ADVANCES IN THE JEANS FINISHING INDUSTRY TOWARDS A MORE SUSTAINABLE PRODUCTION MODEL

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Michael Andrew Kininmonth trabalhou por 48 años na indústria têxtil, com formação em Engenharia Têxtil pela Universidade de Bolton, no Reino Unido. Ele teve uma carreira diversificada que incluiu desde fiação de fios até produção de vestuário, fabricação de tecidos até têxteis médicos, e detém várias patentes têxteis. Ele se juntou à Courtaulds pouco depois do lançamento do TENCEL™ e contribuiu para o desenvolvimento dos tecidos TENCEL™ Lyocell. Em 2004, ingressou na Lenzing Fibers, onde originou projetos como o Cotton Enhance e TENCEL X REFIBRA™. No segmento de denim e sustentabilidade, foi um foco principal de seu trabalho e, em 2023, foi listado entre as 100 pessoas mais influentes da indústria do denim pela revista WeAr.

ABSTRACT

The jeans industry is one of the most iconic within the textile sector but also one with a significant environmental impact. From cotton production to the processing and finishing of the final product, the manufacturing process of jeans can be highly polluting. The complexity of the manufacturing chain and the high number of stages, often carried out by different companies, make it difficult to objectively analyze the impact at each stage of the production. However, one of the areas recognized as having the greatest impact is garment finishing, where complex processes combining dry and wet treatment techniques are applied to achieve a specific appearance and garment performance.

The jeans finishing industry has been and continues to be a primary focus for reducing environmental impact in jeans manufacturing. Currently, various technological alternatives exist that significantly reduce environmental and human impact compared to traditional techniques by reducing water and energy use, implementing safer chemicals, and replacing manual techniques that negatively affect workers' health.

This work aims, through the EIM environmental impact measurement software, to analyze data from more than 100,000 measured jean styles to offer a clear view of the current industry. The impact categories collected by EIM (water and energy use, characteristics of the chemicals used, and the impact on workers from manual garment treatments) will be analyzed, as well as the available alternatives to reduce this impact. Furthermore, the analysis will help identify the main challenges of this industry to advance towards a sustainable transformation. This work also aims to lay the foundations for monitoring progress in this field.

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"An ounce of action is worth a ton of theory"

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1.- INTRODUCTION

"You can't improve what you don't measure" (Peter Drucker)

Climate action is becoming increasingly important for the textile apparel industry. Whether it is from external pressure by consumers or investors, (inter)national legislation, entrepreneurial spirit or risk management, more companies are taking steps to incorporate climate action all along their value chain.

The textile industry is one of the oldest and largest manufacturing sectors in the global economy, providing employment to millions of people and essential products for daily life. Companies in the textile supply chain are key to this climate action movement, as they account for some of the most resource-intensive areas of the industry.

How significant the environmental impacts are is a matter of debate. In order to be able to make credible environmental impact claims, it is necessary to be able to have access to credible data, and this concept is the basis of this report in regard to the denim and jeans industry.

The year 2023 marked the release of the final instalment of the Intergovernmental Panel on Climate Change's (IPCC) Sixth Assessment Report (AR6) [(1),] an eight-year-long undertaking from the world's most authoritative scientific body on climate change. This report gave a stark final warning to the world:

We have to limit global temperature increases in line with the 2015 Paris Agreement by transitioning to net zero by no later than 2050. If there is no immediate action, the consequences of rising greenhouse gas emissions around the world will be devastating, destroying homes, jeopardizing livelihoods, and fragmenting communities, among other impacts.

Published data by the European Union [(2)], suggest that the textile sector is the third largest source of water degradation and land use, responsible for about 20% of clean water pollution and upto 10% of total carbon emissions, making textiles the second most polluting industry in the world.

However, these figures have since been challenged. A combination of data from the World Bank, EcoTextile News and the Apparel Impact Institute (Aii) details more up-to-date figures.

According to the Apparel Impact Institute (Aii) Roadmap to Net Zero report [(3)], the textile and apparel fashion industry's carbon footprint fell slightly in 2022 although the long-term trend remains upward. Estimates suggest that the sector was responsible for 879 million tonnes of carbon dioxide equivalent (CO_2e) in 2022, compared to 897 million tonnes in 2021, a 1.17% decrease. However, the apparel sector's emissions are still projected to be 1,243 million tonnes

in 2030 whereas they need to fall to 489,000 to stay within the 1.5°C goal of the Paris Agreement.

The 2022 figure represents roughly 1.85% of global GHG emissions, according to Aii, which bases its figures on fibre volume data from Textile Exchange and GHG impact data from the Higg MSI tool.

Reliable data on water use is even more difficult to quantify. The garment and textile industry is known for its high water consumption, which annually uses 79 trillion litres of water [(4)], enough to meet the needs of 27% of the world's population under WHO standards.

Therefore, it is widely accepted that water usage in the textile supply chain is significant, and very high water use per unit of production in many facilities is not acceptable. In the world of wet processing, (of which laundry processing is part of), the difference between the world's best and world's worst facility in terms of water and energy use for a given process is believed to be around a factor of 10. It's also estimated that textile processing also contributes significantly to global industrial wastewater, posing risks to both human health and aquatic life if untreated.

There have been many well-meaning scores, schemes and measures to show how good or bad brands, products, processes or facilities are, or how they are progressing towards targets. The textile sector has seen a proliferation of voluntary schemes and green labels – over 100 are listed in the Ecolabel Index. In the debate around the use of the Higg MSI (material sustainability index) tool in apparel fashion, one of the most common issues raised is data. Is data being used to underpin Higg labels of sufficient quality? Is it up to date and credible?

This is particularly relevant to the denim finishing industry. This is a sector which, unless you work or have worked in it, is mis-understood within the textile industry. From being a marginalised, niche part of the denim industry in the 1970s and 1980s, the industry expanded rapidly to become the product development driving force of the denim business in the 1990s and 2000s.

The denim industry is unique, in that industrial processing extends beyond the cut and sew operations. Much of the final products added-value happens following garment making, as does the possibility of significant environmental impacts taking place.

There is no doubt that the denim finishing industry has contributed significantly to environmental impacts, however the 'deviation' from a typical apparel supply chain has meant that denim products did not fit the existing voluntary schemes or initiatives, consequently the lack of a collective approach to measuring and assessing these impacts means that the denim finishing industry has remained an outlier within these schemes.

The issue is that we need a standardised way to calculate environmental impact. Leading industry bodies Apparel Impact Institute (Aii) and the Zero Discharge of Hazardous Chemicals (ZDHC) are working on benchmark guidelines for both CO_2 emissions and water use in garment and textile manufacturing facilities. Aii aims to create benchmarks for carbon emissions for factories and processes across the fashion and textile industry supply chain, while ZDHC aims to establish guidance limits for water use in mills and factories.

The EU is pushing for standardisation with its Green Deal, which states: “Companies making ‘green claims’ should substantiate these against a standard methodology to assess their impact on the environment.”

Additionally, the EU’s Product Environmental Footprint methodology (PEF) is aimed at assessing all the environmental consequences that happen during the life cycle of a product –from emissions to water, air, and soil. It also includes resource use and the implications of land and water usage. The PEF methodology has stricter standards than a standard LCA and contains product-category-specific regulations, all standardised and decided upon by the European Commission. The method is still under review, but some evidence suggests PEF evaluations are more reliable than single LCAs

The fact that the EIM. (Environmental Impact Measuring software) relies on internal specialist knowledge and expertise from the sector, the results that it produces are relevant, accurate and comprehensive. Therefore, the vision is that benchmark guidelines for the garment processing sector will sit alongside or be adopted by these other key guidelines and standards, demonstrating the denim finishing industry is serious about driving environmental improvements.

2.- SCOPE OF THE REPORT

“If competition got us into this mess, perhaps collaboration can get us out.”

The environmental impacts of the textile production chain are linked to the use of resources and chemicals. One of the most impactful areas is garment finishing, where dry and wet processing steps are combined to achieve specific looks, colours, hand feels, or functional properties.

Fig.1 Denim value chain and main environmental impacts.

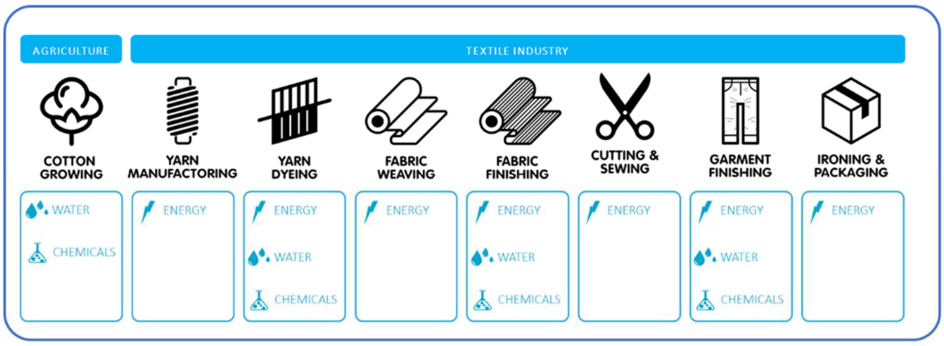


Fig.2: Vintage details of a garment

This industry has long been better known for the 'art' rather than the 'science' – out of all the apparel sectors, denim is a product which historically was mainly handcrafted and required a lot of manpower. So, as well as the associated environmental issues, there are also ethical issues related to health and safety.

Over the last decade and half, the industry has been undergoing a dramatic, technology-fuelled makeover. It has been likened to an analogue to digital (r)evolution. New technologies have facilitated optimized processes which have allowed for significant reductions in environmental emissions and improved worker conditions.

This technological 'opportunity' however, has only been grasped by a limited number of companies and so many of the 'ills' of the past still remain.

The fashion apparel sector must unite to address its particular social and environmental challenges. As one of the planet's more polluting industries, it has much work to do. For apparel manufacturers, retailers and brands this means collaboration and progress, not conflict and platitudes.

