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Investigating sustainable packaging practices: a framework approach

Derya Lekesiztürk[1], Bengü Sevil Oflaç[2*]

[1] Procurement and Import Expert, Manisa, Turkey;
[2] Izmir University of Economics, Department of Logistics Management, Izmir, Turkey.

***Correspondence:** bengu.sevil@izmirekonomi.edu.tr

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Abstract: With the growing concerns on environmental issues, employing sustainable practices has become one of the most significant issues in today's business agenda. Sustainable packaging is an umbrella term referring to different packaging related operations at various levels of supply chains. This study investigates the sustainable packaging practices and inhibiting factors in packaging supply chains. Semi-structured expert interviews were employed with a quartic perspective, involving diverse packaging supply chain members. By proposing a Sustainable Packaging Practices Model (SPPM), nine sustainable packaging practices are presented: (1) raise awareness, (2) innovate: sustainable raw materials and processes, (3) reduce packaging material and carbon footprint, (4) recollect and reuse, (5) save energy and use sustainable energy sources, (6) sort waste and recycle, (7) consume water less and recycle water, (8) certify, (9) co-create. Moreover, the findings of the study show that the scarcity and high costs of sustainable raw materials, low demand for sustainable packaging, legal incompatibilities, and production and quality related issues inhibit sustainable packaging practices.

1. Introduction

In recent years, environmental aspects have gained significance in the worldwide packaging industry (Kozik, 2020). Packaging has become an important tool for green applications, providing many opportunities for research and design, causing suppliers, manufacturers, customers, and public opinion groups to contribute to sustainable developments in this area. To meet the growing market constraints and to assert their environmental credentials, many companies have adopted ecological administration and practices.

Sustainable packaging aims to minimize the environmental impact by limiting the packaging waste created, increasing the utilization of sustainable materials and renewable energy (Noissue, 2021). Sustainable packaging can also be defined as ecological or environmentally friendly packaging. This kind of packaging does not pose health risks and contributes to a healthy environment during the product life cycle (Zhang and Zhao, 2012). The market size for global sustainable packaging was USD 258.35 billion in 2020 (Fortune Business Insight, 2021) and is anticipated to reach USD 270.543 million by 2022 (Allied Market Research, 2021).

Sustainable packaging is an umbrella term referring to different levels of packaging in supply chains, and is characterized by sourcing sustainable raw material (e.g. biomaterials, recycled materials), optimization of packaging material use, clean production processes, energy efficiency and renewable energy utilization in all phases, and the creation of closed loops through waste management, reprocessing and reuse (Gustavo et al., 2018). Thus, herein, we consider sustainable packaging practices as

the actions to be accomplished in multiple phases, throughout all packaging supply chains. Recognizing that the need for an eco-friendly footprint extends beyond the final industrial stage, progressively more attention should be given to green supply chain management (Seuring and Müller, 2008). In this regard, by adopting a quartet view, we aim to reveal the key sustainable supply chain packaging practices and to identify the major inhibitor factors to the implementation.

The research questions are as follows:

- What are the sustainable packaging practices adopted in the packaging supply chains?
- What are the inhibitor factors in the sustainable packaging supply chains?

The contribution of the paper is the exploration of the research problem from the perspectives of multi-level players, such as raw material suppliers, packaging producers, service providers and business buyers in the packaging industry. Thus, we aim to provide a holistic view of the sustainable packaging practices and the problems within the supply chains.

This paper is planned as follows. First, we present the theoretical background. In the methodology section, we explain our data collection and analysis stages. Then we provide a detailed explanation of our findings, and describe the contribution to theory and practice. Finally, we discuss the limitations and make recommendations for further research.

