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How Design Thinking Helped Craftwomen to Solve a Plastic Pollution Problem †

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Abstract: In Morocco, the project was aimed at reducing plastic pollution and increasing the local craftwomen's income. Design thinking and Facebook were used to support craftswomen in the search for solutions. The research question was: What is the relevance of the craftswomen's solutions, when they are supported with design thinking and Facebook? A total of 37 evaluators analyzed the participants' prototypes with creativity criteria. The craftswomen created innovative manufacturing techniques: stuffing objects with plastic scraps, assembling compact discs to make decorations, etc. Several prototypes contributed to reduce the plastics thrown into the Sea. The adaptation criterion was given a good score. The criteria of novelty and originality were fairly reached. The elaboration criterion received a lower score.

Keywords: design thinking; sustainable development solutions; environmental education; plastic pollution

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1. Introduction

The Plastic-Free Surf Project took place in the Al Hoceima Park, Morocco. It aimed at reducing local plastic pollution and contributing to an increase in the income for the local population, especially rural women. The Al Hoceima National Park is located on the Mediterranean coast of Morocco, near the town of Al Hoceima. Thanks to its geomorphology and contiguity between the sea and the mountain, the Park is characterized by important terrestrial and marine biodiversity. In addition to many socio-economic issues, the Park also has a number of environmental problems. One of these problems is significant solid waste pollution, more particularly plastic waste, which negatively impacts both the quality of the natural landscape, as well as the continental and marine biodiversity. This plastic waste, discarded by the local population and visitors to the Park, is carried by flood waters directly into the sea, aggravating plastic pollution, an already very significant problem in the Mediterranean Sea.

Like other environmental problems, the problem of plastic waste is complex, with multiple impacts, causes, actors, and risks. It seems reasonable to think that removing plastics in a coastal community requires that residents understand the harmful effects of plastics on marine animals and, ultimately, their own health, not to mention the effect of plastics pollution on income-generating tourism activities. This paradigm shift is not easy for anyone, including the communities of Al Hoceima. Everywhere in the world, plastics are part of everyday life. Their ease of shaping, durability, and resistance to impact, temperature, humidity, and detergents, make them useful in a diversity of industries, such as packaging, construction, automotive, electrical, etc. Although new plastics, made from resins, plants, or milk are available around the world, these alternatives are not yet present

in the communities of Al Hoceima. Most residents in these communities use and discard plastic products regularly, mostly unaware that substitute products exist, such as, for example, reusable bags made of natural materials for shopping or metal and glass bottles to transport liquids. Reducing plastics and alternatives (not widely available in shops) are, therefore, not common practice within the local population. In addition, local waste collection systems are not designed to recycle garbage, making change in this regard rather difficult to implement. Finally, people in the communities of Al Hoceima seem to have developed a habit of throwing their plastic waste and other garbage directly into nature.

2. Materials and Methods

Faced with a variety of environmental problems, citizens from our study communities and throughout the world are looking for solutions to improve their living conditions. Sometimes, researchers accompany them during their quest for such solutions. What are key interventions for promoting effective support towards solutions among citizens? How are these interventions applicable and adapted to the needs of those affected? Several international organizations are currently using a creative problem-solving approach called design thinking to pedagogically assist social groups as they analyze local problems, propose and test solutions. Such organizations, including IDEO.org (in the United States), INDEX (in Denmark), Hasso Plattner Institute (in Germany), and Design for Change (in India), use design thinking to create products or experiences that improve the lives of communities.

Design thinking comes mainly from two pioneers: Tim Brown and David Kelley, founders of the IDEO design and innovation firm. It is a human-centered approach that relies on innovation, collaboration, and creativity to solve a multitude of social or environmental problems. Intuition matters in design thinking and there are typically numerous solutions, which are quickly produced through experimentation. Failure is valued and, above all, the needs of users are considered [1]. A creative and analytical approach, design thinking is an amalgam of concepts in engineering, design, arts, social sciences, and business. It is a collective intelligence approach that places people, their behaviors and needs at the center of a process of co-creativity involving frequent feedback from the solutions users.

