

# A multi user-centred design approach framework to develop aesthetically pleasing and sustainable OTCP packaging

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## Abstract

With the healthcare industry moving towards self-medication, the number of self-service pharmacies stocking over-the-counter pharmaceuticals (OTCP) is rising. The aesthetic attributes of OTCP packaging are critical to attract consumers' attention against competing products. Moreover, sustainable design aims at minimising the negative environmental impacts of packaging. Studies show that stakeholders' interests should be represented more in pharmaceutical packaging, specifically in the early stages of the design process. For this reason, OTCP packaging design is challenging, as sustainable packaging is typically seen as unappealing. Within this context, this paper presents a novel and comprehensive framework aimed at supporting designers to develop aesthetically pleasing and sustainable OTCP packaging, placing multiple users at its core. Studies with OTCP packaging stakeholders were first conducted to identify the framework requirements together with the necessary OTCP packaging attributes. A framework architecture was developed and subsequently implemented in a proof-of-concept computer-based tool. The framework and its implementation were evaluated with the OTCP packaging development stakeholders. Results provide a degree of evidence that the framework contributes significantly to guide OTCP packaging designers in taking the right decisions and can also provide the first steps towards considering aesthetics and sustainability in the packaging design in other sectors, namely, food and beverage.

## KEYWORDS

design decisions, Design for X, design support tools, sustainable packaging

## 1 | INTRODUCTION

Packaging is an essential component in the distribution phase of a product's life cycle, as it serves to protect, preserve and promote the product inside. Given the fact that its main contribution is throughout transportation to the consumer, it is typically designed to be of single-use. After packaging has fulfilled its primary functions, it is considered an environmental burden.<sup>1</sup> Sustainable design ensures that the

environment, economy and society are minimally impacted throughout the packaging's life cycle.

Food and pharmaceutical packaging are similar in nature, where both are required to ensure that the product is safe for the consumer, by assuring hygiene, quality and effective containment of the product.<sup>2</sup> In terms of sustainability, both types of packaging can make use of single-use materials that are rarely recycled, such as polystyrene in the food sector and for the take-away containers and

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polyvinylchloride in the pharmaceutical sector for blister packaging.<sup>2</sup> The environmental impact of food packaging has been researched in great depth.<sup>3–5</sup> However, a limited number of studies, which assess the impacts of pharmaceutical packaging throughout its life cycle,<sup>6–9</sup> have been published. This could be because of the strict regulations and standards that pharmaceutical packaging must abide by.<sup>10,11</sup>

Belboom et al<sup>8</sup> investigate the impacts of injectable drug primary packaging, throughout its life cycle. They compared the impacts of glass vials with polymer vials. Similarly, Dhaliwal et al<sup>9</sup> perform a life cycle assessment on glass and polymer bottles for contrast media delivery. Both studies found that overall, polymer packaging has a smaller impact on the environment than its glass counterpart. These studies only consider the environmental impacts of pharmaceutical packaging.

To generate a holistic assessment of the sustainability status of pharmaceutical packaging, the social and economic pillar must be considered. By taking user requirements into account, packaging designers can understand how to feasibly integrate emotive aspects in sustainable pharmaceutical packaging design. Designing to the user's needs and abilities directly supports the economic pillar by enhancing the packaging utilisation and quality. This will ensure that the packaging developed is cost-effective. A user-centred approach in packaging design promotes the well-being, health and engagement of the end-user.<sup>12</sup> Inclusive pharmaceutical packaging is essential, as the potential user groups include elderly people who may have age-related difficulties, for example, in opening the packaging.<sup>13</sup> Although the packaging should be designed in such a way that the pharmaceutical is easily accessible, the designer must also incorporate child-resistance features to promote child safety.<sup>11,12</sup>

Over-the-counter pharmaceuticals (OTCP) are bought without a prescription and used to treat minor ailments, such as mild pain and common colds. As the medication is sold without a prescription, the consumer is typically not influenced by authorities in the field, such as doctors and pharmacists.<sup>14</sup> Self-medication is becoming increasingly common with consumers.<sup>15</sup> This is accommodated by the number of self-service pharmacies, groceries stocking OTC pharmaceuticals and those being sold over the internet.<sup>14–18</sup> A study conducted by More and Srivastava<sup>19</sup> considered data from chemists who stated that consumers remember OTCP products by their aesthetic attributes. They have the opinion that, if OTCP companies focus on aesthetics, sales can increase.<sup>19</sup> Colours can be used to convey the price and quality of the product.<sup>19,20</sup> They are also used to attract consumers' attention and influence their emotional responses towards the product.<sup>21–23</sup> The OTCP packaging's aesthetic appeal acts as the silent salesman and greatly influences the consumer's decision-making process.<sup>24</sup> A study conducted by Kauppinen-Räsänen and Luomala<sup>25</sup> found yellow, red and blue to be the colours typically preferred for OTCP packaging. Colours have different meanings and associations depending on the geographical location.<sup>14</sup> For example, in Japan painkillers are grey and blue; whereas, the Americans associate painkillers with red.<sup>14</sup>

Consumers use packaging materials to judge how sustainable the packaging is.<sup>26–28</sup> Blister packs and bottles are the two types of OTCP packaging commonly used for solid dose tablets. The type of

packaging will affect the overall sustainability status of the product. Blisters cannot be recycled due to adherents and surface treatments of materials.<sup>29</sup> Without material separation, they cannot be separated upon disposal, as the packaging is made from multi-materials. Bottles provide the opportunity for monomaterial packaging systems, where only one material is used throughout,<sup>30</sup> for example, a plastic bottle with a plastic cap. Bottles offer less protection to pharmaceuticals than blister packaging.<sup>29</sup>

Consumers can only perceive the product's sustainability through the packaging cues.<sup>31</sup> Designers can add cues to communicate its sustainability status, including colour, imagery and labels. This implies that the packaging's visual appearance plays an important role when consumers aim to make sustainable decisions. Greenwashing describes a packaging carrying misleading sustainability cues, such as being paper-based with a minimalistic design or is of the colour green, without having the verbal information to accompany it.<sup>32</sup> It was shown that consumers' product perception positively increased when the colour green was accompanied with a label.<sup>32</sup> Despite this, sustainable packaging is typically seen as less aesthetically appealing than conventional packaging.<sup>33–35</sup> For this reason, designers must strike a balance between the sustainability and aesthetic attributes. Consumer demand for sustainable packaging in low risk products, such as food, has been greatly researched.<sup>36–39</sup> However, to the authors' knowledge, there are no studies that investigate the importance the consumers give to packaging sustainability in high-risk products, such as pharmaceuticals.

The development of sustainable pharmaceutical packaging is still in the initial phases.<sup>40</sup> Research on sustainable packaging design has been stimulated by consumer demands and government standards. This produced various packaging design support systems, which are available to packaging design stakeholders.<sup>41</sup> However, the high number of design support systems creates incongruity in sustainable packaging design. Ma and Moultrie<sup>42</sup> suggest that designers may not know which tool is best suited for the design stages or what results to expect from each design support system. Studies show that stakeholders should be better represented in early stages<sup>43</sup> of the OTCP packaging design process.<sup>13,44–47</sup>

It was also shown that in recent years, the need for environmental impacts of packaging to be considered in a more systematic and holistic way has been realised.<sup>48</sup> Poslon et al<sup>49</sup> stated that the packaging's appearance evokes emotions in the consumer, thus contributing to a positive experience and raise their expectations of the product inside.<sup>24</sup> Given the complex balance that the packaging designer must strike to ensure that all requirements are met, a design support framework can be used to facilitate this process.