2. Materials and Methods

2.1. Literature review. Sustainable Packaging and Green Supply Chain Management (GSCM) Practices

The rising significance of GSCM is driven fundamentally by increasing environmental concerns, such as climate change and the related issues of pollution, waste handling, and raw material scarcity that accompany industrial development (Sheu et al., 2005; Srivastava, 2007). Green supply chain management is combined environmental decisions in supply chain management, involving product plan, manufacturing process, material resourcing and selection, shipment of the finished product to the customers, as well as the end of life administration of the product (Srivastava, 2007). GSCM practices underline the importance of coordination and collaboration among different supply chain parties. In the literature, GSCM practices refer to various environmental activities carried out by different supply chain actors to minimize their impact on the environment (e.g. Vachon and Klassen, 2006; Sarkis and Bai, 2010, Handfield et al., 1997; Narasimhan and Carter, 1998; van Hoek, 1999; Bowen et al., 2001; Zhu and Sarkis, 2004; Zhu et al., 2007; Perotti et al., 2012). The existing literature mainly focuses on the following: the design of sustainability (Zhang et al., 1997; Zhu and Deshmukh, 2003; Diwekar and Shastri, 2010; Perotti et al., 2012), reusable inventory (Guide and Srivastava 1997; Guide, Srivastava, and Jayaraman, 1999; Wong et al., 2005; Kim et al., 2007; Perotti et al., 2012), planning and controlling remanufacturing (Bras and McIntosh, 1999; Guide et al., 1997; Guide, 2000; Perotti et al., 2012), green assembly and product recuperation (Guide et al., 1996; Gungor and Gupta, 1998; Perotti et al., 2012), purchase of sustainable products (Min and Galle, 2001; Cousins et al., 2004; El Tayeb et al., 2010; Perotti et al., 2012) and logistics (Fleischmann et al., 1997; Jumadi and Zailani, 2010; Perotti et al., 2012).

Regarding sustainable packaging, some academics, adopting a micro perspective, focus on sustainable materials (e.g. Wu et al., 2021), technologies to trace reusable packaging such as digital passports within value chains (Ellsworth-Krebs et al. 2022), environmental packaging design with regard to consumers (Yokokawa, et al., 2021), combined perspectives for sustainable package design (Svanes et al., 2010), and reusable packaging systems (Greenwood et al., 2021).

Through a systematic review and web data mining for 478 international apparel and footwear retail brands, Jestratijevic et al., 2022) developed a sustainable packaging framework known as the 7R's approach: rethink (rethink packaging design, materials, construction, and production), refuse (stop using plastic packaging), reuse (use packaging materials more than once in their original form), reduce (reduce packaging components, weight, and size), recycle (use fully recycled packaging content), repurpose (utilize multipurpose packaging e.g. using recycled cardboard that can be converted into a dollhouse), and rot (composting biobased packaging after use) components.

In a case study, Verghese and Lewis (2007) demonstrated the life cycle benefits of cooperative supply chain efforts in environmental packaging to reduce the costs and optimize the operations. In another study by Koeijeret al., 2017, a multi-actor view was adopted to reveal the decision-making tradeoffs in sustainability. In their study, the barriers and enablers of sustainable packaging were categorized as external and internal at both operational and strategic levels. Similarly, Wang et al. in 2016 identified four key barriers to the implementation of green supply chain management in the packaging industry: inadequacies in training, monitoring, awareness, and obligation.

2.2 Method

We conducted semi-structured interviews with eleven experts to identify sustainable packaging practices. The sample consisted of five packaging manufacturers, two business customers, two raw material suppliers, one company that both demands and supplies packaging, and a recycling company. The interviews, lasting from 30 to 45 minutes, were digitally recorded and then transcribed for analysis. Participants were asked about their environmental awareness, green practices employed, the problems experienced in environmental practices, innovations, waste management, purchasing decisions, legal issues, and certificates. Repetition in the information given by interviewees implied that adequate information had been accumulated. The details of the interviews are given in the sample table below (Table 1).

Table 1. Sample Characteristics

P*	Positions	Company Info	Scope of Company	D**
P1	Research and Development Chief	Packaging Producer	Number of factories around the world: 4 Number of employees: 770	42
P2	Product Developer	Business Customer	Number of factories around the world: 230 Revenue: US 7.7 billion Number of employees: 47.000 +	38
P3	Production Engineer	Packaging Producer	Number of factories around the world: ü11 Revenue: EUR 303 million Number of employees: 2.000 +	44
P4	Raw Material Supply Associate	Business Customer	Number of factories around the world: 110 Revenue: JPY 2.175 billion sales Number of employees: 40.000 +	36
P5	Research & Development Team Leader	Supplier and Customer	Number of factories around the world: 24 Revenue: JPY 257 billion Number of employees: 8.000 +	37
P6	Purchasing Responsible	Packaging Producer	Number of factories around the world: 109 Revenue: US 6.2 billion Number of employees: 12.000 +	39
P7	Business Development and Sales Manager	Recycling Service Supplier	Number of factories around the world: 800 Revenue: EUR 6.4 billion Number of employees: 30.000 +	29

