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NATURAL DYEING: SOCIAL AND ENVIRONMENTAL IMPACT AND APPLICATION OF WORKSHOPS FOR WOMEN IN VULNERABLE SITUATIONS

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ABSTRACT

The textile industry is a sector of great importance in the economy, moving billions of dollars and employing millions of people. However, due to the high use of synthetic materials and water, combined with the intensive business model and exacerbated consumption, this sector is also among those that generate the most worrying environmental and social impacts. This scenario contrasts with sustainable initiatives, such as natural dyeing, a practice that takes up ancestral methods and promotes environmentally responsible processes. Unlike synthetic dyes, natural, biodegradable and less harmful dyes stand out for reducing environmental impact and aligning with the circular economy and the Sustainable Development Goals, established by the United Nations (UN). In this context, natural dyeing reemerges as a viable alternative to mitigate

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the challenges of the modern textile industry. This approach offers a promising path to balancing production, sustainability, and ethics in fashion.

Keywords: Natural dyeing. Sustainability. Fashion Design.

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INTRODUCTION

The textile industry plays a crucial role in the global economy, moving billions of dollars annually and employing millions of people (MARATOS, 2023). However, the sector is also responsible for serious environmental and social problems, many of them aggravated by the intensive production model driven by fast fashion (MARAFON et al., 2023; MARATOS, 2023). This production format aims to meet the high seasonal demand for new products, often using unsustainable practices that compromise terrestrial and aquatic ecosystems and contribute to global warming. (DEEPAK et al., 2023).

THE ENVIRONMENTAL AND SOCIAL IMPACT RELATED TO TEXTILE MANUFACTURING

One of the main environmental problems related to the textile industry is the high consumption of water and the contamination of water bodies by chemical residues from the dyeing of fabrics (ISLAM et al., 2022). According to the Minas Gerais Association for Environmental Defense (2018), it is estimated that the sector consumes about 93 billion cubic meters of water annually and is responsible for 20% of the global waste of this resource. In addition, greenhouse gas emissions associated with industry reach about 8% of the global total, contributing significantly to the degradation of the environment by enhancing global boiling (UN, 2022). In addition, solid waste from synthetic fabrics and other improperly disposed materials increases the negative environmental impact, as evidenced by the formation of dumps that occupy 300 hectares of land in the Atacama Desert, in Chile, and by data that indicate that, in Brazil, 80% of discarded textile waste is dumped in nature (AGRO, 2022; PAÚL, 2022; DEEPAK et al., 2023).

Some of these environmental impacts are closely linked to human health impacts – local communities near textile mills experience health conditions due to mistreatment followed by effluent discharge. Among these conditions, asthma and viral infections stand out. (TAFESSE & YETEMEGNE, 2014). In addition, exposure to heavy metals from these effluents can also occur. Soil contamination also occurs, thus bringing negative effects to agriculture. Many compounds possibly present in effluents negatively affect the natural growth of plants. (SINGH, GUPTA & DAS, 2021). There is also, in most cases, a high biological activity, as well as a high biochemical demand for oxygen and a high amount of dissolved oxygen in the effluents of the textile industry due to various contaminants.

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Dominant practices like this in the textile industry are completely against the principles of one health. (PITT & GUNN, 2024).

The social impacts of the textile industry also deserve attention. Practices such as outsourcing production to developing countries often result in poor working conditions (JIN, 2022). Exhausting working hours, wages below the minimum and exposure to unhealthy and dangerous environments are common, as observed in the collapse of the Rana Plaza building in 2013, in Bangladesh, where the terrible structure and lack of inspection cost the lives of more than a thousand people. (JIN, 2022; UDIN et al., 2022; WILLIAMS, 2022). In Brazil, major brands such as Zara and Renner have been denounced for work practices analogous to slavery, demonstrating that the problem is global and persists even in contexts with labor regulations (VERONESE & LASTE, 2022).

NATURAL DYEING AS A PROCESS FOR FASHION DESIGN

Understanding that these elements concern not only the final product originating from the different sectors circumscribed to the textile chain - the case of many products in the area of fashion design, for example - we understand the relevance of the discussion that we seek to raise from this article. In this context, it is of interest to address processes intrinsically related to the textile and fashion industries based on a cross-cutting view of operational aspects and impacts of such processes, especially when guiding this perspective from what strategic design presents (FRANZATO, 2023).

