging subsumes concepts like reusable packaging, recycling or reduction of materials, these aspects are gaining ground in the journey towards sustainability. Worth noting about these concepts is that all reusable packaging will not necessarily lead to sustainable packaging solutions (Coelho et al., 2020), and circular rebounds (Zink & Geyer, 2017) may happen through excess wastage or consumption, once consumers are aware of recirculation route (Castro et al. 2022). Circular economy is a plausible solution to plastic & to improve sustainability (E. MacArthur Foundation, 2024), but can create new sustainability challenges (Nielsen et al., 2019; Pauer et al., 2019). While industry may advertise minimum compliances as systemic changes (Nielsen et al., 2019) or the circular loops may rely on downgrading or be too large to sustain, caution is required as recycling does not consider reducing production of unsustainable products (Roper & Parker, 2013).

Further, organisations adopting sustainable packaging will need to own both the product & its packaging (Koeijer et al., 2023), & not leave onto consumers, municipalities & governments to deal with the packaging waste. Post consumption or after 'unboxing', the leftover packaging needs appropriate treatment to elude it from turning into, & terming as waste. Packaging & its constructs include multitude of materials, resources, participants in its value chain, requiring diverse set up & actors to handle end-of-life (EoL) activities, thus the concept of sustainable packaging finds fitting theoretical ground in Stakeholder Theory.

Challenges to sustainable packaging may arise from any external factor in the supply chain or even from within the organisation and could pertain to any domain like technology, innovation, regulatory, leadership etc. This systematic literature review focusses on identifying challenges being faced in adoption of sustainable packaging in respect to (RQ1) technology & (RQ2) marketing aspects including those originating from customer perspectives to propose a conceptual framework. The paper is arranged sequentially to go through packaging, sustainable packaging, theoretical framework, technological, marketing & consumer perspective challenges, conceptual framework, conclusions & suggested further research.

2. METHODOLOGY

In this study, a scoping review was conducted considering the broad scope of this research and heterogeneity in the body of evidence. The scoping review is reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) (Tricco AC, Lillie E, Zarin W, et al, 2018)

2.1 Identification of articles

The databases were systematically searched for published literature on sustainable packaging without any limitation of period.

2.2 Selection of articles and data extraction

Empirical research included original & review articles which were peer-reviewed and pre-print articles, focussed on sustainable packaging and drivers & barriers in its implementation. Articles relating to all types of packaging (flexible,

metal, paper etc.), without differentiation were included, and so were articles relating to barriers and drivers to circularity, biodegradability etc. Articles written in English language were selected & initial screening was done on basis of title & abstract. Data extraction was performed using a standardized form with which data were extracted regarding the title, first author, year of publication, country, study aim, methodology, theoretical framework employed, findings & conclusion.

A matrix was drawn up for data extraction that would allow for summarizing recommendations based on the themes of inquiry around technological & marketing challenges in adopting sustainable packaging.

The key filtering criteria and the rationale for the same is discussed below:
Criteria and rationale for selection of time period: No period was defined as sustainable packaging has come under focus in last decade and has gained wider attention & action in recent past. The concept has been in existence for a longer period but very little research on challenges on sustainable packaging existed in prior periods.

Identification: Queries were run on EBSCOHOST databases, Scopus, Web of Science indexed and Google scholar to search for the fields of: article title, abstract and author keywords for the following set of keywords: sustainable packaging, sustainable packaging barriers and/or challenges, drivers and/ or enablers, circular economy, sustainable packaging and marketing and/or consumer, sustainable packaging and technology, consumer perspective towards sustainable packaging and/or recyclability.

Filtration: Given the intent to limit the review to journal articles, filters for selecting 'journals' (as 'source type') and 'articles' (as 'document type') have been used. To ensure further relevance, filtration was also done by 'Language'. This resulted in 431 Journal articles.

Screening: Out of the resulting articles, 139 were excluded based on a reading of the topic and abstract for topic relevance resulting in 292 articles.

Eligibility: The resulting articles were screened further to select only peer reviewed research articles and those related to marketing or technological challenges in sustainable packaging which resulted in 130 articles.