P*	Positions	Company Info	Scope of Company	D**
P8	Manager of Safe, Healthy and Environment	Packaging Producer	Number of factories around the world: 100 Revenue: EUR 6.6 million Number of employees: 26.000 +	38
P9	Senior Sales Manager	Supplier	Number of employees: 19.000 + Number of factories around the world: 94 Revenue: US 27.75 billion	36
P10	Research and Development Manager	Supplier - Trader	5 exclusive representative companies/ 10 non-exclusive representative companies	37
P11	Environmental Management Manager	Packaging Producer	Number of factories around the world: 43 Revenue: US 3.2 billion Number of employees: 22.000 +	44

*P=Participants; **D=Duration of the Interview (minutes)

We followed the premises of the grounded theory approach in data analysis by conducting open, axial, and selective coding (Strauss and Corbin, 1994). In particular, we centered on iterative-inductive topical examination throughout the interviews to generate a new set of concepts . Open coding enabled us to focus on the smallest unit of data and to develop the theoretical sensitivity of new ideas related to data. Once a complete set of categories was defined, with axial coding, it was possible to make new connections across the data, between the numerous categories (Strauss, 1987). This process helped us to establish a selective coding step in which we aimed to systematically identify the categories closely related to the core categories (Haid et al., 2010).

Based on the initial interview, the interview guideline was revised to eliminate the questions that were vague or disrupting the flow.

4. Results

4.1. Sustainable Packaging Practices

Our findings revealed the sustainable packaging practices employed in the packaging supply chains (Table 2). In the light of our findings, herein we propose a Sustainable Packaging Practices Model (SPPM) (Figure 1) with nine key practices: (1) raising awareness, (2) innovating sustainable raw materials and processes, (3) reducing packaging material and carbon footprint, (4) sorting waste and recycling, (5) recollecting and reusing, (6) saving energy and using renewable energy, and (7) consuming less water and recycling water (8) certifying (9) co-creation.

4.1.1. Raise Awareness

Company awareness determines the method and the responsibilities in sustainable packaging to ensure that the necessary actions for the protection of the environment are carried out systematically. The participants described the various sustainability-related projects and practices employed within their companies. These projects are mostly related to raising companywide sustainable awareness (e.g. promoting basic actions for reducing general waste, waste sorting, and reducing the use of plastic by distributing glass bottles to employees), and among the consumers through social media and official channels. In collaboration with environmental organizations, some companies organize events to clean up the environment, especially the coast, by removing garbage.

"On such days, we form groups of three or four people and collect the garbage. Then we report the collected garbage and deliver it to the municipalities. We try to contribute to the environment" (P2).

With the findings, we realize that companies underscore the change in corporate sustainability perspectives. Some informant companies deploy elaborate sustainability philosophies to underpin the taken actions. In one of the informant companies (P11),

the sustainability framework was underlined by a three-pillar sustainability philosophy: (1) protect natural resources (2) strengthen sustainability through actions and (3) develop sustainable and energy-efficient products.

Table 2. Sustainable Packaging Practices

Informant Companies/Practices	RA	I	R	SR	RR	SU	RRW	C
P1: Packaging Producer	✓	✓	✓	✓	✓	-	-	✓
P2: Business Customer	✓	✓	✓	✓	-	-	-	✓
P3: Packaging Producer	✓	✓	✓	✓	✓	✓	✓	✓
P4: Business Customer	✓	-	✓	✓	-	✓	✓	✓
P5: Supplier/ Business Customer	✓	✓	✓	✓	✓	✓	-	✓
P6: Packaging Producer	✓	-	✓	✓	-	-	-	✓
P7: Recycling Service Supplier	-	✓	-	✓	✓	-	-	✓
P8: Packaging Producer	✓	✓	✓	✓	✓	✓	✓	✓
P9: Supplier	✓	✓	✓	✓	✓	✓	✓	✓
P10: Supplier/Trader	✓	✓	✓	✓	-	-	-	-
P11: Packaging Producer	✓	✓	✓	✓	✓	✓	✓	✓

*__RA__ = Raise Awareness; __I__ = Innovative; __R__= Reduce; __SR__ = Sort & Recycle; __RR__ = Recollect & Reuse; __SU__ = Save & Use RE; __RRW__ = Reduce& Recycle Water; __C__ = Certify