Brands, retailers and manufacturers must collaborate to fill the current gaps in sustainability data. Without it, there is no credible way forward. To reach crucial climate and human rights goals, each company must first understand its current status. Otherwise, there is no way of knowing what action to take. That's why independent, scientifically accurate and standardised data is essential.

Substantial systemic change only happens when all stakeholders are all involved. Our industry – with its immense creativity, innovation, knowledge and ability to collaborate pre-competitively – has the capacity to be an example for others.

This report aims to guide the garment finishing industry towards greater environmental responsibility by identifying challenges, uncovering opportunities, tracking progress, and promoting transparency through a comprehensive examination of environmental metrics. The data for this analysis was collected using the EIM (Environmental Impact Measuring) software throughout 2024 (from January 1st to December 31st).

By analysing EIM data, the report focuses on several key areas:

a.- Identifying Major Challenges: Analysing data to pinpoint the most significant environmental challenges faced by the garment finishing industry. This includes assessing the impact of water usage, chemical consumption, energy efficiency, and the effects of industrialized manual practices on worker health. Understanding these challenges is crucial for developing targeted strategies to mitigate negative environmental impacts.

b.- Uncovering Opportunities: Highlighting areas where the industry can make significant improvements. This could involve identifying best practices, innovative technologies, and sustainable methods to reduce the environmental footprint. By showcasing successful case studies and benchmarking against industry standards, the report aims to inspire and guide garment finishers towards more sustainable practices.

c.- Tracking Evolution: Monitoring the industry's progress over time through annual reports, using EIM data to track improvements and setbacks. This longitudinal analysis provides valuable insights into the effectiveness of implemented strategies and helps adjust approaches as needed.

d.- Promoting Transparency and Accountability: Making the findings accessible through annual reports to promote transparency within the industry. This openness encourages accountability and fosters a culture of sustainability. Industry stakeholders can use the data to make informed decisions and support sustainable practices.

3.- ABOUT EIM

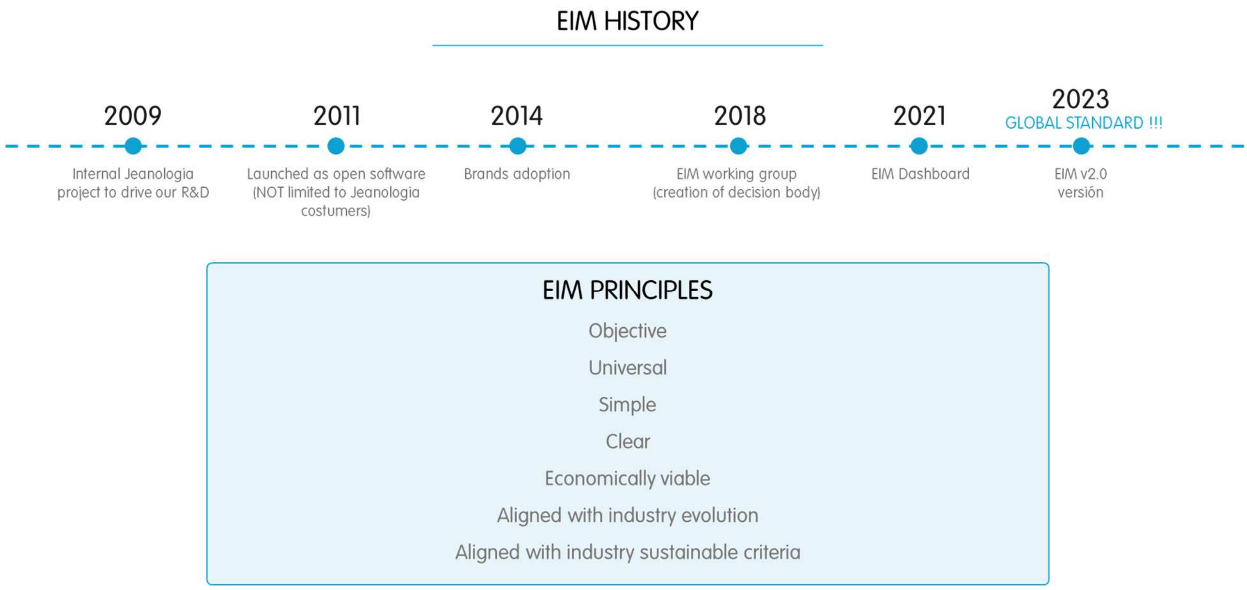
“Serendipity (noun): The occurrence and development of events by chance in a happy or beneficial way”

EIM stands for “Environmental Impact Measuring”. It is a software platform designed to evaluate the environmental impact of garment finishing processes. EIM evaluates the impacts of four categories: water consumption, energy consumption, chemical products and worker health. The results are calculated and EIM scores are generated in a simplified traffic light format classifying the overall process into low, medium, or high impact.

If anyone had predicted that the EIM software would become an industry standard back in 2009, when it was just a bullet point on the agenda of a ‘Brainbox’ meeting (‘Brainbox’ being the name of the R&D team in Jeanologia), no-one would have believed it.

The development of the EIM software was initially something of a ‘Friday afternoon side project’ that had to be fitted in around a busy working schedule. In 2009, Jeanologia were at the forefront of garment laundry R&D. They were leading the sector into a new era of environmental responsibility, based around new machines, products and processes. A request was made internally from both the engineering and design departments to develop a way of demonstrating the advantages of using and adopting the new machines and processes.

Fig.3: EIM History & principles



The resultant internal software platform that was developed proved to be a great tool to direct Jeanologia's development teams; not only to develop commercially attractive garments but also to focus on the "how" those garments were manufactured; motivating the teams to study ways to reach the equivalent aesthetics but resulting in lowering the environmental impact of the processes applied to those said garments.

Over time, the software was demonstrated to customers by the sales and technical teams – initially to laundries and subsequently brands, as a way of marketing the new products Jeanologia were developing for the industry. Aside from the environmental aspects of the EIM, there was a realization by the laundries and brands that adopting alternative processes could also result in cost savings.

Encouraged by the breadth and speed of adoption of the EIM platform, there was a realisation that changes were needed, if the ambition to have the EIM embraced as an industry standard were to be realized. It was clear that in order to determine the credibility of the EIM, there was a need to establish some level of independence. Thus, 2018 saw the formation of an advisory working group, consisting of members both from the laundry sector as well as brands and retailers. This was a crucial appointment, as it brought a new level of unbiased, critical feedback and diverse perspectives on to how the EIM was to be managed and developed for the future.

The result of launching a commercial version of the software has resulted in the possibility of adopting a continuous improvement tool – ***a tool that is available to everyone in the finishing industry, whether Jeanologia technologies are employed or not.***

The EIM is open to use on all finishing equipment, including those manufactured by direct Jeanologia's direct competitors, thus facilitating the standardization of its use with clear and transparent measurement rules and criteria, as well as facilitating access to every kind of producer.

Jeanologia has approached the makers of other sustainability measurement platforms, however, the needs of the garment processing industry were not a easy fit and so the EIM has subsequently flourished because it is based on the knowledge and expertise of people from within the industry.

EIM is a versatile tool, which helps both technical and non-technical understand the manufacturing process and assess the environmental impact of their garments.

Key features of EIM include:

- Identifying high-impact areas and taking actions to reduce the environmental footprint.
- Comparing different processes to make informed choices.
- Monitoring the effectiveness of those choices.
- Encouraging the adoption of new finishing techniques to reduce environmental impact.
- Providing a standard measure for the environmental footprint of garment finishing, regardless of production location.
- Providing a standard measure for the environmental footprint of garment finishing, regardless of machinery used.
- Offering a new decision-making element for both B2B and B2C buyers.

Overall, EIM is a powerful self-accreditation tool designed to enhance the environmental performance of garment finishing processes, such as denim jeans, garment wash and garment dye.

The calculation of the EIM score starts with a description of the process or recipe applied to a garment in the following 3 steps:

1.- **Quantification**: Each category is measured using specific criteria and calculation methods. To gather the necessary data, the software guides the user on the information to be given according to the machine selected for each step of the process.

2.- **Benchmark**: The results from the quantification step are compared against predefined environmental thresholds for each impact category. These thresholds help determine whether the category impact is low, medium or high.

