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BUSINESS ADMINISTRATION

Decision support model for evaluating barriers of circular supply chains for sustainability in the textile industry A case study in Vietnam

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Chapter 1: Introduction

- Background & Problem
- CE & Circular Supply Chain
- Research objectives
- Research questions
- Research scope

Background & Problem

Vietnam is one of the 5 largest garment exporting countries. Vietnam's textile and garment industry has an average growth rate with export turnover contributing 10%-15% of annual GDP.

(GovermentNews, 2021)

Vietnam's textile and garment industry also contributes to creating jobs for nearly 2.6 million workers every year

(Virac, 2023)

Background & Problem

Environmental pollution is second only to oil and responsible for about 2%-8% of greenhouse gas emissions

(World Wide Fund for Nature in VietNam, 2021)

Uses about 93 billion cubic meters of water and accounts for about 20% of industrial water pollution

(Nhandan, 2023)

X

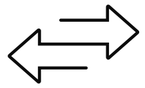
Increasing the amount of waste

(Vietnam National Textile and Garment Group, 2022)

CE & Circular Supply Chain

Circular Economy is a closed-loop industrial economic model that aims to minimize waste

(Ghisellini et al., 2016; Geissdoerfer et al., 2017)



The transition from a linear economy to CE is inevitable

(Vermeulen, 2015)

Try to make the “closed loop” cycle possible

(Jia et al., 2020)

Research objectives

Objective1

Understand and identify the barriers of Circular supply chain for the textile industry in Vietnam.

Objective2

Determine the relative weights of the CSC barriers.

Objective3

Propose the managerial implications of the proposed work and constructive recommendations for Vietnamese textile and garment enterprises to overcome the most important barriers to moving towards a circular economy.

Research questions

Question 1

How important is the circular economy to Vietnam's textile and garment industry?

Question 2

Which is the top 5 barriers affecting the transition to a circular economy for Vietnam's textile and garment industry?

Question 3

What are constructive recommendations for Vietnamese textile and garment enterprises to overcome barriers to moving towards a circular economy?

Title	Authors	Number of Respondents
The transition from linear economy to circular economy for sustainability among SMEs: A study on prospects, impediments, and prerequisites	(Sharma et al., 2020)	6
Barriers to the adoption of the circular economy in the Brazilian sugarcane ethanol sector	(Jesus et al., 2021)	4
Managing operations for circular economy in the mining sector: An analysis of barriers intensity	(Singh et al., 2020)	7
Exploring barriers to smart and sustainable circular economy: The case of an automotive eco-cluster	(Kayikci et al., 2021)	5
Investigating barriers to circular supply chain in the textile industry from Stakeholders' perspective	(Kazancoglu et al., 2020)	11
Exploring the decisive barriers to achieve circular economy: Strategies for the textile innovation in Taiwan	(Huang, Y.-F. et al., 2021)	9

Research scope

Number of respondents: 7 experts

Number of years of experience: over six years experience

- Field of work: working in departments at small, medium-sized, multinational corporations and foreign-invested enterprise textile enterprises in Vietnam
- Management level: from Middle Management Level and above

Chapter 2: Literature Review

Literature review

Circular SC barriers framework

Research GAP

Literature review

CIRCULAR ECONOMY

- *'Conceptualizing the circular economy: An analysis of 114 definitions'*

  (Kirchherr et al., 2017)

- *'Circular economy: The concept and its limitations'*

  (Korhonen et al., 2018)

- *'Mapping the social dimension of the circular economy'*

  (Mies & Gold, 2021)

MCDM, AHP, BARRIERS

- *'Managing operations for circular economy in the mining sector: An analysis of barriers intensity'*

  (Singh et al., 2020)

- *'Barriers to the adoption of the circular economy in the Brazilian sugarcane ethanol sector'*

  (Jesus et al., 2021)

- *'The analysis of barriers for implementing circular economy practices using the Analytic Hierarchy Process (AHP)'*

  (Santos et al., 2021)

- *'Designing Strategies to Anticipate Circular Economy Barriers in Furniture Industry'*

  (Wicaksono et al., 2021)

Circular SC barriers framework

MAIN BARRIERS

Management and decision-making B1	Labour B2	Design challenges B3
Materials B4	Rules and regulations B5	Knowledge and awareness B6
Integration and collaboration B7	Economic B8	Technical infrastructure B9

Circular SC barriers framework

B1 - MANAGEMENT AND DECISION-MAKING SUB-BARRIERS

B1.1 LACK OF PERFORMANCE EVALUATION SYSTEM

Measure management-related activities, especially for fiber, fabric, and clothing manufacturers, as well as collectors and recycling regimes.

B1.2 LACK OF ACCEPTANCE OF CE MODELS

Vietnamese textile and garment enterprises are still reluctant to accept CE as a new business model to deploy for their businesses.

B1.3 LACK OF ACCEPTANCE OF CE MODELS

Monitoring product life cycles and material flows, stems from a lack of data on raw material origins, identification of ingredients and raw materials, and information relevant to the decision-making process.

Circular SC barriers framework

B2 - LABOUR | **SUB-BARRIERS**

B2.1 NECESSITY OF INTENSIVE WORKFORCE

Employing many workers in the textile industry, especially circular economic activities in the textile industry require a large amount of labor.