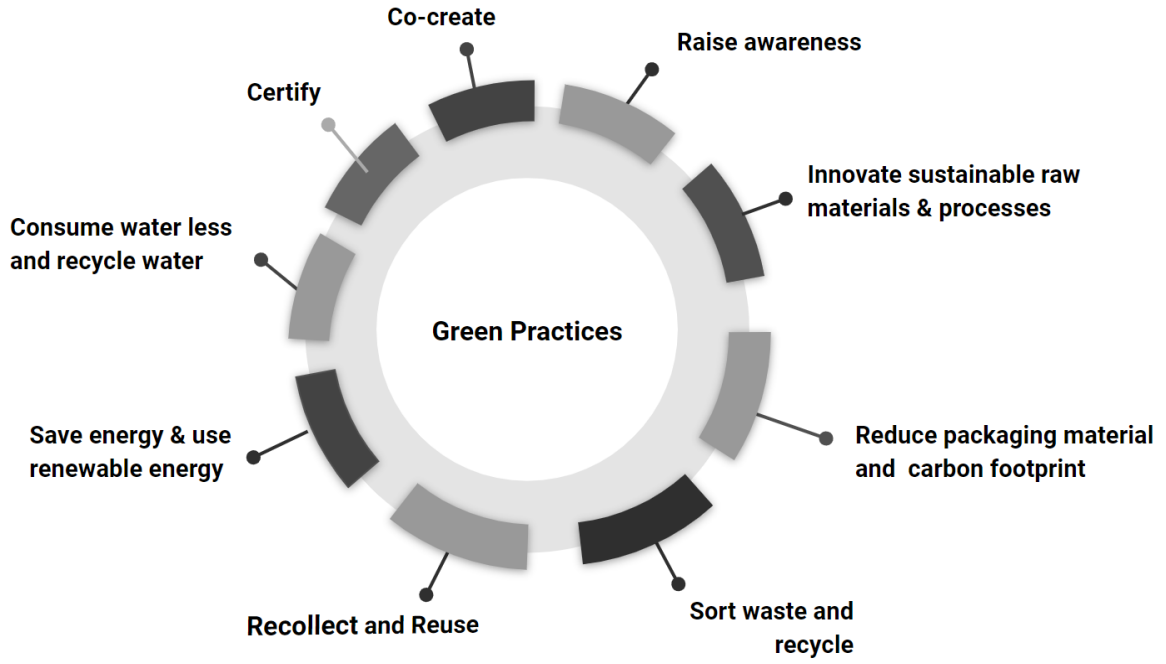

Figure 1. Sustainable Packaging Practices Model (SPPM)

4.1.2. Innovate: Sustainable Raw Materials and Processes

In the packaging industry, the recent trend is to utilize the new forms of innovative sustainable materials such as biodegradable materials, bio-renewable pp, bio-based/compostable ink, natural pigments, lacquer with a bacterial wall, and biopolymers. Some informants noted a rising trend to consider environmental aspects at the product concept stage (P2, P5).

"...70 % of an opp-style film is natural plants…Polyethylene or polypropylene materials are being obtained by using vegetable-based fibers" (P2).

"Especially the use of biocompatible or plant materials is on our agenda and within our strategic goals" (P5).

In addition to the innovations on the material side, informants also underlined the new production processes for sustainable packaging. For instance, with double-sided

stretching, the downaging process diminishes the amount of material used in production by enabling to pack more units and providing a cost advantage (P1).

4.1.3. Reduce Packaging Material and Carbon Footprint

Findings elicit that the informant companies make efforts to reduce material use through the design changes affecting packaging weight and thickness. In addition, companies utilize special adhesives to reduce the material used. On the logistics packaging side, some companies pursue projects for the reduction of pallet numbers used.

"In a project, we reduced the pallet waste, in which we changed the pallet arrangement, to increase the number of raw materials on each pallet, to make more room for storage, and to reduce the number of pallets" (P4).

"By reducing the film thickness of the stretch material that we wrap the products placed on the pallet, we achieved less package consumption and cost reduction" (P8).

"We glued the boxes to the pallets and to each other with a special adhesive to reduce the use of stretch film on the pallets." (P4).

According to the findings, companies pay attention to carbon emission measurements, monitoring, and reporting.

"One of our customers requested that the level of ink used for paper and cardboard packaging should have a low carbon footprint. At this stage, we worked with the university experts on the methods of calculating the damage of these volatile organic compounds to the ozone layer. Apart from that, we have some product projects that have reduced carbon footprint by 50-60%" (P5).

4.1.4. Recollect and Reuse

Recollection and reuse help companies to achieve lower costs in their operations and reach environmental targets. Collection of used pallets and plastic parts from the customers is a practice employed by some (P9, P10). In plastic packaging, reusing waste is a common practice (P1, P3).

"We collect plastic parts. We usually do after-cost studies. It is cost saving and at the same time, our environmental damage is reduced." (P3)

Some companies mentioned specific projects, such as print separation and reuse, and the production of paper from tobacco dust. The reuse option in the packaging industry depends on the type of packaging material. For instance, virgin raw materials are expensive, but require maximum recovery during reuse processing, making it a costly process.