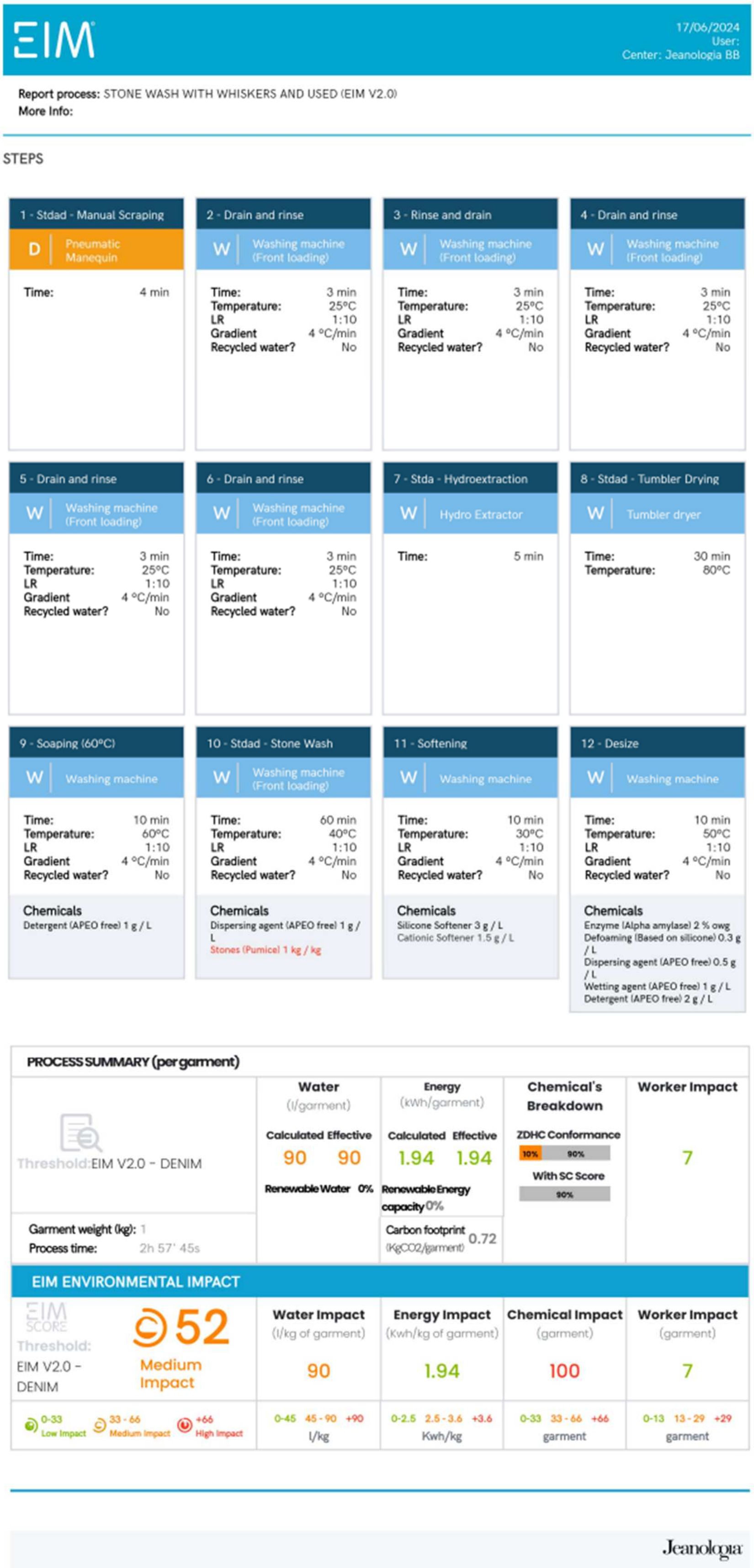
3.- **EIM score calculation** The final EIM score is calculated as the average of the scores from the four categories. The score allows to classify the overall environmental impact of the production process as process of low, medium or high impact to the environment.

3.1.- Calculation Steps:

A garment finishing process involves multiple steps, which can be categorised as either wet or dry. Wet steps are performed on batches of garments, while dry steps are carried out on individual garments.

The definition of each step begins with selecting the machine or tool. Based on the chosen equipment, the system will guide the user to input information related to step variables that may affect the environment or workers' health. Once all process steps are defined, the system will calculate the impact according to the criteria for each category, as summarized below.

Fig.4: Example of EIM process report detailing the combination of wet and dry steps.



3.1.1.- Water Consumption:

The quantity of water consumed in every single step of the process, will vary depending on the liquor ratio (liters of water per kg of garments) defined for every step of the washing / dyeing process. The total quantity consumed in a complete wet garment process is the sum of the liters required for each of the steps that involved water.

When using recycled water for one step, a correction factor will be applied to the calculated water. The factor applied is calculated based on the capabilities of the production site to clean and re-use water and express in the EIM report as effective water used.

Water consumption is related to the kilos of garments produced but since the weight of the garment is a required value, the report gives also the liters required per garment produced. EIM score calculation is based on the effective calculate per kg of garments produced.

3.1.2.- Energy Consumption:

EIM aims to use an energy calculation methodology that allows the user to have an accurate estimation of the energy requirements with independence of the specific machines and installation. This methodology will allow comparison between processes made at different locations and / or following different finishing processes at a product level. The energy calculation result, need in consequence, be taken as a reference as well as good estimation on the process efficiency.

EIM measures the total energy required in kwh considering both the one required to run the machines (electrical energy) and the one required to heat the water and the air for drying processes. Electrical energy is variable as per the machine running time and the nominal power of the machine used. The heating energy will depend on the final temperature to reach, the quantity of water or air to heat to the set point. It also accounts for the heating energy the one required to maintain the set temperature through the step processing time. The capabilities of a production facilities to generate clean energy, is also considering in EIM. The calculated energy is corrected by calculating the correction factor according to the percentage of self-sufficiency in renewable energy of the facility. Equally to water, energy value consider for the calculations of the EIM score is the effective energy required per kg of garment produced but as in water, data per garment produce is given in the reports.

Based on the energy requirements, EIM can give as well a first estimation on the kg of CO2 emitted by each garment produced. For this first estimation we are considering an average factor mix (current factor mix: 0.46) for the electrical energy. To calculate CO2 emission due to the use of fosil fuels, the consideration taken is that most common heating sources are gasoil and gas. In consequence an emission factor of 0.29 is the one consider calculating emissions due to heating energy needs.

3.1.3.- Chemical Impact:

Currently the EIM. focuses on the chemicals used and their individual characteristics. The methodology adopted by EIM. to quantify and calculate the chemical impact as a number involves first scoring each chemical product or formulation used in the finishing process. Scivera, (https://www.enhesa.com/about-us/) an Enhesa Group company, brought its expertise to define the EIM. Chemical Impact Score (CIS) and its calculation methodology. Scivera is a leader in providing chemical suppliers, formulators, manufacturers, and brands across all industries with intelligence about the chemicals they are using in their products.

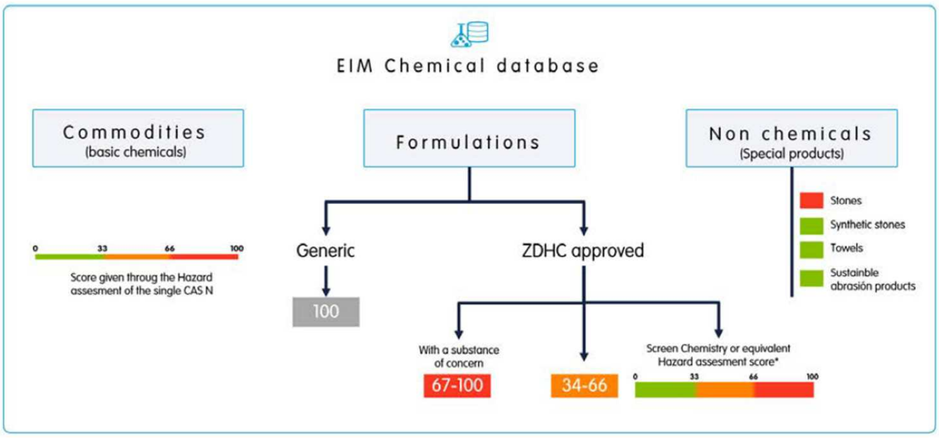
The EIM. CIS integrates ZDHC MRSL (Roadmap to Zero)conformance and the hazard assessment of each individual ingredient of a chemical product or formulation, following the Screened Chemistry Score methodology. The need to have each chemical characterized and scored according to the defined criteria also makes it necessary to have a list of options from which the user can select the chemical formulations or commodities they are using in their processes.

The EIM. chemical database currently lists more than 3,000 options, among which we find the following groups:

- **Commercial formulations** with at least ZDHC Level 1 third-party certification. This is the minimal requirement for a commercial formulation to be included in the EIM.
- **Commodities or basic chemicals**.
- **Generic chemicals** based on functionality such as enzymes, detergents, softeners, etc.
- **Other special products** such as pumice stones and their alternatives, which are not chemicals but can be considered as such when describing a garment finishing process.

All chemicals in EIM. have their EIM. CIS represented by colour and a number. The EIM. CIS can range from 1 (most sustainable chemicals, preferred chemicals to be used) to 100 (products of concern with significant environmental or human health hazards).

Fig.5: EIM chemical scoring data base scheme



The chemical impact score is calculated through a complex algorithm that considers both the EIM. CIS and the quantity of each chemical used. The algorithm has been developed by Summera (Sumerra - Workplace and Environmental Consulting), an advisory company with expertise in sustainability rating systems, including data modelling and calculation.

An example of products of concern is pumice stone. Pumice stones belong to the group of special products used to achieve a specific look. The use of pumice stones during the garment finishing stages is unmatched in its ability to achieve what is considered authentic wear and tear or vintage look. The use of pumice stones is associated with relevant negative impacts, including habitat degradation occurring during the extraction of the pumices, intensive water use and water pollution, generation of solid waste, and impact on worker health due to exposure to pumice dust. A natural, though not renewable, resource, pumice handling and use generates considerable pollution in denim finishing processes. The transportation of these heavy loads contributes to greenhouse gas emissions. Their handling is time and space consuming. Their abrasive properties not only degrade jeans but also washing machines. As they break down into finer particles and dust, they require numerous rinse cycles to clean garments, and they generate difficult-to-manage sludge and effluent. That is why the chemical impact is scored as 100 (the worst possible rate) when pumice stones are used in the finishing process.

Fig.6.- Chemical impact when using pumice stones

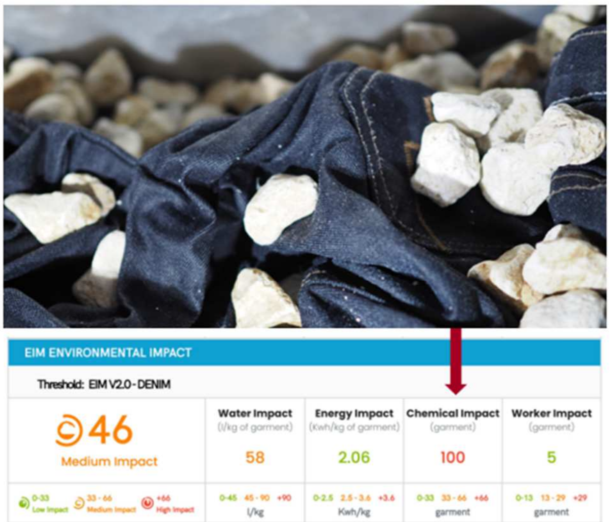


Fig.7: Chemical impact calculation algorithm.