B2.2 LACK OF TRAINED INTERMEDIATE STAFF

Adequately trained employees are vital due to the countless intermediate processing steps involved in the textile industry.

Circular SC barriers framework

B3 - DESIGN CHALLENGES | **SUB-BARRIERS**

B3.1 LACK OF COMPLEMENTARY PROCESSES

Key stages from raw material sourcing to garment production. Coordination between these processes is imperative to ensure the quality, efficiency, and adaptability of textile production.

B3.2 COMPLEXITY IN PRODUCT ARCHITECTURE

When product design becomes too complex, it will increase production costs, be susceptible to errors and damage, and limit innovation in the product development process.

Circular SC barriers framework

B4 - MATERIALS | **SUB-BARRIERS**

B4.1 AVAILABILITY OF RECYCLABLE MATERIALS

Finding and accessing reusable materials is vital to reducing the environmental impact of products.

B4.2 LACK OF HIGH QUALITY

Sourcing recycled materials used in the textile process and addressing the higher costs associated with premium fibers and materials.

B4.3 COMPLEXITY IN MATERIAL COMPOSITION

Textile products are complex garments and are made from a variety of materials, reducing the possibility of extracting resources from the product and finding alternative solutions.

B4.4 HIGH COST OF RAW MATERIALS

The cost of recycled materials is higher than the cost of normal materials, because machinery and labor must be used to turn them into usable materials, so higher costs are required.

Circular SC barriers framework

B5 - RULES AND REGULATIONS | **SUB-BARRIERS**

B5.1 LACK OF SECTORIAL STANDARDIZATION

Vietnam's textile and garment industry does not have a roadmap or standard regulations for specific requirements on waste collection and recycling so that businesses can comply.

B5.2 LACK OF CERTIFICATIONS

Lack of quality inspection certificates to monitor whether raw materials and recycled materials purchased from suppliers comply with standards.

Circular SC barriers framework

B6 - KNOWLEDGE AND AWARENESS | **SUB-BARRIERS**

B6.1 LACK OF CE AWARENESS

Businesses lack knowledge about what materials should be used in products and how to produce textile products using a circular economy.

B6.2 LACK OF THEORETICAL INFORMATION

Vietnamese textile and garment enterprises are still reluctant to accept CE as a new business model to deploy for their businesses.

B6.3 LACK OF TECHNICAL KNOW-HOW

Technical knowledge about the circular economy in the textile and garment industry of companies is limited and not widely accessible in Vietnam.

Circular SC barriers framework

B7 - INTEGRATION AND COLLABORATION SUB-BARRIERS

B7.1 LACK OF SHARING INFORMATION AND COMMUNICATION

Lack of sharing and exchanging information, methods and techniques on the circular economy of the textile and garment industry between businesses.

B7.3 LACK OF SHARED VISION AND WILLINGNESS TO COLLABORATE

Lack of common vision, willingness to cooperate, reluctance to enter into partnerships throughout the enterprise's supply chain.

B7.2 LACK OF CONSTANT SUPPLIER

Lack of regular raw material suppliers in the textile industry for businesses.

Circular SC barriers framework

B8 - COST | **SUB-BARRIERS**

B8.1 HIGH INVESTMENT COST

The use of new technology, certification processes, and employee retraining increase costs, and companies are hesitant to invest.

B8.2 UNCERTAINTY IN PROFITABILITY

Companies are concerned about profits because they cannot be predicted or known with certainty when investing in a new business model.

B8.3 FAILURE TO PROVIDE THE SCALE OF PRODUCTION

To apply the circular economy, businesses need to expand production scale. Vietnam still has a majority of small and medium enterprises.

Circular SC barriers framework

B9 - TECHNICAL INFRASTRUCTURE SUB-BARRIERS

B9.1 INADEQUATE OF INFRASTRUCTURE FACILITIES

Lack of infrastructure in the textile industry, such as production facilities, warehouse systems, transportation networks, technical facilities, etc.

B9.2 LACK OF HIGH-TECH IN REVERSE LOGISTICS

Hinders the effective functioning of reverse logistics systems and sustainability in organizations, contributing to mitigating environmental problems.

Summary of evaluation barriers

Authors [Ref]	*Management and decision-making (B1)*			*Labour (B2)*		*Design challenges (B3)*		*Materials (B4)*				*Rules and regulations (B5)*		*Knowledge and awareness (B6)*			*Integration and collaboration (B7)*			*Economic (B8)*			*Technical infrastructure (B9)*	
	Lack of performance evaluation system	*Lack of acceptance of CE models*	*Lack of traceability*	*Necessity of intensive workforce*	*Lack of trained intermediate staff*	*Lack of complementary processes*	*Complexity in product architecture*	*Availability of recyclable materials*	*Lack of high quality*	*Complexity in material composition*	*High cost of raw materials*	*Lack of sectorial standardization*	*Lack of certifications*	*Lack of CE awareness*	*Lack of theoretical information*	*Lack of technical know-how*	*Lack of sharing information and communication*	*Lack of constant supplier*	*Lack of shared vision and willingness to collaborate*	*High investment cost*	*Uncertainty in profitability*	*Failure to provide the scale of production*	*Insufficiency of reverse logistics infrastructure*	*Inadequate of transport infrastructure*
Jia et al.	☑	☑		☑	☑							☑	☑							☑				
Hartley, K. et al.			☑		☑				☑		☑	☑				☑				☑		☑		
Koszewska, M.			☑					☑		☑	☑	☑		☑								☑	☑	☑
R. Rathinamoorthy		☑						☑			☑	☑			☑	☑	☑						☑	
Majumdar, A. et al.	☑				☑	☑					☑	☑		☑				☑	☑	☑			☑	☑
Garcés-Ayerbe et al.			☑	☑	☑							☑								☑				
Charef, R. et al.		☑	☑			☑	☑		☑	☑	☑	☑		☑			☑		☑					☑
Fabian Takacs et al.			☑	☑				☑	☑		☑	☑		☑	☑	☑	☑		☑	☑	☑			
Binoy Debnath et al.	☑			☑	☑			☑				☑			☑	☑			☑		☑	☑		☑