4.1.5. Save Energy - Use Sustainable Energy Sources

In the packaging industry, companies have begun to employ different sustainable energy sources, for example, generating electricity from natural gas or installing solar panels.

"There are investments such as electricity supply from natural gas, electricity generation with solar panels. We produce our energy. We have a big trigen facility, and we generate electricity from natural gas." (P4)

To increase the efficiency in energy consumption, the participant companies control the resource consumption of the setup values and invest in more efficient machines to reduce electricity consumption.

"We have activities such as reducing the crushing times by improving the crushing performance of the products and saving the energy used in the machine." (P5)

"With the machinery investments we make every year, we try to reduce energy consumption by buying equipment with highly energy-efficient motors." (P8)

Some participant companies made investments to adjust the heat-humidity balance to save energy. Glass ceilings were installed to benefit from natural light. Continuous

monitoring and reporting are considered as fundamental actions for obtaining energy efficiency.

"Our energy consumption is being monitored online. Energy reports are made annually." (P11)

4.1.6. Sort Waste and Recycle

Based on the findings, the waste management process generally occurs as follows: (1) wastes are collected in waste zones and separated into waste dustbins, (2) operational decisions are made for wastes that are separated for reuse, recycling, converting into energy, and scraping, (3) the licensed companies collect the separated wastes with the purposes of recycling and reuse. Waste management begins with separation at the source. Sorting has a significant role in the waste management system as the first step of the cycle, which determines whether the company can create value out of the waste processing. After the classification of waste, decisions can be made on whether to recycle, reuse, or scrap.

"If we can't separate it at the source, there are many issues such as contamination, mixing of polymers, mixing of paper with polymer in the separations we make later." (P10)

The problems arise when the wastes are not kept in the appropriate area, or when there is non-compliance with the waste sorting process. In addition, if a particular waste is not sorted correctly, licensed waste management companies may increase their service fee due to the increase in the logistics operations costs and the number of employees needed. In addition, for some materials which are complex to reuse, such as virgin raw materials, the main objective is to minimize the waste (P7).

"If a product is produced with the wrong pantone code in an ink factory, it cannot be used, it can be made available by converting it to the closest color. In this way, we reduce the amount of product that will be released as waste." (P5)

Based on the findings, we found that most of the informant companies have their own in-house waste sorting systems. Wastes are sorted by companies' employees with appropriate equipment (P5). The waste sorting system provides environmental, financial, and social benefits, decreasing carbon emissions, and energy consumption, and producing salable separated waste, resulting in money flow and cost advantages.

"The waste management system provides cost savings for the production process because when the waste is separated well, we can reuse the product in the process or when we sell the waste we can earn money." (P3)

Regarding recycling operations, we found that the global companies operating in diverse locations have established their own recycling facilities, or they have established recycling companies as subsidiaries in their networks (P1, P7).

"Our company has its solvent recycling facility. Here, all the solvents we buy from our facility are recycled and sent back to the field." (P3)

"All of our suppliers in Europe have a subsidiary because recycling is a significant issue. For this reason, companies invest in the establishment of their recycling facilities and try to produce recycled products that they can use." (P1)

4.1.7. Consume Water Less and Recycle Water

Companies have various practices to reduce water consumption and increase efficiency. Water is classified as a direct and an indirect input for companies.

"Water is an important factor both in terms of cost and accessibility, so our company management pays particular attention to water management." (P9)

Water consumption rates and the amount of polluted water is tracked by the companies through the established waste-water management systems and water treatment plants. In addition, companies maximize water efficiency by recycling and reuse, and by using groundwater in their operations.

"Our water consumption is monitored online. Water consumption is tracked and reported in our environmental performance reports." (P11)

In geographical areas of water scarcity, the companies with high water consumption develop various projects on water use and seawater utilization.

"A considerable amount of our facilities are in the Middle East region, Saudi Arabia. That's why we have to be very careful about water." (P9)

4.1.8. Certify

During the interviews, the participants talked about their certifications and the requirements of these, ensuring certification continuity, and the required audits and conditions. In the interviews, it was revealed that companies mostly have ISO 14001, ISCC, or zero waste certificates.

"Our company shows responsibility for the environment. It meets the requirements of 14001 on issues such as water use, flue gasses, paint spillage, or solid waste separation.'' (P1)

With International Sustainability and Carbon Certification (ISCC), information flow is provided about the purchasing details and content.

