



# Using a morphological chart to develop fashion products from recycled knit waste

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### **ABSTRACT**

*This article aims to investigate and experiment environmentally sustainable solutions using cotton knit waste and hand knitting to develop new fashion products. The know waste came from imperfect knit fabrics discarded by fabric industries and circular knit garments discarded by consumers. The tool used as a creative mean of development was the morphological chart, which allowed approximately one hundred and fifty ideas of garments to be generated. Five ideas were identified as main product concept. A prototype of a vest was made to test the viability of the use of the morphological chart do develop a creative fashion product. The reproducibility of the methodology was successfully tested by handcraft artists that work with handknitting.*

**Keywords:** Morphological Chart. Recycled. Fashion.

## Uso da matriz morfológica para desenvolvimento de produtos de moda a partir de matéria-prima reciclada

### RESUMO

O presente artigo tem como objetivo investigar e experimentar soluções ambientalmente sustentáveis, utilizando resíduos de malharia circular de algodão e o tricô, para a fabricação de novos produtos de moda. Como matérias-primas principais foram utilizados tecidos defeituosos descartados por empresas e peças descartadas por consumidores. A ferramenta usada para o desenvolvimento do processo criativo foi a matriz morfológica, com esta técnica foram geradas aproximadamente cento e cinquenta ideias de produtos de vestuário. Cinco ideias de concepção de produtos foram identificadas como principais. Foi confeccionado um protótipo de um colete curto com o objetivo de mostrar a viabilidade da aplicação da matriz morfológica para o desenvolvimento de produtos criativos em moda. A reprodutibilidade da metodologia proposta foi testada com sucesso por artesãos que trabalham com técnicas de tricô manual.

**Palavras-chave:** Matriz Morfológica. Reciclado. Moda.

## **Uso de matriz morfológica para desarrollar productos de moda a partir de materia prima reciclada**

### **RESUMEN**

*Este artículo tiene como objetivo investigar y experimentar soluciones ambientalmente sostenibles, utilizando residuos de prendas de punto circulares de algodón y tejido de punto para fabricar nuevos productos de moda. Las principales materias primas fueron tejidos defectuosos descartados por las empresas y piezas descartadas por los consumidores. La herramienta utilizada para el desarrollo del proceso creativo fue la matriz morfológica, con esta técnica se generaron aproximadamente ciento cincuenta ideas de productos de confección. Se identificaron cinco ideas de diseño de productos como clave. Se realizó un prototipo de chaleco corto para mostrar la viabilidad de aplicar la matriz morfológica para el desarrollo de productos creativos en la moda. La reproducibilidad de la metodología propuesta ha sido probada con éxito por artesanos que trabajan con técnicas de tejido a mano.*

**Palabras clave:** *Matriz Morfológica. Reciclado. Moda.*

## 1. INTRODUCTION

It's known that the post-modern society lives in a consumerism that is almost irrational. This consumerism forces people to consume new things every instant. These new things provoke the creation of new products that can be necessary or totally unnecessary.

To create new products means to produce more waste; if more waste is created, more space it needs to be thrown. It's clear that this is a textile process that takes advantage of natural resources to satisfy human needs. As Almeida (2002) stated, this is a scenario where human beings sees itself away from nature, thinking about it only as means for production. When human beings exclude themselves from the ecosystem - the system of all living beings - human beings create serious environmental issues, using so much of natural resources that nature can run out of it. In the past, the planet was one cyclic and unlimited biosphere where each living being would, at the same time, use and generate a resource. In a specific way, the fashion market can be an example of that worrisome reality (HOSKINS, 2014; GIUDICE, LA ROSA E RISITANO, 2006).

In that context, it is necessary to adopt new ways of developing products, ways that are concerned about the environment, the economical growth and social justice, that revise the productive chain, finding ways to a cyclic production, where each material is part of a product that can come back with a new function. Daily tons of textile waste are generated each day, whose end are usually landfills or incineration (BRAUNGART and MCDONOUGH, 2009; CLINE, 2012).

This research show different ways of developing a creative product in fashion, giving the basis for developing

new products from textile waste and hand knitting techniques.