Pertinent to observe that the literature carried different perspectives about sustainable packaging for e.g. functional, supply chain, technology, regulations, environmental, organisational, consumer reflections etc. While research on this subject exists in fragmented form, it spreads over different fields like product and application areas, and lacks systemic approach, as also stated by Bradley & Corsini (2023).

3. WHAT IS PACKAGING? Definition, Function, Levels & Types

Packaging facilitates transport of goods, their storage, distribution, sale and consumption. (Coles et al., 2003). The cost of packaging which, being an integral part of product & distribution reflects the cost incurred in making the product reach in expected condition and therefore packaging has a techno-commercial function, that of optimising costs of distribution and thereby maximising profits (Gronberg & Hulthen, 2022). Multiple authors have defined packaging in different ways. Most of the definitions consider the core functional requirements of protection, containment & communication. Whereas one of the more detailed definition as given by Jezyk & Kaniewska-Seba reflects upon packaging as a finished product in itself with a suitable structure, intended to protect the packed product against external environment and vice versa, and enabling products movement through transport, storage, sale & use while informing the user about the its contents, affecting (or influencing) the buyer/ user through its aesthetics and giving extra economic value (Wyrwa & Barska, 2017). Being integral to marketing, packaging also influences consumers' multisensory experience (Nyrhinen & Uusitalo, 2013, Velasco & Spence, 2019) & purchasing behaviour (Gomez et al., 2015, Velasco & Spence, 2019).

3.1 Functions of Packaging

Packaging imparts protection to the product and ensures its safe transportation in distribution. (Lindh et al., 2016; Paine, 1991; Pålsson & Hellstrom, 2016). It acts as a physical barrier between the product and external factors including temperature, humidity & others contaminants (Yam et al., 2005). Off late, innovative 'active' packaging systems have ensured protection of products from their own, potentially damaging, chemical or biological activity (Realini & Marcos, 2014, Robertson, 2013). These help improve the shelf life of the products especially food products. (Keranen et al., 2021). Newer packaging technologies can incorporate features like sensors, indicators, anti-counterfeit etc. to monitor the environmental conditions- within as well outside the packaging as it moves through the supply chain and can store and disseminate information relating to products origin, authenticity, traceability, storage conditions, freshness etc. (Schaefer & Cheung, 2018, Young et al., 2020).

Convenience provided by packaging is associated with lifestyles of the consumers (Rundh, 2005). Convenience parameters guide packaging's shape, size, form & material etc. Rise in e-commerce has brought to fore the 'unboxing experience' for consumers which can enhance, reinforce or dilute the product/ brand image. Packaging supports & entices engagement with customer to create a powerful experience (Velasco & Spence, 2019) through interactive packaging, based on technologies like scented inks, Radio Frequency Identification (RFID) tags, Augmented Reality (AR), Quick Response (QR) Codes etc. (Joutsela et al., 2017, Lydekaityte & Tambo, 2020).

Packaging communicates through text, graphics images, logo, colour, bar codes, tags etc. to convey information like product attributes, contents, regulatory information, brand etc. (Velasco & Spence, 2019). With influx of innumerable brands, branding has become even more critical. Closely related to branding (Simms & Trott, 2014) packaging can be visualised as a manifestation of the brand itself (Wyrwa & Barska, 2017) and helps building brand equity (Aaker, 2009). Packaging through its design draws consumers' attention, reinforcing brand image & triggering purchase like a silent salesman (Ampuero & Vila, 2006, Lindh et al., 2016).

3.2 Levels of Packaging

Packaging levels are categorised as primary, secondary and tertiary. These are not water tight compartmentalisations but context specific. Primary is, more often than not, in direct contact with product and also referred as consumer or sales packaging. It can be flexible pouches, bottles (glass, tin, aluminium, plastic etc.), metal container, paper board etc. For example the inner butter paper wrapper of butter packaging is not primary but the printed board package with product & regulatory details is considered the primary package. Secondary package is collation of many primary packages for ease of storage, transportation & handling through supply chain. For e.g. the corrugated carton containing, say four dozen packets of biscuits. These can be of corrugated cartons, moulded or thermoformed trays, Polyethylene or Poly Vinyl Chloride shrink wrap etc., and usually removed before products are placed on the shelf or point of sale. Tertiary packaging, also called transit packaging consists of pallets or plastic wrapping wherein multiple secondary packages are collated & grouped into bigger loads for transportation. Each level of packaging is inter-related & connected within the overall marketing & distribution framework to achieve optimum costs with due considerations provided for material handling resources, transit time, regulatory requirements etc.

