youth alliance

RESOLUTE

RMIT UNIVERSITY

M HOLDINGs Communication

WE ARE OAKIA

OAKIA

Nguyen Kim Giao

Human Resources

RMIT University

Nguyen Cu An Khang

Economics and Finance

RMIT University

Luong Thao My

Information Technology

RMIT University

Nguyen Nhat Minh

Information Technology

RMIT University

Dinh Hong Phuc

Digital Marketing

RMIT University

END-USER PAIN POINTS

> Why are people today so fond of wearing **second-hand clothes** or items made from **recycled textiles**? I can't imagine those being wearable!

Hong Phuc
2nd-year student

> I'm uncertain if these materials are **safe for my skin**, especially with concerns about **allergies** and **sensitivities.**

Thao My
3rd-year student

Remarkable statistics on TEXTILE WASTE in Vietnam market.

5M TONS OF CO2

The textile industry in Vietnam emits about **5 million tons of CO2** every year

93 - 42 -1

- **93** billion cubic meters of water
- **42** million tons of chemicals
- **1** million tons of dyestuffs each year

15M KILOGRAMS

Vietnam's textile industry produces an estimated **15 million kilograms** of waste annually

Source: Vietnam News; IJSRA; MDPI

Vietnamese fashion producers and retailers pain points.

Nguyen Thi Lan

Operations Manager at a Mid-Sized Textile Factory

As a Manager, I have faced many concerns regarding the **recycling process**. Moreover, adapting to the **net-zero mission** has caused interruptions in my business.

COLLECTION

***Pain Point 1*: Where and How to collect textile waste?**

SORTING

***Pain Point 2*: How to sort the textile waste efficiently?**

PRE-TREATMENT

***Pain Point 3*: How to conduct an effective pre-treatment process?**

PRODUCTION

***Pain Point 4*: How to produce final product correctly?**

SITUATION | **SOLUTION** | **MARKET** | **FEASIBILITY** | **IMPACT**

OAKIA's VISION

How can OAKIA propose a comprehensive solution that supports Vietnam's Textile Waste Management strategy to achieve a circular economy?

OAKIA solution overview.

INPUT

WASTE

TRANSPORT

CIRCULAR WASTE MANAGEMENT

OAKIA

SELL

CLIENTS

FASHION RETAILERS

MANUFACTURING

DISTRIBUTE

PRODUCTION

OTHER RETAILERS

WASTE TRANSFERED

SITUATION | SOLUTION | MARKET | FEASIBILITY | IMPACT

Core Solution Technology

1%

3 types of Waste Recycling

3 types of Waste Recycling

Micro bial Enzymes

Small Bacteria Catalysts

Higher Compatibility[1]

Eco-Friendly process[2]

Higher Textile Quality

Note:
1, 2: Refer to Appendix for in-depth details and proof-of-concept.

ISO

International Organization for Standardization

> “When things don't work as they should, it often means that standards are absent.”

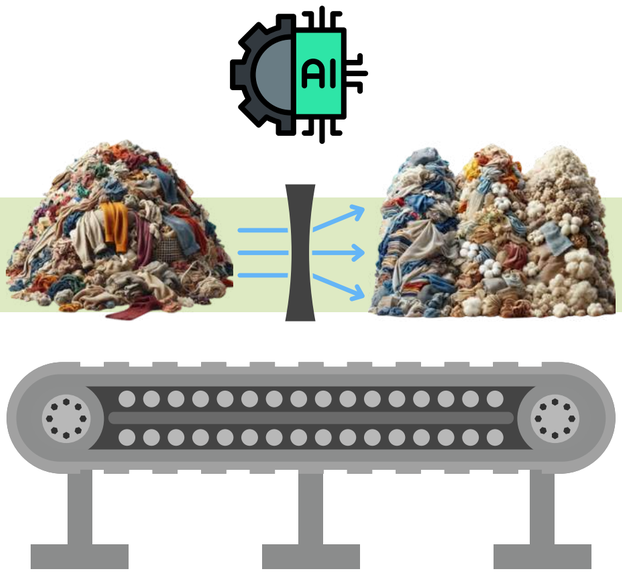
RESISTANCE TO
FORCE
ISO 13934-1

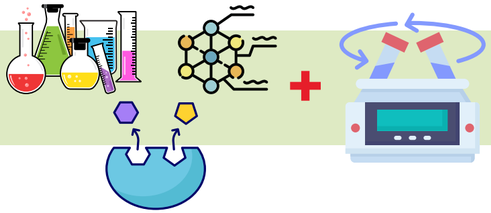
RESISTANCE TO
ABRASION
ISO 12947-2

RESISTANCE TO
COLOR FASTNEST
ISO 105-C06

SOFTNESS &
COMFORT
ISO 9237

OAKIA's comprehensive process.