To the authors' knowledge, there are currently no studies that describe the design process for sustainable pharmaceutical packaging. Therefore, to understand how to design OTCP packaging, methodologies proposed by Pahl et al<sup>50</sup> and Bix et al<sup>51</sup> can be adopted. Pahl et al<sup>50</sup> describe a model to design products, which starts with the task clarification stage. In this stage, the problem is formulated, and a list of specifications is defined. These specifications are then used as a reference to generate design concepts in the conceptual stage. The

most appropriate design concept is optimised in the embodiment stage. The detailed design stage finalises the documentation related to the product development. Bix et al<sup>51</sup> developed a model for packaging design in general. Similarly, the packaging is planned in the initial stages of the design process. Following this, packaging design concepts are generated, and the packaging system is defined to include all packaging components. The manufacturing and graphic requirements for the packaging are then specified and refined.

An extensive literature review indicates that there is a gap in investigating the aesthetics and sustainability aspects in OTCP packaging design. This motivated an evaluation of 10 design support systems, three of which support design in the pharmaceutical industry. However, this resulted in a gap in design support systems, as none of them satisfied all the established review criteria. This raises the following research problem, concerned with *developing a framework for a computer-based tool, aimed at guiding designers when developing sustainable and aesthetically pleasing OTCP packaging*. To address this research problem, this paper presents a novel and comprehensive approach framework, ASSIST-OTCPP.<sup>52</sup>

The material and methods used in this study are described in the second section, followed by a review packaging design support systems. The computer-based proof-of-concept implementation of the ASSIST-OTCPP<sup>52</sup> framework is presented. An evaluation of the framework and computer-based tool follows. The results obtained are discussed, and subsequently, conclusions are drawn, highlighting this work's contribution in packaging design.

## 2 | MATERIALS AND METHODS

ANSYS Granta EduPack<sup>53</sup> is a software for materials education, typically used for students and academics. It provides a database of materials and process information to assess sustainability in engineering design. In this study, it was employed to gather data on the sustainability metrics of OTCP packaging materials. This data was used throughout the environmental and cost analysis of typical OTCP packaging applications. It was chosen because it was an accessible software that the authors were familiar with and provided a sufficient depth of data to conduct the environmental and cost analysis within the framework.

Three types of methods were employed throughout this study, which are a literature review, market research and observation through data collection instruments. A literature review of related studies of aesthetics in OTCP packaging, sustainable packaging and knowledge generation for design support systems was conducted to understand how to develop a framework, which guides OTCP packaging designers. An adapted design process model for OTCP packaging was also developed through the literature review.

Market research was carried out to set a benchmark on existing OTCP packaging on the market. This was used to generate the knowledge within the framework, whereby, the OTCP packaging available on the market was used as case studies in aesthetic and sustainability analyses.

Observations of OTCP packaging stakeholders through semi-structured interviews and surveys generated insight on the requirements to develop the user-centred framework. The stakeholders encompass (i) consumers who will be purchasing the OTCP product, (ii) pharmacists who will be dispensing the OTCP product and (iii) OTCP packaging development stakeholders who will ultimately be using the framework.

Semi-structured interviews with eight OTCP packaging development stakeholders were first conducted to identify framework requirements. The participants were three females and five males, with five Maltese participants and three international participants (the Netherlands, India and England). A good mix of design experience was achieved despite the small sample size, as participants had a range of 2–25 years of experience in handling OTCP packaging. Small sample sizes of between five and 10 participants is sufficient to reach saturation in a qualitative research,<sup>54–56</sup> as the depth achieved in the data leads to a more complex internal consistency.<sup>57</sup> The participants were first recruited through social media, where they were given a letter of information describing the objectives of the study, and they were asked to sign a consent form to allow the interviews to be recorded and transcribed. A thematic analysis was conducted using QSR International's NVivo 12 software.<sup>58</sup> The identified themes were tested for intercoder reliability that resulted in an average Cohen's kappa score of 0.71, which proves that there is substantial agreement between the codes.<sup>59</sup>

In addition, surveys with consumers and pharmacists were carried out to understand the requirements for aesthetically pleasing and sustainable OTCP packaging. The participants formed are part of the Maltese adult population. Both surveys were tested for reliability and validity, using IBM Statistical Package for Social Sciences software.<sup>60</sup> The Person's coefficient for the consumers' and the pharmacists' survey were 0.984 and 0.868, respectively. The Cronbach's alpha score of the consumers' survey was 0.903 and 0.986 for the pharmacists' survey. Pilot tests with 14 consumers and 10 pharmacists were then conducted, which proved that the proposed data collection instrument was appropriate to reach the objectives of the study. The consumers' survey was carried out with 102 participants in total, ranging in age, gender, level of education and location of residence. The pharmacists' survey was carried out with 48 participants. The participants' demographic strata are in line with the Malta population norms.

The results from this study contributed to the development of the corresponding stakeholders' knowledge base in the framework. The results of these surveys are presented throughout this paper. To evaluate the framework and its prototype tool implementation, further semi-structured interviews were employed as data collection instrument.

## 3 | REVIEW OF PACKAGING DESIGN SUPPORT SYSTEMS

The semi-structured interviews with eight OTCP packaging development stakeholders provided insight on what is required from a

framework used to design OTCP packaging. These interviews also defined the essential engineering characteristics of sustainable and aesthetically pleasing OTCP packaging. Participants were asked how likely they are to use a framework to guide them when integrating aesthetic and sustainability considerations in the design of OTCP packaging. All participants stated that they would 'Always' use such a system. The results of the interviews indicated that a framework would-be should (a) use OTCP packaging on the market as case studies in aesthetic and sustainability analyses, (b) suggest aesthetic qualities based on the target consumer demographics, (c) inform designers on standards to observe, (d) be implemented as a computer-based tool rather than paper-based design guidelines and (e) be used throughout the task clarification design stage.

The design framework requirements were used to critically review design support systems used in the industry. The critical review was conducted to determine whether they are adequate to design sustainable and aesthetically pleasing OTCP packaging and to evaluate trends in the packaging design support systems. A set of references was created to define the literature search. Searches were conducted using Google, Academia and Design Society. The OTCP packaging development stakeholders emphasised the importance of striking a balance between sustainability and aesthetics. Therefore, it is essential to consider a multidisciplinary approach to OTCP packaging design such as those in previous studies.<sup>61-70</sup> However, none of these design support systems are related to packaging, so the critical review concentrates on design systems to support packaging design. The term 'packaging' was searched with terms such as 'design tool'

and 'design support'. The search was restricted to studies in English from 1997 onwards, as the initial and fundamental sustainable design publications are from this time. Duplicates were excluded from this selection. In total, 10 design support systems were reviewed, which were classified into two categories, pharmaceutical<sup>71-73</sup> and general<sup>51,74-79</sup> packaging design support systems (refer to Table 1).

The review criteria for the critical appraisal were derived from the interviews with OTCP packaging development stakeholder results, where it was concluded that the framework should:

- Use OTCP packaging on the market as case studies in aesthetic and sustainability analyses;
- Suggest aesthetic qualities based on the target consumer demographics;
- Inform designers on the standards to observe;
- Be implemented as a computer-based tool, rather than a set of paper-based design guidelines and
- Be used throughout the task clarification design stage.