3.3 Types of Packaging Material

Multiple materials are utilised in production of packaging. These include Polymers (in common parlance- plastic), metals, glass, paper/ board and have sub-categories within (Ibraham et al., 2022). Polymers like polyethylene (PE), polypropylene (PP), polystyrene (PS) & polyester (PET) (Pal et al., 2019) used in filmic form (for e.g. potato chips packet which is a combination of PP, Metallised PET & PE) as well as rigid form (HDPE shampoo bottle). Polymers either standalone or through combinations with other polymers or with paper or aluminium gained popularity due to their strength, permeability, stability, easy-to-sterilize nature, transparency, & high liquid resistant properties (Muller et al., 2017). But their non- biodegradability is causing accumulation in landfills, or being scattered over land/ water bodies has become a major concern (Chinaglia et al., 2018).

Paper & paperboard packaging have biodegradability but has limitations around their resistance to water, oxygen, chemicals, strength and stretchability etc. (Chinaglia et al., 2018). Glass provides better food safety, excellent barriers & therefore preservation & aesthetics but has limitation of high cost, is susceptible to breakages, fragile especially in very low temperatures and potential handling/ usage hazard. Amongst metals, tin & aluminium are popularly used due to their strength, recyclability, rigidity and barrier properties. Aluminium is more widely used and is favoured for products like beverages for its light weight, conductivity allowing faster cooling and ease of decoration. Aluminium is also used as a foil or filmic form in combination with other polymers/ paper due to its properties of providing exceptional barrier against oxygen (odour) as well as water (moisture).

Despite the advantages & benefits extended by packaging, lack of proper end-of-life handling avenues have resulted in an environment threatening condition to the extent that it has been referred as "moving waste" (Granato et al., 2022a). Taking cognizance consumers, society & governments have demanded actions to reduce the environmental impact of packaging, entailing initiatives from all stakeholders through sustainable disposal behaviour and by industry through adopting & implementing sustainable packaging measures. (Esslinger, 2011).

4. SUSTAINABLE PACKAGING

Sustainable Packaging implies integrating & implementing the objectives of Sustainable Development to packaging's complete life cycle, encompassing its raw materials, their sources, to the end-of-life disposal of the packaging material, while considering the TBL (Triple Bottom Line) Impacts of packaging- i.e. Environmental, Social & Economic. (Parada et al., 2021)

4.1 Sustainable Packaging Basis

The basis & orientation of sustainable packaging can be traced to the concept of sustainable development as published in 'Our Common Future' (also known as Brundtland Report) in October 1987 by World Commission on Environment & Development. The report defined sustainable development as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (WCED 1987: 43). While pursuing development it called for more efficient use of resources, causing less pollution and waste, based on renewable instead of non-renewable resources and has least irreversible adverse impacts on humans & environment. (WCED 1987: 213). In conjunction with sustainable production, "sustainable consumption" is also an important aspect and has been defined by the IISD in Oslo Roundtable (Oslo, 1994) as "consumption that meets basic needs while minimizing the use of natural resources, toxic materials, waste emissions, & environmental pollutants throughout the product or service's life cycle so as not to jeopardise the needs of future generations," while also acknowledging that political reality in democratic societies being such, that it will be much easier to change consumption patterns than consumption volumes, although both issues need to be addressed.

4.2 Sustainable Packaging: Definition or Guideline?

While genesis of sustainable packaging can be related to sustainable development, there exists varied definitions of sustainable packaging. Organisations like Sustainable Packaging Alliance (SPA), Sustainable Packaging Coalition (SPC) or diverse academics have formulated different definitions which lack alignment (Pauer et al 2019).