This article is a part of the dissertation "Methodology to develop new garments based on handmade techniques and cotton circular waste", that aims to investigate and experiment sustainable and environmental solutions for developing fashion products, using waste from circular knit fabrics, hand craft techniques, like knitting, and the Zwicky's morphological chart. In this article, a prototype of a short vest that was knitted using as a resource waste from textile industries and from consumers.

## 2. RECYCLING IN FASHION

It's known that recycling is a necessary process. It's a demand not only from the scarcity of resources but also important to control pollution and reuse waste generated from the industry (BHATIA, SHARMA, MALHOTRA, 2014).

Recycling, a practice adopted by the environmental movement, has been growing fast in the last few years. The interest for recycling is rising because of conscious consumerism, the cost of landfills, the new legislations that are created and a new market that opened up using waste as a commodity (KOCH; DOMINA, 1999).

As Wang (2010) said, recycling technologies are divided into primary, secondary, tertiary and quaternary. Primary is the one that uses waste directly from the industry; secondary evolves a mechanical action on post-consumer waste; tertiary is the one that takes pyrolysis or hydrolysis to transform waste in basic chemical components; and quaternary is the waste burned to generate heat.

For the 25% of the textile that are reused in the United Kingdom, a donation bank is set to collect clothing donations and the these clothes are sorted. The clothes that are in

better conditions are sold in second hand shops and a small part is upcycled or customized. Most of these donations are sent to thrift stores in Africa or west Asia. A small part is recycled by being reduced to small fractions of fabric to become filling or new fibers. More than half of those textiles is incinerated (FLETCHER, 2008).

The waste generated during the textile production can be classified in three eventual types: the dirty waste, that demands some cleaning before it is used, like remaining from carding, spinning, filter dirt, etc.; the clean waste, that doesn't require any kind of cleaning; and the rigid waste, that need some machinery to change it into a new resource (WANG, 2010).

Waste is also classified by who discarded it: the pre-consumer waste and the post-consumer waste. The pre-consumer waste is the one discarded before the final consumer buys it at a store, generated by the industry. In textile industries, these can be fibers, threads, fabric waste and imperfect fabrics, tests, etc (BHATIA, SHARMA, MALHOTRA, 2014).

In her guide for sustainable fashion, Gwilt (2014) finds it is unnecessary to generate waste while cutting the fabric or bad planning of a garment, where even 15% of the fabric might be wasted. She suggests that designers find alternatives while working on samples or intelligent patterns to get to zero waste during the creation of a garment.

The post-consumer waste is the one generated by the consumer after using a garment that was bought. The one who buys it decides that it's no longer needed, even by being damaged or used, or even for aesthetically reasons. Post-consumer waste can be garments as well as curtains, sheets, towels, carpets and rugs (BHATIA, SHARMA, MALHOTRA, 2014).

In a study by Koch and Domina (1999) with college students, it was asked about their methods for desecrating textile waste. The most frequent answers were that the garments were passed along to friends or relatives, followed by using it as cleaning rags or donated to entities. When asked why the waste were discarded, most of them answered that it didn't fit their body any longer.

It's curious that most consumers feel environmental conscious when relating to paper and plastic recycling, or when they reduce the use of energy among other responsible practices. But when it comes to fashion and clothing, this subject doesn't seem so important. Initiatives that educate about recycling show that raising awareness on the waste volume generated at home, like paper, plastic and glass, makes consumers rethink and decrease the generation of the waste. In this sense, it's important to exist a motivation to increase the awareness on textile waste. In this way, it would prevent the generation of these waste (SHEPARD and POOKULANGARA, 2014).

It's known that consumers and even fashion designers are distant from the textile production. This reality makes it easy to create new products to replace old ones that are used, which is pretty much an inversion of the relationship between quantity and quality and the carefree regarding resources. A lot of garments that can't be used could be fixed, for example. As Sennet has quoted (2012, p.223), "...it's fixing things that it can be understand how it works".

Gwilt (2014) talks about the responsibility of remanufacturing existing materials, where the designer, instead of using natural resources, reworks old garments or pre-consumer and post-consumer waste. As the author says, the designer will face problems, like the lack of color unity and material diversity; a careful evaluation on the materials



that will be used must be done so that the designer won't face holes, stains or teared areas.