Design thinking applies the designer's sensitivity and methods to solve complex problems. Indeed, designers are used to confronting complex problems by generating various solutions that they test in order to gradually improve them. In a rigorous process using well-defined tools, design thinking, sometimes divergent and sometimes convergent, uses both creative and analytical modes of reasoning [2]. Design thinking takes place according to a sequence of distinct, non-linear steps in which back-and-forth actions (iterations) intersect:

1. Observation-inspiration: an ethnographic survey is performed to understand the people's (the users) concerned around the problem and to empathize with their perspective on the situation.
2. Definition-synthesis: the problem is defined several times. Information and various perspectives related to the problem are researched. The information is synthesized to pose the conceptual challenge in a few statements.
3. Ideation: many ideas are generated and some are chosen.
4. Prototyping: prototypes are quickly constructed to illustrate the ideas chosen so as to share these ideas with users and to evaluate their potential.
5. Tests: prototypes are assessed by collecting the opinions of users and experts. The winning prototypes are refined.
6. Communication: the final solution is made public [1].

Generally, in design thinking, facilitators use traditional tools: post-its, whiteboards, role-play interactions, etc. However, today there are also collaborative digital tools (ICT) that could facilitate the co-creation of solutions during design thinking. Using these ICTs, the problem solvers could share information (Empathy Maps), synthesize information

(Popplet), propose and comment on ideas (Padlet), choose ideas (Loomio), draw prototypes (Tinkercad), plan (Wrike), and communicate (Facebook) [3]. The technological tools used in design thinking have, however, not been widely investigated. Used in conjunction with design thinking, collaborative digital tools (ICT) can facilitate the co-construction and the resolution of a problem. According to El Jai et al. [4], Facebook represents a relevant tool to complement design thinking, when problem solving. Though the solvers are not physically near each other, the sharing of opinions, information and solutions about a problem is still possible through ICT and, as such, the design thinking process can continue. Additionally, Facebook lets solvers express diverse opinions, making it easier to express a range of perspectives related to the problem [5].

Three intervention tools (one procedural tool and two collaborative digital tools) were chosen to support 10 craftswomen of the Al Hoceima Park, as they searched for solutions to a local plastic pollution problem, namely design thinking, Facebook and WhatsApp. The research question was expressed as follows: What is the relevance of the solutions proposed by the craftswomen to the problem of plastics, when they use a design thinking process and are supported in problem solving with Facebook and WhatsApp?

In Bades, an emblematic historical and natural site of the Rif region, in the Al Hoceima Park, Morocco, the participants in the «Plastic-Free Surf Project» were members of an artisanal cooperative. This cooperative works in the manufacture of knits, crocheted items, and products made from vegetable matter (alfa and saw palmetto). Representatives of this cooperative were contacted and they demonstrated a willingness to participate in the activities of the project. About 10 artisans participated and were accompanied by the research team for a total of 12 months, with the aim of reducing plastic objects discarded in the region, ultimately ending up in the Mediterranean Sea. The idea was also to allow these women to manufacture and sell new products that would help to reduce the plastic objects used locally, promoting reuse of these plastic objects. In face-to-face workshops and as part of a private Facebook group, the project followed the steps of design thinking as experienced by the participants: observation, synthesis, ideation, prototyping, testing, and communication.