"ISCC is a certification process for recyclable products. Required to use recycled material in production and to declare it in use." (P1)

The zero-waste certificate officially registers the waste separation operation, and waste rates. As P5 and P6 stated, the primary purpose of the companies in this field is to ensure waste minimization and to establish a zero-waste management system.

"Since we have adopted the concepts of zero waste management system and waste minimization in packaging and packaging, we use recyclable materials." (P6)

Companies organize internal audits to solve the problems that arise, and to ensure the continuity of the certifications. They are also subject to external audits by the certifying organizations (P2, P5).

"External auditing is instantaneous. ISO inspectors come without notice. In addition to all these, we have internal auditors for ISO." (P2)

The certificates obtained also provide benefits to the companies by helping to increase employee awareness. Companies use the certificates to establish a corporate social image.

"Companies are willing to have a zero-waste certificate to increase their prestige and invest in the future situation." (P11)

Moreover, with certification companies can take faster actions on the environmental problems due to the structured guidelines that are in place (P1, P6, P8, P11).

"Since each process has procedures and the job descriptions are determined, problems are resolved faster in the company." (P6)

"It is very important that certificates provide awareness by conveying the system information and serving guidelines to people through standards." (P8)

4.1.9. Co-create

Value co-creation can be defined as the actions in which suppliers and clients are associated with joint cooperative exercises (Grönroos, 2012). Manufacturers and raw material providers in the packaging industry attach importance to joint development and creating environmental value together. In particular, it was stated that productivity increases are achieved with the inclusion of suppliers in the production process. Almost all participants work with their suppliers, especially in the product design phase. These joint efforts elicit new ideas and innovations.

"We meet and make joint decisions. Packaging manufacturer, ink marker supplier, and finished product customer, we discuss package design, the printing issues, the feasibility of production in terms of cylinders and ink." (P2)

"Our supplier had a new idea: deinking. By applying lacquer to the film that has been printed with ink, you can purify it from the ink and use it as a film again. Or you can cut it small like a masterbatch and use it in film production." (P3)

"With our customer, we created a new bottle label. The bottle labels used by one of our customers- one of the largest beverage companies in the world- are polypropylene, but the bottles were made of polyester and the label and the bottle must be separated. We wanted to make both label and bottle of polyester, removing the need to separate them, and we made this label from recycled polyester." (P1)

The inclusion of partners in the process also increases productivity throughout the company and provides cost advantages. In addition, the supply chain actors support and encourage their customers or suppliers to use or formulate environmentally friendly products (P1, P2, P3).

"We encourage our suppliers to ensure the compatibility of the inks, and their dissolvent structure in nature." (P2)

With the findings, we realize that recycling companies take active roles in developing their partners in the environmental areas. These companies organize workshops and trainings to create value with their customers.

"Each process- the formation, separation at source, system management, and intake of each waste- is different. We provide training according to unique needs of the company." (P7)

4.2 Inhibitors in sustainable packaging supply chains

4.2.1 Scarcity and high costs of sustainable raw materials

The low number of producers supplying environmentally friendly raw materials affects the market. High costs, insufficient resources, the lack of new generation raw materials, and the inability to create an alternative to existing raw materials are among the main problems. Since the sector of sustainable packaging materials is developing, the sustainable raw material market remains a niche business. The main reason for the high cost of sustainable packaging materials is the price of recycled components or natural raw materials, which are limited in supply and difficult to access.

"Environmental-friendly materials are incredibly expensive. It can be as expensive as %300-400-500 of the normal raw material, maybe even more." (P1)

"Due to not being produced on a large scale, those raw materials are rare and expensive." (P10)

"The number of companies producing polylactic acid is only two in the world. The fact that the products are very rare and the companies that produce them are very few, it is very difficult to supply the environmental raw materials." (P1)

Plastic packaging manufacturers conduct research and development studies for the production of recyclable or biodegradable packages. However, the operations are inhibited by the difficulties in sourcing recycled or pp material made from wood, biodegradable, or bio compostable materials (P1, P2, P3).

"We are working on using polymers obtained from a tree, but the resource is very limited and we cannot find the raw material." (P1)

Moreover, the recycling process is one of the key factors affecting the cost of recycled products.

"The plastic bottles are collected. Collecting is a separate process. Then the bottle is divided into its monomers. For this, a factory with a heat reactor is needed. Manpower and land are needed. After the separation, it is necessary to combine them again. The polymer must be made again, which is a separate process." (P1)

4.2.2 Low Demand for Environmental Materials and Products

On the business-to-business (B2B) side, the rare usage of environmentally friendly materials is a problem, especially in emerging countries, where there is low demand for compostable and biodegradable inks, reflecting the low awareness levels (P5, P10).