Research GAP

Author(s)	Title	Country	Method research
Oliveira et al., 2023	*Combining SWOT with AHP for analyzing the adoption of a circular economy in the apparel industry in Brazil*	Brazil	AHP method
Tong et al., 2012	*An AHP-based water-conservation and waste-reduction indicator system for cleaner production of textile-printing industry in China and technique integration*	China	AHP method
Thinakaran et al., 2023	*Analyzing the challenges to circular economy in Indian Fashion Industry*	India	MCDM method
Huang et al., 2021	*Exploring the decisive barriers to achieve circular economy: Strategies for the Textile Innovation in Taiwan*	Taiwan	FDM method
Snoek, 2017	*Circular Economy in the Textile Industry - Transition theory in start-ups in the textile industry*	Netherlands	Semi-structured interviews
Zoupalova et al., 2023	*Barriers to the circular economy in textile industry: a case study of the Czech Republic*	Czech Republic	Purposive sampling method

Chapter 3: Methodology

Introduction

Proposed Method

Introduction

DATA COLLECTION

QUANTITATIVE METHOD

Characterized by the results presented in the form of numbers.
This kind of study involves comparing and evaluating general criteria.

QUALITATIVE METHOD

Expressed in the form of words, such as expert opinions
Allows gathering deep insights on topics that are not well known.

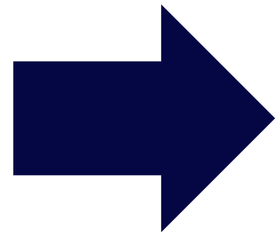
(Creswell, J. W., 2009)

Combined numerical and descriptive data to leverage the advantages and address the drawbacks of each kind of data.

Proposed Method

MULTIPLE CRITERIA DECISION-MAKING

MODM	MADM
• continuous decision spaces • there are many alternatives to choose from and they can be measured by numbers.	• discrete decision space • there are a limited number of alternatives to choose from and they can be described by words or categories.



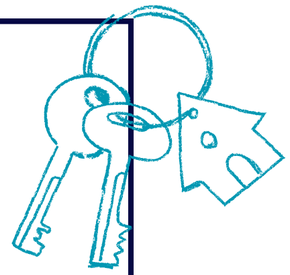
AHP

(Velasquez et al., 2013)

ANALYTIC HIERARCHY PROCESS

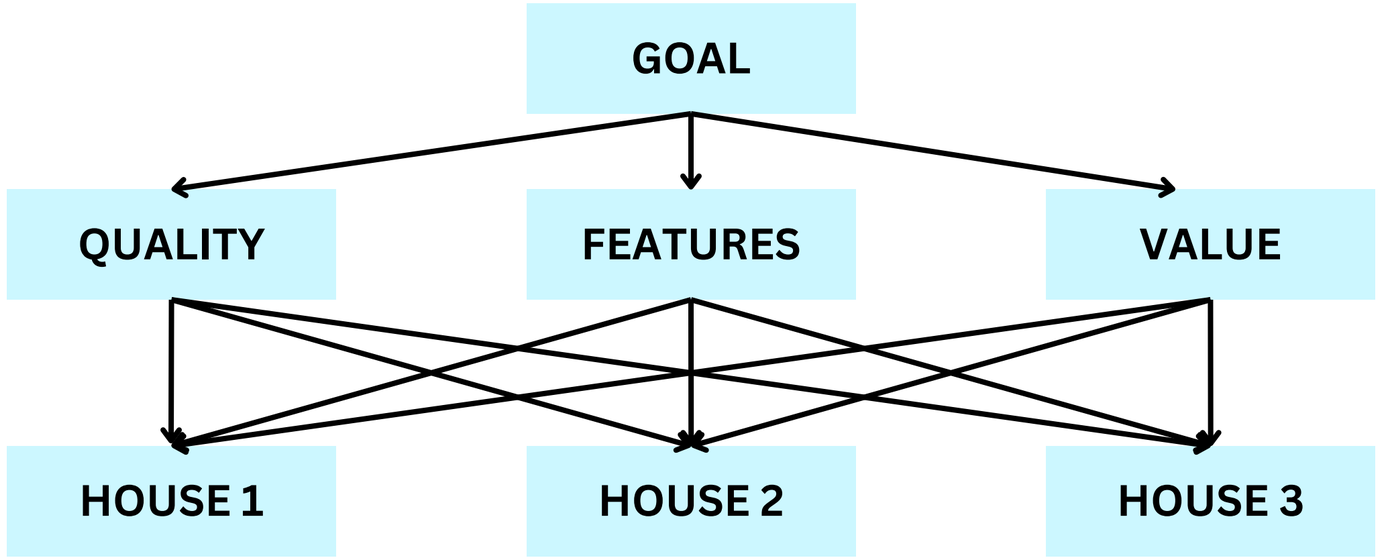
- AHP is one of the most basic, popular MCDM methods, helping to organize and analyze complex decision problems, based on mathematics and psychology.
- AHP is a way of comparing different criteria and alternatives based on their importance and preference.
- The AHP method was invented in 1980 by Saaty.

