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Investigating the Implementation of Circular Economy in the Textile Industry in Indonesia

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ABSTRACT

This study investigates and analyzes the influence of business analytics capability (BAC), green human resource management (GHRM), and digital supply chain (DSC) on circular economy implementation (CEI), as well as its influence on business sustainability (BS). Furthermore, this research also analyzes the mediating role of CEI in the influence of BAC, GHRM, and DSC on BS. The population and respondents comprised all textile MSMEs (fashion and clothing materials) located in the provinces of Central Java and West Java, Indonesia. The target respondents consisted of 300 textile MSMEs, selected purposively based on the following criteria: (1) having a waste water treatment plant (WWTP), either privately owned or shared; (2) generating a minimum monthly net income of IDR 10 million; and (3) being owned and/or managed by individuals with at least a high school education. Data were collected through direct visit to the respondents. After data recapitulation and screening of the completed questionnaires, 251 valid responses were obtained. The statistical analysis was conducted using SmartPLS3. This research found that CEI mediates the positive relationships between BAC, GHRM, and DSC with BS. CEI also mediates the positive relationships between BAC, GHRM and DSC with business performance (BP), environmental performance (EP), and social performance (SP). However, there are no significant differences in these relationships (across all variables) between the subgroups analyzed (fashion and clothing Materials). This study contributes to and enriches circular economy theory by examining the influence of BAC, GHRM practices, and DSC on improving BS, encompassing BP, EP, and SP. In addition, this study analyzes the differences between types of textile MSMEs in terms of BAC, GHRM practices, and DSC.

1. INTRODUCTION

Indonesia is one of the ten largest textile-producing countries in the world. Many textiles manufacturing in Indonesia are labor-intensive. The textile industry contributes significantly to employment in Indonesia, as 26% of the country's workforce is employed in the manufacturing sector, employing more than 43 million people in 2019 [1]. The textile industry is expected to contribute even more in the future, as the Indonesian government aims to increase the value of textile exports to $75 billion by 2030 [2].

The textile industry is one of the industrial sectors that has great potential to adopt a circular economy approach. Circular economy (CE) aims to generate economic growth by maintaining the value of products, materials, and resources in the economy for as long as possible, thereby minimizing the social and environmental damage caused by the old linear economic approach [3-8]. Adopting CE principles in the textile industry can offer many benefits, as the production process typically involves intensive use of water, energy, and chemicals. In addition, raw materials should be managed and processed efficiently to reduce costs and minimize the pressure of their volatile prices in the market.

The textile industry accounts for 10% of the global carbon footprint. Wastewater from textile dyeing is the second largest water polluter. Indonesia wants to establish a Green Industry Standard (SIH) in the textile industry; this cannot be achieved without adopting CE principles, especially in the production process, by optimizing the use of materials and mitigating hazardous chemical emissions and waste. The textile industry requires compliance to achieve SIH [2]. Circular economy implementation (CEI) in the textile industry can reduce waste by 14% and recycle as much as 8% of the remaining textile waste [1]. Generating less and recycling more waste can have a significant impact on Indonesia's economy. The research found that transitioning to CE could add IDR 593 to 638 trillion (equivalent to USD 42 to 45 billion) to Indonesia's gross domestic product (GDP) by 2030 (equivalent to 2.3 to 2.5% of projected GDP in 2030). The economic added value could surpass that of the 'business as usual' scenario in which Indonesia does not actively implement CE [1].

One of the key strategic issues gaining attention in the industry, including the textile industry, is adopting CE [3, 4, 6]. Textile companies can implement CE by focusing on environmental benefits and stakeholder satisfaction. Efficiency must be enhanced across raw material consumption, production processes, and finished products [2].

Meanwhile, digitalization in the current era has compelled companies to consider sustainability aspects more seriously [9]. CEI requires resource support and business analytics capability (BAC), and digitalization is required [4, 10, 11]. Several research results found that CEI can be supported when the company has an established BAC [6], good business digitization [9, 12, 13], an effective CE strategy [5], and quality human resources, especially in Green human resource management (GHRM) [14-17]. All of them are aspects that make a significant contribution to increasing business sustainability (BS) [4, 6, 12, 13, 16-18]. This research has novelty and, at the same time, addresses the following research gap:

1) BS is currently an important and strategic aspect in the current digital era. Companies today not only emphasize aspects of improving financial performance (FP) but also environmental performance (EP) and social performance (SP). This is important considering that currently companies cannot survive and live without paying attention to environmental aspects [4, 6] and having concern for the surrounding community and even stakeholders.