"In some countries the environmental perception is low. Just a few companies demand environmental materials such as sustainable ink." (P5)

Consumer preference and demand for environmentally friendly products is the major force lying at the heart of the green business. As informant 8 stated, the greater the awareness of end-users for the importance of eco-friendly products, and the more they demand those products, the more material suppliers and manufacturers will be forced to take action and develop environmental strategies. High costs for eco-friendly products constitute a barrier to consumer preference. The informant's view was that the more consumers chose these products, the less they will pay for them.

"As consumers prefer environmentally friendly products with higher costs, the market will grow, and perhaps, product costs will decrease with the proliferation of alternatives." (P10)

4.2.3 Production, Processing and Quality Issues

In their sustainable packaging operations, companies encounter quality-related issues. Quality levels vary depending on the usability of recycled, biodegradable, and compostable materials. Due to processing issues in the production process, the produced packages may fail to meet the required specification limits. Since the materials used in the production differ, it is also difficult to achieve the standard in production (P3, P11). An example given by Participant 1 was a plastic manufacturer producing popcorn bags for cinemas with recycled materials. Unfortunately, the corn bags produced a louder, more metallic sound, and due to customer complaints, their production was stopped. Moreover, problems also arise due to the incompatibility of production machines for using such materials, and employees' lack of qualifications for material and machine use. For instance, polylactic acid and starch-based polyethylene require specialist machines.

"Machines are not suitable for the use of recycled products, which also reduces productivity." (P1)

Another problem in the recycling process is that it is impossible to fully recycle all the wastes. Products such as plastic, glass, cardboard, tin, and aluminum are the most suitable products for recycling. Cardboard can be recycled, but not all of its fibers can be used. Another example is that plastic waste can also be recycled, except when wastes have different polymer structures, or cannot be separated from the ink.

Furthermore, recycled materials may cause printing and lamination problems because the inks cannot adhere to the package surface. Manufacturers who are suppliers of printing ink mentioned the difficulty of using recyclable materials and the possibility of rapid transition issues. These quality concerns prevent the use of some sustainable materials in the food industry, in which health and safety concerns are paramount.

"It is not possible to use recyclable packaging, especially in food packaging." (P5)

4.2.4 Legal Incompatibilities within Supply Chains

Respondents believe that the laws should put more pressure on companies on environmental issues. The increase in legal obligations will ensure a raise in environmental practices (P1, P3). In emerging countries, there is not sufficient legal control over the enforcement of separation at the source and the use of recycled raw materials in production (P1, P3).

"The rate of legal regulations needs to be increased. The introduction of recycled materials into packaging is on the agenda now. There is no legislation yet, but these

issues should be enacted. Unless it is enacted, it will be difficult for this awareness to be established." (P1)

Furthermore, as stated by P6 and P7, recycling operations are not monitored closely by the state and so penalties are not being applied. In underdeveloped or emerging countries, most manufacturers neither have environmental certifications nor seek environmental certifications from their partners (P1, P6, P9). For example, many companies in emerging countries do not request environmental certification from their domestic suppliers, while European companies pay much more attention to such certifications in supplier selection (P1, P9).

"Environmental issues, especially in countries like Saudi Arabia, India, and South Korea, where we buy the raw materials cheaper, are not at a stage yet." (P1)

The informant companies emphasized the importance of incorporating environmental aspects into supplier selection phases, and contract terms with enforcement. However, this is generally neglected in emerging countries. In global companies in which purchasing decisions are made by the headquarters, environmental statements are generally included in the purchasing and sales contracts.

5. Discussion

With a multiple- level player perspective, we examined the sustainable packaging practices and the inhibitors to implementation. The paper's main contribution is that the research problems are explored from the perspectives of multi-level players, such as raw material suppliers, consultancy firms, packaging producers, and business buyers in the packaging industry. Moreover, in the literature studies generally focus on sustainable design, remanufacturing, and reuse (e.g. Perotti et al., 2012) in different industries and the packaging related studies mostly discuss the food packaging (Wang et al., 2016) or plastic packaging (e.g. Mathiyazhagan et al., 2016) by neglecting a holistic view of the entire industry. Thus, this study contributes to the literature by focusing solely on the packaging industry with lenses on plastic, glass, and metal packaging.