But Gulich (2006) emphasizes that it's hard to prove the characteristics of defibered materials, once there is a mixture of origins and materials during the process and each material acquires their own characteristic. Among the uses for defibers, they can be turned into new yarns or nonwovens. The process of developing defibers doesn't generate waste and it's a low environmental impact.

Nakano (2004) tested how consumers accept recycled products. The different perceptions regarding market and manufacturers, one of them is that the industry believes that recycled materials quality is lower when compared to natural resources. The study shows that, to exist more consumers to recycled products, industry must invest more in them. Nakano compares the relationship consumers have with organics, like organic cotton, that is produced in a beneficial way to the environment and it's use isn't harmful to the skin, while recycled products are associated with something used, therefore, a inferior quality. As a result, it's been showed that, besides most users find it positive to have a garment made of recycled materials, most of them wouldn't pay a higher price for the product if there would be the same garment made out of natural resources.

### **3. MORPHOLOGICAL CHART**

The Swiss astronomer Fritz Zwicky (1898-1974) proposed in 1940 an orderly visualization method to ease problem solving em astronomy called the morphological method.

According to Zwicky (1957), the morphological method aimed to research total solutions on a given problem and the knowledge on all the essencial characteristics of the

solutions found; still, it takes a conviction that all solutions for all problems are useful in a proposal prism and performance criteria that each have their own optimistic qualities.

The morphological thought deals with the following problems (ZWICKY, 1957, p.19):

- What are the possible solutions?
- What other informations are found in the possible solutions, if not all, a number of limited investigations?
- What are the minimum tools necessary to study all the characteristics of a phenomenon?

According to Yan (1998), the morphological analysis happens following this method that consists in a technique that divides a problem in subproblems in a structural way, envisioning a better comprehension of it to analyze the structure of its shape, idea, products, system or process.

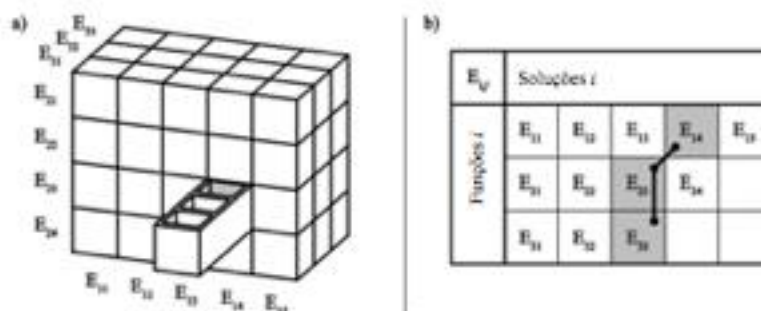
To solve a problem, the morphological analyses can proceed from the clear formulation of the problem, the analysis of all parameters that are suitable of a solution and the building of a morphological chart that has all possible solutions e all are examined and proved (ORTIZ, 2014).

The morphological chart is a chart where the columns and lines represent different parameters to solve a problem. The first column is used to describe the characteristics relevant to the problem; the horizontal lines are filled with all possibilities of each of these parameters. The chart is visualized like a box full of drawers, with many solution inside each box, like a multidimensional tool for visualization.

Figure 1 shows how the drawers can be visualized and how it can be built; the lines in it represent the subfunctions of a problem and are indicated by index *i* and the solutions correspond to *j*. The drawers are demonstrated in two

dimensions (columns and lines) of the same parameter and its solutions are highlighted in gray. This chart was used for engineering (HELLER *et al.*, 2014; PEREIRA *et al.*, 2014; ZWICKY, 1957).

Figure 1 - Morphological Chart.



Font: Heller *et al.*, 2014.