(Saaty, T.L., 1980)



BUY A NEW HOUSE

- First, you should define your goal and alternatives.
- Second, you should construct a hierarchy that represents the relationship between the goal, criteria, sub-criteria, and alternatives.



Intensity of importance	Definition
1	Equal importance
3	Weak importance of one over another
5	Essential or strong importance
7	Demonstrated importance
9	Absolute importance
2,4,6,8	Intermediate values

TABLE 2: Scale of Relative Importance

A pairwise comparison matrix is used, which compares the relative importance of each pair of elements using the scale shown in Table 2.

(Saaty, T.L., 1980)

1 **ANALYSIS**

- Identify the main goal, criteria, and alternatives
- Construct a hierarchical tree that represents the structure of the decision problem

2 **EVALUATION**

- Create pairwise comparison matrices.

$$A = (a_{ij})_{k\times k} = \begin{bmatrix} 1 & a_{12} & \cdots & a_{1k} \\ a_{21} & 1 & \cdots & a_{2k} \\ \vdots & \vdots & \vdots & \vdots \\ a_{k1} & a_{k2} & \cdots & 1 \end{bmatrix}$$

(Saaty, T.L., 1980)

2 EVALUATION

- Develop normalized matrices

$$C_{ij} = \frac{A_{ij}}{\sum_{i=1}^{n} A_{ij}} \begin{bmatrix} C_{11} & C_{12} & \cdots & C_{1n} \\ C_{21} & C_{22} & \cdots & C_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ C_{n1} & C_{n2} & \cdots & C_{nn} \end{bmatrix}$$

For all j = 1, 2, …, n.

- Calculate the Consistency Index (CI)

$$CI = \frac{\lambda_{max} - n}{n - 1}$$

(Saaty, T.L., 1980)

2 **EVALUATION**

- Calculate the Consistency Ratio (CR)

Matrix size	Random Consistency Index (RI)
1	0.00
2	0.00
3	0.58
4	0.90
5	1.12
6	1.24
7	1.32
8	1.41
9	1.45
10	1.49

$$CR = \frac{CI}{RI}$$

TABLE 3: The values of Random Index (RI) *(Saaty, T.L., 1980)*

3

SYNTHESIS

- Calculate the overall weight of the objective function

$$Function\ 1 = F_{11} \times w_1 + F_{12} \times w_2 + \ldots + F_{1u} \times w_u$$
$$Function\ v = F_{v1} \times w_1 + F_{v2} \times w_2 + \ldots + F_{vu} \times w_u$$

(Saaty, T.L., 1980)

Chapter 4: EMPIRICAL CASE ANALYST

Industrial Experts

Results

Findings

Discussion

List of industrial experts

Expert	Education level	Position in the supply chain	Expert's position	Work experience (years)	Gender
E1	B.Sc	Garment manufacturer	Quality & sustainable development leader	10	Female
E2	MBA	Garment manufacturer	Garment Technology - Account Manager	10	Female
E3	M. Sc	Garment manufacturer	Procurement manager	8	Male
E4	B.Sc	Yarn, Fabric Manufacturer	Production & quality manager	9	Female
E5	MBA	Retailer Yarn, Fabric Manufacturer	General Director	15	Male
E6	B.Sc	Raw Material Supplier	Sustainable Development Manager	10	Male
E7	PhD	Governmental and Policy Maker	Researcher	20	Male

Questionnaire

EXPERT PROFILE		
No.	***Questions***	***Answer***
1	**Name**	
2	**Gender**	
3	**Highest educational qualification obtained** ** B. Sc, M. Sc, Ph. D, etc*	
4	**Areas of expertise** **Please explain specifically the position and area of expertise, e.g., Senior manager of the Quality management Department of Garment company A*	
5	**Do you have experience in the textile industry?** **yes/ no*	
6	**Years of work experience in the textile and garment industry** ** < 5 years, between 5 years and 10 years, > 10 years*	

SURVEY ON BARRIERS OF CIRCULAR SUPPLY CHAIN IN VIETNAM'S TEXTILE INDUSTRY

Background

This study aims to identify and rank circular economy barriers for Vietnam's textile industry in the current context. Barriers were identified from existing literature and expert recommendations. Using the AHP approach, this study ranks each of the factors' pairwise comparisons. From there, deep insights are provided for Vietnamese textile and garment enterprises that transform into a circular economy for sustainable development.

☎ You serve as an expert in this study. Your contribution is an indispensable part of completing this research.