While the design support systems for packaging in other industries provided valuable insight on how to design for sustainability, OTCP packaging have different requirements over the typical characteristics. OTCP packaging must abide by strict hygiene, manufacturing and artwork standards over the typical packaging for fast moving consumer goods and food packaging. Packaging of other industries, namely food packaging, is recycled more easily. While shelf appeal is important in OTCP packaging, it is not as important as in other

**TABLE 1** Critical review of packaging design support systems.

System name/authors		Review criteria				
		Case studies	Suggests aesthetic qualities	Standards	Mode	Design stage
Pharmaceutical packaging	PharmaSC <sup>71</sup>	X	X	X	+Computer-based tool	-Throughout
	Sustainable packaging guide for the pharmaceutical sector <sup>72</sup>	X	X	X	-Paper based guidelines	-Embodiment
	packaging design and selection criteria <sup>73</sup>	X	X	✓	+Computer-based tool	-Embodiment
General packaging	Packaging design and development <sup>51</sup>	X	X	X	-Paper based guidelines	-Throughout
	Envirowise <sup>74</sup>	✓	X	✓	-Paper based guidelines	-Embodiment
	The LiDS wheel <sup>75</sup>	X	X	X	+Computer-based tool	-Conceptual
	PackageSmart <sup>76</sup>	X	X	X	+Computer-based tool	-Conceptual
	COMPASS <sup>77</sup>	X	X	X	+Computer-based tool	-Conceptual
	SPC design guidelines for sustainable packaging <sup>78</sup>	X	X	X	-Paper based guidelines	-Embodiment
	PIQET <sup>79</sup>	X	X	X	+Computer-based tool	-Conceptual

sectors, such as the fast moving consumer goods industry.<sup>52</sup> This was also mentioned in the interviews with OTCP packaging development stakeholders. However, the participants noted that while shelf appeal is not as important, the visual and verbal elements facilitate identification, which is an important requirement in the OTCP packaging industry. It was found that identification using colour cues reduce medication error.<sup>80</sup> Similarities in packaging have contributed to incorrect medication administration.<sup>81</sup> Therefore, design systems for packaging of other industries are not suitable to guide OTCP packaging designers.

Table 2 presents the strengths and limitations of the design support systems which support designers when developing sustainable pharmaceuticals and pharmaceutical packaging.

Out of the 10 design support systems reviewed, only three concern the pharmaceutical industry. From this review, it was observed that the design support systems overlook aesthetic qualities of the packaging. Overall, two (20%) design support systems consider the

**TABLE 2** Strength and limitations of the pharmaceutical design support systems.

System name	Strengths	Limitations
PharmaSC <sup>71</sup>	+Use of the AHP technique, where analysis is done using pairwise comparisons. This is advantageous over the weighting system, as the user subjectivity when assigning weights is eliminated.	–Aimed at pharmaceutical products not directly at their packaging.–Does not take existing packaging as case studies for either the aesthetic or sustainability analysis.
Sustainable packaging guide for the pharmaceutical sector <sup>72</sup>	+Aimed at pharmaceutical packaging.	–Guidelines mention the fact that there are standards that OTCP packaging artwork must follow, but do not inform the designer on what they are.–Do not consider existing packaging as case studies for the aesthetic analysis
Packaging design and selection criteria <sup>73</sup>	+Considers global and company standards, which are updated regularly.	–This tool does not consider the aesthetic attributes of the packaging.–Does not take packaging on the market as case studies during the aesthetics and sustainability analysis.

relevant standards of packaging, and one (10%) uses existing packaging as case studies in aesthetic and sustainability analysis. While none of the reviewed systems support design activities in the task clarification design stage, six (60%) are computer-based tools. These findings are illustrated in Figure 1.

The main conclusion from this critical review is that none of the systems are adequate to design sustainable and aesthetically pleasing OTCP packaging, as they do not satisfy all the established review criteria.

## 4 | ASSIST-OTCPP FRAMEWORK

The framework aims to inform designers about stakeholder preferences and to analyse aesthetic and sustainability impacts of OTCP packaging. The framework proposed by Camilleri et al<sup>52</sup> is ASSIST-OTCPP, which supports the stakeholder-focused design for aesthetically pleasing and sustainable OTCP packaging.

The ASSIST-OTCPP<sup>52</sup> framework is aimed at providing OTCP packaging designers support throughout the task clarification stage. An adapted design process model was generated based on the models proposed by Pahl et al<sup>50</sup> and Bix et al.<sup>51</sup> This is presented in Figure 2. A designer is given a product proposal sheet, which defines the requirements for a pharmaceutical packaging. The first stage, like in the model proposed by Pahl et al,<sup>50</sup> is the task clarification stage, where the designer must consider requirements relating to the environment, aesthetics, consumer, cost and so forth. This is followed by the conceptual design stage, where the designer will generate packaging design concepts, evaluate them and compare them with existing packaging on the market. Next, in the embodiment design stage, the designer will optimise the chosen packaging concept for manufacturability, sustainability and so forth. Finally, in the detailed design stage, the designer must ensure that the documents are complete and correct and that the product abides with the relevant standards.

The ASSIST-OTCPP<sup>52</sup> framework is used to either design new or improve existing OTCP packaging. The designer first specifies the target consumer demographics, OTCP tablet specifications and OTCP packaging specifications, if applicable. The framework gives indications on how to consider sustainability and aesthetics in OTCP packaging design that meets the necessary relevant standards. The framework then aims to strike a balance between stakeholder requirements and engineering characteristics by means of a Quality Function Deployment (QFD) table. As mentioned previously, surveys with 102 consumers and 48 pharmacists were carried out to generate knowledge on their requirements for aesthetically pleasing and sustainable OTCP packaging.

The ASSIST-OTCPP<sup>52</sup> framework was implemented in a prototype computer-based tool. Its framework architecture consists of two frames, as shown in Figure 3, which are (1) Designer Interface and (2) Knowledge Acquisition and Management Frame. The output is sectioned into two parts. The first part, Steps 6, 7 and 8, give indications on how to design aesthetically pleasing and sustainable OTCP



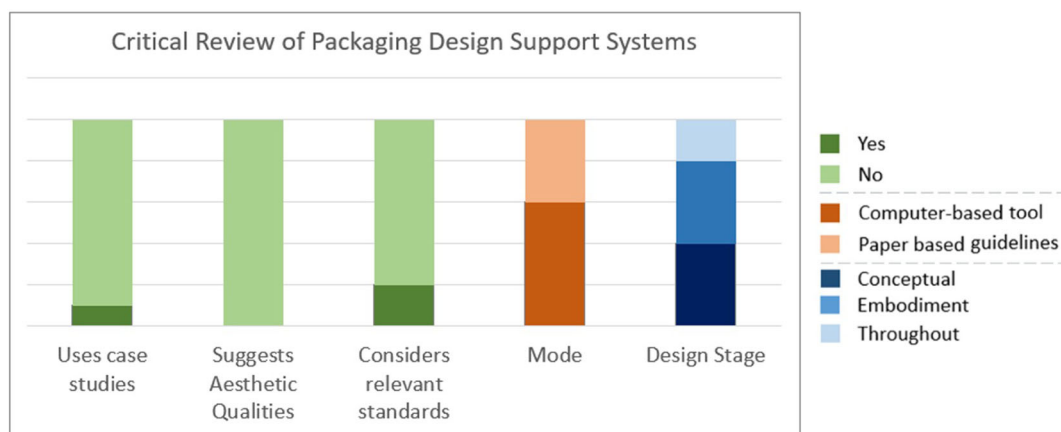


FIGURE 1 Graphical summary of relevant design support system with respect to the review criteria.