2) CEI remains uncommon among companies, particularly in Asia, especially in Indonesia [3-5]. Currently, stakeholders focus on aspects of material design and material flow assessment [19], both in micro, meso, and macro contexts [7]. The implementation of CE remains largely a theoretical discourse and is challenging to apply in both business and non-business sectors, especially when aiming to enhance BS at the same time. (economic, social, and environmental) [20].

3) BAC can help companies to make the transition and at the same time accelerate the implementation of CE [4, 6] which in turn can increase work effectiveness and efficiency in improving BS [21], which requires the support of tangible and intangible resources [6, 22-24].

4) GHRM research is rarely associated with the implementation of CE even though CE has made a significant contribution to environmental management. GHRM has also played a crucial role in improving the company's BS [16-18, 25].

5) Business digitization is one of the strategic contributing factors in CEI and BS [12, 13, 25]. When associated with digital management in the supply chain (SC), companies need to further focus on digital supply chain (DSC) research with a quantitative approach, which is currently still rarely found [9, 26].

6) Currently, consumers and stakeholders demand speed of service, which apparently must be followed by speed and agility in supply chain management in order to anticipate changes in the competitive digital environment [9, 27-29] because it can reduce material waste [30, 31]. The SC environment should be a further trigger to examine the role of digital SC in improving BS [32, 33].

The urgency of this research is carried out in order to participate in achieving the success of the Nine Nawa Cita agendas of the President of the Republic of Indonesia. In addition, it wants to succeed UII's 2021-2025 research strategic planning, namely inclusive development realizes a civil and sustainable society (*baldatun thoyibatun wa-robbun ghofur*) facing the Industrial Age 4.0 and Society 5.0 in Indonesia. This research has specific objectives, including testing and analyzing the effect of BAC, DSC, and GHRM on BS mediated by CEI in the textile industry in Central Java and West Java Provinces. Additionally, the study aims to examine the differences in the relationships among all variables across the subgroups studied (Fashion and Clothing Materials).

2. LITERATURE REVIEW

2.1 Business analytics capability and circular economy implementation

In the digital era, it turns out that the issue of sustainability and CE has become a strategic issue and the main goal of the company. The various resources owned by the company must be utilized as effectively as possible so that the decisions made are correct and can benefit the company. To realize this, companies need to have BAC. BAC is a collection of technologies, methods, and applications that enable business data analysis to promote better and data-driven decisions [10, 11]. BAC can accelerate the CE transition [6] by helping companies expand their decision-making scope, providing insights and options that were previously unavailable [34], increasing the speed of response time, effectiveness, and efficiency in adapting environmental changes [21].

With BAC, companies can effectively mobilize, deploy, and utilize resources and align planning with their business strategy to improve company performance [35, 36]. The challenge for companies is that they need to identify organizational resources that can support transformation when using BAC. Companies need to develop a combination of tangible, intangible, and human resources [6, 22-24]. BAC can also enhance a company's ability to operationalize its circular strategy and overall CEI [6, 37]. The role of BAC can accelerate a company's CE adoption and realize the company's business value. According to Kristoffersen et al. [6], BAC strengthens the implementation of circular strategies and firm performance, particularly in terms of competitiveness, corporate reputation, financial performance, and EP.

H1: *BAC has a significant positive influence on CEI.*

2.2 Green human resource management and circular economy implementation

The literature on CE is growing rapidly, but the implementation of CE in companies rarely intersects with GHRM. The understanding of CE principles is very limited in the wider community [15], whereas the development of CE competencies is needed [14]. Therefore, Jabbour et al. [18] developed a theoretical framework that conceptualizes GHRM for CE. GHRM and CE have certain similarities and produce certain synergies that need to be explored so that these synergies can be enhanced [18]. GHRM practices can improve corporate sustainability, especially in terms of better BP, EP, and SP [38]. GHRM should be considered as part of the concept of sustainability and CE business models that will affect company performance [16, 17].

However, the average company ignores the key role of GHRM in the organization as one of the determining factors in the CE model. Therefore, Jabbour et al. [18] proposed an integrative framework to link GHRM and CE at the organizational level. HRM enables CE by aligning GHRM practices and dimensions of recruitment and selection, training, performance appraisal, rewards, culture, teamwork, and empowerment with the CE business model. Jabbour et al. [18] argued that the implementation of workplace-based

GHRM practices can positively influence the development of CE strategies in organizations. Dimensions that focus on such things as organizational culture, empowerment, and teamwork enhance the success of sustainability initiatives. It can be concluded that GHRM can aid the implementation of CE business models [38-40]. In addition, top management commitment, managerial leadership, and employee motivation can facilitate GHRM in positively influencing CEI and firm performance [40]. GHRM policies can facilitate transformation in creating an environmentally friendly organizational culture [5]. This turns out to have an impact on the application of GHRM practices on the implementation of CE principles. Jabbour et al. [18] argued that CE and the adoption of CE business models can be achieved if workplace-based GHRM practices are used and integrated.