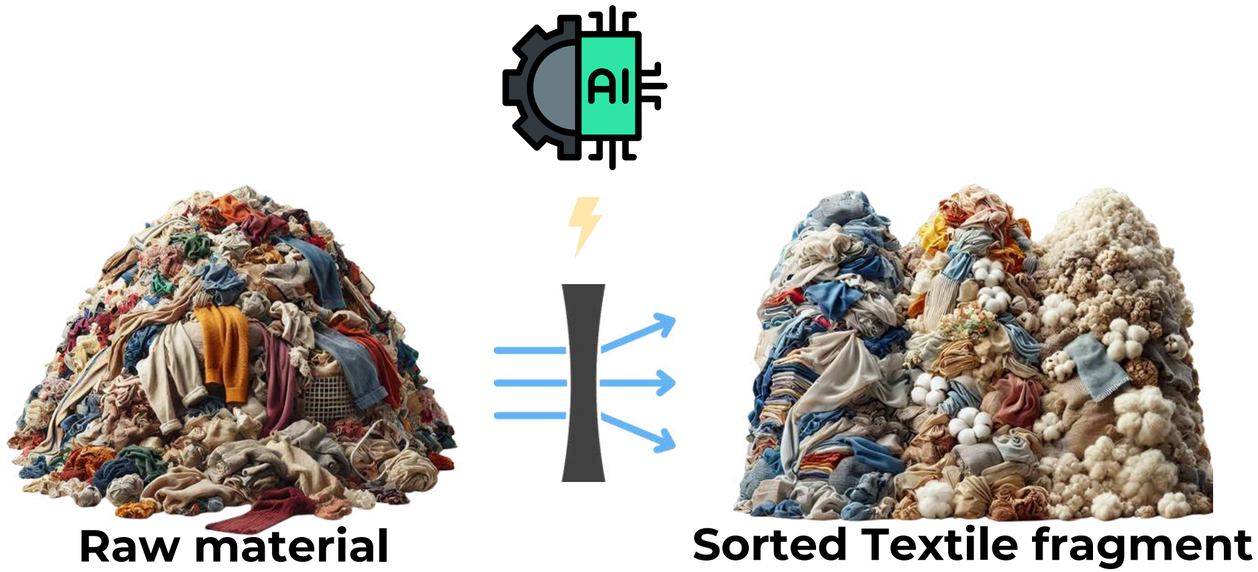


Synthetic fibers in polymer form

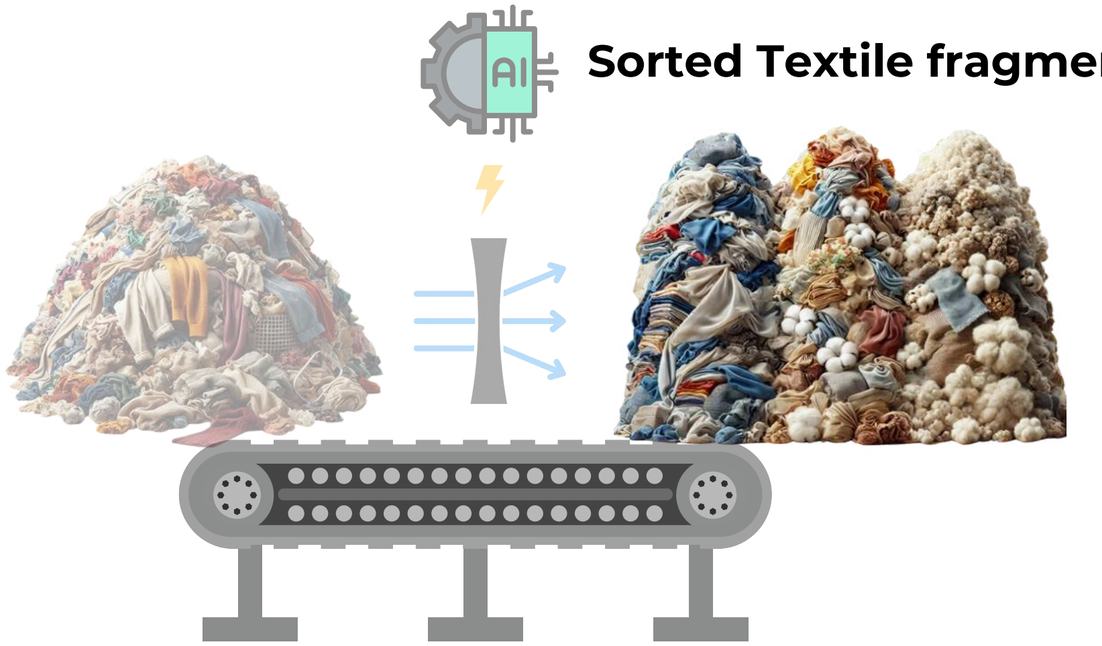
Finalizing

High-quality fabrics

AI + NIR Spectroscopy

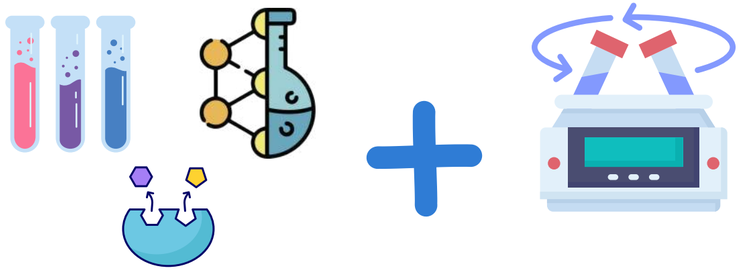


The current process and pain points that affect the performance.



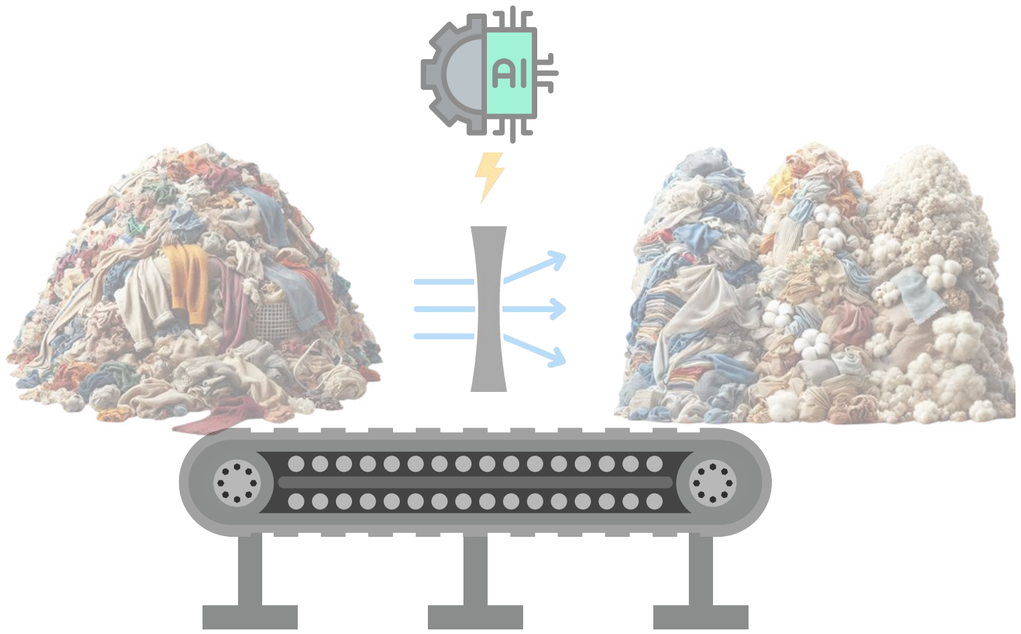
Sorted Textile fragment

Enzyme Hydrolysis process



Fabric fibers in polymer form

The current process and pain points that affect the performance.



Fabric fibers in polymer form

Finalizing

+ Fiber blending
+ Spinning
+ Knitting/Weaving
+ Dyeing
+ Testing
...

High-quality fabrics

OAKIA’s SDG Targets and Indicators

Reduce cities' per capita environmental effect by 2030, focusing on air quality and municipal and other waste management.