Table 1: Definitions of Sustainable Packaging (Adapted from Boz et al., 2020)

Origin of Definition	Definition of Sustainable Packaging
Sustainable Packaging Alliance, Australia	1. Effective: "Reduces product waste, improves functionality, prevents overpackaging, reduced business costs, achieves a satisfactory return on investment (ROI)" 2. Efficient: "Improves product/ packaging ratio, improves energy, material, and water efficiency, increases recycled content, reduce waste to landfill" 3. Cyclic: "returnable, reusable, recyclable, biodegradable" 4. Clean: "Reduces airborne, waterborne, and greenhouse gas emissions, reduces toxicity & litter impacts"
Sustainable Packaging Coalition, USA	1. Beneficial, safe & healthy for individuals and communities throughout its life cycle 2. Meets market criteria for performance and cost 3. Is sourced, manufactured, transported & recycled using renewable energy 4. Optimizes the use of renewable or recycled source materials 5. Is manufactured using clean production technologies and best practices 6. Is made from materials healthy throughout the life cycle 7. Is physically designed to optimise materials & energy 8. Is effectively recovered and used in biological and/or industrial closed loop cycles.

These definitions of SPC & SPA or guidelines as some academicians call them, do not reflect the complexities in packaging value chain. Recycling as a tool can have differing environmental implications depending upon distances, emissions during the process, recycling efficiency etc. and cannot be construed as sustainable under all circumstances. Sustainable packaging goal is not an absolute number but an improvement over current standards. It is a complex issue with no common definition and lacks exactness. This causes confusion among consumers about actual & relative sustainability of packaging (Acuti et al., 2022, Boz et al., 2020) & among other supply chain members (Trubetskaya et al., 2022), leading to potential greenwashing (the practice of making products or practices or services appear more sustainable than they actually are). Interchangeable usage of terms like Eco-Friendly, Ecologically Conscious, Green, Circular, Recyclable, Closed Loop, Refillable, Biobased, Biodegradable and Compostable etc. have added to this

confusion thus requiring harmonisation to ensure uniform understanding & development of appropriate resolution strategies to achieve sustainability (Dornyei et al, 2023).

4.3 Sustainable Packaging: bio-based or biodegradable?

Sustainable packaging can be achieved through amongst others, use of sustainable raw materials- recycled or bio-based, biodegradable materials, through sustainable factors of production including renewable energy or at packaging design level itself through deploying material suitable for recycling (Dornyei et al, 2023). Distinctly, 'biobased' refers to polymers that are produced fully or partially from biomass or renewable organic material of biological origin and has no relation with the end life treatment of the material (Di Bartolo et al., 2021). 'Biodegradable' refers to the ability of the material to degrade into nature as a result of actions by microorganism. (Rahman & Bhoi, 2021) i.e. bio-based is not equal to biodegradable as biodegradation is linked to the chemical structure rather than the source of the material. Hence bio-based may be or may not be biodegradable depending upon the biodegradation behaviour of the specific biobased material.

4.4 Costs of shifting to Sustainable Packaging- expensive or economical?

Enhanced costs of sustainable packaging solutions (Palsson & Sandberg, 2022, Silva & Palsson, 2022), or additional cost required for reorganising supply chains (Coelho et al., 2020) reflect costs as one of the major challenges, but SPA advocates sustainable packaging fosters reduced amount of packaging, resource conservation, efficient use of materials, benefits in supply chain leading to overall beneficial cost impact. These contrarian views exists due to specific situational perspective & remain concurrently valid. Additionally, circular economy is one of the means to achieve improved sustainability and hence concepts like refuse, reduce, reuse, repair, repurpose, recycle and recover would have a positive bearing on the cost impact of sustainable packaging

Sustainable packaging may appear as a straightforward idea requiring TBL approach, but operationalizing it poses a major challenge due to involvement of multitude of actors in the packaging value chain, diverse technologies, materials, production infrastructure/ process etc. Literature highlights multiple impediments in finding & implementing sustainable packaging solutions, for e.g. legislation, financial limitations, value chain capability (Palsson & Sandberg, 2022), physical access to appropriate waste management (Allison et al., 2021) etc. Similarly consumer have expressed preference towards sustainable solutions but their preferences do not translate into actual purchase behaviour (Schiano & Drake, 2021).