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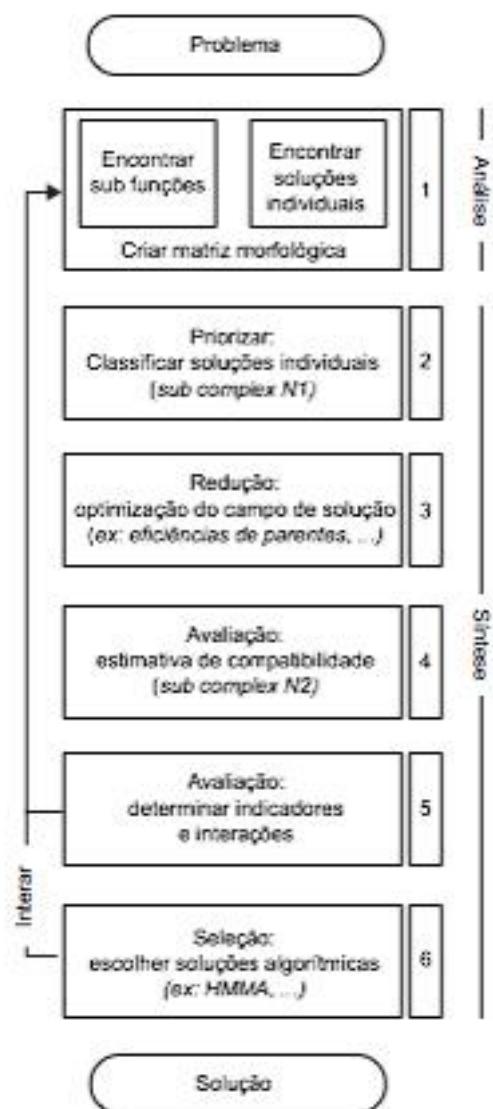
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Figure 2 - Morphological Analysis Proposal.



Font: Heller *et al.*, (2014)

## 4. MATERIALS AND METHODS

### 4.1 Materials

This work used knit fabric from garments wasted by consumers and knit fabrics in bad conditions wasted by the industry.

### 4.2 Methods

Aiming to generate an alternative solution to develop a creative process and making a prototype on fashion and design, the following tools were used: brainstorming and morphological chart.

The brainstorming of ideas involved the authors and a group of thirteen crafters, realized on May, 12th, 2018, to increase the perception of the alternative to develop with the textile selected and, simultaneously, allow to develop a innovator product. The groups that were selected are experienced in the use of handcraft techniques to develop garments and accessories to their own use and also for family and friends.

The morphological chart was elaborated by the same group, to promote alternatives generated by the models that could attend to the selected variables.

The method was reproduced by another group of crafters that had never been in contact with the techniques used to develop this research.

The method used to develop fashion products was:

#### **4.2.1 Preparing the material**

The following steps were used to transform the garment wasted by consumers in usable yarns:

The garments were folded in half lengthwise, leaving about 2 cm without overlapping. Then, the overlapped part was cut to make the yarn (Figure 3):

Figure 3 - Cutting a garment to turn it into knit waste yarn.



Font: BERTOLUCI, 2018.

To make sure the garment would turn out into one continuous yarn, diagonal sections were cut as shown in Figure 4.

Figure 4 - Diagonal cuts.



Font: BERTOLUCI, 2018.

The same process was used to cut knit waste from industry. The process tried to use the most of these fabrics, trying to waste only the parts that were not good for use (Figure 05).

Figure 5 - Fabrics from industry.