According to Franzato (2023), the relationships between fashion design and strategic design are desirable, given the complexity implied in the design of fashion products, especially when dimensioning the procedural factors - something that is directly in line with the transversal approach of strategic design and the vocation to develop strategies to think/rethink design/redesign processes.

In order to explore these relationships, in this article we will focus on artisanal dyeing processes and how they can be used as a mechanism for the development of sustainable procedural strategies for fashion design, especially when combining the perspective of artisanality with a methodology that aims to standardize these processes. In this sense, our approach aims to present means of practical replication of this standardization, enhancing both the applicability in different realities of the textile and fashion industries, as well as obtaining a wide color palette from the use of the same inputs and repetition of some processes of alteration of chemical properties.

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A SUSTAINABLE ALTERNATIVE

Natural dyeing emerges as a sustainable and socially responsible alternative to mitigate the negative impacts of the textile and fashion industries. Natural dyes are extracted from plants, minerals, fungi and lichens, such inputs were widely used since the Neolithic period, where evidence is found in paintings made in caves (STOTHERS & ABRAHART, 2024). Examples such as indigo and Tyrian purple show the historical and cultural richness of these materials (STOTHERS & ABRAHART, 2024; DESAI et al., 2023). With the rise of synthetic dyes in the nineteenth century, natural dyes lost ground, and textile manufacturing began to grow exponentially. Given the current conditions, with the growing concern for our planet and the search for sustainability in different fields and sectors, natural pigments are regaining relevance (COVA et al., 2017; MILLBERN et al., 2022).

In addition, recent studies show that dyes derived from natural sources have antimicrobial and antioxidant properties, expanding their applications in industry, in addition to providing safer working conditions by reducing workers' exposure to toxic chemicals, contributing to healthier production environments (YOUSAF & AQSA 2023). In this way, the use of natural dyes promotes an interconnected approach between human health, environmental sustainability, and social responsibility, contributing to a One Health model, in which the textile industry can balance profit, environmental protection, and human well-being (PITT & GUNN, 2024).

In view of these factors, the next section of this work presents, on the one hand, the methodology developed in order to standardize and replicate the processes already mentioned. On the other hand, we also present the involvement and relationship developed with local agents, whether in learning the techniques developed, or in the production of textile and fashion products resulting from them.

METHODOLOGY

Initially, a methodology for natural dyeing of fabrics was developed using food waste as raw material and source of natural dye. The methodology developed was adapted to the different reaction media, in order to change the reaction medium (pH of the medium), and thus ensuring the maximum number of colors from a single residue.

Several laboratory experiments were carried out using the following residues: yellow or red onion skins, expired black beans and saffron root, to evaluate the parameters that

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influence this process, being established as: amount of residue, effects of fixatives (scientifically known as mordants, a term that will be adopted in this article), conditions of the reaction medium that can be neutral medium, acid or basic, color uniformity, appearance of stains and color fastness.

The second practical part of the project was conducted in a support house for women in vulnerable situations located in Porto Alegre (Brazil). The Viva Maria Support House offers a comprehensive assistance program, with health actions, psychological, social and legal support, occupational and pedagogical guidance for women in vulnerable situations. Most of them are women between the ages of 20 and 39 (80.6%), with two children. The level of education is low. These women come from peripheral neighborhoods of Porto Alegre and are referred to Casa Viva Maria by the Women's Police Station, the Reference Center for Women's Assistance and the Specialized Reference Center for Social Assistance (*Casa de Apoio Viva Maria welcomes 2.5 thousand women in 30 years of activities | Porto Alegre City Hall*, 2022). The participant's target audience consisted of women who were victims of domestic violence, whether physical or psychological. The workshops for women took place continuously, not being one-time courses. In this way, the project's audience was the same women over several sessions.