Sustainable Packaging thus is a complex idea requiring systematic approach & critical thinking, with imperfect, contextual, suboptimal solutions which need constant validations (Dörnyei et al., 2023). Hence, sustainable packaging's complexity, diversity & heterogeneity necessitates collaborative actions encompassing 'stakeholders' & beyond, to create, innovate and implement appropriate solutions.

5. THEORETICAL FRAMEWORK- The Stakeholder Theory

Sustainable Packaging field exhibits little theoretical guidance. Multiple theories like contingency theories, transaction cost theory, resource based theory, agency theory, paradox theory, natural resource view, ecological modernisation theory, social capital theory have been used to study sustainable packaging.

With numerous actors involved in producing multiple types of packaging, it is a rather complex system of interaction (Golini et al., 2016). Thus, involvement of experts from varied fields like design, engineering, polymers, regulatory, environmental, agricultural etc. is a precursor to development of sustainable packaging, for it needs a multidisciplinary, collaborative & holistic approach (Svanes et al., 2010). Collaborative approach helps in dealing with complex, systemic problems that require commitment & actions of several interdependent actors (Gray & Purdy, 2018), which are impossible to be governed solely through regulatory policies (Hansen, 2006). Stakeholder collaboration, therefore is a key aspect for increasing sustainability in packaging systems (Chan, 2007).

Further, in sustainable packaging decision-making process is also complex involving multiple stakeholders & at times having conflicting requirements (Afif et al., 2022), whereas 'business model innovations' in this field require partnerships with other stakeholders (Pfoser et al., 2022), implying internal & external collaborations are necessary & crucial (Gerassimidou et al., 2022, Palsson & Sandberg, 2022, Roy, 2022). There is significant heterogeneity, interconnectivity and nonlinearity of networks involved in sustainable packaging. (Gerassimidou et al., 2022). Considering all these aspects, use of Stakeholder theory has gained attention in sustainability policy & practice (Jabbour et al., 2020).

The book 'Strategic Management: A Stakeholder Approach' defined stakeholders as individuals or groups who can affect, or who are affected by, the activities of the firm (Freeman, 2010). Stakeholder theory grew from corporate social

responsibility which is described as business leaders are servants of society & that management operating in the interests of shareholders is not the sole end of their duties. Ackoff (1974) tried to see stakeholders from a system view & claimed that stakeholders must play participatory roles in the solution of systemic problems. Even if the definition is broad, researchers need to apply the theory & give it narrative interpretation case by case (Jones & Wicks, 1999).

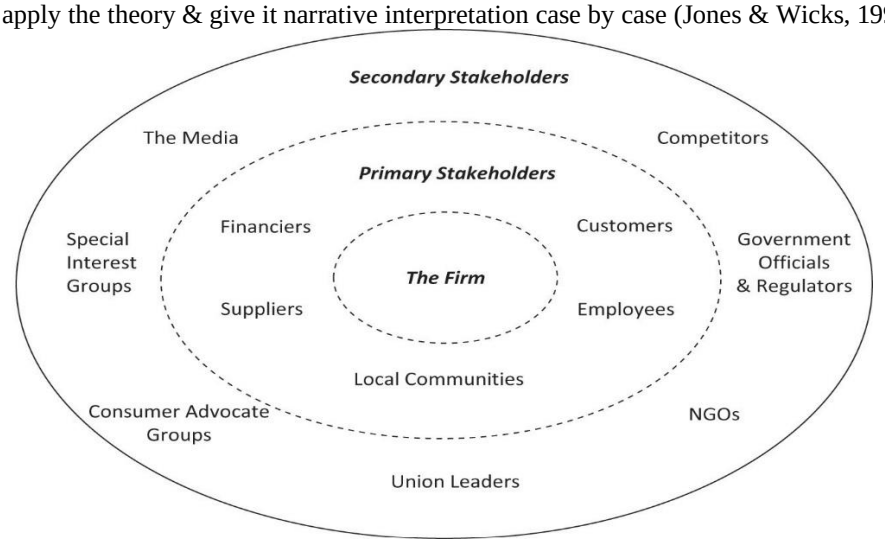

Figure 1: Stakeholders as per Stakeholder Theory (adapted from Freeman, 2010)