City municipal solid trash collected and handled in regulated facilities percentage of total municipal garbage created (Indicator 11.6.1)

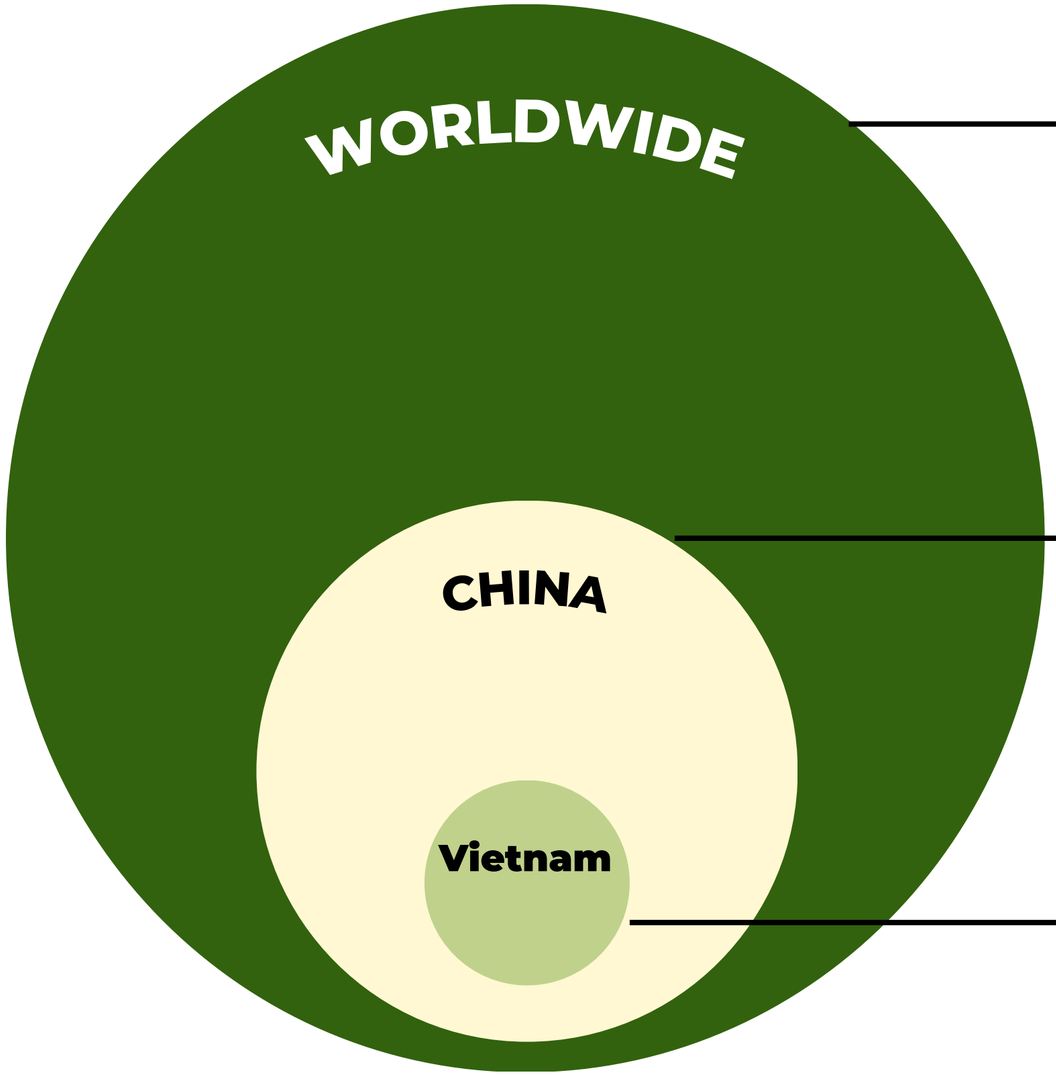
Implement the 10-Year Framework of Programmes on Sustainable Consumption and Production Patterns, with industrialized countries leading and taking into consideration developing countries' progress and capacities.

Number of nations creating, adopting, or implementing sustainable consumption and production policies (Indicator 12.1.1)

OAKIA’s Key Impacts

Proposing the sustainable solution in textile waste management from waste to high quailty sustainable product.

Creating a circular economy solution that improves quality of life, reduce raw material dependence, create jobs and save consumers money.



81 million tons of fashion textile waste

Target Market (Mid-term)

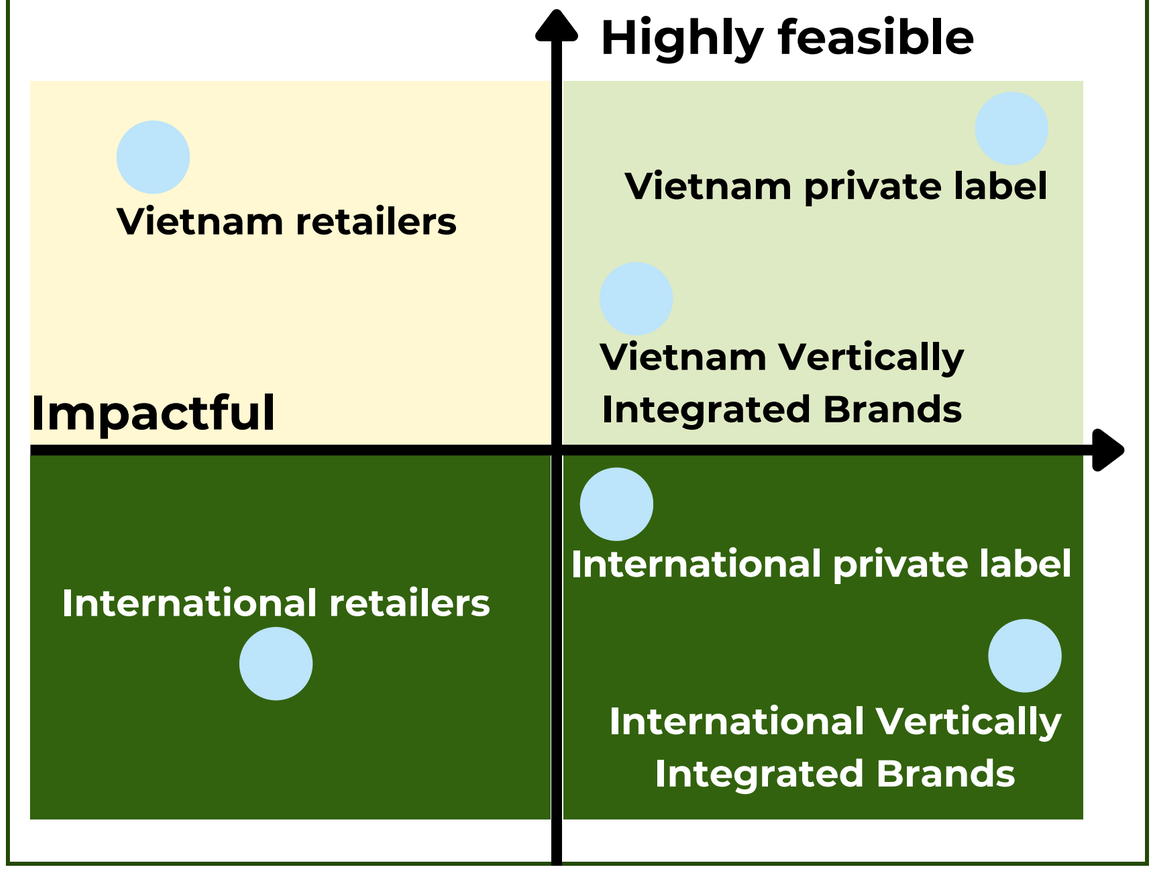
21 million tons of fashion textile waste

Pilot Market (Short-term)

16.5 thousands tons of fashion textile waste

OAKIA is targeting Vietnamese fashion producer and retailers.