Small-scale natural dyeing techniques were explained to the women of the Viva Maria support house. The natural raw materials chosen were turmeric, coffee, yellow onion skins, red onion skins, yerba mate and beans. Natural dyeing was explained using homemade measurements and household utensils, to facilitate understanding and demonstrate that it was possible to be carried out at home. The method initially consisted of mixing, in a medium saucepan, one liter of water, three handfuls of the chosen natural raw material (one tablespoon, if it is turmeric powder) and one tablespoon of copper acetate/iron acetate/salt, these being used as mordants). The raw cotton fabric was immersed and kept in the mixture, which was brought to low heat (replaced by only boiled water, due to house rules) for 30 minutes. It is important to note that there was always a constant mixture to standardize the dyeing in the fabric, thus avoiding stains and burnt parts. Afterwards, the fire was turned off, with the mixture being kept at rest in the middle for another 30 minutes. Finally, the fabric was removed from the mixture, being dried naturally in the shade of the ambient air.

The mordants used were homemade (except for salt, which is available in the form used). To obtain iron acetate and copper acetate, a teaspoon of cornstarch, a teaspoon of

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sugar, half a cup of vinegar, half a cup of warm water and ten grams of rusty nails (for iron acetate), or ten grams of rusty copper wire (for copper acetate) were mixed in a glass container. With the mixture made, after homogenizing, it was left to rest for three days before using them. This methodology was passed on to the women and a protocol with all the measurements and step-by-step, both to carry out the dyeing and to obtain the mordants was delivered to them.

After the initial small-scale dyeing workshop, the proponents of the workshops carried out dyeing on a larger scale at home or in laboratories - with the aim of making dyed fabric available for the following workshops, to enable a greater quantity of material for later making of textile and fashion products. In the clothing workshops, some ideas were presented through a catalog, and the choice of what to produce was free. Throughout the process, handicraft techniques such as sewing, embroidery, customization and macramé were taught. In this way, all dyed raw cotton fabrics and threads were transformed into sustainable products.

RESULTS

EXPERIMENTAL RESULTS

With the methodology developed for the fabric dyeing process mentioned in the previous section, it was possible to obtain a chart composed of 48 varied natural colors. To obtain these different colors, from the same natural raw material (such as the peels of yellow onions), combinations were made between mordants, amounts of dye, heating time and conditions of the reaction medium. Thus, the methodology used was the standard one, adapted to each procedure, in order to obtain a range of different stains. Among the results obtained, it was possible to verify some relevant observations in this process, such as the effect of the mordants, conditions of the reaction medium, color uniformity, appearance of stains and color solidity.

It was possible to observe that the mordants interfere in this process, in addition to increasing the affinity between the fabric and the dye, they also change the color, affecting the intensity of the color. In this work, three types of mordants were used, namely sodium chloride (table salt), copper acetate and iron acetate. It was also observed that the results using copper acetate as a mordant were very similar to those of sodium chloride. The use of iron acetate together with the peels of yellow onions resulted in the presentation of a greener hue, thus increasing the range of colorations. Another interference is the

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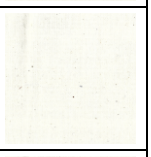
conditions of the reaction medium: in basic media (pH is greater than 7.0) the colors are generally less intense, and in acid medium (pH is less than 7.0), the colors are more intense compared to the neutral medium, (pH equal to 7.0).

The uniformity of the color in the fabric depends on its complete submersion in the solution in the heating process, thus preventing the appearance of stains. One of the potential reasons for this occurrence is that, during heating, gas bubbles form and, if the tissue is not submerged, these bubbles attach to it, causing irregularities. Thus, strict temperature control is necessary both to avoid stains and to prevent burns on the fabric. The following are the resulting colors for each natural dye extracted from food waste.

Table 1. Colors obtained in raw cotton fabrics using yellow onion skins as a natural dye.