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#### 4.2.2 Brainstorming

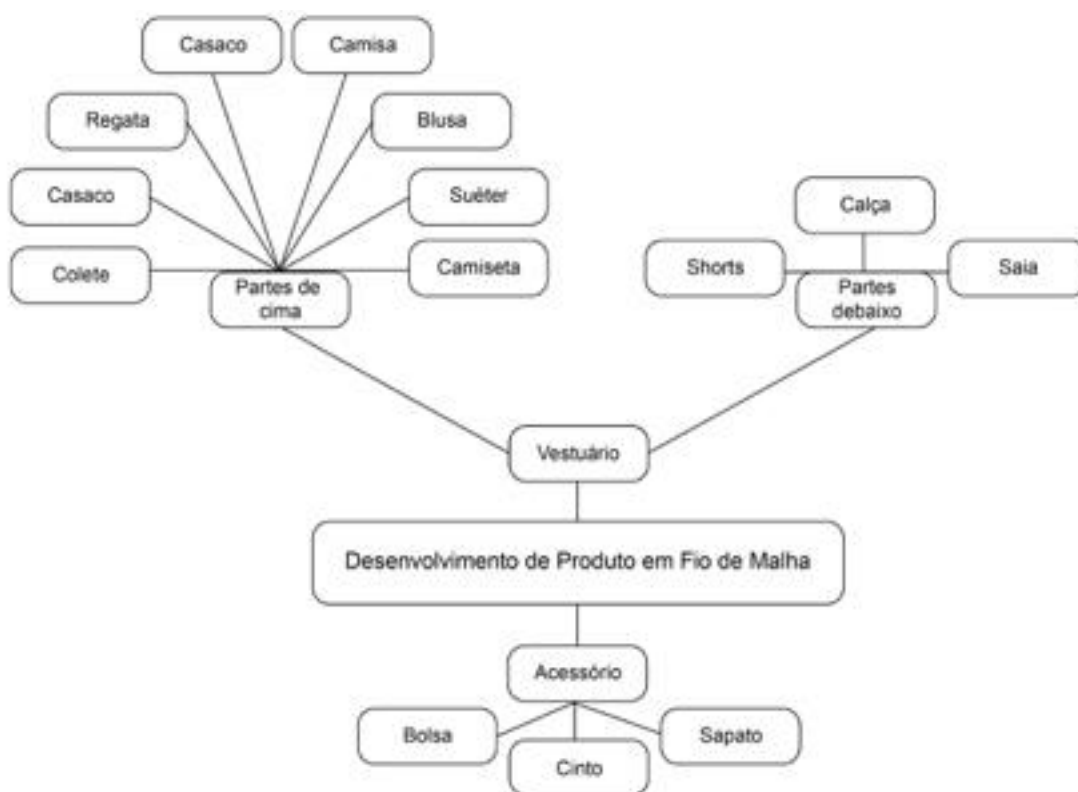
Brainstorming is a strategy for solving problems that promotes the creative thinking. It was first proposed by Osborn on his book *Applied Imagination* in 1953 and it's used to let the ideas flow naturally and help to find the solutions for a problem. The technique can be performed in group or individually. It's supposed to generate ideas in a informal and relaxed way, with lateral thinking, that incentive new unusual ideas that can take to original answers or new ideas (ALMUTAIRI, 2015; BUCHELE *et al.*, 2017; DALY *et al.*, 2017).



The tool can be used in many areas and phases of a project; it's applied to develop products and services, teaching and education, business and creating new business models and also planning and generating hypothesis, decisions and creating new strategies (ALMUTAIRI, 2015; BUCHELE, 2017).

For this research, the tool was used to search for new alternatives for innovating garments, demonstrating the possibility of recycling a resource and turn it into a new piece with a new meaning. Figure 6 illustrates the result of applying the tool.

Figure 6 - Brainstorm ideas for new garments.



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The ideas generated by the brainstorm were divided into two main categories: accessories and garments. The same group of people that were part of the brainstorm also

defined the partial parameters and the functions to make a morphological chart. Five prototypes of garments and one accessory were generated by the morphological chart.

This article will present the idea of one vest only. The aesthetics of the garment is timeless and doesn't follow any defined fashion trend. The pattern that was chosen is functional and can easily adjust to different sizes and is easy to graduate.

Different than a woven material, the development of a knit fabric or hand knitting requires the knowledge or experience with materials, shapes and techniques, where everything starts by the yarn to be used (AFFINITO, CONTI, MOTTA, 2017).

### **4.2.3 Selecting hand knitted patterns**

To start the morphological chart, a few patterns in hand knitting were tested to verify which ones were more adequate to make the selected garments. All patterns were worked in needles bigger in size, from 15mm to 25mm. The patterns testes were:

a – Garther Stitch

When all rows are worked on the same stitch - knit or purl (Figure 7).

Figure 7 - Garther Stitch.



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b – Stockinette

When rows are alternated between knit and purl (Figure 08).

Figure 8 - Stockinette.



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c - Elongated Garther and Interwined Variation

When the farther stitch is worked with a double loop to be more elongated. The intertwined variation is made by crossing six stitches (Figure 9).

