Customer Involvement in the Development of New Sustainable Products: A Review of the Literature

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Abstract—The acceptance of sustainable products by the final consumer is still one of the challenges of the industry, which constantly seeks alternative approaches to successfully be accepted in the global market. A large set of methods and approaches have been discussed and analysed throughout the literature.

Considering the current need for sustainable development and the current pace of consumption, the need for a combined solution towards the development of new products became clear, forcing researchers in product development to propose alternatives to the previous standard product development models.

This paper presents, through a systemic analysis of the literature on product development, eco-design and consumer involvement, a set of alternatives regarding consumer involvement towards the development of sustainable products and how these approaches could help improve the sustainable industry's establishment in the general market.

Still being developed in the course of the author's PhD, the initial findings of the research show that the understanding of the benefits of sustainable behaviour lead to a more conscious acquisition and eventually to the implementation of sustainable change in the consumer. Thus this paper is the initial approach towards the development of new sustainable products using the fashion industry as an example of practical implementation and acceptance by the consumers.

By comparing the existing literature and critically analysing it, this paper concluded that the consumer involvement is strategic to improve the general understanding of sustainability and its features. The use of consumers and communities has been studied since the early 90s in order to exemplify uses and to guarantee a fast comprehension. The analysis done also includes the importance of this approach for the increase of innovation and ground breaking developments, thus requiring further research and practical implementation in order to better understand the implications and limitations of this methodology.

Keywords—Consumer involvement, Products development, Sustainability.

I. INTRODUCTION

SINCE the United Nations conference on the human environment in 1972, many terms and concepts surrounding sustainable development have been developed aiming to create less environmental devastation, to increase organic compounds, decrease 'ecotoxity', improve the greenhouse emissions and carbon footprint, also emphasising economic benefits and raising social concern. Sustainable development then embraced all of this concepts in one, dividing itself into six main characteristics [1]: ecological and social significance; life cycle orientation; deal globally with socio-ecological problems; be competitive; guarantee customer's satisfaction; and above all, continuously improve in these matters.

In the 70s the concern with the development of new environmentally sustainable products increased, being led by [2]. However, the sustainable PDP and the traditional PDP were separated processes until 1987, with the 'Our common future report' [3], when the concern seemed to be integrated into the development.

From the interaction between both PDP and the challenges involved in incorporating environmental concern into de development of new products, a large number of publications reached academia, aiming to set a tone to the best way to develop new sustainable products, aiming towards zero emission.

Innovations in sustainable products and supply chains play an important role in climate change mitigation. However, researchers such as [4] defend that there are doubts that technological advances would be able to mitigate the increasing output of greenhouse gases, passing the responsibility on to other actors within the product's lifecycle. Considering this perspective the project proposes the involvement of the final consumer in the development of new products, thus aiming to improve sustainability throughout the value chain and increasing the environmental pressure on the textile and fashion industry.

The idea of involving the final consumer in the development has been developed and researched over the last thirty to twenty years starting from the idea of the 'prosumer' [5], consumers who produce their own food, goods and services, the concept of consumer involvement in the development of new products, as well as the democratisation of the PDP evolve into the notion of the 'creative/participative consumer', whose participation becomes strategic to the development as it creates value and a sense of property not seen in the traditional or environmental PDP.

The contribution to knowledge associated to this paper rely in understanding the importance of combining different areas of information towards sustainability, especially when dealing with sustainability and the general lack of acceptance from the final consumer. It is divided into four main areas: Introduction; Review of the literature where the stances which endorse the research as well as its chronology are elucidated in details, from traditional development of new products into consumer-oriented development; the discussion section brought up by the research; and finally, the conclusion which

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justifies the importance of the research and concludes the core of this report, leading to future topics in the area.

II. LITERATURE REVIEW

According to [6] the valuation of the Life Cycle Assessment (LCA) includes the entire life cycle of the product, process or activity, evaluating thus the whole life cycle of the product (from cradle to grave), encompassing extracting and processing raw materials; manufacturing, transportation and distribution; use, reuse, maintenance, recycling and final disposal [7]. However, the PSS and the Systemic design propose to switch the production-consumption activities into a production-consumption system which would reduce the effects of all stages of life cycle that relate to the supply. Thus, the relationship between supplier and buyer would not end with the moment of purchase, but perpetuates over time [8]. Additionally, [9] defend the importance of Design for 'X' during the pre-development phase of the project as it will directly influence costs, properties and functionality of the final product, reflecting thus in its performance and market competitiveness. In contrast, research regarding ecologically concerned textiles is not available in the published literature, especially those regarding its whole lifecycle and supply chain, on one hand due to privacy issue, and on the other, due to a known lack of interest in this line of products, also seen as superfluous. This paper was built from this literature gap and criticism, the absence of interaction between the researched methodologies and the textile industry, for they clearly can add interesting insights to each other when analysed as a group of potentialities and improvements.