For the calculation of the chemical impact the following factor are being consider:

- A factor (W) that will consider the sustainability of the chemicals used in the recipe.
- A factor (Q) that will consider the total quantity of chemicals in a recipe.
- A factor (N) that will consider the number of unique chemicals in a recipe.

The score (S) will be the average of the three factor scores.

$$S = (W+Q+N)/3$$

The Sustainability factor will be a simple mean of the maximum EIM CIS score of the chemicals used in the recipe.

$$W = \text{Weight Score} = \{csi, \; ...csn\}$$

Where csi = EIM CIS Score for each chemical

For the quality factor (Q), each chemical in the recipe will be put in a cluster based on the EIM CIS score:

- Cluster 1 < 34
- Cluster 2 = 34 to 66
- Cluster 3 >66

Each cluster is weighted by a multiplier as follows.

- Cluster Multiplier 1 (CW1) = 0.5
- Cluster Multiplier 2 (CW2) = 1
- Cluster Multiplier 3 (CW3) = 3

The sum of the % of on weighted goods (o.w.g) in each cluster is multiplied by the number above and added together to generate a sum of weighted cluster scores (Wsum)

$$Wsum = (\sum\{owgi...owgn\}, cl=1)*CW1 + \sum\{owgi...owgn\}, cl=2)*CW2+ \sum\{owgi...owgn\}, cl=3)*CW3$$

Where $owgi$ = o.w.g. for each chemical in the cluster (cl)

n = number of chemicals in the cluster

Once the Wsum is generated we use the sigmoid function to create a sigmoid curve using a scaling factor (steepness of the curve) and a start value (point in curve where scale increases exponentially) for the designed curve and generate the Q factor.

$$Q = 100 / 1+e(-kq*(Wsum-sq)$$

Where Kq = scaling factor = 0.08

Sq = Start Scale = 20

For the number factor (N) the number of chemicals in each cluster (see above) are counted. Each cluster count is weighted by a multiplier as follows:

- Cluster Multiplier 1 (C1W) = 0
- Cluster Multiplier 2 (C2W) = 1
- Cluster Multiplier 3 (C3W) = 5

The count of each number in the cluster is then multiplied by the number above to generate a sum of weighted number scores (Nsum)

$$Nsum = ncl1*C1W + ncl2*C2W + ncl3*C2W$$

Where $ncl1$ = number of chemicals in cluster 1

$ncl2$ = number of chemicals in cluster 2

$ncl3$ = number of chemicals in cluster 3

Once the Nsum is generated we use the sigmoid function to create a sigmoid curve using a scaling factor (steepness of the curve) and a start value (point in curve where scale increases exponentially) for the designed curve and generate the N factor.

$$N = 100 / 1+e(-kn*(Wsum-sn)$$

Where Kn = scaling factor = 0.2

Sn = Start Scale = 20

3.1.4.- Calculating Worker Impact:

The health impact of each technique used in garment finishing is analysed, including assessing the risks associated with manual operations and the potential health hazards for workers. Each operation is scored based on its ergonomic hazard risk detailed in the hazard risk matrix inspired in the work developed by experts in ergonomics of the UPC (Universitat Politècnica de València). The focus is on eliminating operations with inherent health risks for workers, regardless of administrative measures in place.

Fig.8 : Worker impact risk matrix

RISK FACTOR MATRIX

	Manual scraping	Ginding with manual grinding device	Grinding with table grinding machine	Damages wih manual grinding device	Damages with cutter	Automatic Damaging machine	Spray	Sponging	3D Whiskers	Mnual Tagging	Automatic tagging	Laser markig
Repetitve mouvements	2	0	1	0	2	0	2	1	1	1	1	0
Load handling	0	0	0	0	0	0	0	0	0	0	0	0
Force application	1	0	0	0	0	0	0	0	0	0	0	0
Force postures	2	2	2	2	2	0	2	2	2	2	1	0
Vibrations	0	2	2	2	0	1	0	0	0	0	0	0
Contact preasure	1	1	2	1	1	0	0	0	0	1	0	1
Themal local environment	0	0	0	0	0	0	1	0	1	0	0	0
Noise local level	0	1	1	1	0	1	2	0	1	0	0	0
Atention and risk	0	1	1	1	1	0	0	0	1	0	1	0
Repetitivity and monotomy	1	1	1	1	1	1	2	1	1	1	1	0
	7	**8**	**10**	**8**	**7**	**3**	**9**	**4**	**7**	**5**	**4**	**1**

0 = Low probability to happen ; 1 = Medium probability to happen; 2 = High probability to happen

3.2.- Benchmark

Once each category is calculated, they are compared against an environmental threshold. The EIM. user can choose from three different thresholds, each suitable for a specific market segment: denim finishing, garment dyeing and garment wash. Each of the thresholds is defined using methodologies that consider common industrial processes for each garment segment.

Fig 9: EIM Threshold by garment segment.

Definition of water & energy thresholds:

For water and energy thresholds, basic industry processes are identified for each garment segment, and upper and lower limits are set using average water and energy consumption of those processes.

Fig. 10.- Water and energy threshold definition for denim finishing processes.

Water and Energy threshold definition for denim products.

1. Identification less impacting processes (Rinse (Dark) / Medium Dark).
2. Identification of more impacting processes (Stone/Enzyme bleach // Super Bleach).
3.
4. Determine "Low impact threshold " as the average water & energy requirement for 1 kg of garment of less impacting processes.
5. Determine " medium impact threshold" as the average water & energy requirement for 1 kg of garment of all 4 processes.

Process Name	Garment Weight (kg)	Water l/kg	Energy kwh/kg¶
Rinse wash (less intensive wash 1)	1	30	2.16
Medium Dark wash (less intensive wash 2)	1	60	2.5
Light bleach (high intense wash 1)	1	120	4.34
Super Stone bleach (high intense wash 2)	1	145	4.78

Fig. 11.- Water and energy threshold definition for garment dyeing and garment washing.

Water and energy threshold definition for garment wash and garment dyeing processes

Water and energy threshold definition for garment wash and garment dyeing processes

1.- Identification basic processes

2.- Calculate average water and energy requirements.

3.- Determine the "low impact thresholds" calculated as the 30% improvement from the average of the 2 processes.

4.- Determine high impact threshold as everything that goes above the 10% of the average.

Process Name	Garment Weight (kg)	Water (L/garment)	Energy (kWh/garment)
Enzyme Wash I	1	60	2
Basic Wash I	1	10	1.11

Process Name	Garment Weight (kg)	Water (L/garment)	Energy (kWh/garment)
Polyamide dyeing 1:10	1	90	3.85
Reactive dyieng 1:10	1	120	3.78
Wash-down cationisation & dyeing 1:10	1	110	3.18

Chemical impact threshold definition:

The chemical impact threshold is calculated directly, with scores ranging from 0-100: 0-33 indicating low impact, 34-66 medium impact, and 67-100 high impact.

Worker impact Threshold definition

The worker impact threshold methodology involves identifying available methods to replicate one vintage detail such as whiskers, damages, and grinding calculating the EIM worker health impact for the lowest, highest, and average combinations. The threshold ranges are defined as green for the lowest impact combination, orange for the average impact combination, and red for the highest impact combination. This comprehensive methodology ensures a thorough assessment of environmental and worker impacts in garment finishing processes.

Fig. 12: Worker impact threshold definition

1. Identification of most common effects that required manual operations:
    - Whiskers and used area
    - Damages
    - Grinding of waist band, waist band and bottom
    - Whiskers and used area enhancement
2. Identification of available methods for each of the effect
3. Calculation of EIM worker health category impact of the lowest, highest and average possible combina-tions.
4. Green upper limit range of the Worker impact threshold will be the score of the lowest impact combina-tion. Orange upper limit range, the score of the average impact combinations and the Red upper limit range, the score of the highest impact combination

		EIM Operation Score	Low Risk	High	Med/ High	Med/ Low
Wiskers and Used Areas (1 operation)	Laser Marking	1	1			
	Manual Scrapping	7		7	7	7
Damages	Cutter	9		9		
	Pneumatic Griding device	8			8	
	Laser	1	1			
	Damage automatic machine	3				3
Grinding	Table griding machine	10	10	10	10	10
Effect	Sponging	4				4
	Spray	8		8	8	
	Laser marking	1	1			
			13	34	33	24
						29

The threshold for worker impact is therefore:

Low worker impact: 0-13

Medium impact worker: 14-29

High worker impact: +29

3.3.- EIM. Score Calculation And Process Classification

According to threshold, the category score is transformed through an algorithm into a common scale that goes from 0-100; the first third (0 to 33) is classified as the low impact section, the second third (from 33.1 to 66) medium impact and the third one (66.1 to 100) the high impact one. The overall EIM. score is the average of each 4-category score for the denim finishing processes. Worker impact category does not account on the EIM. score of garments dyeing or garment wash processes since dry steps are not relevant in most common processes of these two types of processes.

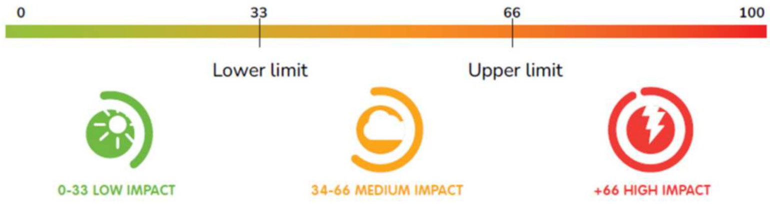


Fig.13: EIM score classification scale.

4.- DATA ANALYSIS

"Without data, sustainability efforts are blind; with accurate data, we can target interventions and measure real impact."

In EIM terminology, a "process" refers to the treatment applied to a specific garment style. Since its launch in 2011 the EIM database accounts for nearly 1 million processes from over 500 users. The analysis of the data considered for this report account for 133.198 processes gathered from January 2024 to December 2024, as it exclusively uses processes measured through EIM V2.0 which replaced the previous version in July 2024 after a year of transition.