Figure 9 - Elongated Garther and Interwined Variation



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#### d - Basketweave cable

It's a two stitch cable in every row to simulate a basketweave (Figure 10).

Figure 10 - Basketweave cable.



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#### e - Simple Basketweave

It's a basketweave stitch in knit and purl variation (Figure 11).

Figure 11 - Simple Basketweave.



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#### f - Turkish Stitch

This is a lace pattern (Figure 12).

Figure 12 - Turkish Stitch.



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### 4.2.4 Selecting the garment patterns

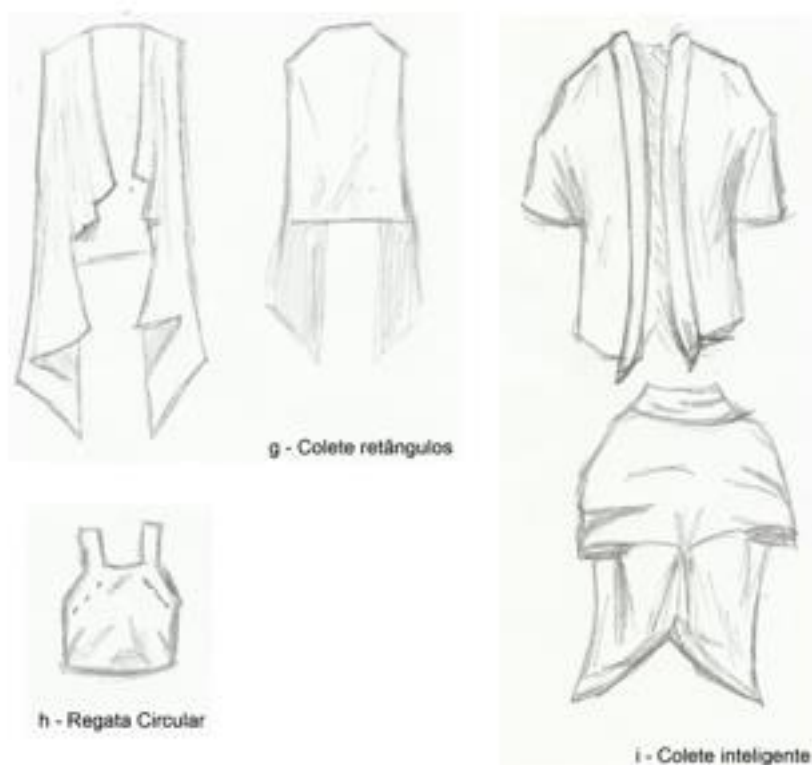
After testing the knit stitch patterns, the patterns for the garments were selected. In this stage, the patterns selected were patterns previously used by the author. Figures 13 and 14 illustrate which patterns were selected to the garments.

Figure 13 - Patterns to develop a garment in circular knit yarn.



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Figure 14 - Patterns to develop a garment in circular knit yarn.



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#### 4.2.5 Morphological chart for garment

To start the morphological chart, a flow chart with the main characteristics of the final product. The technical parameters, from finished garments to accessories, were defined by research in literature. The results were presented to the same group that participated in this research and discussed to define the partial parameters and its function in the morphological chart. The flow chart illustrated in Figure 15 presents the parameters used to create the development of garments in circular knit yarn.

Figure 15 - Flow chart to create a Morphological Chart to develop garments in circular knit yarn.