In order to construct a clear and objective conceptual framework three aspects were analysed and exposed in-depth: the traditional development of products, the development of green products, the existing literature available on consumer-oriented development, and eventually the main issue to be considered in this research, the development of sustainable products in the fashion industry. They were then evaluated and its main contributions, problems and strengths highlighted providing an overview and a framework not only of the material available but also its flaws and potentials, enabling its comparison and providing material for the research developed afterwards.

A. Traditional Development of Products

In 1963, when Buck discusses the problems related to the development and design of new products, one of the main complaints he argues about is the lack of a formal process to follow, along with a serious of uncertainties he had faced in the industry. From then to 1995, when Ulrich and Eppinger published their book on product design and development [10] the scenario had changed a great deal. The literature available on de the development of products and its implications is immense, mainly providing an overview of the product life cycle as a whole, as well as on business and success factors of the development.

In order to provide a deeper understanding of the product development process (PDP) the generic framework below

(Fig. 1) was developed in accordance to the three macro-phases model [7]: Pre-development, development and post-development; and the combination of the different literature analysed.
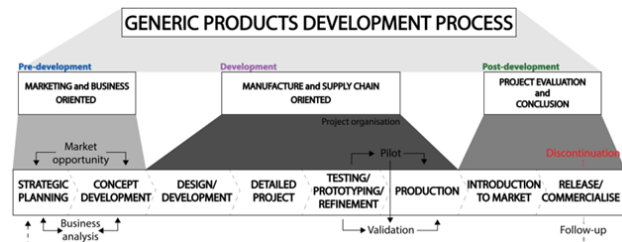

Fig. 1 Generic Product Development framework [11]

The macro-phases are then divided into eight main stages [7], [12]-[14], [10]:

· Strategic planning: which complies with the company's objectives;
· Concept development: which investigates the feasibility of a project's concepts in accordance to the user's needs as well as key production issues;
· Design and development: definition of product's architecture and identification of key activities to be developed;
· Detailed project: definition for product's details, tolerances, documentation, etc.;
· Testing/Prototyping/Refinement: production and material testing and regulatory approvals;
· Production: evaluate internally all the activities from the supply chain in order to guarantee the launch of the product into the market;
· Introduction to market: strategic test with key consumers in an external situation within the mix of activities comprising the market launch;
· Release/Commercialisation: final and costly stage which deeply on the targeted market and distribution systems.

Four parallel processes are also highlighted by the literature: market opportunity and business analysis [12] during the two initial phases of the PDP and a pilot and validation process between the prototyping and production phases [14]. These processes are alternative certifications to ensure the success of the product in artificial situation within the project, being finally confirmed in the introduction to market stage, but working as a safety net for the product being developed.

Finally, after and during the product release and commercialisation [7] propose two strategic phases: Discontinuation and Follow-up. These comprise the systematic withdraw of products from the market which can involve its total or partial reuse, the dismantling and the utilisation of its parts, the recycling of the material or its complete disposal, also enabling the registry of the acquired knowledge (a fact also present in the previous phases), in order for the experiences to work as a reference for future developments. According to the authors the investor in a for-

profit enterprise will only support a product which will be produced and sold profitably, what is only possible if the development follow: product quality and cost as well as the development's time, cost and capabilities.

From the literature and the model generic issues emerge, initially seen in the linearity of the process and in the lack of communication between non-sequential stages of the development. Another issue noticed is the artificiality of the tests done in order to approve the product, always done within the company and without the customer's actual participation [13]. Combined with small practical issue the traditional PDP tends to present a rigid framework which inhibits creativity and other features required in the textile PDP.

B. Sustainable Development of Products and Services

Sustainable development, differently from Traditional development, is researched as a more practical approach towards development, having a large number of publications comparing different methods and its advantages on the development of new products and in business (the use of green-developments as a key to competitiveness and differentiation).

From the analysis of these methodologies and a comparison with the traditional PDP it became essential to understand its information flows as they are crucial to ensure the sustainable features of a product. The first framework (Fig. 2) clearly represents three main areas for information gathering, being most activities manufacture and supply chain oriented, however with a key information flow from the follow-up which provides strategic planning, research information and

the concept on which the project should be developed [7]. Three main additions were brought to the initial model when transforming it to attend ecologic expectations:

The initial pre-development was grounded on the conceptualisation and strategic planning of the processes, highlighting the importance of risk analysis throughout the development using previous data to ensure it, the evaluation of opportunities for improvement and most of the research phase of the product development process.

The development macro-phase is then responsible for implementing and ensuring the production of the concept provided by the pre-development.