Instructions

If you think the barrier on the left is more Strongly Important than the barrier on the right, you can tick (✔) in column Strongly Important (5) on the left side. However, if you think that the factor on the right is more Strongly Important than the factor on the left, you can tick (✔) in column number Strongly Important (5) on the right side.

However, suppose you think that both barriers are of equal importance. In that case, you tick (✔) the middle option, i.e. column Equal (1).

Intensity of Importance	Definition
1	Equal Importance
3	Moderate Importance
5	Strong Importance
7	Very Strong Importance
9	Extreme Importance
2, 4, 6, 8	Intermediate values

PAIRWISE COMPARISONS (MAIN BARRIERS)

Extremely important (9)	(8)	Very strong important (7)	(6)	Strongly important (5)	(4)	Slightly important (3)	(2)	BARRIER	Equal (1)	BARRIER	(2)	Slightly important (3)	(4)	Strongly important (5)	(6)	Very strong important (7)	(8)	Extremely important (9)
☐	☐	☐	☐	☐	☐	☐	☐	*Management and decision-making*	☑	*Labour*	☐	☐	☐	☐	☐	☐	☐	☐
☐	☐	☐	☑	☐	☐	☐	☐		☐	*Design challenges*	☐	☐	☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐	☐	☐		☐	*Materials*	☑	☐	☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐	☐	☐		☐	*Rules and regulations*	☑	☐	☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐	☐	☐		☐	*Knowledge and awareness*	☐	☑	☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☑	☐	☐		☐	*Integration and collaboration*	☐	☐	☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐	☐	☐		☑	*Economic*	☐	☐	☑	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐	☑	☐		☐	*Technical infrastructure*	☐	☐	☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☑	☐	☐	☐		☐	*Design challenges*	☐	☐	☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐	☐	☐		☐	*Materials*	☑	☐	☐	☐	☐	☐	☐	☐

PAIRWISE COMPARISONS (SUB-BARRIERS)

Extremely important (9)	(8)	Very strong important (7)	(6)	Strongly important (5)	(4)	Slightly important (3)	(2)	BARRIER	Equal (1)	BARRIER	(2)	Slightly important (3)	(4)	Strongly important (5)	(6)	Very strong important (7)	(8)	Extremely important (9)
B1. Management and decision-making																		
☐	☐	☐	☐	☐	☐	☐	☐	*Lack of performance evaluation system*	☐	*Lack of acceptance CE models*	☑	☐	☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐	☑	☐	*Lack of performance evaluation system*	☐	*Lack of traceability*	☐	☐	☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☑	☐	☐	*Lack of acceptance CE models*	☐	*Lack of traceability*	☐	☐	☐	☐	☐	☐	☐	☐
B2. Labour																		
☐	☐	☐	☐	☐	☐	☑	☐	*Labour intensiveness*	☐	*Lack of trained intermediate staff*	☐	☐	☐	☐	☐	☐	☐	☐

See more on page .. - ... of the Thesis Report

Main barriers

PAIRWISE COMPARISON MATRIX OF MAIN BARRIERS

Main Barriers	B1	B2	B3	B4	B5	B6	B7	B8	B9
B1	1	1.286	6.571	0.905	0.476	0.326	3.857	0.243	1.857
B2	0.778	1	4.857	0.524	0.362	0.314	3.143	0.205	1.786
B3	0.152	0.206	1	0.217	0.168	0.146	0.350	0.132	0.310
B4	1.105	1.909	4.615	1	0.512	0.357	2.857	0.248	3.143
B5	2.100	2.763	5.951	1.953	1	0.929	4.571	0.690	4.143
B6	3.066	3.182	6.853	2.800	1.077	1	4.714	0.595	3.286
B7	0.259	0.318	2.857	0.350	0.219	0.212	1	0.165	1.214
B8	4.118	4.884	7.603	4.038	1.448	1.680	6.074	1	4.714
B9	0.538	0.560	3.231	0.318	0.241	0.304	0.824	0.212	1
Column Sum	13.116	16.108	43.540	12.105	5.503	5.269	27.391	3.489	21.452

NORMALIZED PAIR-WISE MATRIX OF MAIN BARRIERS

Normalized	B1	B2	B3	B4	B5	B6	B7	B8	B9
B1	0.076	0.080	0.151	0.075	0.087	0.062	0.141	0.070	0.087
B2	0.059	0.062	0.112	0.043	0.066	0.060	0.115	0.059	0.083
B3	0.012	0.013	0.023	0.018	0.031	0.028	0.013	0.038	0.014
B4	0.084	0.119	0.106	0.083	0.093	0.068	0.104	0.071	0.147
B5	0.160	0.172	0.137	0.161	0.182	0.176	0.167	0.198	0.193
B6	0.234	0.198	0.157	0.231	0.196	0.190	0.172	0.171	0.153
B7	0.020	0.020	0.066	0.029	0.040	0.040	0.037	0.047	0.057
B8	0.314	0.303	0.175	0.334	0.263	0.319	0.222	0.287	0.220
B9	0.041	0.035	0.074	0.026	0.044	0.058	0.030	0.061	0.047
Column Sum	1	1	1	1	1	1	1	1	1