OAKIA's Potential Clients



Note:
1) Feasibility is measured as the easiness in regulation and hierarchy issue if OAKIA is implemented
2) Impact is measured as the scalability and the reach of the target toward the market (how much customers will they be serving according to market share)

PRIORITIZED

OAKIA target manufacturing companies, as Vietnamese brands, particularly OEMs, need to reduce carbon emissions to stay competitive and stand out internationally.

STRATEGIC

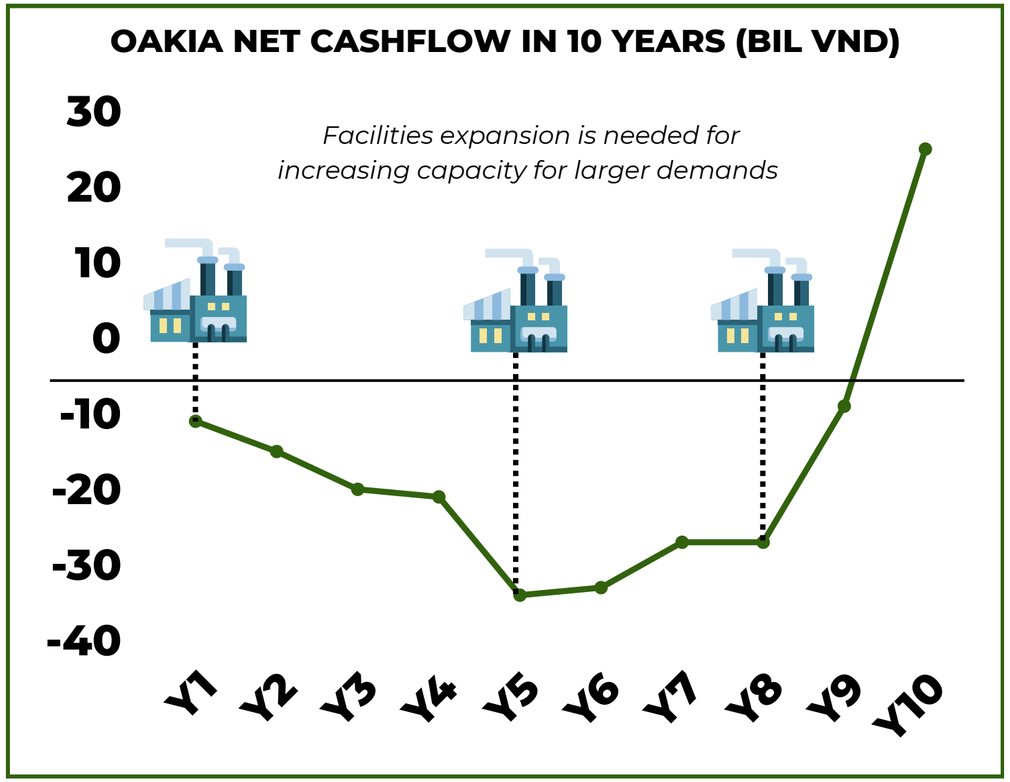
Retailers compete on price and brand initiatives, gaining an edge by sharing a compelling "quality sustainable story" amid the trend of sustainable consumerism.

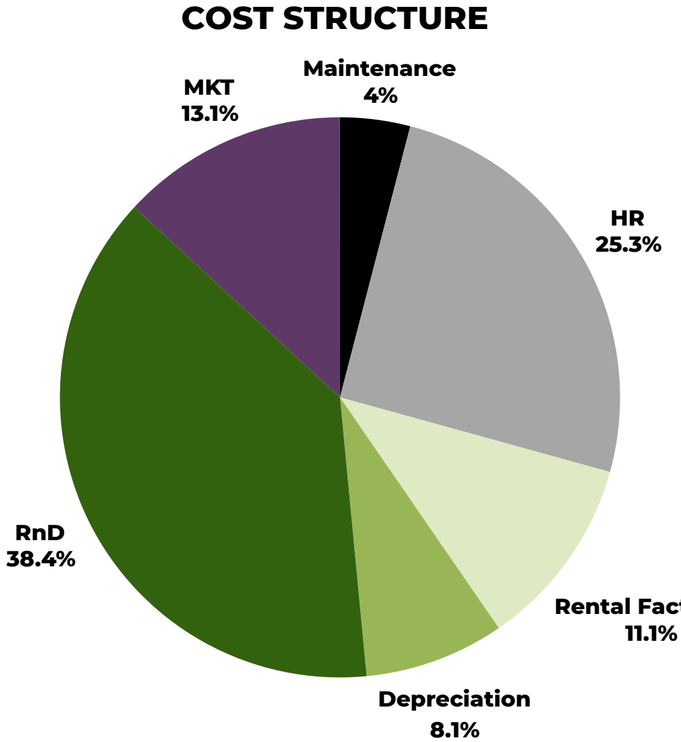
LONG-TERM

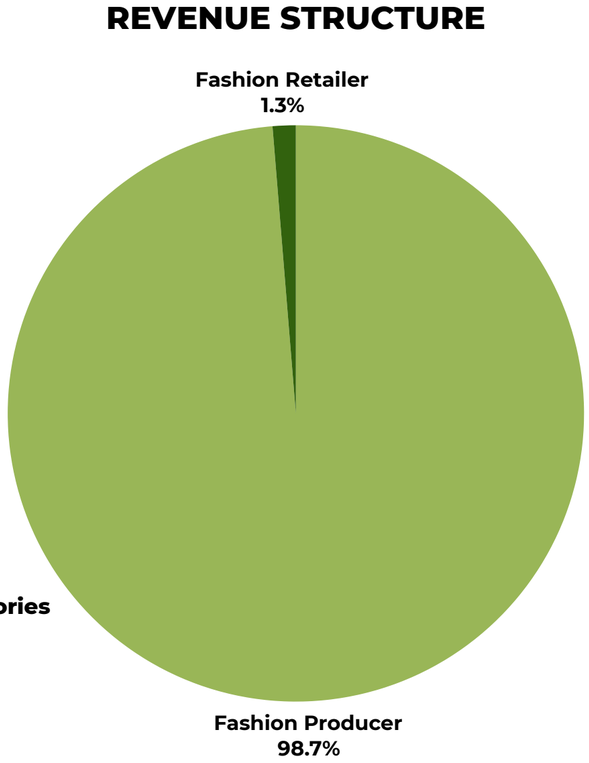
International organizations must undergo a detailed, long-term alignment with headquarters, including clear use cases, before system implementation.