The post-development phase is essential to an eco-friendly approach, though this is not to disregard the importance of the pre-development.

Previously responsible mainly for the recognition of the customer's satisfaction and the discontinuation of a product, the post-development becomes an important asset for the development, for gathering and providing important information not only about customer's satisfaction but of the products usability, its outputs, possible improvements, etc. In this perspective, the post-development becomes a key source of information for the pre-development and the activities developed then. The knowledge building was considered as an opportunity to guarantee a continuous knowledge construction and improvement process, in which organisation members continually create and improve knowledge to adapt to changes in organisational environment [15].

Fig. 2 How traditional product development approaches contribute to the information flow towards an integrated eco-design framework [16]

Enriched by a stronger Customer Relationship Management phase, the post-development macro-phase of the PDP becomes a source of important information which can be classified as Experience Return (REX) [17]. This new spring of information becomes a much valuable asset for it provides information to ensure strategies and advantages for the implementation of a new project bringing information gathered in the use phase of the product as well as in its production. This then supports the risk analysis of new projects by using known problems and solutions found in previous developments.

Even though the traditional models relied mostly on three main aspects of the PDP (target user, time-to-market and the company's strategic planning) the sustainable framework had to be equally concerned with the supply chain involved in the development of each new product. It is not only the product that has to be ecologically acceptable but also its production, suppliers, retailers, etc. For a product to be considered 'eco', it has to fulfil a wide diversity of requirements and expectations not only from the industry and legislation but also from its increasingly demanding and better informed users [18]–[21].

TABLE I
COMPARISON OF USER CENTRED RESEARCH METHODOLOGIES (ADAPTED FROM [22])

Approach	Cost	Time	Overview	When To Use
Focus Groups	High	Little	Two way debate on a particular set of issues, whilst allowing the researcher to investigate and identify group norms and explore conflicting views (difficult to capture the views of individuals and group dynamics may affect who speaks and what they say)	- Wide range of applications; - determine customer needs - gain feedback on ideas - evaluate new/existing products
Participant Observation	Intermediate	Intermediate	Encompasses a range of techniques and tools designed to enable researchers to access consumers thoughts, beliefs and behaviours when using a product or service (demanding task which relies deeply on researchers own interpretation of events) – useful for initial conclusions	- To gather stimulus for Focus Groups - Early stages of project to investigate user behaviour & gather visual stimulus
User Trials	High	Little	Simulations of product usage, in which subjects are asked to fulfil specified tasks in an experimental setting, using a product or product simulation. Trials are ideally conducted in the customer's real environment and subjects are given a set timescale in which to complete the tasks, then being interviewed about any problems or difficulties they encountered or observed. The insights gained from these interviews can enable designers to make changes which improve function, control and ease of use	At any stage in a project where product evaluation is required (often undertaken as part of initial research to evaluate existing products, although they can be used to test working prototypes).
Product-In-Use	High	Intermediate	Interactive, naturalistic, observational method designed to "capture peoples' behaviour in real-life contexts" providing an "account of the behaviour surrounding a product or activity"	Early stages to evaluate existing products/service investigate user behaviour & visual stimulus/ idea generation
Customer Diaries	Low	Little	Inexpensive method of gaining an insight into the everyday use of products and the associated habits, behaviours, problems and difficulties and are especially useful for evaluating existing products and practices in "situations where researchers find it difficult to observe customers first hand"	Early stages to evaluate existing products/ services & investigate user behaviour (it may be productive to combine the user diary, with Product-in-Use and in-depth interviews, as this would enabled to capture 'automatisms', naturalistic behaviour and provide an understanding of the participants motives)
Scenario-Of-Use	Intermediate	Long	Aims to uncover previously unvoiced needs using role play as a cue for recall. Between 5 and 20 customers are invited to attend a workshop during which they are encouraged to comment on the activities being carried out by the actors	Early stages to evaluate existing products/ services & investigate user behaviour (participants may find the activities uncomfortable if they are unaccustomed to acting; they can be time consuming and expensive to run as they require the preparation of props, costumes and furniture; and the data can take a huge amount of time to analyse)
Consumer Idealized Design	Intermediate	Intermediate	In this process users, arranged in small groups, are asked to design the concept for a new product, by suspending judgment on existing artefacts and allowing themselves to imagine the 'ideal' (although participants are discouraged from basing designs on currently unfeasible 'future' technologies)	Very early stages - 'futuring' technique to inspire new design solutions.
Web Of Association	Very high	Little	Online word association technique available through Brand Genetics which enables researchers to extract and understand semantic components of brands in consumer's minds (potential for bias is reduced as subjects enter their responses individually in isolation via the website) - identifies "values rewarded by consumers but not yet 'owned' by brands"	Prior to product development to reveal niche areas in which to situate new products.
Layered Games	Low	Intermediate	A series of four games to investigate insight, expectation and motivation of owners of a certain sort of products. It encourages participants to consider their perceptions of themselves as owners of the product in question, thus providing insights of what they expect	To gain insight into target customers values & evaluate concepts /theories
Mood Boards	Low	Intermediate	Mood boards are a collection of images selected and assembled by participants in response to a brief set by the facilitator. They may be generated to represent: participant's feelings, emotions and experiences about tasks or situations; and perceptions of product use or lifestyles	Early stages to gather visual stimulus for idea generation