0.778 / 13.116 CELL / SUM BY COLUMN

Main barriers

NORMALIZED PAIR-WISE MATRIX OF MAIN BARRIERS

Normalized	B1	B2	B3	B4	B5	B6	B7	B8	B9	Barriers Weights
B1	0.076	0.080	0.151	0.075	0.087	0.062	0.141	0.070	0.087	**0.0919**
B2	0.059	0.062	0.112	0.043	0.066	0.060	0.115	0.059	0.083	**0.0731**
B3	0.012	0.013	0.023	0.018	0.031	0.028	0.013	0.038	0.014	**0.0209**
B4	0.084	0.119	0.106	0.083	0.093	0.068	0.104	0.071	0.147	**0.0971**
B5	0.160	0.172	0.137	0.161	0.182	0.176	0.167	0.198	0.193	**0.1717**
B6	0.234	0.198	0.157	0.231	0.196	0.190	0.172	0.171	0.153	**0.1890**
B7	0.020	0.020	0.066	0.029	0.040	0.040	0.037	0.047	0.057	**0.0394**
B8	0.314	0.303	0.175	0.334	0.263	0.319	0.222	0.287	0.220	**0.2706**
B9	0.041	0.035	0.074	0.026	0.044	0.058	0.030	0.061	0.047	**0.0462**
Column Sum	1	1	1	1	1	1	1	1	1	**1**

$$\frac{0.076+0.080+0.151+0.075+0.087+0.062+0.141+0.070+0.087}{9}$$

B8. ECONOMIC	**1**
B6. KNOWLEDGE AND AWARENESS	**2**
B5. RULES AND REGULATIONS	**3**
B4. MATERIAL	**4**
B1. MANAGEMENT AND DECISION-MAKING	**5**
B2. LABOUR	**6**
B9. TECHNICAL INFRASTRUCTURE	**7**
B7. INTEGRATION AND COLLABORATION	**8**
B3. DESIGN CHALLENGES	**9**

Main barriers

APPLY CONSISTENCY TEST

PAIRWISE COMPARISON MATRIX OF MAIN BARRIERS X **PRIORITY VECTOR** = **PRIORITY WEIGHTING**

$$\begin{bmatrix} 1 & 1.286 & 6.571 & 0.905 & 0.476 & 0.326 & 3.857 & 0.243 & 1.857 \\ 0.778 & 1 & 4.857 & 0.524 & 0.362 & 0.314 & 3.143 & 0.205 & 1.786 \\ 0.152 & 0.206 & 1 & 0.217 & 0.168 & 0.146 & 0.350 & 0.132 & 0.310 \\ 1.105 & 1.909 & 4.615 & 1 & 0.512 & 0.357 & 2.857 & 0.248 & 3.143 \\ 2.100 & 2.763 & 5.951 & 1.953 & 1 & 0.929 & 4.571 & 0.690 & 4.143 \\ 3.066 & 3.182 & 6.853 & 2.800 & 1.077 & 1 & 4.714 & 0.595 & 3.286 \\ 0.259 & 0.318 & 2.857 & 0.350 & 0.219 & 0.212 & 1 & 0.165 & 1.214 \\ 4.118 & 4.884 & 7.603 & 4.038 & 1.448 & 1.680 & 6.074 & 1 & 4.714 \\ 0.538 & 0.560 & 3.231 & 0.318 & 0.241 & 0.304 & 0.824 & 0.212 & 1 \end{bmatrix} \times \begin{bmatrix} 0.092 \\ 0.073 \\ 0.021 \\ 0.097 \\ 0.172 \\ 0.189 \\ 0.039 \\ 0.271 \\ 0.046 \end{bmatrix} = \begin{bmatrix} 0.858 \\ 0.680 \\ 0.191 \\ 0.915 \\ 1.615 \\ 1.802 \\ 0.359 \\ 2.581 \\ 0.424 \end{bmatrix}$$

PRIORITY WEIGHTING / PRIORITY VECTOR = CONSISTENCY VECTOR

$$\begin{bmatrix}0.858\\0.680\\0.191\\0.915\\1.615\\1.802\\0.359\\2.581\\0.424\end{bmatrix} / \begin{bmatrix}0.092\\0.073\\0.021\\0.097\\0.172\\0.189\\0.039\\0.271\\0.046\end{bmatrix} = \begin{bmatrix}9.337\\9.301\\9.131\\9.422\\9.403\\9.533\\9.106\\9.536\\9.185\end{bmatrix}$$

Avarage

The maximum eigenvalue of the comparison matrix

$$\lambda_{max} = \frac{9.337+9.301+9.131+9.422+9.403+9.533+9.106+9.536+9.185}{9} = 9.3281$$

Consistency Index

$$CI = \frac{\lambda max - n}{n-1} = \frac{9.3281-9}{9-1} = 0.0410$$

The values of random index (RI)

n	1	2	3	4	5	6	7	8	9
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	**1.45**

Consistency Ratio

$$CR = \frac{CI}{RI} = \frac{0.041}{1.45} = \mathbf{0.0283} < 0.1$$

The pairwise comparison matrix is consistent, and the results are satisfactory.