SITUATION | SOLUTION | **MARKET** | FEASIBILITY | IMPACT

OAKIA's Cost Structure.







KEY ASSUMPTIONS

Demand by channel:
Fashion producer: Equal to market share multiply with total textile waste per year.
Fashion retailer: 300,000 tonnes per brand (2,000 shirts per year).

Price per tones of textile is **50 million VND** (equates with the current market of normal textile).

The RnD expenses will allow for increasing capacity by **x2 after 10 years (10% improvement per year).**

Life cycle of the technologies are **10 years**.

Sales and Market Penetration strategy

OAKIA's expectation	Implement sales strategy to market testing	Utilize efficient marketing to provide OAKIA's solution	Extend Solution portfolio	Enhance Sales growth
PHASES	Market testing	Promotion strategy		Acceleration strategy

Expansion and Potential clients ecosystem

Vertical Integration

- Retailer
- Wholesaler
- Distributor
- Manufacturer
- Supplier
- Commodity Producer

Horizontal Integration

FINANCIAL IMPACTS

65%

Annual impact growth

10

years to be break-even

30%

share of the fashion production will be renewed

SOCIAL IMPACTS

18%

saved per year to the total of carbon emission in Vietnam per year

2000

tons of waste/ year after 10 years

1.5%

saved per year to the total of water washed by the industry

OAKIA





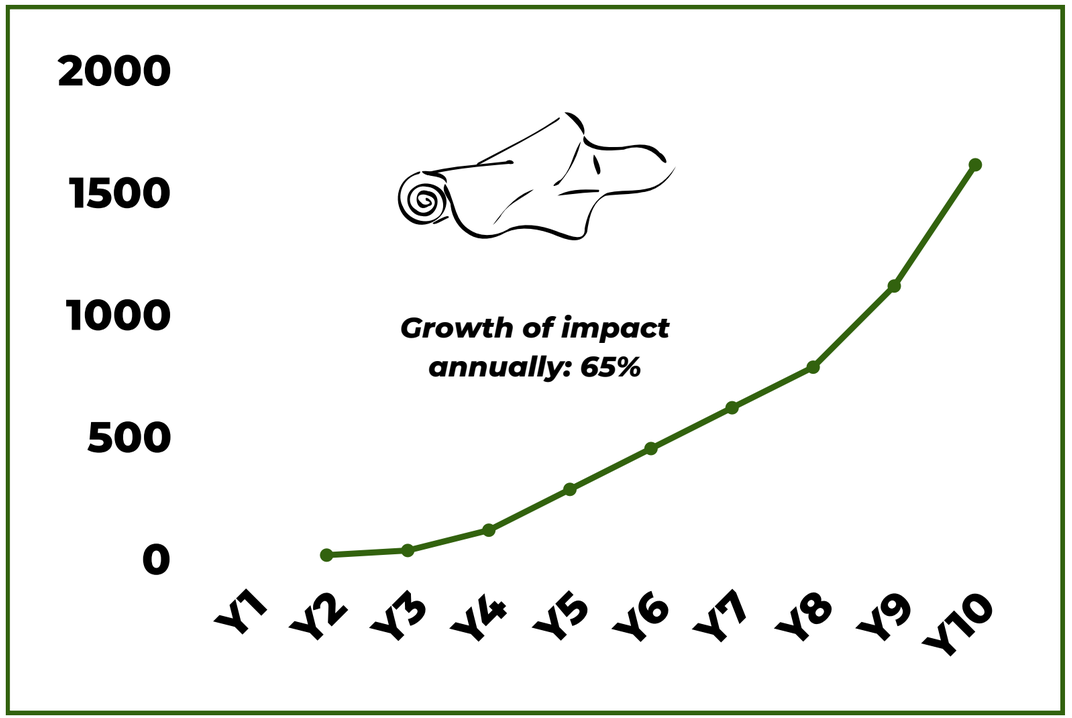
Each member brought a unique strength to the table...

~ THANK YOU FOR LISTENING ~

	2025	2026	2027	2028	2029
SERVICE	Primarily offer the solution for individual fashion producers.		Offer the full solution and service to Fashion chain, Retailers, corporations, etc.		
		Collaborate with government organizations to implement the solution nationwide.			
TECHNOLOGY	Invest and enhance the technological chain				
	Focus on Microbial Enzyme and related technologies.		Expand expertise in related technologies, such as biotechnology, to enhance performance.		
OPERATION	Gain the awareness to foster the social and environmental campaign.				
	Grow into a company that offers a complete recycling process.		Increase the value and payment of the service by contributing to the CSR commission.		
INTERNATIONALIZATION			Research and expand the company to the new market.		

APPENDIX

AMOUNT OF TEXTILE TONNES MITIGATED IN 10 YEARS



9

CORE PRODUCTION LINES WILL BE "RENEWED"

Fashion producers are our key target as it has the widest span of reach. Not only will help OAKIA to sustain a large order, but also allow OAKIA to contribute largely to the reduction of textile wastes

50

FASHION RETAILERS WILL BE PIONEERING SUSTAINABILITY TREND

Although fashion retailers might not have the biggest impact, it is crucial for a direct reach to consumers to educate their behavior via their promotional campaigns.

The first factory will need **entire year** to prepare. Other factories will need less than 1 year to go into operation

The first 4 years can only target textile producers that have less than 0.1% market share due to lack of reputation

Year 5 to Year 10 can target producers that have >1% market share given our 5Y survival to prove the concept to VN market

Both fashion retailers and fashion producers will be reordering each year

	Y1 - Y4	Y5 - Y7	Y8 - Y10
Revenue (mil VND)	**8,748**	**68,137**	**176,064**
Manufacturers	8,268	66,967	174,444
Retailers	480	1,170	1,620
Tons of Textile Managed	**175**	**1,362**	**3,521**
Manufacturers	165	1,339	3,489
Retailers	10	23	32

	Y1 - Y4	Y5 - Y7	Y8 - Y10
Cost (mil VND)	**30,050**	**74,249**	**134,536**
CAPEX	9,380	9,380	9,380
OPEX	20,670	64,869	125,156
Maintenance	2,225	2,922	3,674
HR	7,200	21,600	32,400
Rental	4,800	7,200	10,800
Depreciation	2,946	5,892	7,856
RND	2,624	20,441	52,818
MKT	875	6,814	17,606