H2: *GHRM has a significant positive relationship with CEI.*

2.3 Digital supply chain towards circular economy implementation

CE is a topic that is widely discussed in various literature amid uncertain climate conditions. Companies are required to take responsibility for the safety of the earth, and CE is the right solution to overcoming these problems [41, 42]. CE is a system to minimize the waste of resources and reduce waste disposal by recycling [13, 30, 31, 43]. There are several efforts to successfully implement CE in a company, one of which is digitalization [12, 13, 44]. In some cases, CEI in a company requires changing the business model, namely by digitizing the business. In China, digitalization has helped and facilitated cooperation between the private sector and the government in CEI [30]. Digitalization is an effective solution for optimizing the implementation of a CE.

Several technologies have been used to carry out waste management, such as the “Pay as You Throw” system, the “Know as You Throw” scheme, and the use of 'Radio Frequency Identification' (RFID), which supervises and monitors waste activities in the industry [31, 45]. Broadly speaking, digitization brings one major change, namely efficiency. Digitalization utilizes information and communication technology to add value to a product or company system [12, 44]. Without digitalization, the implementation of CE will be slow, and the impact will be small [46]. Digitalization is also very suitable for post-pandemic conditions so that post-pandemic economic problems can be resolved [31]. Agarwal et al. [47, 48] argued that what can optimize the implementation of CE is digitalization. Therefore, companies must be able to identify and optimally utilize their supply chain management. This is important because can be used to improve CEI in all value chain activities from upstream to downstream. When the use of digitalization is well integrated and supported by quality human capital, DSC will be able to improve BS in the long term [32, 33, 49-51]. The adoption of DSC is expected to strengthen the integration and agility of the supply chain so that customers and stakeholders will be satisfied and can make repeat transactions with the company [9, 52, 53].

H3: *DSC has a positive effect on CEI.*

2.4 Circular economy implementation on business sustainability

Companies today are given the responsibility to maintain economic prosperity and improve environmental quality. One of the efforts that can be made is to design and implement CE strategies in every business activity [3, 5, 7, 54]. In reducing resource wastage and emissions as well as waste disposal, CEI can be used to accelerate it [55, 56]. The implementation of CE has a principle known as the 4R framework, namely reduce, reuse, recycle, and recover [7]. When companies can implement CE properly and correctly, business performance (BP) will improve [4, 6, 57, 58]. Companies can operate efficiently by carrying out several activities, such as reusing raw materials, carrying out recycling processes, and recovering resources used in business processes from upstream to downstream [59].

Shahzad et al. [60] and Yu et al. [61] stated that the implementation of CE can improve business efficiency in all aspects such as production efficiency and environmental cost efficiency. The recycling process in CE can save scarce resources through the reuse of materials used in the production process. On the other hand, recycling also saves land that is usually used for industrial waste disposal, thus eliminating harmful gases such as methane that arise from waste [62-68].

Various literature has also introduced the concept and implementation of CE in producing environmental sustainability performance [3, 4, 56, 69] to social sustainability [70-72]. Several studies agree that the implementation of CE can improve EP [4, 37, 56, 63, 69, 73]. Schwarz et al. [69] and Vollmer et al. [74] argued that the recycling process in CEI can have a major impact on EP. CE can reduce the adverse impact of business operations on the environment. The implementation of CE minimizes producers' dependence on resources through recycling and remanufacturing. This practice provides many benefits for companies in the form of performance efficiency and improved EP [18, 63].

Business, environment, and society are three aspects that must be considered by companies. Business is related to profits and company performance; the environment is related to government regulations and also the company's obligation to participate in preserving the environment. No less important is the social aspect, which is the key to synergizing with other parties and a form of social responsibility [72, 75]. Padilla-Rivera et al. [70] collected 31 social aspects that can be developed through CE. Of these 31 aspects, the two most affected aspects are society and practice and decent work. More specifically, the most discussed aspect is about employment. The social dimension is important due to the need for cooperation and interdependent relationships between various stakeholders [64, 65]. Saidani et al. [67] and Moreau et al. [68] recommended integrating social dimensions in the implementation of CE to create good SP and EP.

Meanwhile, Jabbour et al. [18] explored the human side of the CE by connecting the CE and GHRM. Several studies prove that CE can have a positive impact on SP [37, 70, 71]. There are several social benefits obtained in the implementation of the CE, namely creating new employment opportunities through new uses of the value embedded in resources, increasing the sense of community, cooperation, and participation through the concept of the sharing economy, and product functions and services are more likely to be in the public interest than individuals [71]. Tetteh et al. [37] in their findings, confirmed that there is a significant partial mediating role of CE on the influence of BAC and BAC sustainable performance.