Challenges like sustainable packaging which have wide ranging global impact to establish sustainable future, require coordinated & collaborative effort to seek solutions, making stakeholder cooperation crucial (Schwab & Vanham, 2021). Therefore, stakeholder theory is an appropriate theoretical framework to study sustainability problems. (Schaltegger et al., 2019). By opening interactions amongst stakeholders, the problem of inadequate knowledge can be addressed in order to identify, understand and resolve sustainability problems (Valentinov, 2023) & can be utilised to develop common definitions and cultivate inter-subjective agreements around a common purpose (Mitchell et al., 2020). Thus Stakeholder Theory provides an appropriate theoretical lens to study challenges in adoption of sustainable packaging.

5. FINDINGS

Literature highlights multiple drivers and challenges in adoption of sustainable packaging. These challenges pertain to reasons like technological, regulatory, consumers, resource availability, knowledge & skill sets etc. and are attributed to internal and/or external actors. This study addresses and is directed solely towards adoption challenges arising from technological & marketing, including consumer-related aspects.

5.1 Technological Challenges in adoption of Sustainable Packaging

Packaging technology has evolved significantly. Beyond convenience, it has added features to trace, track, improve shelf life, use innovative designs or newer materials, and also more sustainable solutions like Poly Lactic Acid (PLA) based film, coated paper etc. Predominantly the technologies were oriented towards cost reduction, light-weighting, material usage reduction etc. They did not incorporate sustainability in a significant way, but in last decade this has changed as good quantum of research, resources & time is being invested to develop sustainable packaging.

Technological challenges identified in adoption of sustainable packaging are lack of technical information, knowledge & skill set, lack of alternative packaging options (Marken & Wagenfield, 2020), incompatible technologies, high technological uncertainty, lack of practice & systems for collecting, sharing & utilising relevant information, lack of infrastructure and mechanism for recovery, lower homogeneity of raw material (Tura et al 2019), over-dependency on available technology, insufficient collaboration with other stakeholders (Stewart et al 2016), apprehension about food safety/ contamination, limited choices of sustainable products, quality & consistency of recyclates (Pfoser et al., 2022) and availability of relevant technology (Retamal et al., 2021, Takacs, 2022).

The above findings imply that availability of information about existing as well as current research, as an initiation point is critical to further developments as it helps avoid duplication & creates a collaborative mechanism guiding further research. Packaging being a multidisciplinary field, sharing of information becomes even more critical & if not so, then becomes a technological challenge in itself. Information on sustainable packaging technology, per se in not easily available. The life cycle assessments are product-context specific & therefore are restricted in their horizontal or vertical deployments. Technology in a specialised field like packaging runs the risk of non-acceptance or non-feasibility and can result in sunk costs. The numerous bio-based and biodegradable materials developed through intensive efforts have not

found way in the main stream even after multiple years. In parallel, the dependency on existing technology is so marked that shift to sustainable mode is undesirable or unfeasible for e.g. many a times switch to sustainable packaging may require changes in operational infrastructure. This implies current lock-in mechanisms need to be unlocked to enable incorporation of a sustainable solution (Simoens et al., 2022).

Food packaging is one the major application areas of packaging & considering the stringent requirement & regulations governing this segment, the participants involved exercise caution while taking up new technology due to apprehensions about the consequences that may arise due to failure of packaging. This becomes a technological challenge as for development, many iterations are required before stabilisation of the technology & processes happen. Additionally in plastic food packaging, understanding granularity at each polymer level is important to understand the complex chain (Iacovidou et al., 2020) as each polymer delivers unique & specific property. (Mercure et al., 2016). It is technological insufficiency that multiple polymers like PET, PP, PE, PVC etc., are still required. Recycling contributes to sustainability but the unavailability of recycling technology to handle multi-layered plastics, material downgrading or inconsistent quality of recyclates become challenges.