Main barriers

APPLY CONSISTENCY TEST

Main barriers

PAIRWISE COMPARISONS OF MAIN BARRIERS

	WEIGHTS	RANKING
B8. ECONOMIC	0.2706	1
B6. KNOWLEDGE AND AWARENESS	0.1890	2
B5. RULES AND REGULATIONS	0.1717	3
B4. MATERIAL	0.0971	4
B1. MANAGEMENT AND DECISION-MAKING	0.0919	5
B2. LABOUR	0.0731	6
B9. TECHNICAL INFRASTRUCTURE	0.0462	7
B7. INTEGRATION AND COLLABORATION	0.0394	8
B3. DESIGN CHALLENGES	0.0209	9
CONSISTENCY RATIO (CR) = 0.0283		

Sub-barriers

PAIRWISE COMPARISONS OF SUB-BARRIERS

B1. MANAGEMENT AND DECISION-MAKING	WEIGHTS	RANKING
B12. LACK OF ACCEPTANCE OF CE MODELS	0.566	**1**
B11. LACK OF PERFORMANCE EVALUATION SYSTEM	0.311	**2**
B13. LACK OF TRACEABILITY	0.123	**3**

CONSISTENCY RATIO (CR) = 0.0043

B2. LABOUR	WEIGHTS	RANKING
B21. LABOUR INTENSIVENESS	0.702	**1**
B22. LACK OF TRAINED INTERMEDIATE STAFF	0.298	**2**

CONSISTENCY RATIO (CR) = 0

Sub-barriers

PAIRWISE COMPARISONS OF SUB-BARRIERS

B3. DESIGN CHALLENGES	WEIGHTS	RANKING
B31. LACK OF COMPLEMENTARY PROCESSES	0.682	**1**
B32. COMPLEXITY IN PRODUCT ARCHITECTURE	0.318	**2**
	CONSISTENCY RATIO (CR) = 0	

B4. MATERIAL	WEIGHTS	RANKING
B44. HIGH COST OF RAW MATERIALS	0.480	**1**
B41. AVAILABILITY OF RECYCLABLE MATERIALS	0.273	**2**
B43. COMPLEXITY IN MATERIAL COMPOSITION	0.165	**3**
B42. LACK OF HIGH QUALITY	0.082	**4**
	CONSISTENCY RATIO (CR) = 0.0108	

Sub-barriers

PAIRWISE COMPARISONS OF SUB-BARRIERS

B5. RULES AND REGULATIONS	WEIGHTS	RANKING
B51. LACK OF SECTORIAL STANDARDIZATION	0.682	1
B52. LACK OF CERTIFICATIONS	0.318	2
	CONSISTENCY RATIO (CR) = 0	

B6. KNOWLEDGE & AWARENESS	WEIGHTS	RANKING
B61. LACK OF CE AWARENESS	0.564	1
B63. LACK OF TECHNICAL KNOW-HOW	0.297	2
B62. LACK OF THEORETICAL INFORMATION	0.139	3
	CONSISTENCY RATIO (CR) = 0.0003	

Sub-barriers

PAIRWISE COMPARISONS OF SUB-BARRIERS

B7. INTEGRATION & COLLABORATION	WEIGHTS	RANKING
B72. LACK OF CONSTANT SUPPLIER	0.657	**1**
B73. LACK OF SHARED VISION AND WILLINGNESS TO COLLABORATE	0.219	**2**
B71. LACK OF SHARING INFORMATION AND COMMUNICATION	0.124	**3**

CONSISTENCY RATIO (CR) = 0.0134

Sub-barriers

PAIRWISE COMPARISONS OF SUB-BARRIERS

B8. ECONOMIC	WEIGHTS	RANKING
B81. HIGH INVESTMENT COST	0.610	**1**
B82. UNCERTAINTY IN PROFITABILITY	0.259	**2**
B83. FAILURE TO PROVIDE THE SCALE OF PRODUCTION	0.131	**3**

CONSISTENCY RATIO (CR) = 0.0061

B9. TECHNICAL INFRASTRUCTURE	WEIGHTS	RANKING
B91. INADEQUATE OF INFRASTRUCTURE FACILITIES	0.632	**1**
B92. LACK OF HIGH-TECH IN REVERSE LOGISTICS	0.368	**2**

CONSISTENCY RATIO (CR) = 0

Findings

The study points out that the five barriers with the highest importance values are listed respectively as:

- **High investment cost (B81)**
- **Lack of sectorial standardization (B51)**
- **Lack of CE awareness (B61)**
- **Uncertainty in profitability (B82)**
- **Lack of technical know-how (B63)**

These are responsible for non-implementation of CE practices in the Vietnamese textile industry.

MAIN BARRIERS' LOCAL WEIGHTS × SUB-BARRIERS' LOCAL WEIGHTS = SUB-BARRIERS' GOLBAL WEIGHTS

Barriers	Weights Concept	Rank Concept	Sub-barriers	Weights Local	Rank Local	Weights Global	Rank Global
B1	0.092	5	B11	0.311	2	0.029	12
			B12	0.566	1	0.052	7
			B13	0.123	3	0.011	20
B2	0.073	6	B21	0.702	1	0.051	8
			B22	0.298	2	0.022	16
B3	0.021	9	B31	0.682	1	0.014	19
			B32	0.318	2	0.007	23
B4	0.097	4	B41	0.273	2	0.027	13
			B42	0.082	4	0.008	22
			B43	0.165	3	0.016	18
			B44	0.480	1	0.047	9
B5	**0.172**	**3**	**B51**	**0.682**	**1**	**0.117**	**2**
			B52	0.318	2	0.055	6
B6	**0.189**	**2**	**B61**	**0.564**	**1**	**0.107**	**3**
			B62	0.139	3	0.026	14
			B63	**0.297**	**2**	**0.056**	**5**
B7	0.039	8	B71	0.124	3	0.005	24
			B72	0.657	1	0.026	15
			B73	0.219	2	0.009	21
B8	**0.271**	**1**	**B81**	**0.610**	**1**	**0.165**	**1**
			B82	**0.259**	**2**	**0.070**	**4**
			B83	0.131	3	0.036	10
B9	0.046	7	B91	0.632	1	0.029	11
			B92	0.368	2	0.017	17