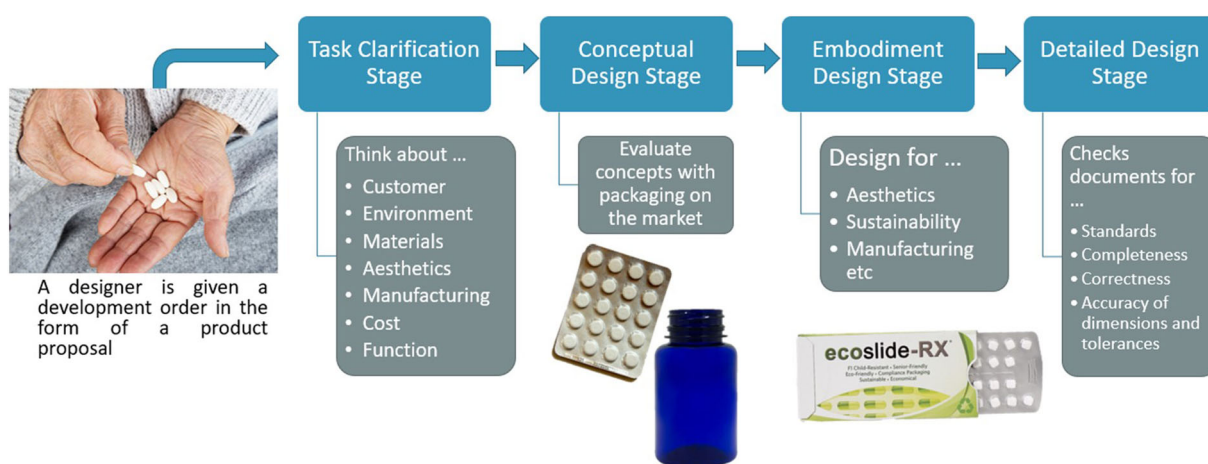


FIGURE 2 Adapted design process model for over-the-counter pharmaceuticals (OTCP) packaging.

packaging (Step 9). Based on this knowledge, the designer would be able to derive the essential engineering characteristics of the OTCP packaging through a QFD table (Step 10).

The ASSIST-OTCPP<sup>52</sup> framework is characterised by 10 steps, as depicted in Figure 3. To illustrate these steps, the following case study is considered. A designer is tasked with improving the packaging for an OTC 'Pharmaceutical X', which meets the clients functional, aesthetic and sustainability requirements. 'Pharmaceutical X' is a solid-dose tablet, used as a pain relief for women during menstruation. The tablets weigh 0.8 g each and are 8 mm in diameter and 6 mm long. Each pack should contain 48 tablets. The tablets are sold in Europe, in plastic bottle packaging with a plastic cap. The bottle is 5 cm in diameter, has a height of 8 cm and weighs 7 g. The cap is 4 cm in diameter, has a height of 3 cm and weighs 5 g.

Step 1: The designer receives the above OTCP packaging proposal with the target consumer demographics (in this case, women of any age and level of education) and OTCP tablet specifications (tablet dimensions and weight and pack size of 48 tablets).

From the survey with consumers, it was found that the level of education influences how often consumers purchase OTCP products. More and Srivastava<sup>19</sup> also found that educational level influences OTCP consumption. Education plays a role in the person's well-being and overall health, as it is a predictor of health outcomes. This is due to the fact that a higher level of education allows for more opportunities and generally, a higher income. Financial disadvantage increases the chance for chronic stress, as there is a reduced access to health-promoting facilities such as clinic visits.<sup>82</sup> Therefore, consumers with a lower level of education would turn to self-medicating to treat the symptoms of chronic stress, such as paracetamol.<sup>83-86</sup> Other studies<sup>87-91</sup> also found that age influences the frequency of OTCP purchase.

Step 2: The information on the target consumer demographics and tablet specifications are inputted into the framework and passed through the inference engine. If the framework is used to improve existing packaging, the OTCP packaging specifications (dimensions and weight), which will be present on the product proposal, are also inputted into the framework.

Figure 4 shows the graphical user interface (GUI) of the computer-based tool, where the designer would be able to input this information through the GUI.

Step 3: The inference engine inputs this information into the knowledge base, which also contains knowledge from the knowledge acquisition module, represented by *IF-THEN* rules.

Step 4: The knowledge base module transfers this knowledge into the inference engine.

Step 5: The inference engine outputs the knowledge to the user, from the knowledge acquisition and modelling frame.

Step 6: The sustainability assessment of OTC packaging. The GUI for this step is presented in Figure 5. Step 6 includes five sections, marked as (6a) to (6e) in Figure 5.

The five sections of Step 6 consist of the following:

Step 6a: Environmental and cost analysis of OTC packaging solutions.

The masses of different blister and bottle packaging are calculated, in this case study, 48 tablets per pack. The masses are then used