	Acidic medium		Neutral medium		Basic means		"Control " fabric
	Code.	**Fabric**	**Code.**	**Fabric**	**Code.**	**Fabric**	
Yellow onion	CA-01 without cheek		CA-02 Without jaw		CA-03 Without jaw		
	CA-04 NaCl		CA-05 NaCl		CA-06 NaCl		
	CA-07 Ac. copper		CA-08 Ac. copper		CA-09 Ac. copper		
	CA-10 Ac. iron		CA-11 Ac. iron		CA-12 Ac. iron		

Using the yellow onion skin, a high diversity of colorations was obtained, including orange, yellow, beige, brown and green tones. Initially, the experiments were carried out keeping the amount of water and mordants fixed, changing only the amount of onion skins. With this, it was observed that the intensity of the tones is directly proportional to the amount of peels. The initial shade was yellowish and turned into an orange hue from 4.5 g of peels. We can observe this proportionality of intensity and quantity of the dye in the experiments CA-04 that was carried out with the standard amount of 6.0 g and the experiment CA-08 that was carried out with the smallest amount, being 4.5 g. After these experiments, experiments were carried out keeping the amount of water and onion skins fixed, changing the type of mordant and the conditions of the reaction medium. Dyeing

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using sodium chloride provided results very similar to those of copper acetate, making differentiation difficult. A very similar final color was observed between the results CA-05 (performed with copper acetate) and CA-08 (performed with sodium chloride), as well as the results in acid medium CA-04 (performed with sodium chloride) and CA-07 (performed with copper acetate). Thus, the use of copper acetate is not essential, given the similarity of the results with sodium chloride, a less toxic mordant. In the literature, it has already been shown that, using yellow onion skin, it is possible to obtain yellow and light orange colors (Zubairo et al., 2015).

The mordants act by increasing the affinity between the dye and the fabric and modifying the color, so for a more intense orange color, the mordant to be selected is copper acetate (Botteri et al., 2022) and, for a greener tone, the preferred mordant is iron acetate (Botteri et al., 2022). After analyzing the residues of copper acetate and iron acetate, the results found were compatible with the limits established by the legislation (CONAMA 357/05), with values within the allowed range. In addition, it was verified that the cheeks were fixed to the raw cotton fabric.

Table 2 presents the colors obtained from raw cotton fabrics using red onion peels as a natural coloring:

Table 2. Colors obtained from raw cotton fabrics using red onion skins as a natural dye.

	Acidic medium		Neutral medium		Basic means		Fabric "Control"
	Code.	**Fabric**	**Code.**	**Fabric**	**Code.**	**Fabric**	
Red onion	CR-01 Without jaw		CR-02 Without jaw		CR-03 Without jaw		
	CR-04 NaCl		CR-05 NaCl		CR-06 NaCl		
	CR-07 Ac. copper		CR-08 Ac. copper		CR-09 Ac. copper		
	CR-10 Ac. iron		CR-11 Ac. iron		CR-12 Ac. iron		

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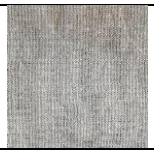
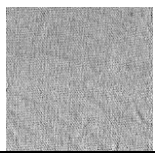
In the experiments carried out with the red onion skin, the variation of possible tones when changing the variables: amount of onion skins and conditions of the reaction medium was unexpected. The same pattern of proportionality between the amount of onion skins and the intensity of the color was observed in these experiments. The choice of the mordant to be used was another factor that influenced the final color. In the experiments carried out using iron acetate as a mordant, the final color obtained was in shades of green in neutral medium and in acid medium, while with copper acetate, we obtained a greenish color in both mediums. In the basic environment, regardless of the use of different mordants, the colors tended to beige/pink. The main challenge was to get the color pink. To achieve this coloration, it was necessary to strictly control the conditions of the reaction medium and ensure that there was no trace of residues from other experiments. In addition to these colorings, it was possible to obtain shades of beige, which have already been reported in the literature, without the need to use a fixative (Debnath, 2018). Table 3 presents the colors obtained from raw cotton fabrics using expired black beans as natural dyes:

Table 3. Colors obtained from raw cotton fabrics using expired black beans as natural dye

	Acidic medium		Neutral medium		Basic means		"Control" fabric
	Code.	**Fabric**	**Code.**	**Fabric**	**Code.**	**Fabric**	
Black beans	FP-01 Without jaw		FP-02 Without jaw		FP-03 Without jaw		
	FP-04 NaCl		FP-05 NaCl		FP-06 NaCl		
	FP-07 Ac. copper		FP-08 Ac. copper		FP-09 Ac. copper		
	FP-10 Ac. iron		FP-11 Ac. iron		FP-12 Ac. iron		