EIM operates on self-evaluation principles, highlighting the importance of reliable and accurate data. To maintain data integrity, two key initiatives have been developed and implemented. The first is an accreditation programme created and managed by Jeanologia, designed to ensure all EIM users possess a uniform understanding of the software. This programme certifies users' capability to produce accurate reports. The second initiative introduces third-party validation, conducted by GoBlu International Limited (https://www.goblu.net/), an independent organization dedicated to advancing sustainable practices. This validation involves comprehensive assessments done at both the facility level and product level, reviewing both past and current orders, as well as ensuring robust management systems are in place to secure data effectively and accurately.

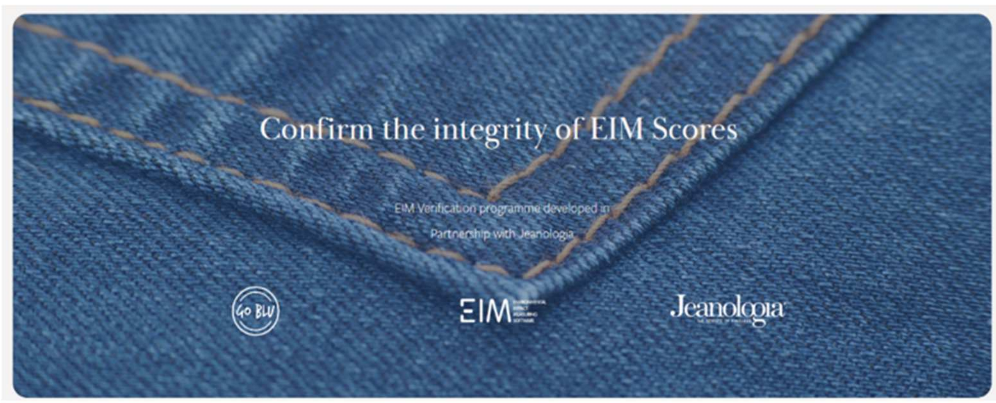
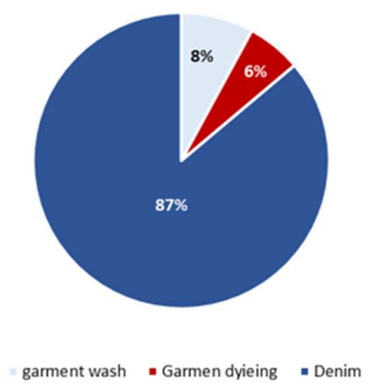


Fig. 14 EIM Third party validation

4.1.- Garment Segment

EIM can measure any process made on any kind of garments. One of the specific upgrades of the EIM V2.0 is the introduction of specific threshold for each garment type or segment because each segment has his own characteristics, consequently, impacts might be different. 89 % of the processes measured in EIM are denim products whilst only, 8% are garment dye and 3% are garment wash. We do anticipate a considerable increase in processes to be compare against these new benchmarks, however, for this year analysis we will focus on EIM V2.0 Denim benchmarked processes. The data under analysis numbers 115.882 processes recorded by 337 EIM users.

Graphic 1 – Breakdwon by product segment

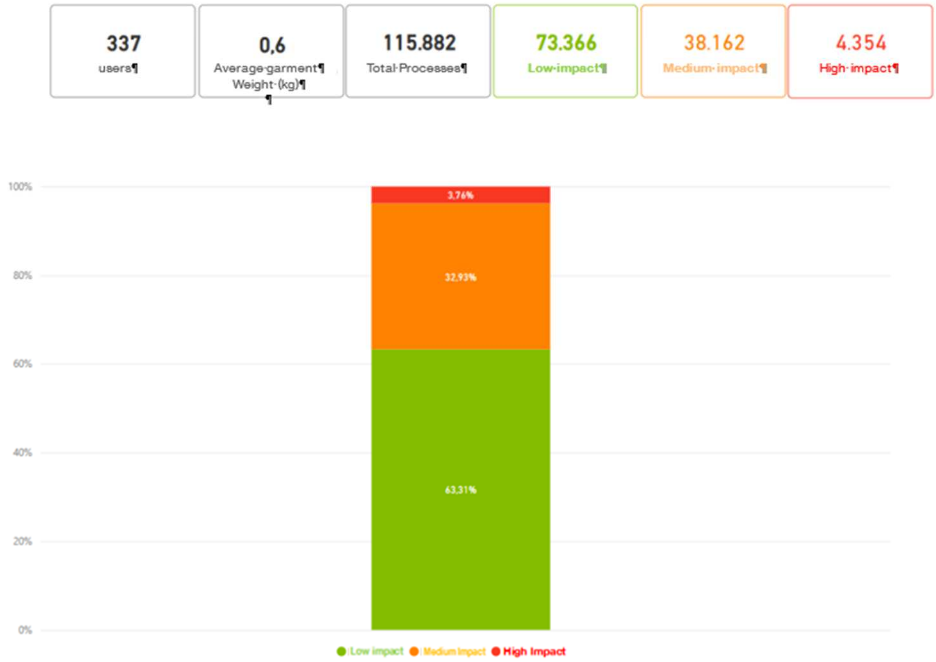


4.2.- Environmental Impact Of Denim. Eim Scores

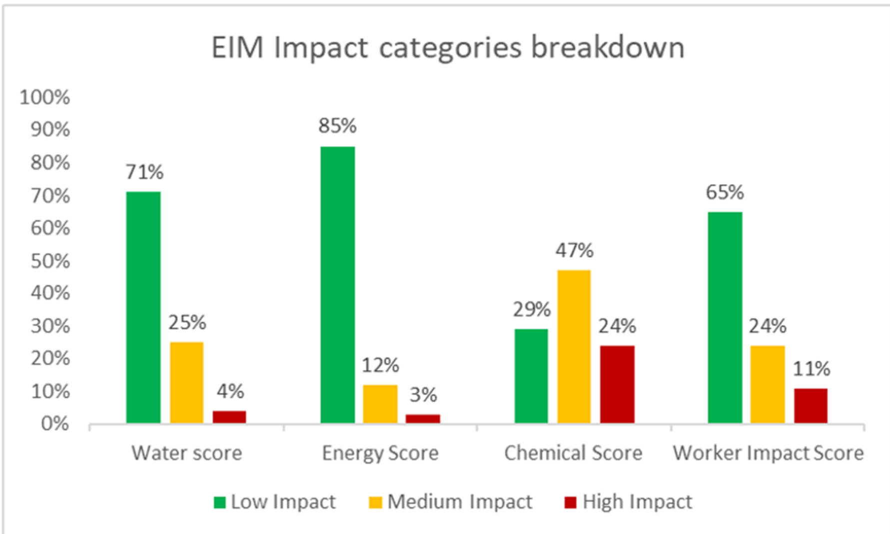
From the 115.882 denim processes measured, 63 % are classified as low impact, 33 % of medium and only 4% of processes are consider of high impact. To achieve the goal of increasing the number of low-impact processes, it is crucial to understand the current distribution and potential areas for improvement.

Currently, more than half of the processes are already low impact, which is positive. However, this analysis suggests that there is considerable room to reduce medium and high impact processes, which should then contribute to increasing the number of low impact processes in the future.

Graphic 2 – Denim processes. Breakdown by EIM score



4.3.- Environmental Impact of Denim: Category Breakdown



Graphic 3 – Denim processes. Breakdown by category of impact

The chart reveals that the *Energy* category has the highest percentage of low-impact processes (85%), suggesting that practices in this area are well optimised. We do, however, expect a growth in the energy requirement, as a result of a growth in the use of new technologies designed to replace the manual operations that create high impacts for worker health. It is important to underline that higher energy demand does not necessarily involve a growth in CO_2 emissions, since the technologies that have been developed are designed to be highly efficient and in addition, they can be supplied by ‘green’ energy.

In contrast, the *Chemicals* category poses the greatest challenge, with only 29 % of processes classified as low-impact and a significant 24% classified as high-impact. This highlights an urgent need for intervention and improvement in chemical management to reduce environmental impact. It is important to note that pumice stones are included in the chemical database, and their use in finishing processes results in the highest possible chemical impact. Consequently, we need to analyse the extent to which the use of pumice stones is contributing to these poor results.

The *Water* category also shows decent performance with 71% of low-impact processes, although there is still 29% of medium and high -impact processes that could be optimised.

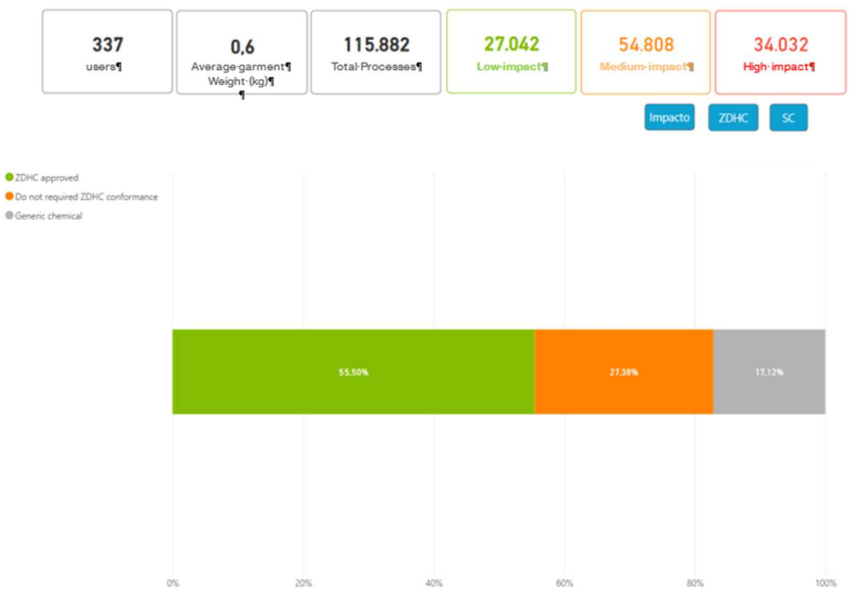
Worker Health, with 65% of low-impact processes, reflects a positive commitment, but the 24% of medium-impact processes and 11% of high-impact processes suggest areas where additional improvements can be implemented.