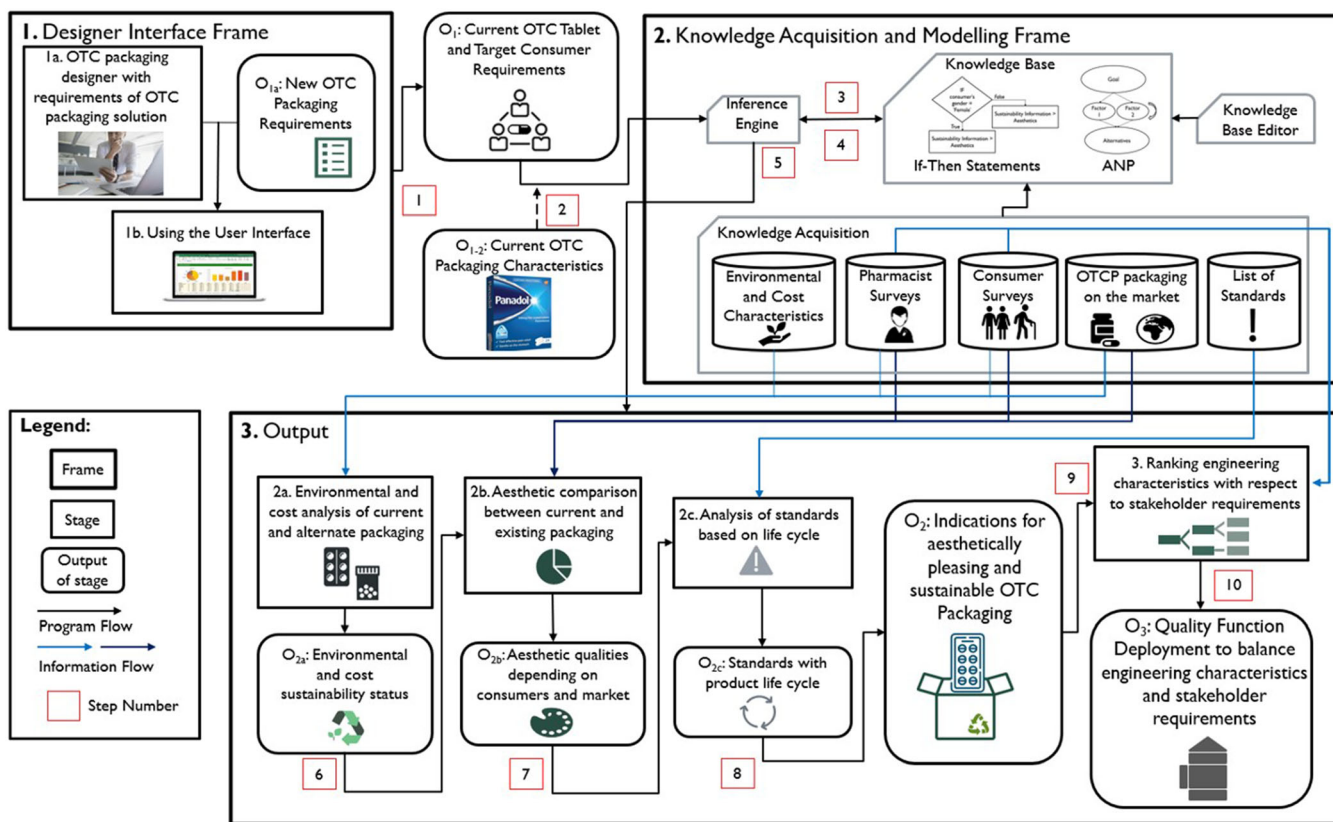
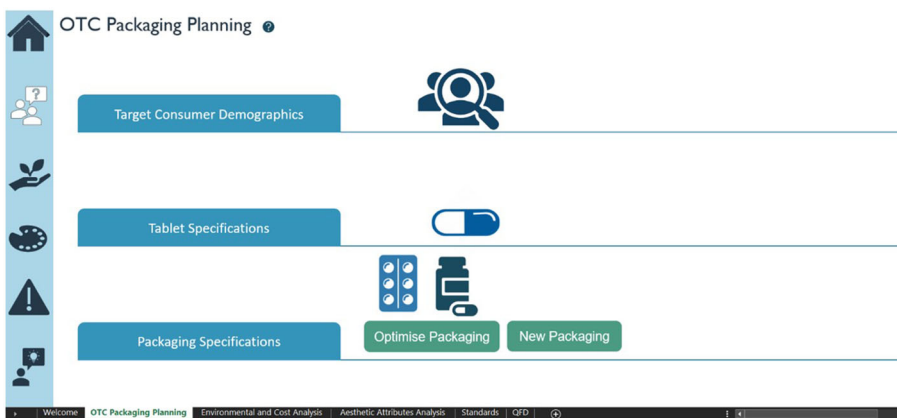
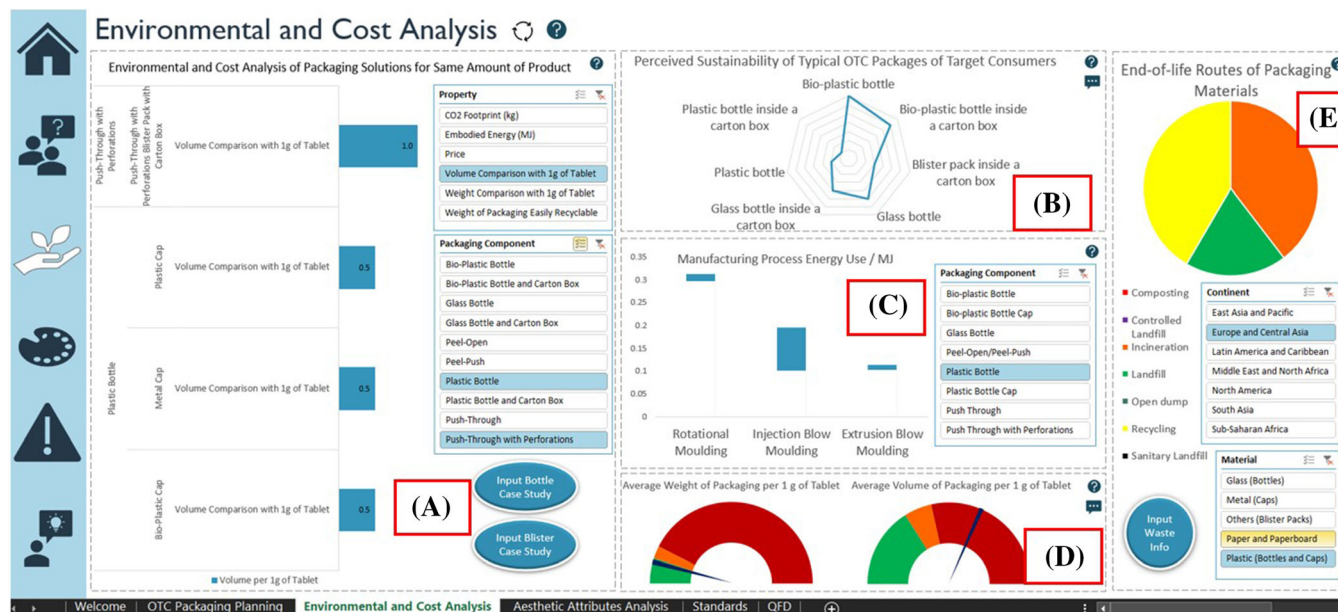


FIGURE 3 ASSIST-OTCPP<sup>52</sup> framework architecture.

FIGURE 4 Graphical user interface (GUI) of the implemented tool, corresponding to Step 2 of the ASSIST-OTCPP<sup>52</sup> framework.





**FIGURE 5** Graphical user interface (GUI) of the implemented tool, corresponding to Step 6 of the ASSIST-OTCPP<sup>52</sup> framework.

to calculate the environmental and cost impacts of the packaging solutions. Data used are from ANSYS Granta EduPack,<sup>53</sup> which quantify the environmental and economic impacts of the different packaging solutions.

Step 6b: Ranking of the perceived sustainability of OTC packaging materials.

The radar chart ranks the level of the perceived sustainability by consumers of typical OTC packaging. These rankings were obtained from surveys with consumers. From this survey, it was found that consumer demographics influence the perceived sustainability of OTC packaging materials. As bio-plastic bottles are perceived as being the most sustainable packaging by the target audience of this case study, the packaging should communicate the sustainable design considerations taken in its design, if bio-plastic bottles are not used.

Step 6c: Analysis of the energy use during the manufacturing of OTC packaging solutions.

Data was again collected from ANSYS Granta EduPack,<sup>53</sup> concerning the typical OTC packaging materials. The energy use of different manufacturing processes per kilogram of material was used to calculate the overall energy use throughout the packaging production. This case study takes plastic bottles as the current OTC packaging for 'Pharmaceutical X'. The ASSIST-OTCPP<sup>52</sup> framework presents the user with a bar chart of different manufacturing processes for plastic bottles of the specified pack size of 48 tablets. This allows the designer to consider alternate manufacturing process depending on the OTC packaging material.

Step 6d: Analysis of packaging weight and packaging volume per 1 g of tablet compared with similar OTC packaging on the market.