From the internal organisational perspective the technological challenges being faced are scale economies, keeping the learning curve alive, insufficient return on investment (Simoens, 2022), complex trade-offs between packaging own function (Afif et al., 2022) and concerns about maintaining product integrity.

5.2 Challenges in adoption related to Marketing

Packaging, a technology oriented field, is deeply embedded within the 4P's of marketing. Internal marketing challenges are primarily encountered by marketing function within the organisation whereas external ones are majorly related to consumers. The major external challenges faced by marketing function are related to awareness, acceptance & ensuring uninterrupted loyalty by consumers apart from higher costs.

From consumer's perspective, as a 'people' part of marketing the issues are- that it is not easy for them to overcome the current conveniences/ familiarity and their motivation to change habits i.e. resistance to change (Gardas et al., 2021). Consumers demand for performance, convenience & price being lower or same (Dhull & Narwal, 2016), their lack of awareness about sustainability, green washing concerns (Bachman et al., 2012), their perception about look and feel of sustainable packaging, restriction on pack types and lack of understanding of labels/ terminology (Allison et al., 2021) are identified challenges. Their disposal behaviour causing insufficient return rates impacting reusability/ circularity (Coelho et al., 2020) along with insufficient demand (Bachman et al., 2012) and scarcity of product (Lekesiztürk & Oflaç, 2022) impair adoption.

Internal to marketing, challenges like uncompetitive prices against conventional packaging (Turkcu & Tura, 2023), it being a source of competitive disadvantage (Bachman et al., 2012) resulting from either high cost of raw material (Dhull & Narwal, 2016) or lower sales margin (Weinrich et al., 2024) have been recorded. Additionally concerns to adoption of sustainable packaging point towards poor customer response, its impact on branding (Lekesiztürk & Oflaç, 2022) and extra efforts required for its communication (Turkcu & Tura, 2023). Design changes if not properly communicated can create suspicion about product resulting in loss of customers.

Consumers perceive sustainability differently i.e. is not a universal concept, and also the perception differs intra- and inter- product categories. (Verain et al., 2016, Schiano et al., 2020). Existence of multiple definitions of sustainability which can be conflicting at times (Schiano & Drake, 2021) & with consumers having limited knowledge on sustainability, compels them to rely on their implicit understanding. It is seen that consumers' overestimate sustainable packaging through the 'recyclability potential of the package' irrespective of actual recycling status or Life Cycle Assessment based values which consider energy & transportation costs of recycling too (Nordin & Selke, 2010, Lindh et al., 2016, Steenis et al., 2017). Consumer's positive attitude towards sustainability fails to get converted into appropriate action due to their lack of clear information about the impact of the choices they make. (Boz et al., 2020, Bradley & Corsini, 2023), while green washing can further result in uninvited consumer backlash (Topal et al., 2019)
Consumers are mindful of environment but often are poorly informed about sustainability of material in a given context. Proper disposal instructions post consumption can lead change (Dornyei et al., 2023) and provide catalytic impetus to the shift, though physical access to recycling infrastructure may become the next bottle neck. Consumers expect sustainable packaging to be same as compared to existing standards while being not harmful to environment (Oloyede & Lignou, 2021) & interestingly they delink their own disposal behaviour from sustainability. Sustainable packaging can alter customer perception, assessment & purchase decision (Granato et al., 2022b). It may enhance perceived quality (Mattia et al., 2022) or favourable assessments by consumers influenced by the green or recycling logo i.e. sustainability halo effect (Steenis et al., 2017) or can diminish product attractiveness due to higher haze of biodegradable packaging films (Granato et al., 2022b, Guillard et al., 2018).

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6. CONCEPTUAL FRAMEWORK

Based on the systematic literature review the conceptual framework is presented below. Literature also reflects influence on multiple other factors and stakeholders in adoption of sustainable packaging. These other factors have not been part of this research.