Weighting and Ranking Results of AHP

Discussion

HIGH INVESTMENT COST

High investment costs appear as the most pressing barrier in implementing the CE process.

(Hart et al., 2019; Masi et al., 2018; Kumar et al., 2019)

Implementing and managing the circular economy required high investment in technology adoption and training of human resources

(Pathak and Endayilalu, 2019)

Discussion

LACK OF SECTORIAL STANDARDIZATION

The need for metrics and standards for recycled products and production standardization also creates a substantial barrier regarding material efficiency.

(Hart et al., 2019)

The absence of refurbishment and recycling guidelines and standards results in mixed product quality in the study.

(Vermunt et al., 2019)

Discussion

LACK OF CE AWARENESS

The lack of awareness and sense of urgency are still acting as important barriers that impede the adoption of sustainable practices.

(Masi et al., 2018)

Playing a significant role in CE implementation in the textile industry. The need for more awareness of industry practitioners is a concern in reducing the negative environmental impact of the industry's supply side.

(Saha et al., 2021)

Discussion

UNCERTAINTY IN PROFITABILITY

It is cumbersome to identify and measure the long-range effects of the benefits of the CE by manufacturers, collectors, and recyclers

(Kazancoglu et al., 2020)

CE helps companies to save money and enhance their profitability.

(Kumar et al., 2019)

Discussion

LACK OF TECHNICAL KNOW-HOW

A lack of technical and technological know-how could hinder SMEs from transforming their linear business model into a circular one.

(Rizos et al., 2016)

An important barrier is the lack of academic and feasible information about the Circular Economy principles.

Snoek (2017), Muradin and Foltynowicz (2019)

The lack of awareness regarding implementing CE, especially about the benefits of the CE for companies, is the biggest barrier for companies to invest and implement the CE.

(Rodríguez, 2017)

Chapter 5: CONCLUSIONS AND IMPLICATIONS

Implication

Contribution

Limitations and Futher research

Implication

HIGH INVESTMENT COST (B8.1) AND UNCERTAINTY IN PROFITABILITY (B8.2)

- Prepare step by step to transition to a circular economy model, share information, willingness to collaborate, calling for major investment support

  (Recommend from Experts)

- Government intervention can reduce the high investment costs of a circular business model by providing financial support

  (Kirchherr et al., 2018)

- Ensuring the continuity of consumer demand for circular economy productson to a circular economy model

Implication

LACK OF SECTORIAL STANDARDIZATION (B5.1)

- Proposing policies to deploy standardization groups: production and standard groups, sustainable use, group of standards on reuse, recycling, remanufacturing in industry and agriculture,...

(Phuong. N.K.L., 2020)

- Governments and policy makers need to be proactive in establishing and maintaining the most common and necessary standards: reusability and recovery, extraction of components for further details, reuse, repair, recycling,...

(Recommend from Experts)

Implication

LACK OF TECHNICAL KNOW-HOW (B6.3) AND LACK OF CE AWARENESS (B6.1)

- Allocate the necessary financial resources for investing in technical know-how company's senior leaders.

  (Recommend from Experts)

- The company's human resources need in-depth training and know-how when applying technology to all circular economy activities

- Government support: technology transfer to eliminate the lack of technical information to implement Circular economy

  (Recommend from Experts)

- Encourage reinforcement for public campaigns, seminars, or conferences in cooperation with academia, enhance the trust of the stakeholders towards circular transition, and increase the awareness

Contribution

THEORITICAL CONTRIBUTION

Become an academic research document in the future. Future research articles can rely on this research article as a foundation to research solutions to these barriers.

PRACTICAL CONTRIBUTION

- The research's insights promote the circular economy model to be applied more commonly in the garment industry in Vietnam
- Valuable practical contributions for identify barriers and helps businesses come up with strategies to anticipate those obstacles.
- Provides constructive recommendations to present the policy and management implications, along with recommendations, are provided to the government, industry, and stakeholders

Limitations

Futher Research

Firstly, the literature review has some other barriers, such as organizational, cultural, and customer interest.	→ To conduct future research regarding these barriers in the textile industry.
Second, this study is based on inputs from a limited number of experts	→ The data can be collected from more industrial experts who work in different links in the textile supply chain to generalize the study results.

Limitations and Futher Research

- Third, AHP approaches have been used in this study, but in the future, other MCDM tools may also be used to compare findings.

- Fourth, it is generally challenging for decision-makers to quantify their evaluations because the study have a lot of barriers.

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Thank You So Much!