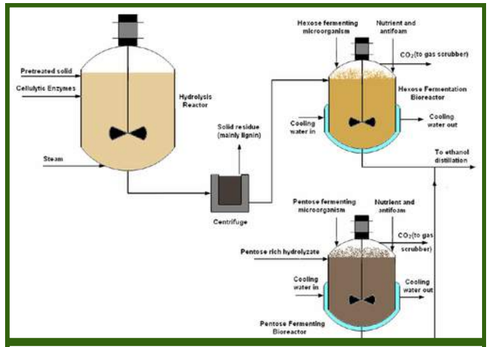
Comparison Criteria	China	US
Textile Waste Size	**20.8M tons (20% recycled)**	**14.45M tons (<15% recyled)**
Market	The Chinese textile recycling market is rapidly growing, driven by government initiatives to recycle a significant portion of textile waste by 2025	Significant growth potential driven by increasing consumer awareness of sustainability
Competitive Landscape	Few businesses focus specifically on microbial processes, offering an opportunity to lead in this niche (**Wenzhou Tiancheng Textile Company**: This is one of China's largest cotton recycling plants. It focuses on recycling cotton textiles into new yarns, primarily for export due to domestic regulations that restrict using recycled cotton for new garments within China)	The market is competitive with many established players in textile recycling, but there is room for innovation with microbial processes
Regulation Barrier	Compliance with environmental and safety standards is crucial, especially for new technologies like microbial processes	Complex regulatory environment with federal and state-level laws. California's laws, for instance, are quite stringent and may impact operational costs

Enzymatic hydrolysis

Enzymatic hydrolysis is a biological process where enzymes from microbials are used to break down complex molecules into their monomer components:

1. **Cellulase: Break down cotton into glucose**
2. **Protease: Break down wool into amino acids**
3. **PETase and MHETase: Break down polyester into monomers**

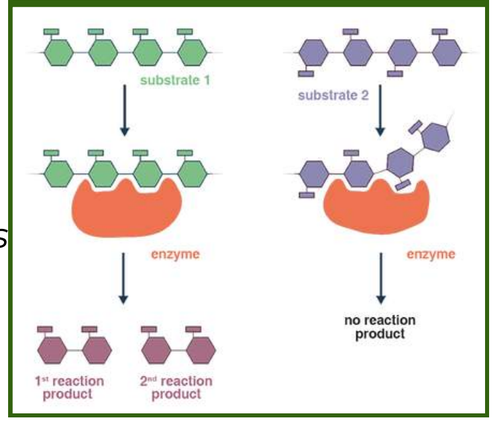
Enzymatic Hydrolysis process



Advantages

Sustainable Process	• Reduced the amount of energy and chemical used during the process • Sustainable sources
Quality Recycled Fibers	• Recycled fibers but match the quality of virgin materials • Can handle multiple contaminations such as dyes, chemicals infuses
Compatibility with Various Fibers	• Can handle both natural and synthetic fibers • Can efficiently deal with blended fabrics

How the enzymes works?



Source:
Semanticscholar; IOM3; Chemistry Europe; MDPI

Enzymatic hydrolysis

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Biotechnological Solutions for Recycling Synthetic Fibers †

by Al Mamun [1], Friederike Kuntz [2], Cornelia Golle [2] and Lilia Sabantina [1,2,*]

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* Author to whom correspondence should be addressed.
† Presented at the 4th International Electronic Conference on Applied Sciences, 27 October–10 November 2023; Available online: https://asec2023.sciforum.net/.

Eng. Proc. **2023**, *56*(1), 181; https://doi.org/10.3390/ASEC2023-16301

Published: 17 November 2023

(This article belongs to the Proceedings of The 4th International Electronic Conference on Applied Sciences)

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Abstract

Biotechnology offers the potential for selective depolymerization of natural and synthetic fibers, isolation of components, or recovery of monomers. This progress solves the problems associated with the regeneration of

Mamun, Al, Friederike Kuntz, Cornelia Golle, and Lilia Sabantina. 2023. "Biotechnological Solutions for Recycling Synthetic Fibers" Engineering Proceedings 56, no. 1: 181. https://doi.org/10.3390/ASEC2023-16301

1. Eco-friendly Process:

“In addition, enzymatic degradation helps reduce the environmental impact associated with the accumulation of synthetic fiber waste [19,20,21]”

“The potential of biotechnology is one of the most promising solutions for recycling synthetic fibers, supporting environmental sustainability, and the transition to a circular economy.”

2. High Compatibility to various Fibers:

“Enzymatic degradation of synthetic fibers occurs through the directed action of enzymes that target specific molecular bonds within the polymer structure [16].”

“Esterases, for example, have been successful in degrading polyester-based synthetic fibers, while other enzymes target different types of synthetic fibers.”

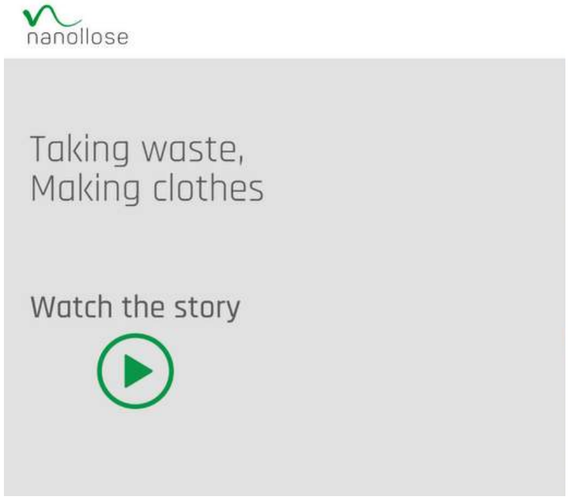
“The proposed process provides a fast and efficient method of transforming cotton waste textiles into glucose, and very likely most cellulose-based waste textiles. The results of the current study show that it is possible to achieve glucose yields above 70% from cotton waste textiles”

Case Study:

1. Carbios

Carbios' process can convert 95% of PET into monomers that are indistinguishable from those used in virgin PET production -> high quality product is FEASIBLE

2. Nanollose



Actual fibers from Nanollose - Nullarbor fabric

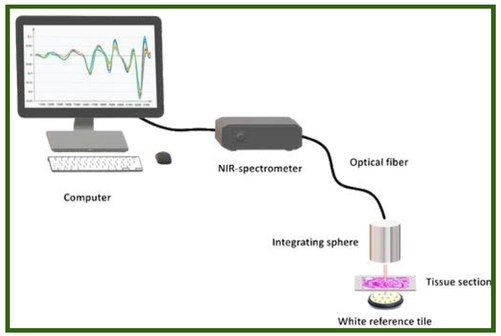
By contrast, Nanollose's has developed a world first process that creates microbial cellulose from industrial organic and agricultural waste, which is then transformed into rayon fibres with minimal environmental impact. The process doesn't involve the felling of trees or require the use of arable land or its associated use of irrigation, pesticides and other resource intensive inputs.