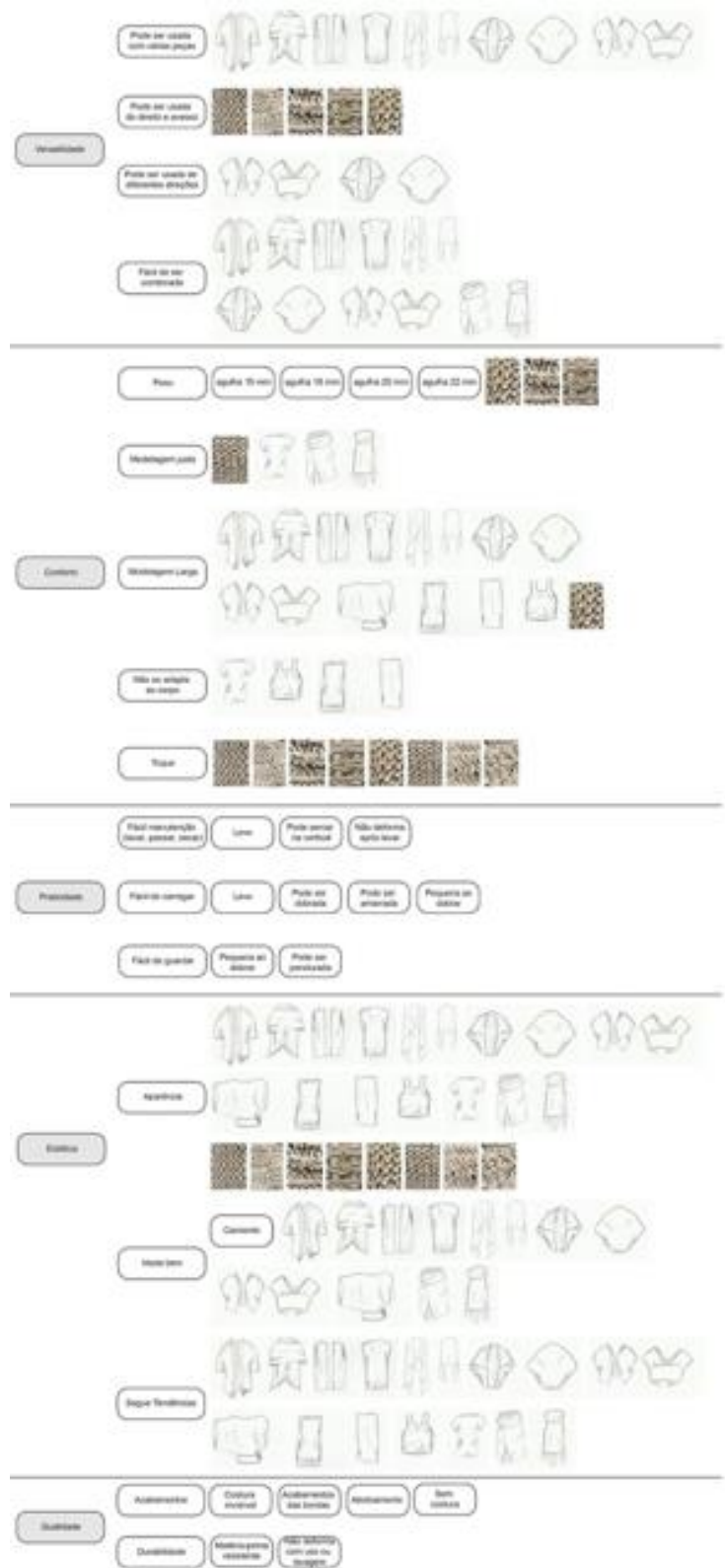


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The morphological chart was created from the flow chart. The first column was filled with parcial parameters (versatility, comfort, aesthetic, etc...) and the functions were set on the second column (can be combined with other garments, weight, etc). Figure 16 illustrates the morphological chart for garments.



Figure 16 - Morphological Chart to develop garments in circular knit yarn.