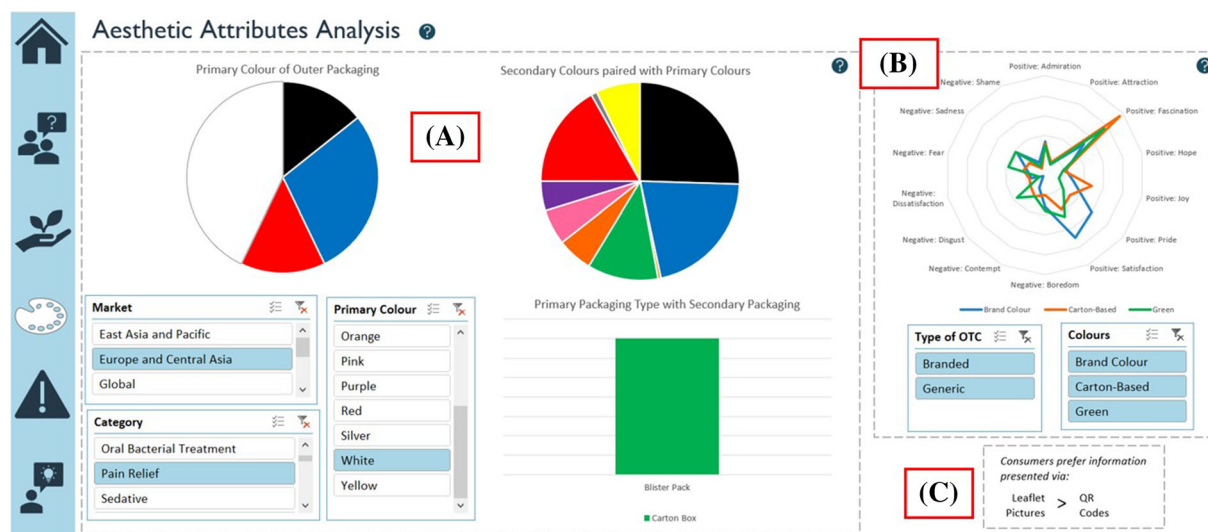
This case study considers improving the plastic bottle packaging for 'Pharmaceutical X'. The ASSIST-OTCPP<sup>52</sup> framework calculates the ratio of packaging weight and volume to 1 g of the tablet and compares it with the ratio of similar plastic OTC bottle packaging on the market. In this case, the current packaging solution has a good ratio of the packaging to product weight. However, it has a high ratio of packaging volume to product weight, so the designer must consider reducing the overall volume of the packaging for the current pack size of 48 tablets.

Step 6e: Analysis of common disposal methods for packaging materials in different markets.

ASSIST-OTCPP<sup>52</sup> presents a pie chart of the most likely end-of-life routes for OTC packaging materials. This is dependent on the market in which the OTC product is sold. This gives the designer an indication on whether a design for recycling approach will be beneficial, based on consumers' most commonly adopted disposal methods. This data was gathered from 2018 waste statistics databases online. For this case study, plastic bottles have a 40% chance of being recycled upon disposal in Europe, as that is where 'Pharmaceutical X' is sold.

Step 7: The aesthetic attributes of OTC packaging are analysed. The GUI for this step is presented in Figure 6, and includes three sections, marked as (7a) to (7c).





**FIGURE 6** Graphical user interface (GUI) of the implemented tool, corresponding to Step 7 of the ASSIST-OTCPP<sup>52</sup> framework.

Step 7a: Analysis of the colours on the OTC packaging and the type of packaging solution used.

The primary and secondary colours of different OTC packaging on the market are compared. These are categorised based on market and type of OTC product. The packaging type, whether it is a blister or a bottle packaging, is also displayed to the user. In this case, in Europe, the packaging is primarily white, with blue and black colours also present. To make the packaging stand out on the shelf, colours other than these can be used on the packaging.

Step 7b: Analysis of emotions elicited in the consumer by different coloured branded and generic OTC packaging.

In the surveys with consumers, participants were shown branded and generic OTC packaging prototypes of different colours; blue, which is the brand colour of the OTC product, green and carton, which are typically associated with sustainable packaging. The participants were asked to note which of the 14 emotions depicted on PrEmo cards<sup>92</sup> were elicited by each of the OTC packaging. These emotion cards were proposed by Desmet<sup>92</sup> and are categorised by seven positive and negative emotions. This is shown to the designer, to understand the effect of branding and the brand colour.

A brand is an identity used to differentiate between products. Good branding should minimise the mental pressure that consumers feel during the decision-making process by reducing the perceived product risks. When the branded and generic prototypes were compared, it was found that the branded packaging was always preferred. As colours are the most striking visual element of the packaging, consumers form an association between the colour and the brand.<sup>31</sup> Green packaging was found to be the least preferred out of the three colours for both the branded and generic packaging. While both carton and green coloured packaging typically have the association of sustainability in packaging,<sup>32</sup> for OTCs, green was disliked. This

could be because certain hues of green are associated with sickness.<sup>93</sup>

Step 7c: Comparison of consumers' preference to visual and verbal elements of OTC packaging and QR codes.

The survey with consumers also asked participants whether QR codes can replace the informational leaflet and images present on the packaging. It resulted that consumers prefer graphical elements on the packaging over QR codes.

Step 8: The OTC packaging standards are presented to the user, organised according to the packaging's life cycle stages.

The standards relate to the packaging's functional characteristics, the testing of packaging materials, filling and assembly, sterilisation, printing and labelling and end-of-life, as shown in Figure 7.

Step 9: Steps 6, 7 and 8 give the designer indications on how to design aesthetically pleasing and sustainable OTC packaging, with a consumer-focused approach.

Step 10: A QFD table ranks engineering characteristics with stakeholder requirements.

Multicriteria decision analysis aims at evaluating conflicting decision alternatives with respect to a decision-making goal. This was a result of interviews conducted with OTC packaging development stakeholders. It was shown that design aspects interact heavily with each other, complicating the design process for aesthetically pleasing and sustainable OTC packaging. Two examples of conflicting criteria are the strict requirements on good quality virgin materials and the negative impacts on the environment.

Two methods for criteria analysis are the Analytic Hierarchal Process (AHP) and the Analytic Network Process (ANP).<sup>94</sup> In AHP, the

decision-making problem has a hierarchal structure, where the goal is at the highest level followed by the criteria that are decomposed into sub criteria. Alternatives are derived from the sub criteria.<sup>95</sup> Contrarily, in ANP, a network structure is adopted to analyse the importance between different levels of elements and the criteria's importance.<sup>96</sup> The ANP algorithm was used because of the high levels of interaction between the elements of aesthetically pleasing and sustainable OTC packaging.

ANP is typically used with QFDs<sup>97-99</sup> to establish the internal relationships between the consumer requirements and engineering characteristics and external relationships between engineering characteristics and consumer requirements.<sup>100</sup>

The GUI for this step is presented in Figure 8. Step 10 is sectioned into two: the QFD table and the circular bar chart, highlighting the weights of engineering characteristics.

The QFD table ranks engineering characteristics (top of table) with respect to consumer requirements (left side of table). The consumer requirements, a result of the consumer surveys where participants were asked to rank OTC packaging characteristics, are weighted. It was found that these ranks are dependent on the gender of the consumer, so in this case, the ranking weights are reflective of women's preference of OTC packaging characteristics.