By using expired black beans as a natural dye in the fabric dyeing process, it was possible to obtain different shades of blue and grayish tones. The factor that most

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influenced the final key was the conditions of the reaction medium. In basic media the color tended to a grayish tone, and in acid medium we obtained the darkest shade of blue. In neutral medium using copper acetate as mordant, we obtained a lighter shade of blue compared to the acid medium. In these experiments we kept the amount of water and the amount of dye fixed, and changed the conditions of the reaction medium and the type of mordant. In the literature there are no studies on the effects and interactions of this process, however a patent was found on the extraction process of a black dye extracted from black beans (LI et al., 2017a, 2017b). Table 4 shows the colors obtained from raw cotton fabrics using turmeric as a natural dye:

Table 4. Colors obtained from raw cotton fabrics using turmeric root as a natural dye.

	Code.	Fabric	Code.	Fabric	Code.	Fabric	"Control" fabric
Turmeric	A-01 NaCl		A-02 NaCl		A-03 NaCl		
	A-04 NaCl		A-05 NaCl		A-06 NaCl		
	A-07		A-08 Ac. copper		A-09 Ac. copper		
	A-10 Ac. copper		A-11 Ac. iron		A-12 Ac. iron		

Finally, by using turmeric root as a natural dye in this process, it was possible to obtain a range of yellowish tones, from weak to intense tones. The proportionality between the amount of dye and the intensity of the color was also observed in these experiments. We can confirm this finding by observing experiment A-01 in which the lowest amount of dye was used and experiment A-09 in which the largest amount of dye was used. The use of different types of mordants did not cause significant changes in color, but rather in the intensity of the tones. When using copper acetate as a cheek, the results obtained were a more vivid yellow, compared to the other jaws used. As there were no significant variations in the use of different types of jaws, no tests were performed with other reaction media, in addition to the neutral medium.

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EXAMPLES OF PRODUCTS MADE

Based on the experimental results obtained in the standardization of dyeing technologies, it was possible to carry out the extension workshops/extension entrepreneurs mentioned above which, in addition to generating products of natural origin, contributed to raising awareness among the participants about the environmental and social impacts of the textile industry. These activities also promoted the training of women for their economic reintegration into society. Some of the pieces made at the Viva Maria Support House are illustrated in Figures 1 and 2.

Figure 1. Macramé stand for pots made of raw cotton threads dyed with black beans and yellow onion skins.

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Figure 2. Macramé pennant dyed with yellow onion skin.

DISCUSSION

EXPLORING POSSIBLE FUTURES FOR NATURAL DYES

The direct and positive environmental impact that natural dyes present is observable, meeting several Agnda 2030 Sustainable Development Goals. Initiatives using natural dyeing show the potential of this method to strengthen the search for sustainable processes that also impact social justice, demonstrating to go beyond a trend, representing a strategy that can be based on the Sustainable Development Goals (SDGs) (UN, 2023). For example, the manufacture of sustainable products aimed at obtaining income can be a low-investment alternative for the most needy communities, contributing to SDG 1, which aims to eradicate poverty, as well as SDG 8, which seeks to promote decent work and economic growth. In addition to these, natural dyes achieve SDG 6, which seeks to distribute clean water and basic sanitation to the entire population, and SDG 14, which aims to protect the oceans and marine life. These objectives are achieved, as natural pigments are biodegradable and less toxic to the environment, reducing the contamination of water bodies (CHIEN & GANESAN, 2024; YOUSAF & AQSA, 2023). SDG 12 addresses sustainable consumption and production, meeting sustainable dyeing technologies that use residual organic raw material, such as yellow onion skins. This organic waste, which is often discarded, can be transformed into high-quality dyes, promoting waste reduction and

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generating added value to underused materials, in line with the concept of circular economy (FURFERI, 2022; YOUSAF & AQSA, 2023).

In this context, it is possible to say that natural dyeing is a viable and necessary solution to face the challenges imposed by the textile and fashion industries, especially when we observe small-scale applications of these processes. Historically, natural dyeing involved the use of plants and heat. Therefore, in addition to improving the techniques for obtaining and dyeing natural dyes, it is possible to expand the sustainable practice aiming at positive impacts on local communities, promoting strategies that involve both environmental and social issues, also offering alternatives for obtaining income through training in the use of this technology for local agents.