OAKIA's solution to tackle the pain points throughout the process.

OAKIA PROCESS

COLLECTION → SORTING → PRE-PROCESS → TREATMENT → POLYMERIZATION → FABRIC PRODUCTION → FINALIZING

SORTING - 1-2 hour per patch



Implement

- **NIR Spectroscopy:** Near-Infrared (NIR) spectroscopy to identify and classify different types of fibers based on their spectral signatures
- **Trim-cleaning system:** Mechanically remove non-fiber component by tearing down into smaller pieces
- **AI and Data Model:** drive the process to be more optimized in term of resources and time by the power of AI and Data

>>> collect and sort textiles efficiently with in hours automatically

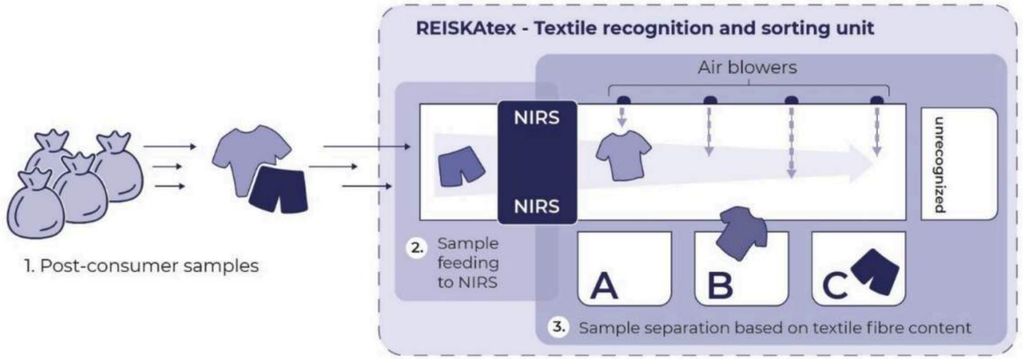
OAKIA's solution to tackle the pain points throughout the process.

OAKIA PROCESS

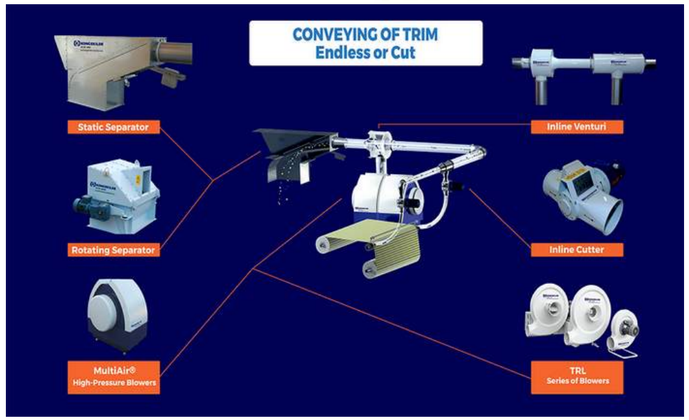
COLLECTION | SORTING | PRE-PROCESS | TREATMENT | POLYMERIZATION | FABRIC PRODUCTION | FINALIZING

SORTING - 1-2 hour per patch

A previous study on NIR technology in textile sorting chain:



A clearer view on the trim-cleaning system



OAKIA PROCESS

COLLECTION → SORTING → PRE-PROCESS → TREATMENT → POLYMERIZATION → FABRIC PRODUCTION → FINALIZING

PRE-PROCESS - about 10 hours

- **Cotton**
  - Detergent + NaOH under 40-60°C (for 4-6 hour)
  - H_2SO_4 under 60-80°C to break down cotton (for 2-4 hour)
- **Wool**
  - Detergent under 40-60°C (for 4-6 hour)
  - NaOH under 60-80°C for 2-4 hour
- **Polyester**
  - Detergent under 40-60°C(for 4-6 hour)
  - Ethylene Glycol/DMSO and weak acid like acetic acid for 2-4 hour

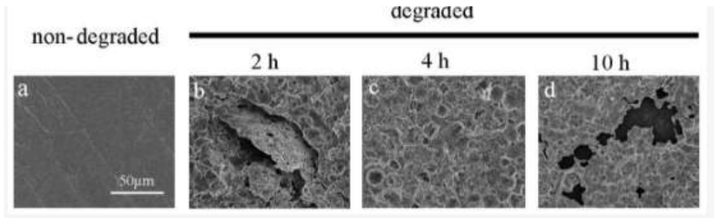
>>>

To breakdown the fibers into smaller pieces in molecule level and prepare the environment for microbial action

OAKIA PROCESS

COLLECTION | SORTING | PRE-PROCESS | TREATMENT | POLYMERIZATION | FABRIC PRODUCTION | FINALIZING

TREATMENT - 24~48h depends on fiber



Degrading process under microscope

ENZYME HYDROLYSIS

To submerge fibers in bioreactor under the right solvent and condition

- **Cotton**

Cellulase (*Trichoderma reesei*) 50-60°C, water with buffer solution (pH 4.8-5.5) to breakdown cotton to smallest glucose

- **Polyester**

PETase/MHETase (*Ideonella sakaiensis*), optimal at ~30°C, water with buffer solution (pH 7.0-8.0), to breakdown polyester into its monome

- **Wool**

Protease (*Bacillus subtilis*) 40-50°C, water with buffer solution (pH 7.0-8.0) to degrade keratin proteins

OAKIA PROCESS

COLLECTION | SORTING | PRE-PROCESS | TREATMENT | POLYMERIZATION | FABRIC PRODUCTION | FINALIZING

MONOMER RECOVERY AND POLYMERIZATION - 24-36h

The monomers will be separated from resulting mixture of hydrolyzed products, unreacted materials, and enzymes, before re-forming into polymers, creating new synthetic fibers

- **Filtration:** Remove solid particles and undissolved residues
- **Centrifugation:** Separate the fibers and other solid particles
- **Polimerization:** Combine the monomers to the polyme structure

Filtration

Centrifugation

Polimerization visualization

Extract the monomers

Realistic Synthetic fibers

OAKIA PROCESS

COLLECTION | SORTING | PRE-PROCESS | TREATMENT | POLYMERIZATION | FABRIC PRODUCTION | FINALIZING

FABRIC PRODUCTION & FINALIZING

Based on customer's order/requirement, from the synthetic fibers, construct the new high-quality fabric:

- **Fiber Blending:** Depends on the requirement
- **Spinning:** Convert the purified and blended fibers into yarn
- **Weaving / Knitting:** Creating fabric from yarn
- **Dyeing:** Add color
- **Finishing:**
  - Add all others functional properties
  - Final touch and packaging

Nullarbor fabric made from microbial cellulose

Source:
ScienceDirect (5, 6)

Resistance to Force

Standard References:

- ISO 13934-1 (Tensile Properties)
- ASTM D5034 (Breaking Strength and Elongation)

Observation on OAKIA's product:

- **Achievable:**
  - By leveraging microbial cellulose technologies, recycle the fibers up to the molecule level, OAKIA's recycled fibers can achieve high tensile strength and durability -
- **Challenges:**
  - Ensuring consistency in tensile properties across different batches can be challenging but can be managed through stringent quality control processes.