The engineering characteristics presented in Figure 9 were derived from the thematic analysis conducted on the interviews with

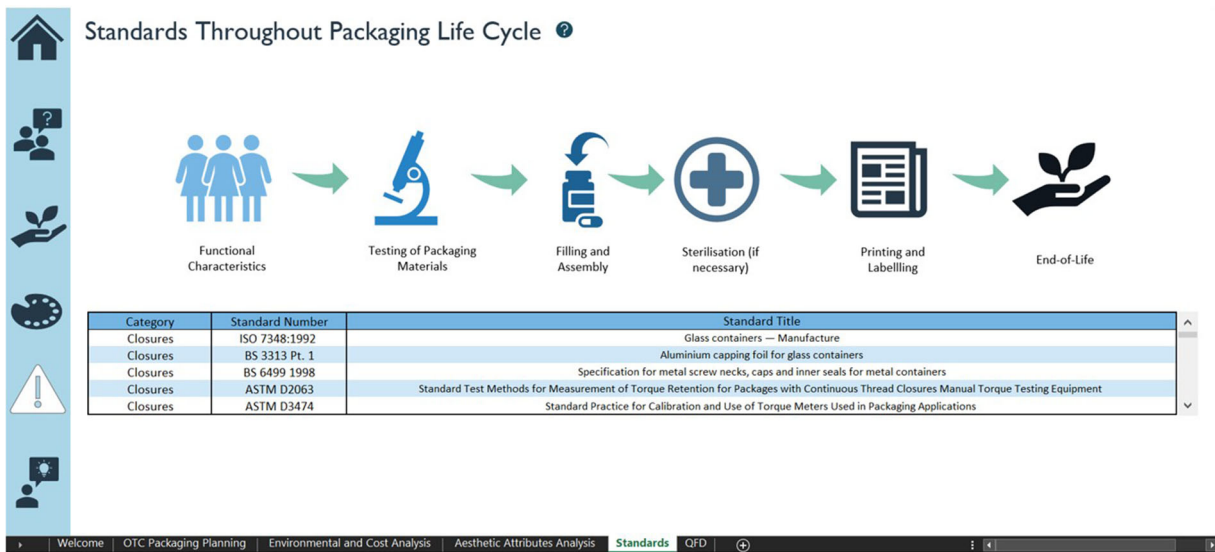


FIGURE 7 Graphical user interface (GUI) of the implemented tool, corresponding to Step 8 of the ASSIST-OTCPP<sup>52</sup> framework.

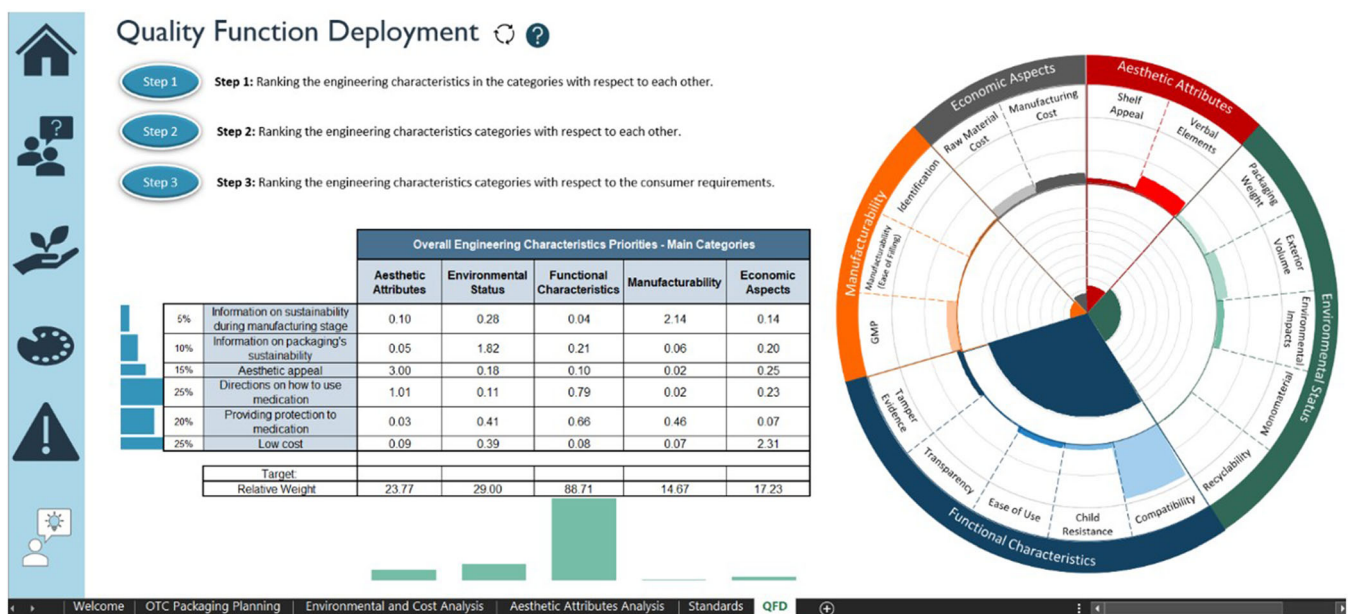
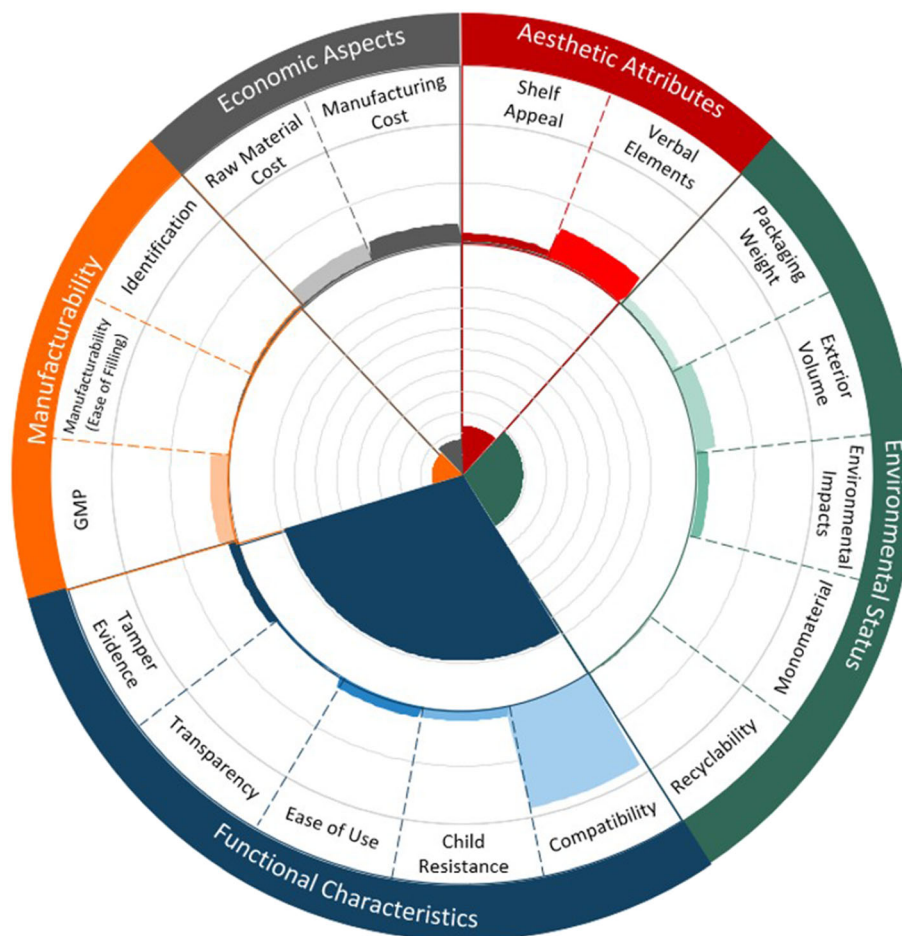


FIGURE 8 Graphical user interface (GUI) of the implemented tool, corresponding to Step 10 of the ASSIST-OTCPP<sup>52</sup> framework.