When reflecting on the expansion of the sustainable practice of natural dyeing to the community, several social groups came to the fore - among them, women in vulnerable situations. The definition of vulnerability is not extremely rigid, but it can be understood that women who face poverty, exclusion, menstrual poverty, and/or violence (among other factors) are in a situation of vulnerability. According to the IBGE (2022), 6.1% of the female population in Brazil lived in extreme poverty in 2022. Regarding violence, it is estimated that 30% of women have experienced it by their partners at some point in their lives (TROISI, 2018). If you count for anyone, this percentage is probably much higher. The definition of violence against women goes beyond the concept of physical violence, and is also composed of psychological, economic or even stalking violence. With such a large portion of the female population being able to be found in situations of vulnerability, it is extremely important that opportunities for income generation and social insertion are provided to these people, and the reception by this group in relation to the work developed was extremely positive.

By seeking to build approximations between the technical approach presented and the principles of Strategic Design, we perceive the feasibility through the scenarios tool, especially in its relational dimension to futures.

In this sense, it is interesting to note that talking about future scenarios is talking about plural visions, also based on plural combinations (FRANZATO et al., 2021; VISONÁ et al.,. 2024).

As Franzato (2023) presents, scenarios have been an inherent practice of strategic design for a few decades, and the work carried out in the 1990s by Francesco Maurie is the milestone of this relationship. From Maurie's (1996) constructions, many contributions

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and new combinations were brought to practice, establishing other ways of developing future scenarios of and for Strategic Design.

In this context, we have both approaches that are more closed in on themselves, such as the Design Oriented Scenarios conceived by Manzini & Jègou (2003), and those that are more speculative (REYES, 2016; MICHELIN, 2024; MANZINI, 2024; VISONÁ et al.,. 2024). But, regardless of the approach to be considered, it is a fact that the construction of future scenarios is an essential tool in contemporary strategic planning, allowing individuals and organizations to imagine future possibilities and make informed decisions in the present (VOROS, 2017). Unlike a forecasting exercise, the scenarios aim to explore multiple potential futures, considering the complexity and uncertainty inherent in modern societies (POLI, 2015). Understanding that there are different ways to configure future scenarios, especially when considering the use of exploratory tools that provide combinations of elements for this, in this work we propose the use of a specific tool: the STEEPH Prism (RASQUILLHA, 2015). We also realize that what we consider here can - and in some way, also must - expand and establish the elements to think and design for (other) future scenarios for fashion design, finding, in this sense, a direct relationship with and for Strategic Design. Thus, in the next section we will establish connections between the factors presented here in a practical way, subsidized by the STEEPH Prism.

A PROPOSAL FOR THINKING AND DESIGNING FUTURE SCENARIOS FOR FASHION DESIGN

The STEEPH Prism tool integrates different dimensions that are interrelated in the common daily life, both on a micro and macro scale. In this context, through the tool we can elaborate connections between the social, technological, economic, environmental, political and human dimensions in a circular and interdependent approach (RASQUILHA, 2015). This methodology allows mapping relationships and developments between contemporary variables, subsidizing thinking from and for anticipation, allowing the projection of different types of futures, whether possible or desirable, or others (RASQUILHA, 2015; VISONÁ et al., 2024).

The fundamental proposal of the tool is to understand how an element identified in the present - which can be a theme, a phenomenon, a sign of change and/or rupture perceived in a specific area, a trend and/or macro trend, etc - impacts and is impacted from the interactions that are established with the particularities inherent to each relational

