SUSTAINABILITY DRIVEN TEXTILE MATERIAL AND PROCESS EVALUATION SUPPORTED BY A CUSTOMIZABLE SOFTWARE TOOL

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Nowadays, sustainability has become a requirement for textile companies to remain long-term competitive. "Pandora" is a software tool that enables a systematic approach to quantify sustainability by a ranking system. Pandora can evaluate fibre material and textile technology within various scenarios or company profiles in order to recommend the most suitable substitution customized to the vision, demands, and prioritization of the user. Therefore, the software can support decision-making processes towards transparent and sustainable long-term planning of businesses. Pandora was successfully implemented in a case-based approach for the replacement of a cotton-polyester tent fabric for a Dutch company.

Key Words: Sustainability, assessment-framework, adaptive-software tool, textile material ranking

1. INTRODUCTION

Under the view of the European Commission's (EC) legal demands for 2020 goals, sustainability has become a requirement for the textile industry. Hence, companies seek to replace textile materials and processes with more sustainable alternatives. Common drivers for material or process substitution are performance improvement, fast-climbing raw material prices, and cost reduction [1]. Nevertheless, these have become concomitant reasons to improved eco- and social parameters [2,3,4]. A revision of the state-of-the-art sustainability evaluation tools [5,6,7] shows limits to help provide holistic support in the sustainability shift for textile companies.

In order to bring a systematic substitution and integrate sustainability into textiles, we designed a software tool to provide guidance by organizing information, next to defining relationships and hierarchy among components. Herein, we present a highly-adaptable tool, named "Pandora", which enables categorically different parameters to be made comparable in order to carry textile material and process evaluation according to environmental, economic, social (the three pillars of sustainability) and quality characteristics. Considering the latter, an equal or even higher performance is achieved, thus allowing the original benchmark to be replaced without affecting performance standards.

3. METHODOLOGY

3.1 Analysis of the data

The tool divides the aforementioned four categories in a set of subcategories, which are defined by the user; e.g. the environmental category may have subcategories like use of energy, water and exhaustion of CO_2. The assessment process starts by entering all data of the materials or processes to be compared. An auto-adjustable algorithm determines the highest and lowest values and sets the minimum and maximum boundaries depending whether the highest or lowest value is considered the best performing. Thereafter, four classes are generated for each subcategory, and sorting is carried out. In any case, the best value is assorted to the highest possible class, which is "class one". A final ranking is created by changing the classes into numeric values, which allows the introduction of a percentage-based weighing system. Ultimately, the ranking is displayed highlighting the optimal material or

production process tuned to the preponderance assigned in accordance to users'/companies' agenda, portfolio, and long-term planning.
Under a balanced sustainability perspective, all categories and subcategories have equal importance, and therefore have the same percentage of contribution in the ranking system. However, in order to allow more flexibility and case adaptation into the tool, several weighting factors were added. With this, different percentages can be assigned to the various categories and subcategories, thus customizing the interface to specific users' priorities.

3.2 Case-study

Pandora was first tested in a case-study looking for alternatives of a cotton-polyester tent fabric. This benchmark was compared against Lyocell, flax and hemp. Here, the environmental data were generated using the Modint EcoTool [8]. Subsequently, standardized materials tests were performed under acclimated laboratory conditions to obtain tensile strength, tear strength, and elongation at break performance data [9,10]. Economic data were obtained from literature research. A social category was not considered in this case.

4. RESULTS AND DISCUSSION

To exemplify the pragmatic and customizable functioning principle of the Pandora, some of the data from the aforementioned case study are shown. Table 1 exhibits the input data for the environmental category, comprised by CO_2 exhaustion, energy consumption, water-, chemical-and land- use as subcategories; and for the quality category with tensile-, tear-strength, and elongation at break as subcategories.

Table 1. Sample input information in environmental and quality categories for a tent textile replacement.

Material	Benchmark (BM)	Lyocell	Flax	Hemp
Environmental Category (per kg of fibre)				
CO_2 (kg) [8]	7.20	8.10	6.00	5.70
Primary E (MJ) [8]	143.40	198.60	80.30	73.20
Use of Water (l) [8]	1098.20	49.40	29.40	40.40
Use of chemicals (kg) [8]	333.20	685.00	83.00	35.00
Use of land (ha/kg) [8]	5.30	1.60	10.00	5.89
Quality Category				
Tensile strength (N)	1000	666	550	740
Elongation at break (%)	13.0	11.7	9.98	14.0
Tear strength (N)	25.0	36.0	53.5	64.0

Table 2 presents the ranking of compared materials based on two scenarios. The first is under an equal consideration of all parameters (same percentage). The second scenario is done by focusing the evaluation on quality subcategories, where tear strength has the highest importance (60%), followed by tensile strength (30%), and elongation at last (10%). Under Pandora's classification system the least score equals the best performance in the evaluation. Consequently, in the first case, flax is found to be the most environmentally friendly substitute of the original tent fabric. On the other hand, hemp results more appropriate for a prioritization with the same environmental terms, but with tailored quality subcategories based on knowing that more than half of customer complaints with the analysed product is tear-related.

Table 2. Pandora's output. Final score of compared materials under two different case scenarios.

Material	Environmental	Quality	Total score	Rank	Environmental	Quality	Total score	Rank
	Case 1: Equal preponderance				Case 2: Customer complaints driven			
Flax	8	10	18	1	8	10	18	2
Hemp	7	13	20	2	7	10	17	1
Lyocell	14	12	26	3	14	12	26	3
BM	14	13	27	4	14	15	29	4

Results from the case-study show the interface can provide guidance to conduct a fibre replacement process based on company's preferences. Pandora creates the connection between numerous and distinct parameters, marked in literature as essential to support sustainable material selection [2,3,4,11]. Furthermore, it suffices the amalgamation of sustainability-quality aspects which increases its attractiveness for companies aiming to pair their qualitative distinction with sustainability, and thus remain ahead in the market plus competitive in the long-run.

As for limitations, Pandora faces a challenge when the values required for assessment are unavailable to the user or simply do not exist. This brings an extra step for data generation or use of estimates, which makes output's accuracy uncertain. Coupling the application with an extensive textile material and process database can help to overcome this challenge. Besides, more case-studies will be performed to extensively assess the adaptiveness of the tool.

5. CONCLUSION

This research addressed the complexity of integrating a wholesome textile material and technology evaluation process when integrating a sustainability perspective. Firstly, it tackles the problem of generating a systematic approach. Secondly, Pandora is capable of assigning a score to categorically different parameters and generate a final rank with the best performing choice based on the given criteria. It brings a basis to quantify textile sustainability, and therefrom support sustainable material and process selection. Also, the consideration of quality criteria confers an added value, thus making Pandora a valuable alternative for sustainability assessment.

Pandora was successfully implemented as a case-based approach for the replacement of a cotton-polyester tent fabric for a Dutch company. A significant finding from applying the method in the company case was the possibility to merge quality-driven decisions and sustainability adoption for long term competitiveness. Comparability among different evaluated criteria enables helping textile companies in managing the ever more required sustaintability shift with ease.

6. REFERENCES

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