Source:
https://newatlas.com/nanollose-nullabor-microbial-cellulose-fiber-eco-clothing/54734/
https://www.yankodesign.com/2022/06/17/new-microbial-weaving-process-can-grow-compostable-fabric-from-microbes/

Resistance to Abrasion

Standard References:

- ISO 12947-2 (Abrasion Resistance)
- ASTM D4966 (Martindale Abrasion Tester Method)

Observation on OAKIA's product:

- **Achievable:**
  - Utilizing microbial cellulose can provide high abrasion resistance due to the integrity of the nanostructure during fiber formation in the production process.
- **Challenges:**
  - Ensuring consistency in tensile properties across different batches can be challenging but can be managed through stringent quality control processes.

Source: https://link.springer.com/article/10.1007/s10311-021-01214-x

Resistance to Color Fastness

Standard References:

- ISO 105-C06 (Colorfastness to Washing)
- AATCC TM61 (Colorfastness to Laundering)

Observation on OAKIA's product:

- **Achievable:** Using microbial-based dyes can ensure our fibers maintain high colorfastness with the previous condition ensuring the texture of the fabric itself can retain the color.
- **Challenges:**
  - Ensuring uniform dye uptake and retention across all fibers, which requires precise control over the dyeing process.
  - The quality of the dyes contribute a large amount in achieving this standard, which is currently out of scope for our technology (this step so far)

Source: https://www.labiotech.eu/in-depth/sustainable-colors-microbes/

Dimensional Stability

Standard References:

- AATCC TM135 (Dimensional Changes after Laundering)

Observation on OAKIA's product:

- **Achievable:** Microbial-based fibers can exhibit minimal shrinkage or expansion, meeting dimensional stability standards.
- **Challenges:**
  - Ensuring consistency in tensile properties across different batches can be challenging but can be managed through stringent quality control processes.

Source: https://link.springer.com/article/10.1007/s10311-021-01214-x

Softness and Comfort

Standard References:

- ISO 9237 (Air Permeability)
- ASTM D737 (Air Permeability)

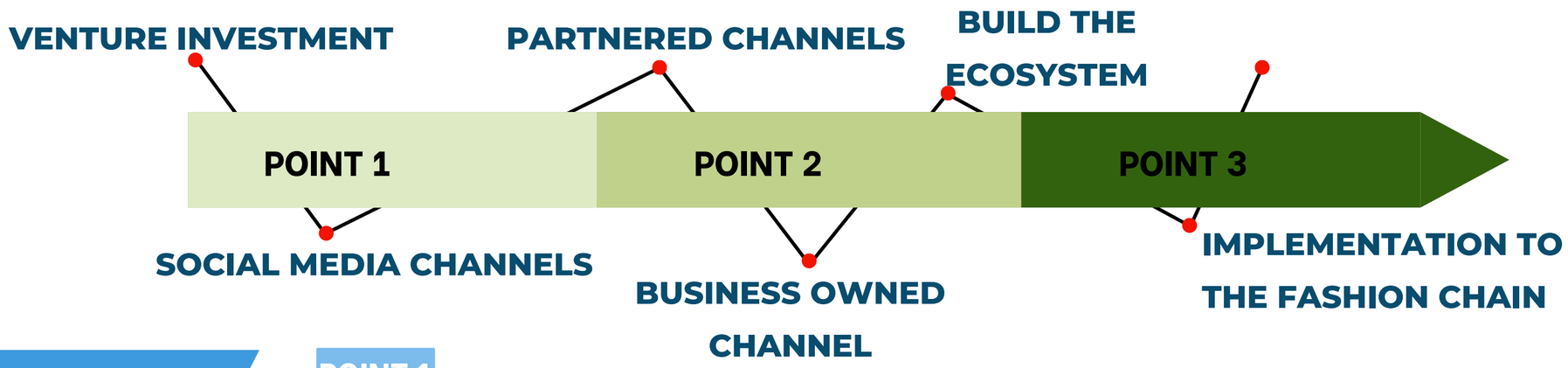
Observation on OAKIA's product:

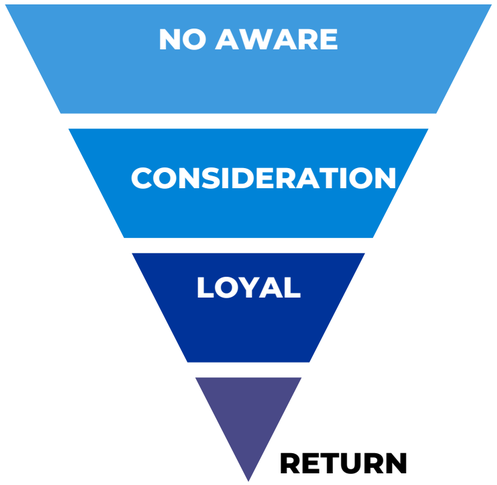
- **Achievable:**
  - Microbial-based fibers can be engineered for high air permeability and softness.
- **Challenges:**
  - Balancing durability and softness in the final product to meet market expectations.
  - However, it will depends on the customer's requirement to have the adjustment on this standard.

Source:
https://www.inven.ai/articles/21-exciting-sustainable-textile-manufacturers-worldwide
https://www.labiotech.eu/in-depth/sustainable-colors-microbes/

OAKIA's awareness process.

BUSINESS JOURNEY IN BECOMING OAKIA CUSTOMER





POINT 1

OAKIA will focus on small and local business in Vietnam.

POINT 2

OAKIA will extend the solution portfolio such as the full process for the fashion retailer to implement our technology into their business.

POINT 3

OAKIA will collaborate with the Business owned channels to ensure the information of recycled textiles is widely spreaded and utilized in the market.

WHAT SHOULD OAKIA DO?

Build the connection between OAKIA and other fashion related businesses to implement our procedure into their business as an unique core technology. Moreover, we will spontaneously marketing and promote the product via social media channels.

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