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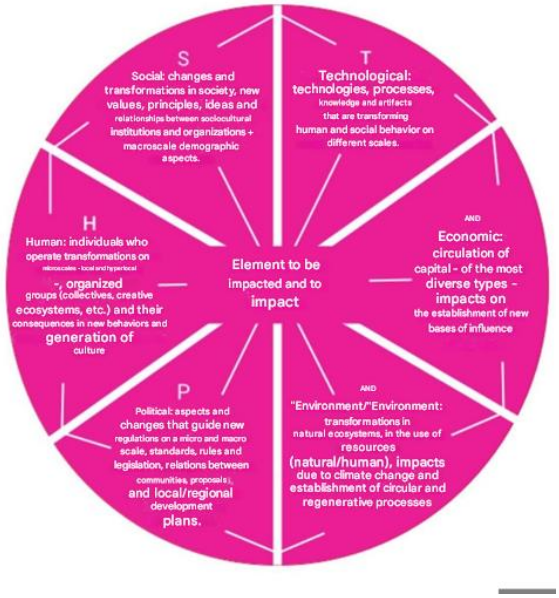
scope. Figure 3 below presents the elements that are combined through the practice proposed by the STEEPH Prism.

Figure 3. Elements of the STEEPH Prism (Adapted from Rasquilha (2015), by the authors).



Based on the combinations that the tool presents, and based on the factors presented in other sections regarding the development of the artisanal dyeing technique using natural inputs and its replication in a context of social and economic vulnerability - in the sense of providing knowledge that produces positive impacts on the lives of people who experience these vulnerabilities - we propose, precisely, that the central elements in Prisma are these and, based on this, we elaborate some future developments. It is also important to say that the developments we present are connected to the expansion of the impacts that the interconnection between factors and variables allows, and it is possible to anticipate through this exercise some possible and desirable future scenarios for the field of fashion design itself, as shown in Figure 4.

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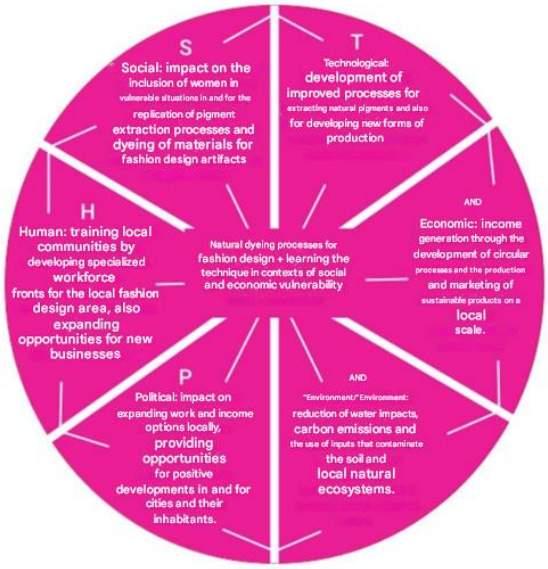
Figure 4. Future scenarios (Prepared by the authors).



Starting from what the STEEPH Prism presents to us as possibilities, we unfold a guiding element to contribute to the exercise of elaboration of future scenarios. This guiding element - the Vision - works as a factor of articulation between the aspects developed when using the tool, being the element that also presents and represents the unfolding of each scenario, as we see below:

Scenario 1: Inclusion through circularity and sustainability

Vision: By 2035, collaborative natural dyeing networks will expand throughout Brazil, led by local communities and supported by public policies and tax incentives at different levels. Women in vulnerable situations become protagonists in the production of circular and sustainable techniques, impacting the development of circular and sustainable processes for national fashion design.

Scenario 2: Adaptation of the fashion field due to overlapping crises

Vision: The year 2035 marks the milestone of a transformation on a global scale for fashion design. This occurs because due to the scarcity of water resources and the regulatory requirements of different agents of society and the market, natural dyeing has become standard in the textile and fashion industry, enabling its adoption by a large part of the industry, which see in these practices safe means of products fashion artifacts consistent with environmental demands.

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CONCLUSION

The use of the Prisma STEEPH tool in the practices of elaboration of future scenarios presented, demonstrates - albeit briefly - that natural dyeing has transformative potential when it is incorporated as a process into fashion design, providing opportunities for the construction of strategies aligned with sustainability, social inclusion and economic development. In this sense, the practice of scenarios allows us to anticipate possible developments that will produce effects at different scales: local, national, and global, facilitating the understanding of what Manzini (2024) proposes when he talks about the practical and effective use of future scenarios to the act of projection that is made from the present. As Poli (2015) points out, foresight is a tool to shape the present and create desirable futures, reinforcing the role of natural dyeing as a viable solution to the challenges of the fashion industry in the twenty-first century.

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