7. CONCLUSION & MANAGEMENT IMPLICATIONS

Sustainable Packaging, an integral part in achievement of Sustainable Development Goals, is a continuously evolving field in terms of scientific development & changing societal preferences. Its adoption has and will always encounter

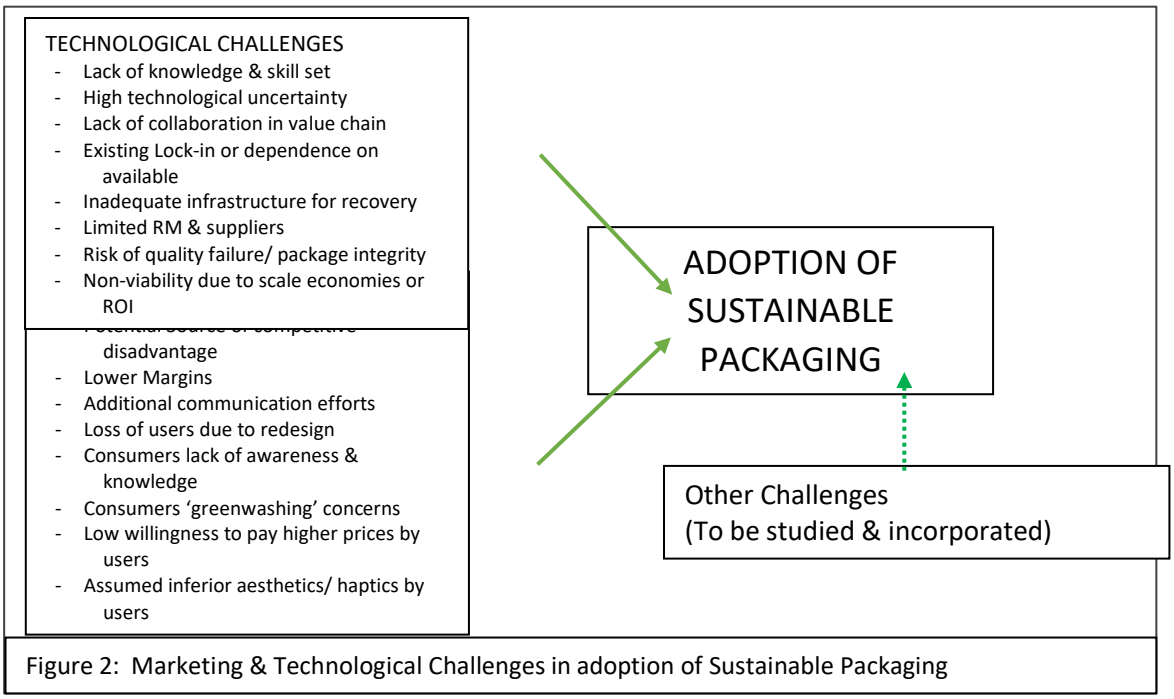

Figure 2: Marketing & Technological Challenges in adoption of Sustainable Packaging

challenges. Technological, marketing and challenges from consumer's perspectives have been identified and presented. With many & distinct stakeholders involved- sometimes with conflicting objectives, collaboration amongst shareholders would foster finding appropriate solutions. Simultaneously consistent communication, enhancing customer awareness & knowledge would create natural acceptance and bring out desirable behavioural change in society. Besides environmental impact, sustainable packaging can positively impact business performances and societies, a fact aligned with study of Afif et al., (2022). Organisations can evaluate these identified challenges, and devise appropriate measures during the strategy formulation stage to have higher probability of success in their efforts to adopt sustainable packaging. This review paper would assist those organisations too, which have not got desired results in their adoption journey, by allowing them to identify the reasons for their suboptimal outcomes.

8. FURTHER RESEARCH

The current study considers aspects related to technology, marketing & consumers. With Stakeholder theory as the base, further studies would be beneficial in identifying challenges related to factors like regulatory/ legislation, social, supply chain & internal challenges emnating from finance, human resources, production etc. Beyond challenges, there are drivers for sustainable packaging, factors that aid adoption of sustainable packaging which need to be identified. Role of intermediaries in adoption can be further studied to devise appropriate strategies. Supporting drivers & surpassing challenges especially in case of dichotomous factors, would hasten the adoption of sustainable packaging.

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The authors of this paper have no conflict of interests to declare.

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