In summary, the analysis highlights areas of success and opportunities for improvement. Energy and Water show good results in terms of low impact, while Chemicals and Worker Health require attention to reduce medium and high-impact processes. This breakdown by categories is essential to effectively direct efforts and prioritise the areas that most need intervention.

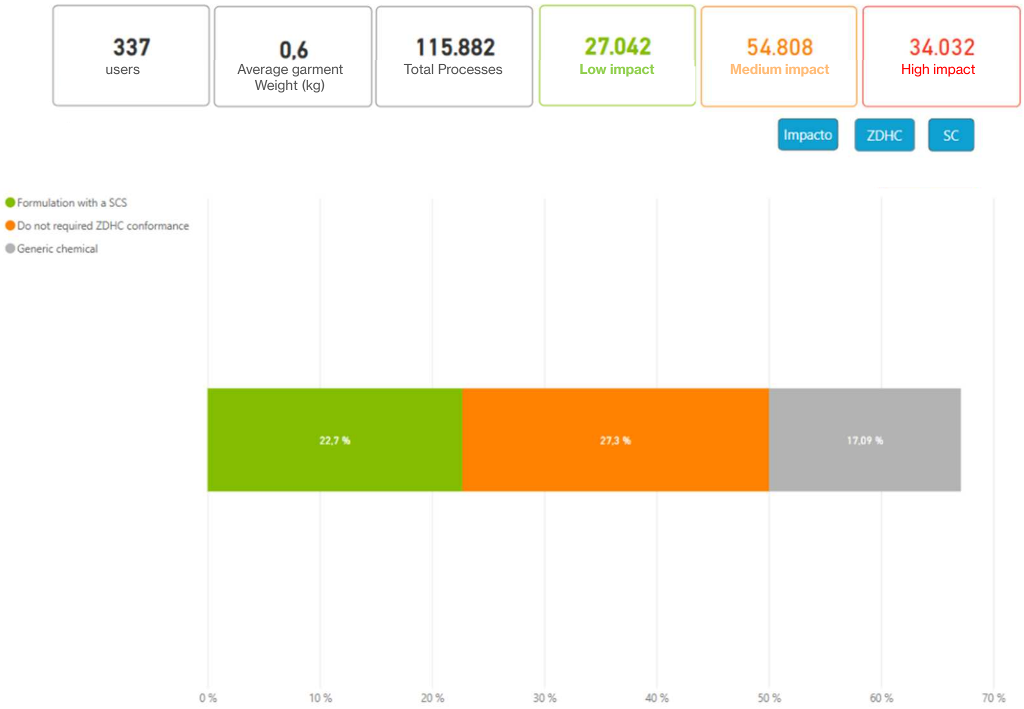
The EIM CIS not only calculates the chemical impact value but also provides information on the performance of the chemicals used.

The breakdown according to the ZDHC and Screen Chemistry certification reveals interesting insights, such as that almost 30% of the chemicals used in denim finishing are commodities chemicals. This reinforces the need for programmes to identify and eliminate any hazardous impurities in these chemical formulations.

Graphic 4 – Denim processes. Breakdown of chemicals according to ZDHC conformance



Graphic 5 – Denim processes. Breakdown of chemicals according to Screen Chemistry Score



It is straightforward to identify those processes using pumice stones, as those processes attract a chemical impact score of 100. Regrettably, 16% of processes involve the use of stones - highlighting a significant challenge for the industry to address.

Additionally, 17 % of the formulations are generic, meaning their performance is unknown. This presents a significant opportunity to increase in transparency and thus improve the chemical impact by adopting chemicals with third-party validation as listed in the EIM.

Furthermore, 55% of the chemicals are in conformance with the ZDHC programme, indicating a good level of implementation of this initiative. However, only 25% of the chemicals have a Screen Chemistry score, suggesting that the implementation of this initiative is lacking.

The dual certification will support the provision of the necessary information to address future circularity challenges ensuring the safe and sustainable use of chemicals.

The worker impact analysis in the new EIM V2.0 highlights the risks associated with manual operations, emphasizing that the industrialization of these techniques often leads to repetitive movements, which can lead to a heightened risk of developing a repetitive strain injury (RSI), which can significantly affect worker health. Replacing manual techniques with automated or safer alternatives will not only reduce these impacts but also contribute to improved EIM scores.

A critical concern emerges regarding the impact of potassium permanganate (PP) blasting operations on worker health and safety. The inhalation of sprayed solutions containing PP is highly toxic, posing severe risks to workers' respiratory systems. The severity of this issue is underscored by the EIM, which assigns the lowest possible score to PP blasting processes to highlight the urgent need for safer alternatives to mitigate these risks. A deeper analysis of the worker impact category reveals that still 9% of processes currently include the use of PP blasting, illustrating its widespread application across the industry and the challenge of phasing it out.

4.4.- Denim Processes. Average Data

Analysing data extracted from a defined period allows us to establish a clear departure point and create a reference from which we can compare progress annually. This approach is particularly valuable in tracking the evolution of the industry towards more sustainable operations. By setting a baseline, we can measure improvements and identify areas requiring further attention.

For instance, in our analysis, we have specific reference values for water consumption, energy consumption, chemical impact, and worker impact per garment. Assuming a garment weighs 0.6 kg, our reference values are 30 litres of water, 1.17 kWh of energy, a chemical impact score of 56, and a worker impact score of 17. These values serve as benchmarks against which we can assess yearly performance.

Graphic 6: EIM average scores

To put this into perspective, the Environmental Impact Measurement (EIM.) thresholds for denim are 45 litres of water per kg, 2 kWh of energy per kg, a chemical impact score of 33, and a worker impact score of 12. Comparing our reference values to these thresholds highlights areas where the industry is performing well and areas where there is certainly room for improvement.

For example, our water consumption per garment translates to 50 litres per kg, which is higher than the EIM threshold, indicating a need for better water management. Additionally, the chemical and worker impact scores are higher than the EIM thresholds, suggesting that these areas require more focused efforts to reduce their environmental and social impacts.

By consistently tracking these metrics year on year, we can observe trends and make data-driven decisions to enhance sustainable practices. This continuous monitoring helps in setting realistic goals, implementing effective strategies, and ultimately achieving better environmental and social outcomes.

Moreover, it allows stakeholders to transparently communicate progress and challenges, fostering a culture of accountability and continuous improvement within the industry.

5.- MEASURES TO REDUCE EIM. SCORES.

"The goal is to turn data into information, and information into insight" (Carly Fiorini)

Improving EIM. scores to reduce environmental impact can be approached from various angles, including fabric selection, process optimisation, and chemical selection. The following chapters set out different measures aimed at this goal. For easier understanding, we have grouped the solutions according to the improvement of specific impact categories considered in EIM.; however, as you will see, each measure can also affect multiple impact categories.

5.1- Water Impact

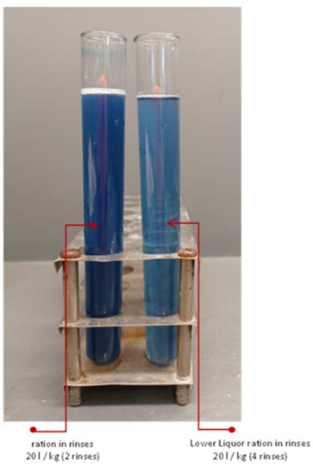
One of the biggest environmental challenges in jeans manufacturing is the use of water. While there is no official data on the average water requirement to finish a pair of jeans, brand research estimates that it ranges between 45 and 70 litres per garment. Recent studies defining the EIM. benchmark set this average at 45 litres per garment, based on an average garment weight of 0.5 kg. Growing awareness of water industry issues has motivated brands to set water consumption reduction targets. Denim stakeholders have developed and implemented solutions to achieve these targets. The industry's efforts have resulted in significant water reductions, establishing a new benchmark of only 30 litres of water per finished denim garment of 0.6 kg, according to the EIM data considered in this report.

Various measures can significantly reduce water usage. Numerous initiatives have already been implemented to reduce water consumption in denim finishing processes. Some of these measures are detailed below. While implementing any of these measures individually is beneficial, the greatest reductions are achieved by combining several of them.

5.1.1.- Process Optimization:

Within the garment finishing process, rinsing is one of the most frequently repeated steps. Rinsing is necessary to eliminate chemicals and other residues from the garments. Traditionally, rinsing has been carried out by using an increased liquor ratio (in some cases laundries would even use over-flow rinsing), based on the belief that more water is more effective and requires less time. However, it has been proven that more effective rinsing can be achieved with lower amounts of water along with additional rinsing steps.

Figure 15. Rinsing effectiveness according to the LR.



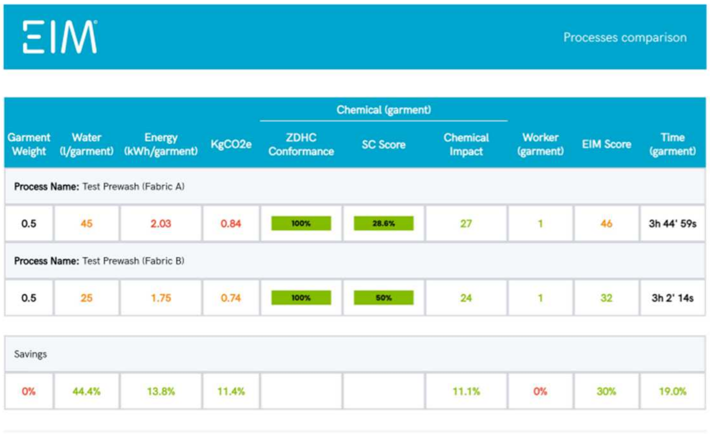
5.1.2.- Fabric Selection:

The way that fabrics react to the various laundry treatments can have a significant influence on the amount of resources required, which subsequently impacts the environmental footprint, when achieving the final aesthetic required.