C. Consumer-Oriented Products Development

Within this scenario, another piece in inserted into the development: the consumer. From the increased concern and regulations on sustainability of the development of new products, companies are constantly more concerned with their image and responsibilities towards the final consumer, surrounding communities and regulating agencies. From this concern, the consumer became a key strategic tool to innovation and to the development of new products.

Considering the phases and stages of the traditional and environmental PDP, the consumer can be inserted into many stages, in order to implement and ensure the participation the literature presents 10 different approaches as shown in Table I.

Within this scenario the need to develop a new product development model was triangulated by analysing the current development process, comparing it to the new products development proposed by the sustainable literature and to the generic perspective of PDP, then developing a new product development model to be used to encourage consumer involvement in the PDP. From the analysis of the two presented models and the possible consumer-oriented approaches the need for a customised development framework for the sustainable-fashion industry became clear as it cannot comply with the rigid structure of the traditional or environmental PDP, and as it is still unacquainted with consumer involvement.

III. METHODOLOGY

A literature review was chosen as research methodology in order to provide a broad synthesis of the researched subject, providing thus a general overview of the subject [23]. According to [24], there are two sets of focuses and goals when developing a literature review: the integrative research review and theoretical review. Due to the aimed results, the project was developed towards an integrative research review.

An Integrative research review presents the state of knowledge concerning the relation(s) of interest and to highlight important issues that research review has left unresolved, adding or altering the existing body of knowledge [24]. However, it is important to note the existence of a high correlation of the exposed factors in different references, providing enough evidence to be considered a test-retest reliability experiment can attest for the projects liability [25].

IV. DISCUSSION

Throughout the literature there were clear definitions and models proposed in order to improve the implementation of consumer-oriented products [5], [26]–[33]; a large number of papers and books on how to develop more efficient, proper and robust products [7], [12], [13], [10], [16], [34]–[38]; and a yet a larger number on the improvements and growth in the development of new sustainable products [17], [39]–[47].

The literature thus present three separate concepts: traditional products development, sustainable products development, and consumer involvement in the development of new products. This analysis comes from the interaction between these three concepts and how they can be combined in order to improve sustainability and the sense of ownership in consumers, essential stakeholder for the success of a new product, or the improvement of existing ones [48], [49], [26].

The design of new products alone is said to influence the user understanding of a product [50] however, the literature also states that in many cases the user does not understand features, products, concepts, and might simply use the product in a less efficient manner [51]. Consumer involvement in the development of new products aims then to help in the understanding and efficiency of a product, what implies in the comprehension of its functionality and features.

Two examples clarify the importance of consumer involvement. The first, researched by [51] regards the consumer behaviour when dealing with household energy consumption. The researchers analysed the consumption and activities related to the use of a fridge/freezer, from that developing a see-through door which inhibited the need to constantly open the fridge to see what was available, saving the consumer around 17% of energy. The second, researched by [28], was developed along with a roof company in order to understand why the consumer did not buy from their large diversity of products, finally finding out that the main reason was that they did not understand what the categories were associated to.

V. CONCLUSIONS

According to the literature consumer involvement is a strategic key to improve sustainability, not only in the development of new product but also in the understanding of the sustainable features implied [50]–[52]. Product-service systems has been using communities to understand the use and acceptance of its products since mid-90s [53], but a more effective approach was deemed needed as the consumers were still seen as the main barriers to sustainability [54].

By involving consumer in the development, either designing for a specific public, with the specific public, or by them [26], the literature believes the innovation rates will increase [5]. Mainly as currently two-thirds of product innovation fail due to misunderstandings of consumer desires [29]. The involvement of consumers would then provide true value and the sense of property, what should improve sustainability, life span (due to emotional value and satisfaction) and the quality of the final product [54].

The next steps for this research will be to apply this perspective on how consumer involvement can improve sustainability, by researching a specific industry: the British sustainable textiles and apparel industry. This second stage of the research is already being carried out at the University of Manchester by means of researching three different companies which fit into the desired profile and which are willing to improve their performance by increasing consumer involvement into their collections.

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