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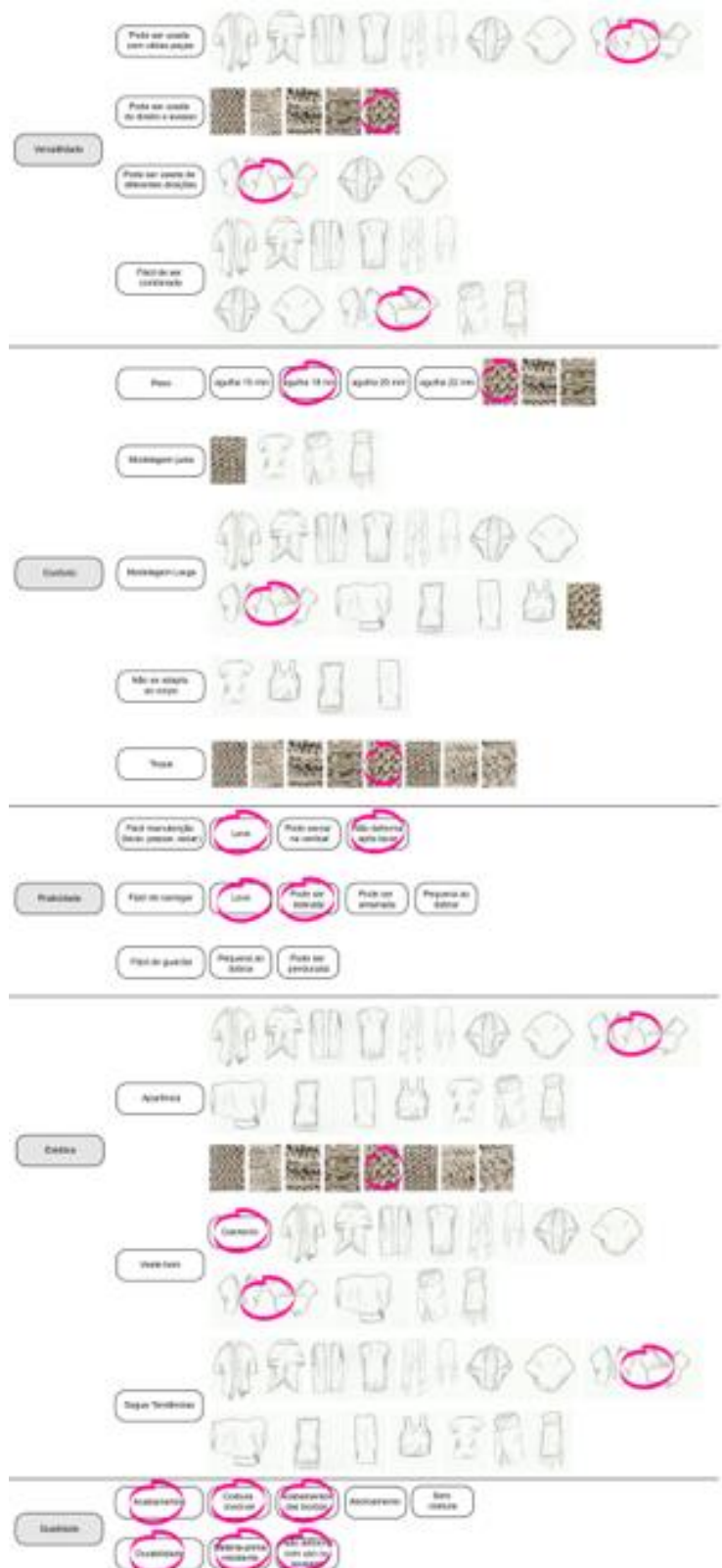
## 5. RESULTS AND CONCLUSIONS

The aim of this research was to investigate and experiment circular knit waste obtained by post-consumer waste and fabrics from the industry to verify if its viability in the use of developing fashion products using hand knit techniques and the morphological chart.

Generating a morphological chart was viable to figure out the development of sustainable fashion garments. The tool allowed to experiment around one hundred and fifty ideas of garments and the criteria for “final weight” was used to select generated ideas with potential to be developed.

After this stage, five main ideas of garments were identified and one of them was developed into a garment. An example of generating a garment is illustrated in figure 17.

Figure 17 - Use of Morphological Chart to generate a product.



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Figure 18 illustrated the final prototype, a hand knitted vest, developed following the methodology proposed in this article and the requirements shown in Figure 17.

Figure 18 - Short Vest.



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To verify if the garment is easy to be reproduced, the steps of developing these products were successfully performed by a group of crafters who work with hand knitting, but didn't participate in the previous stages of this research and didn't have any knowledge on project methodology.

Given the above, it can be affirmed that the development of a method, like the now proposed but the authors, is a valuable approach to solve a problem and to create a product by not only designers and creators and it reiterates to be possible to create and develop products and garments using crafts. On the other hand, textile waste from cotton circular knits have shown to be practicable on making fashion garments using handcraft techniques.

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