Based on our findings we suggest a framework for the sustainable packaging practices (SPPM). The nine sustainable packaging practices in the proposed framework are as follows: (1) raising awareness, (2) innovating sustainable raw materials and processes, (3) reducing packaging material and carbon footprint, (4) sorting waste and recycling, (5) recollecting and reusing, (6) saving energy and using renewable energy, and (7) recycling and consuming less water (8) certifying (9) co-creation. Aligned with previous research (e.g. Lewis and Gretsakis, 2017), we confirmed the existence of environmental sustainability awareness. With their sustainability philosophies and organization or participation in green-related activities, companies are eager to raise more awareness among their employees and customers. Findings also revealed that innovation is a key issue in achieving green goals in the packaging industry. It has become important to keep pace with the latest developments in sustainable packaging materials and sustainable production processes. The findings also demonstrate several sustainable packaging practices employed within the packaging supply chains, such as reduction of materials, waste sorting and recycling, recollecting and reusing. We also realize that informant companies strive for the utilization of renewable energy sources such as solar energy, and companies monitor the energy and water use with the aim of achieving efficiency in consumption. More importantly, there is a tendency to purify and reuse the water, especially in areas of water shortages. As another point, packaging companies acknowledge the importance of certification and the most prominent certificates are ISO 14001, ISCC, or zero waste qualification. In this study, we also reveal collaborative practices among the supply chain partners. The literature is very scarce in the field of value co-creation in packaging supply chains; we found that, in line with one of the few studies (e.g. Verghese and Lewis 2007), the involvement of suppliers at the early stages of package design is fundamental in sustainable packaging innovation and success.

In line with previous literature (e.g. Wang et al., 2016; De Koeijer et al. 2017), our findings revealed the inhibiting factors in sustainable packaging practices. The low number of sustainable raw material producers affects the market. Among the main problems are high costs, insufficient resources, and the lack of a new generation of raw materials. Low demand for environmentally friendly products and materials in consumer and business markets (especially in emerging countries) is another concern. In addition to the existing inhibiting factors in the literature, we reveal that some quality related issues inhibit the wide use of sustainable packaging; processing issues in the production process mean that the produced sustainable packages may fail to meet the required specification limits. Moreover, different legal requirements affect supply chain actors operating in diverse countries. By spreading and imposing regulations such as ecotaxes or recycling obligations worldwide, the supply chain actors may overcome the hurdles derived from functioning in different countries. Also, the informant companies emphasize the necessity of mandatory environmental measurement and contractual statement integration.

Diverse actors (e.g. packaging manufacturers and suppliers, customers, and service providers) in the packaging industry can benefit from the results. In all stages of the packaging supply chain , with the inclusion of all stakeholders, higher awareness levels can be achieved both in consumer and business markets. In addition, to overcome the inhibiting factors, more attention should be given to the sustainable raw material and processing aspects. With the development of supply markets and greater collaborative efforts, sustainable development can be achieved in packaging supply chains.

6. Limitations and further study

In this study, we adopt a quadratic perspective by involving raw material suppliers, packaging manufacturers, industrial customers, and recycling companies. However, in addition to these, packaging supply chains embrace consumers, retailers, wholesalers/distributors, logistics companies and governing institutions. Therefore, in further studies, with a more holistic approach, a wider range of stakeholders should also be involved. Herein, we also present a generalized view by focusing on actors supplying or demanding different types of packaging, but it would be beneficial to investigate the differences and commonalities of sustainable packaging practices across supply chains for different packaging types.

Additionally, we realized that more detailed and focused research is required in the area of sustainable raw material sourcing. Therefore, future studies should focus specifically on this area. Additionally, the sustainable packaging innovation area is a deep domain that should be under academic research lenses.

7. Conclusions

This study reveals the sustainable packaging practices by proposing a Sustainable Packaging Practices Model (SPPM). Sustainable packaging is an umbrella term referring to various operations at multiple supply chain levels and thus provides many opportunities to contribute to the sustainability area. Findings indicate that the informant companies have adopted sustainable practices to respond to the rising environmental concerns and to meet the growing market constraints. While companies put effort into raising awareness, waste sorting, recycling, material reduction, recollection and reuse, energy and water saving practices, environmental certification and co-creation also emerge as important components of sustainable practices.

On the other side, this study manifests the inhibiting factors in the sustainable packaging area. The findings of the study show that the scarcity and high costs of sustainable raw materials, and low demand for sustainable packaging inhibit sustainable packaging practices. Additionally, more needs to be done in the area of legal regulations and auditing part to create a more integrated effort along the supply chains. As another important finding, the findings present the production related issues ending in quality

problems. By shedding light on those factors, this study provides process improvement avenues to sustainable packaging practitioners.

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