Workshops were organized in November 2019 within the cooperative and participating members applied the stages of design thinking. Facebook and WhatsApp groups were also used for networking and to continue the design process while the women were away from the research team. During the first stage (observation-inspiration), a two-day workshop was held with participating women. They were invited to describe the waste problem in their region, to provide their opinion on this issue and to identify the sources of plastic pollution in Al Hoceima National Park. To enrich the discussion, images showing plastics accumulated in the sea and on beaches, as well as plastic waste collected in the field were made available to the participants. During the second step (synthesis), a Journey Map encouraged them to describe and draw the use of plastics from sunrise to sunset by various people in the region (themselves, farmers, fishermen, traders, hoteliers . . .) and by tourists. The women described how they use plastic bottles and bags, cosmetics, etc., in their daily lives. They expressed knowledge that plastics are ubiquitous and harmful. Indeed, pieces of plastic are often found in the stomach of animals they raise and in locally caught fish. To help the women come up with ideas for reusing plastics (ideation), images of replacement items were provided (biodegradable bags, sandwich cases, bamboo utensils, beeswax covers). Images showing products created with recycled plastic and microplastics were also shown (jewelry, paintings with relief in microplastics, decorative objects).

The following problem was then posed in collaboration with the participants: How could we reduce the quantity of plastics rejected from the village of Bades, while creating products that can be marketed by the cooperative? The challenge was to reuse existing plastic objects to make them useful again in a different way, ideally with an aesthetic added value. In principle, reuse solutions should be durable and useful, with an aesthetic added value. Another possibility was to reduce the use of plastic objects (bags, bottles), replacing them with alternative products. Through brainstorming, the women proposed

initial ideas for involving the cooperative in the reduction and/or valuation of plastics and microplastics. For example: painting pictures on which pieces of plastic would be stuck, making replacement products such as fabric bags, decorations, and jewelry.

The rest of the project took place mainly on the Facebook and WhatsApp groups created during this first workshop. In fact, from 2020, the COVID-19 pandemic prevented all planned trips by researchers to Bades. Over the next nine months, the prototyping and testing stages were experienced entirely on Facebook and WhatsApp, through daily exchanges. The artisans created hundreds of prototypes and posted them on private social media, receiving feedback from peers and researchers. Ideas for craft products from websites such as Pinterest were also exchanged. The craft products from Pinterest were not made from plastic, but the craftswomen tried to construct the same products from plastic samples cut from household products: bottles, bags, compact discs (CDs), etc. Interestingly, the initial prototypes gradually inspired completely new ideas. After six months, some prototypes, designed by the participants, lacked development and were difficult to market. However, after nine months, the researchers noticed new ideas and saw an improvement in the quality of the prototypes. It was then that 35 prototypes were selected to assess the impact of the design approach experienced on the local resolution of the plastics problem.

The research part of the project adopted a mixed method design, since the participants' prototypes were evaluated using both quantitative scores and qualitative comments. After nine months of work with prototypes, Canadian and Moroccan evaluators (n = 37 in total) from different arears of expertise (sciences, art, law, journalism, education) were invited to comment and score 35 prototypes. The researchers analyzed the participants' prototypes with the following creativity criteria, adapted from Demirkan and Hasirci [6]: environmental value, adaptation, novelty, originality, elaboration, and fluidity. These creativity criteria were applied in the project as such:

- Environmental value: product which helps to lower the quantity of plastics discharged into the Mediterranean Sea, in Bades.
- Adaptation: marketable product, likely to be purchased by tourists.
- Novelty: new product, never made by other craftsmen in Morocco.
- Originality: completely new idea of using or replacing plastic.
- Elaboration: aesthetic product, demonstrating fine workmanship and attention to detail.
- The fluidity criterion (large number of ideas) was used to evaluate the whole group of prototypes.

3. Results

The average score for all prototypes and for all criteria was 14.03 (out of a total possible score of 20). The prototype in Figure 1 had the highest score, while the prototype in Figure 2 had the lowest score. In addition, 19 products (out of 35) scored above-average and 16 products (out of 35) were rated below-average.

Figure 1. The prototype that received the best average score (for the five criteria).

Figure 2. The prototype that received the worse average score (for the five criteria).