For the garment finisher, there ‘raw material’ is a sewn garment, and historically there was no way of predicting how a fabric may react during processing. Different fabrics can be highly variable and quite individual, and it is down to the skill and knowledge of the laundry technicians to design a recipe to meet the aesthetics required of the product designers. Predicting fabric behaviour in finishing processes without prior deep analysis is challenging, if not impossible.

In light of these barriers, fabric producers are now striving to manufacture fabrics that perform more efficiently and consequently require fewer intensive wet processes to achieve the desired look and performance.
The are quite a big number of examples of commercial fabrics that can lead to process optimization through fabric selection combining, for instance, the latest indigo dyeing technologies in conjunction with sustainable fabric finishing using the Jeanologia G2 Dynamic technology. Improved fabric preparation translates into a better EIM score during the garment finishing stage because less intense washing is required to achieve the same level of abrasion and wash-down.

Fig. 16. Example of fabric influence in the EIM



EIM — Processes comparison

Garment Weight	Water (l/garment)	Energy (kWh/garment)	KgCO2e	Chemical (garment): ZDHC Conformance	Chemical (garment): SC Score	Chemical Impact	Worker (garment)	EIM Score	Time (garment)
Process Name: Test Prewash (Fabric A)									
0.5	45	2.03	0.84	100%	28.6%	27	1	46	3h 44' 59s
Process Name: Test Prewash (Fabric B)									
0.5	25	1.75	0.74	100%	50%	24	1	32	3h 2' 14s
Savings									
0%	44.4%	13.8%	11.4%			11.1%	0%	30%	19.0%

Jeanologia have developed a predictive tool in conjunction with their G2 technology. This is a test which is designed to analyse the way that a fabric reacts to laser marking. The 'Light Sensitive Test' assesses several elements of how a fabric reacts to certain processes. These include ease of marking, ease of fabric damage, whiteness levels, gradation levels, creation of virtual slubs, cross-hatch and ring spun looks, permanganate spraying substitution and the quality and strength of the weft yarn (or fill yarn) after washing.

These initiatives at both fabric and laundry level are designed to formulate washing and finishing recipes to reduce water, chemicals and energy consumption whilst at the same time imparting the desired aesthetic.

Fig. 17: LSF (light fabric sensitive test)

5.1.3.- Chemical Selection

Chemical suppliers play a crucial role in designing formulations that combine multiple processes, thereby reducing the number of finishing steps and significantly lowering water requirements. Notable examples include formulations from different and worldwide well-known chemical suppliers which enable desizing and abrasion to take place in a single step, saving up to 50% of water in the washing cycle. Recently, advancements have resulted in the creation of enzyme treatments that can be applied without the need for water. There are already some of these enzymes commercially available.

5.1.4.- Update Of Washing Equipment:

Different washing machine designs require different washing conditions. Machine characteristics can limit the reduction of the liquor ratio (litres of water required per kilogram of garments washed). Horizontal loading machines are traditionally more water-demanding, requiring liquor ratios above 1:10 to be practical and effective. In contrast, front-loading machines are usually more efficient, partly because they integrate more advanced software to operate the equipment. To optimize the process through liquor ratio in denim finishing, Jeanologia has developed the Dancing Box technology, which allows the further reduction of the liquor ratio, down to as low as 1:3. The characteristics of this technology and the kinetics of the garment movement inside the machine help generate higher mechanical action, also reducing processing times.

Fig.18. Washing machines and its working liquor ratio

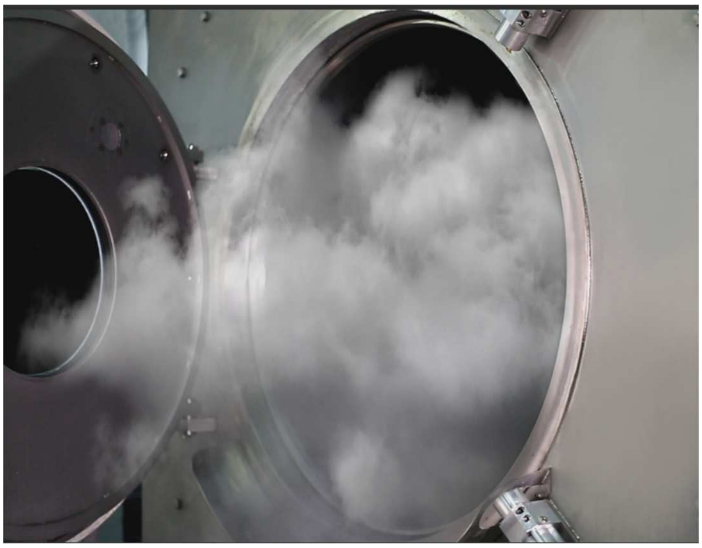
5.1.5.- Introduction Of Technologies And Process Re-Engineering.

Technologies like e-flow and ozone have significantly enhanced water reduction in laundry processes. For instance, pre-ozonic treatments can substantially decrease water usage by replacing traditional desizing operations with advanced ozone treatments. Where garments are processed in a Jeanologia G2 ozone smart box, allows for a transformation from a wet process into a dry one.

Fig. 19 Jeanologia Pre-Ozonic process

The combination of micronization or nebulization techniques with specially developed chemicals can also result in significant water reductions. There are numerous alternatives available for various washing purposes including cleaning, bleaching, softening and even to effectively apply performance processes.

Fig.20: Nebulization system



Another development in this line has been developed by Kemin. Their smart foam system which uses carriers to transfer chemicals to textiles rather than using water. Combined with specific chemicals, the company claims this system can reduce the liquor ratio to 1:1 or 1:2 in processes such as stone washing, bleaching, dyeing, and softening.

5.2- Reducing Energy Impact

Greenhouse gas emissions in denim garment finishing are a priority focus for reducing the environmental impact of textile production. The decarbonization of textile production aligns with industry sustainability goals and reflects a commitment to addressing environmental challenges. Energy requirements in the finishing process can come from various sources, such as the energy to run machines, heat water to optimal process temperatures, or heating air in order to dry garments. The EIM energy benchmark shows that more than 80% of washes are of low impact. However, these promising results should not slow down the development of solutions to further reduce impact, using this year's average (2 kWh/garment) as a reference.

5.2.1.- Water Reduction:

The highest energy demand in denim finishing processes is related to water heating and air heating. Therefore, measures to reduce water consumption will directly impact energy requirements.

Consequently, all previous measures to reduce water will also positively impact energy use. For example, reducing the liquor ratio from 1:10 to 1:4 using the Jeanologia Dancing Box washing machine can reduce heating energy by 40%.

5.2.2.- Chemical Selection

A significant contribution to the decarbonization of the garment finishing industry can occur through the reformulation of chemicals to be effective at lower temperatures. There are several good examples of this. Major chemical suppliers have developed versions of their enzymes for abrasion processes that are as effective at room temperature as they are at the typical enzyme working temperature of 60ºC, reducing energy requirements by up to 20% in the enzyme bath.

5.2.3.- Drying Optimization

Tumbler dryers are the main equipment type used for garment drying. Despite optimization and efficiency improvements, the drying process remains quite inefficient. Some garment producers, such as Saitex [8], have developed smart drying solutions that reduce drying energy requirements by almost 100%. By hanging the garments on a specially designed carousel, inspired by sewing goods transportation systems, garments are air-dried.

Fig.24: Carrusel for air drying ((https://kingpinsshow.com/denim-talks-episode-3-time-for-a-reset-a-conversation-with-saitexs-sanjeev-bahl/)

5.2.4.- Drying Technologies

Research into technologies such as infrared, microwave, or ultrasound is ongoing; however, there are no commercially available alternatives using these heating sources yet. The Italian company Mactec has developed an automatic loading drying conveyor that, according to the company, can reduce steam requirements by one-third.

Fig.21: Mactec, Secomatic drying technology.

5.3- Reducing Chemical Impact

According to EIM. chemical classification and calculation criteria, less than 30% of processes are of low chemical impact and about the same percentage shown processes of high impact. To understand the reason of the lower performance of the finishing processes, it is necessary to look at the chemical breakdown according to the ZDHC conformance, that as mentioned in previous sections of the report, show clear directions to improve the chemical impact score and therefore reduce the EIM. score.

5.3.1.- Chemical Selection:

The 18% of generic chemicals used presents a great opportunity for improvement. The minimum requirement for a formulation to be listed in the EIM. is to have a valid 3rd party ZDHC conformance report. Selecting generic chemicals when generating an EIM assessment means that the generic chemical is not available in the EIM database, primarily because it does not fulfil the minimum requirements. The only positive alternative is to choose to replace these generic formulations for those listed in EIM. chemical impact breakdown thus improving the percentage of processes in the medium and low chemical impact categories.

Chemicals with a “red” EIM. CIS classifications are going to have a negative influence on the chemical impact score and consequently in the overall EIM. score. Searching out alternatives to those chemicals and only using preferred (green EIM. CIS) or (orange EIM CIS) chemicals will result in reducing impact scores.

5.3.2.- Replacing Pumice Stones:

Following the ethical ban on sand-blasting, replacement of pumice stones and potassium permanganate, are according the EIM. measuring criteria, the two major areas for the denim finishing industry to address. There are multiple alternatives to replace pumice stone-wash – amongst those we can find:

Synthetic stones & other abrasives:

Synthetic stones are an alternative to traditional pumice stones. These stones are typically made from materials like silicate, plastic, rubber, or even recycled materials. Some key points about benefits of this alternatives are greater durability, no generation of sludge and reduction in use of water since less rinses are required.

Fig.22: HMS synthetic stones

There are other abrasive solutions aimed at generating mechanical abrasion during wet processing to imitate the pumice stones effect. Those alternatives keep the main benefits of synthetic stones reducing water, eliminating dust and preserving machinery.