**FIGURE 9** Circular bar chart of engineering characteristics subcategories of over-the-counter pharmaceuticals (OTCP) packaging.



OTCP packaging development stakeholders. These are given weights by the designer, by means of a Saaty scale,<sup>94</sup> which is typical of the ANP algorithm.

From this step, the designer is guided to prioritise the functional characteristics of the OTCP packaging, namely, its compatibility with the pharmaceutical. They will also be aware that the sustainability status of the packaging is important and should prioritise the minimisation of the exterior volume of the packaging. Regarding the aesthetic attributes, in this case, it can be seen that verbal elements on the packaging are more important than the visual.

## 5 | EVALUATION OF ASSIST-OTCPP

Interviews with OTCP packaging development stakeholders were carried out to evaluate ASSIST-OTCPP.<sup>52</sup> Three female and five male OTCP packaging development stakeholders volunteered to participate in the evaluation study. They had an average of 6.8 years of experience, ranging from 1 to 18 years in the OTCP packaging industry. Each interview lasted approximately an hour and a half. The usability survey questions were measured using a 5-point Likert Scale. This allows for a quantitative analysis using the IBM Statistical Package for Social Sciences software.<sup>60</sup> A thematic analysis was carried out on the transcripts, using the QSR International's NVivo 12 software.<sup>58</sup> The

Intercoder Reliability was calculated to establish trustworthiness in the qualitative results, following Nowell's et al model.<sup>101</sup> Cohen's kappa was used as a measure for reliability, as it produces similar values to Krippendorff's alpha in studies with small sample sizes.<sup>102</sup> The average Cohen's kappa score for the evaluation study's transcripts is 0.68. Following the interpretation by Landis and Koch,<sup>59</sup> this suggests that the codes had a substantial agreement in the codes generated.

All participants praised the uniqueness of ASSIST-OTCPP,<sup>52</sup> as they have not used any other frameworks or tools in their design practice. All participants commented on how the framework and tool does guide designers on how to consider aesthetics and sustainability within OTCP packaging design, with five participants mentioning that all OTCP packaging aspects are represented. Participants mentioned that the framework is 'organised', 'value to designers', 'exceeds expectations' and 'useful'. One participant added that 'if you've got this from the beginning of the project, it helps to have a thread going all the way through if you'd like. It helps with continuity and uniformity.' Another participant mentioned 'It's just so visual, that's what I really like about it. It will be brilliant for helping designers to get that balance.'

However, participants also gave insight on some limitations that the framework has. The first of which being that, given 'packaging, is a complex discussion', some more design aspects could have been

included, such as manufacturing or additional aesthetic attributes, 'maybe what can go into here is type of varnishes'. While there are other aesthetic considerations that could be taken, this study focuses on the colour of the packaging, as it is the most striking visual element.<sup>16,19</sup> In the medical domain, colour is used as an identification aid to reduce medication error,<sup>80</sup> and incorrect medication has been taken because of the similarity in packaging.<sup>81</sup> This framework uses OTCP packaging as a basis for the aesthetic attribute's comparison to display what colours are most common based on the type of OTCP product (such as painkillers or vitamins). The response to colours is dependent on the country,<sup>14</sup> and the framework categorises the colours based on market. Two participants suggested including more regulatory aspects, which are dependent on the active ingredient. This system does not consider the chemical aspects of the pharmaceutical but uses its specifications as a basis.

One other participant noted that 'it is a generic tool, in the sense that it is not customised to a particular product or company. So, it has to be open.' As a generic framework was generated, each company would need to tweak this framework and implement the tool to meet the necessary packaging functional requirements. One participant gave the example of an OTCP product that is required to have blister packaging. Therefore, while options for bottles are given, this framework gives suggestions on how to improve blisters for sustainability and suggests aesthetic qualities, based on target consumer demographics.

Given these limitations, all participants agreed that the framework and tool would be an asset in their design practice and would consider using them. One participant stated that 'If I had it, I would always use it. Because that will be of fantastic value to anyone of, designers in the future.'

## 6 | DISCUSSION

A literature review shows that even with a high number of design support systems available,<sup>41</sup> designers may not know which design support system is most adequate for their design practices.<sup>42</sup> Furthermore, designers lack support when understanding stakeholder requirements.<sup>13,43-47</sup> The critical review provides a degree of evidence that there is a research gap in the development of a framework aimed to be used during task clarification and which supports OTCP designers when considering sustainability and aesthetics.

The proposed framework has the potential to result in improvements by ensuring that the stakeholder requirements and the identification of OTCP packaging are met through the aesthetic attribute analysis. Sustainable packaging contributes to a stronger environment, society and economy, as it reduces the negative impacts. This framework guides OTCP packaging designers to consider alternate forms of OTCP packaging. The impacts on the three pillars of sustainability are dependent on the type of packaging; therefore, the framework informs the designer on the environmental and cost impacts of the OTCP packaging solutions.

The framework and computer-based tool incorporates knowledge generated from studies with OTCP packaging stakeholders, which was highlighted as a strength in the evaluation of the design support system. The participants, however, also suggested that the aesthetic attributes could also include the surface finish of the packaging, such as varnishes. Additional aesthetic attributes of the packaging could be included in the computer-based tool implementation of the framework in the future. If this limitation can be overcome, the framework can be used to formulate a problem statement in terms of sustainable, aesthetic and stakeholder requirements.

The interviews with OTCP packaging development stakeholders disclose overlapping requirements between food and pharmaceutical packaging. Both types of packaging are required to protect the edible product inside and assure hygiene and quality to the consumer.<sup>2</sup> Given these similarities, the framework and its implementation in a tool can also be used to design food packaging. The OTCP packaging development stakeholders also noted that the main difference is that shelf appeal in food packaging is more important. The knowledge base would need to be updated in order to reflect consumers' perceptions of aesthetically pleasing and sustainable packaging of other sectors and knowledge concerning packaging on the market.

The participants' selection of the *ASSIST-OTCPP*<sup>52</sup> evaluation reflect a range of expertise in the OTCP packaging industry. A group of OTCP packaging design engineers could potentially deliver different results. However, the variety in the participants' backgrounds provides a holistic view of OTCP packaging design, thus reducing the bias of one discipline.

## 7 | CONCLUSION

It is concluded that the main contribution of this paper lies in an unprecedented framework for a computer-based tool, aimed at guiding designers when developing a sustainable and aesthetically pleasing OTCP packaging. The proposed framework and its implementation in a computer-based tool to guide OTCP packaging designers contributes to a holistic approach in the task clarification design phase. The novel aspect of the *ASSIST-OTCPP*<sup>52</sup> framework is that it presents the user with a stakeholder-focused design approach to produce sustainable and aesthetically pleasing OTCP packaging. *ASSIST-OTCPP*<sup>52</sup> could also be used for improvement and the design of new and existing OTCP packaging. The knowledge contained in the framework provides insight on stakeholder requirements in the form of emotions and preferences and OTCP packages on the market. This was gathered from surveys with Maltese pharmacists and consumers. In future work, investigating how these preferences vary across cultures might prove important.

### DATA AVAILABILITY STATEMENT

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.



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