On average, the environmental value of the products was judged to be quite good (3.00 out of 4). Indeed, the evaluators concluded that several prototypes, while not perfect, contributed to reduce the quantity of plastics discharged into the Mediterranean Sea, in Bades. The adaptation criterion (marketable product) was given an average score of 2.83 (out of 4), likely because the participants only started to adapt their products to tourists' taste and needs at the end of the project. As for novelty and originality, these criteria's respective scores were 2.71 and 2.76 (out of 4). Indeed, the craftswomen's prototypes demonstrated a particular level of ingenuity, since they produced new uses for a material that is often difficult to reuse. The participants carried out the construction of varied prototypes, also meeting the criterion of fluidity (large number of different ideas). Craftswomen made jewelry, home decorations, toys, fashion accessories using innovative manufacturing techniques, such as sticking microplastics on paintings, stuffing objects with plastic scraps and used bags, cutting compact discs to assemble them with fabrics, embroidering plastic jewelry covered with felt, etc. The elaboration criterion received a score of 2.73 (out of 4). Overall, the team's researchers believe that the craftswomen's prototypes still lack a certain aesthetics and attention to detail. During the Facebook exchanges, the researchers noticed that the participants were motivated and creative and constantly wanted to produce new solutions, without necessarily taking the time necessary to complete their work well.

Figures 3 and 4 show examples of prototypes that received high scores for «environmental value» and «elaboration».

Figure 5 shows an example of a prototype that received a medium score for originality (2.85, out of 4). Indeed, the participants had the idea of cutting plastic scraps with which they stuffed toys. The judges found the idea original but expressed concerns for the safety of children if these toys were to break.

Figure 3. A prototype that scored well for «environmental value» (3.51 out of 4).

Figure 4. A prototype that scored well for «elaboration» (3.32 out of 4).

Figure 5. A prototype that received a medium score for «originality» (2.85 out of 4).

Finally, Figure 6 shows an example of a prototype that received low scores for elaboration (2.27 out of 4) and adaptation (2.46 out of 4). Here, the reviewers found the idea of repairing an old plastic chair for reuse interesting. However, they felt that this product was not as aesthetically appealing and likely difficult to market.

Figure 6. A prototype that scored low for elaboration (2.27 out of 4) and adaptation (2.46 out of 4).

4. Discussion and Conclusions

Design thinking, complemented by Facebook and WhatsApp, along with the participating women's high level of motivation, seems to have led to the production of many

different prototypes, some of which quite promising in terms of the environment, commerce and craftsmanship. The conceptual challenge of creating marketable products that reduce the plastics discarded into the sea was partially met for the village of Bades. The fluidity aspect seems to have dominated the experience, but the environmental and aesthetic criteria could stand to be reworked.

The craftswomen's efforts to improve the plastic problem made them more environmentally conscious. They said they now reduced the plastics that their village discard into the sea. Periodically, they also organized community beach clean ups. These behaviors could reduce the amount of plastic present in the stomachs of fish and locally raised hens.

This experience shows that it is not easy to create aesthetic and marketable products from plastic scraps. Some products are not good enough to sell and others will end up in the trash after a quick use. For this region, replacing disposable plastic bottles and bags with more durable accessories will require widespread education, peer modelling, and well-targeted advertising. The manufacturing of new types of compostable and reusable plastic, made from plants for example, would also be of crucial importance.

Design thinking can create more fluidity in solutions. In sustainable development, design thinking could be complemented regularly by inviting problem solvers to reflect on the effects of environmental problems and on the solutions for local natural species [7]. The ambitious idea of "nature regeneration", newly popular during the COVID-19 pandemic, could be a source of inspiration. The solvers could be asked the following question: How could you regenerate both your business activity and the quality of life of local natural species?

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Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Comité d'éthique de l'Université de Moncton.

Informed Consent Statement: Informed consent was obtained from all persons involved in the survey implanted in this study.

Data Availability Statement: All data are available with the main author and can be accessed on request.

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