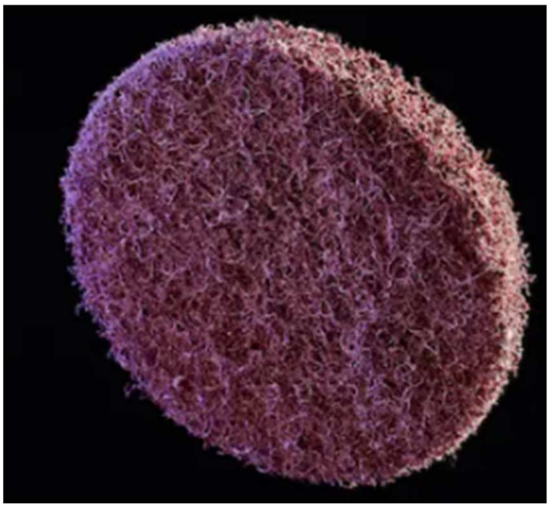


Fig.23: Jecorock abrasive

Chemical alternatives:

In addition to cellulase enzymes, chemical suppliers are offering specific chemical formulations that do not require the use of stones to achieve the stone-wash effect. There are different branded products available for this purpose. Some of the alternatives are especially suitable to be used in combination with spray applications or micronization systems such as e-Flow, not only does it effectively produce a stone-wash appearance, but also helps to reduce both water and energy use.

Ozone technologies:

The application of ozone has been proven to be a highly effective technology to reduce water use in denim finishing processes. Ozone can be used in gaseous form or dissolved in water. Ozone gas has been demonstrated to be both more efficient and more effective in controlling consistent concentration and batch-to-batch reproducibility. Ozone gas can be applied on dry or wet garments; with greater indigo oxidation being achievable when applied to wet garments. The use of ozone to clean indigo back-staining as a replacement for bleach is now widely known and widely implemented.

The technique used to mimic the effect of pumice stones requires a combination of ozone gas on dry garments in a humid atmosphere. The Atmos process, developed by Jeanologia, uses ozone under these exact conditions, allowing for the replacement of stones, in conjunction with a considerable reduction in water and energy.

Fig.24: Atmos process as replacement of pumice stones

5.4.- Reducing Worker Impact:

According to the data collected through the EIM. reporting, worker impact is another area that requires special attention. Worker impact scores are excessively high as compared to other categories. This is primarily due to techniques such as potassium permanganate spray – which unfortunately is still widely used in the industry today. In addition to the complete elimination pp blasting, the automatization of manual operations is necessary to reduce impact of this category of impact.

6.4.1- Replacing Potassium Permanganate Blasting

Potassium permanganate is a strong oxidizer classified as a hazardous substance by the European Chemicals Agency (Substance Information - ECHA). Potassium permanganate (PP) is commonly used in the denim industry for localised bleaching. However, its use poses significant health and environmental risks, making it essential to reconsider its application in denim production

There are several reports highlighting the health risks associated with this product and the application technique which have helped to raise awareness and bring viable alternatives to replace its use.

Here below some of these alternatives:

Ozone cleaning

One reason for using potassium permanganate is to enhance and whiten areas that have been locally decolorized, allowing for further colour reduction in specific parts of the garment. This need often arises because these areas become contaminated when loose indigo bleeds into the water during the washing process. Ozone is highly effective at removing back-stained colours, and utilizing ozone technologies solely for cleaning can often eliminate the need for additional bleaching. Additionally, providing fabrics that bleed less during washing can reduce back-staining, ultimately leading to better results.

Laser technology.

The use of laser technology for denim manufacturing can be regraded has revolution in the industry. Specifically engineered laser tools such as the ‘Light pp’ from Jeanologia is an effective replacement to enhance previously abraded area. ‘Traditional’ Pp blasting is used in both pre-lasered garments or garments manually sand blasted. In both cases, the ‘Light pp’ highly effective replacement for Pp blasting which results in reducing the EIM. score considerably.

Alternative chemicals.

Around 2015 some pioneer chemical suppliers, launched alternative product to replace potassium permanganate. Today there are multiple available alternatives. Each of the alternative have their own characteristics and each of them are suitable to replace potassium permanganate.

5.4.3- Automatization Of Manual Techniques

The integration of automatic tools to replicate manual processes in the denim industry is crucial for several reasons, particularly in reducing worker health issues. The adoption of automatic tools fosters a safer working environment and helps to reduce impact according to EIM.

Each manual operation requires specific equipment. The Teca machine developed by Mactec that automatically imitates natural wrinkles produced during the used life of the garments, is a good illustration of a machine with a purpose.

Fig.25: Teca (Mactec).

5.4.2- Digitalization Of Manual Techniques

Manual scraping is one of the more hazardous operations carried out in the garment finishing process and therefore finding an alternative technique is highly desirable. Digitalization has numerous environmental benefits when replacing manual scraping. Replacing this operation by laser technology the worker impact is considerably reduced.

Fig.28: Manual abrasion (Hand sanding)

Fig.29: Digital local abrasion

Fig.30: Summary of Measures to reduce the EIM score

Category	Measures	Details
Water Impact	Process Optimization	Effective rinsing with less water.
	Fabric Selection	Choosing fabrics that require less intensive washing.
	Chemical Selection	Using chemicals that combine processes to reduce water usage.
	Washing Equipment	Upgrading to machines that use less water.
	Technologies and Process Re-engineering	Implementing e-flow, ozone treatments, and smart foam systems to minimize water use.
Energy Impact	Water Reduction	Measures to reduce water consumption also lower energy needs.
	Chemical Selection	Reformulating chemicals to work at lower temperatures.
	Drying Optimization	Using smart drying solutions and exploring new drying technologies like infrared and microwave.
Chemical Impact	Chemical Selection	Replacing generic chemicals with those conforming to ZDHC guidelines.
	Replacing Pumice Stones	Using synthetic stones, chemical alternatives, and ozone technologies and boosters to achieve the stone wash effect without traditional pumice stones.
Worker Impact	Replacing Potassium Permanganate Blasting	Using ozone cleaning, laser technology, and alternative chemicals.
	Digitalization and Automation	Replacing manual techniques with automated tools to reduce worker health risks.

6.- CONCLUSIONS

"An ounce of action is worth a ton of theory"

For the last three decades Jeanologia has dedicated its time and resources to finding ways of improving the environmental footprint of the garment processing sector – a sector that was badly in need of change.

Their leadership has catalysed the industry - customers and competitors - to begin a much-needed transition to a more responsible future for an industry that we all love.

The design and development of the EIM platform was born out of the need to support the company's technological innovations.

Initially, there was only modest ambitions for the EIM platform, simply as an internal tool. However, thanks to the latent demand in the industry to strive to improve the environmental footprint of the denim industry, there was an encouraging uptake in the use of the platform.

There is no doubt that it is recognized that a sector-wide transformation to responsible production is a climate and biodiversity imperative, and that all parts of the supply chain must embrace all opportunities to act, and EIM is eager to catalyse support for this shift.

By working together strategically, the denim supply chain – garment makers, laundries, technology providers, chemical suppliers, NGOs, brands and retailers all have a contribution to make.

We cannot pretend that we are happy or complacent with the progress made with the adoption of the EIM platform. There is a need to increase the number of users and the pace of change.

Currently, the changes that would make the greatest improvement in the garment laundry sector is the reduction in or elimination of the use of pumice stones and potassium permanganate spray.

Processes or techniques that are common in the industry, such as potassium permanganate or pumice stones, need to be eliminated just as sandblasting was. The International Textile, Garment and Leather Workers' Federation launched a campaign to eliminate sandblasting in 2009 after the World Health Organization confirmed it caused silicosis, leading to lung fibrosis and emphysema. In 2010, Levi Strauss & Co. and H&M implemented a global ban on sandblasting in their supply chains, going beyond the Turkish Ministry's ban. Since then, multiple leading brands have also eliminated sandblasting. There is no evidence that sandblasting is currently used in the industry.

Following the prohibition of sandblasting, however, other methods took over. PP took over due to production speed and low initial investment cost. As mentioned in chapter 4, PP blasting needs to be eliminated from our industry.

In the textile industry, environmental progress is evident, however the pace of transformation falls short of what is needed to prepare for impending regulations. Across the textile industry, the polluting use of fossil fuels continues to dominate production while circular business models are still in their infancy.

Regulators are stepping in as the industry struggles to move forward, with the EU leading the charge towards a climate-neutral, circular economy. The EU's Strategy for Sustainable and Circular Textiles, passed in June 2023, aims for an industry that respects the environment and social rights. Sixteen pieces of legislation are under discussion, and the window for compliance is narrowing.

Starting in 2025, the EU will require large and listed companies to disclose ESG-related risks and opportunities. The EU's new rules are expected to impact regions beyond Europe, especially Asia, where most of the EU's textiles are manufactured. Other regions, including the US, the UK, and China, are also progressing with their own initiatives.

These new directives require data, "granular" data. Granularity in data refers to the level of detail or precision of the data. For example, data that has a high level of granularity would have a large number of individual pieces of information, such as individual records or measurements. Data that has a low level of granularity would have a small number of individual pieces of information, such as summary data or aggregated data.

Existing data from external institutions is readily available and requires little effort to find. However, this would be classified as secondary data, and although the collection of such data takes less effort, it has important limitations.

Collection of primary data, data that is directly from your current supply chain (or enlisting the help of a trusted third-party auditor.), will correctly inform your environmental impact assessment and give you a solid foundation to implement a sound environmental sustainability strategy.

The adoption of the EIM platform as a tool in our sector of the textile industry is designed to create and collect that granular primary data.

"Our sector of the textile industry" – the denim sector – has a strong, if not the strongest community spirit. The spirit of the denim industry is a combination of innovation, tradition, and an increasing commitment to sustainability.

We would like to invite you to drive our leadership in advancing our sustainable targets by supporting the use of the EIM platform and also encouraging others to do so. The more data we can generate, the more up-to-date data we can generate, the more we can refine the targets and the more we can drive excellence in our industry sector - and therefore the more we can be recognised as a leader of responsible manufacturing within the textile industry.

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