H4: *CEI has a positive effect on BP.*
H5: *CEI has a positive effect on EP.*
H6: *CEI has a positive effect on SP.*

H7: *CEI mediates BAC on BP.*
H8: *CEI mediates BAC on EP.*
H9: *CEI mediates BAC on SP.*
H10: *CEI mediates DSC on BP.*
H11: *CEI mediates DSC on EP.*
H12: *CEI mediates DSC to SP.*
H13: *CEI mediates GHRM on BP.*
H14: *CEI mediates GHRM on EP.*
H15: *CEI mediates GHRM to SP.*

Corsini et al. [76] recommended that since the CE is systemic, it should involve a holistic approach, one of which can be analyzed by clustering the characteristics of consumers or producers. The results of their research even prove that there is a significant gap between circular demand and supply. In shaping circular production and consumption, linear producers make up the largest group of companies, while linear consumers represent the smallest segment. Her research underscores the need for comprehensive involvement of both producers and consumers. The research also proposes to analyze the differences in the relationship between variables (covering all the variables studied, i.e., BAC, GHRM, and DSC) between the subgroups studied (both fashion and clothing materials) in CEI. It is also important to look deeper into CEI when it is associated with contingency variables such as BAC, GHRM, and DC.
H16: *There is a significant difference in the relationship between variables (covering all variables studied, i.e., BAC, GHRM, and DSC) between the subgroups (both fashion and clothing material) in CEI.*

3. RESEARCH METHOD

Textile MSMEs, especially fashion, currently have great potential to adopt CE. This is because the production process in the textile industry usually uses water, energy, and chemicals intensively.

This research will be conducted on MSMEs in the textile industry (fashion and clothing materials) in Central Java and West Java provinces, Indonesia. These two provinces are known to have a very large textile industry. This research uses a positivist approach because it tests and analyzes the relationship patterns between variables [77]. The overall population of this research is the owners or managers or concurrent owners and managers of textile industry MSMEs in Central and West Java Provinces. The Indonesian textile industry is technically and structurally divided into three complete, vertical, and integrated industrial sectors, namely:

1) The downstream industry sector, also known as downstream, is the apparel manufacturing industry, including sewing, cutting, washing, and finishing processes that produce ready-made garments. It is this sector that absorbs the most labor so the nature of the industry is labor-intensive.
2) The midstream sector includes the process of weaving yarn into raw fabric sheets through gathering and knitting processes which are then further processed through dyeing, finishing, and printing processes into finished fabrics.
3) The upstream industry sector is the industry that produces fiber and spins it into yarn products.

The textile industry sector used in this research population includes downstream and midstream sectors in Central Java and West Java Provinces, with a target sample of 300 respondents. This research uses a purposive sampling technique with the criteria: (1) textile industry MSMEs in the upstream to downstream process that use natural materials, (2) have waste water treatment plants (WWTP) in waste disposal, (3) MSME owners/managers have a minimum high school education, and (4) net MSME income of at least 10 million per month. This research uses a questionnaire to collect data. The results of data recapitulation and screening that can be processed further are 251 textile MSMEs (fashion and clothing materials).

The questions in the questionnaire were directed at the 7 variables used in the research, namely, BAC, DSC, GHRM, CEI, BP, EP, and SP. The answer options use a Likert scale: 5 (strongly agree) to 1 (strongly disagree) for BAC, DSC, GHRM, and CEI variables. As for the BP, EP, and SP variables, the answer options were 5 (Very High) to 1 (Very Low), where respondents were asked to compare the performance of competitors over the past 3 years. While secondary data is obtained from various publication sources. The statistical analysis technique uses structural equation modeling with Smart Partial Least Square 3. The operational definitions of each variable are explained as follows:

1) BAC is a set of technologies, methods, and applications used for business data analysis to promote better, data-driven decision-making in support of CEI in the textile industry. The questionnaire was adapted from [6].
2) DSC refers to digital-based supply chain management practices in MSMEs that utilize information and communication technologies to create added value for products and the organizational system. The questionnaire was modified from [46].
3) GHRM refers to environmentally oriented HR practices, including recruitment and selection, training and development, performance appraisal, and compensation. The questionnaire was adapted from [25, 39].
4) CEI refers to the application of circular economic principles throughout the processes of raw material selection, production of final products, and product packaging, by prioritizing natural materials and minimizing or avoiding the use of synthetic inputs. The questionnaire was modified from [4, 5, 59].
5) BP refers to the business performance of textile MSMEs over the past three years, including both financial and operational dimensions. The questionnaire was modified from [3, 4, 9].
6) EP refers to the environmental outcomes achieved by textile MSMEs over the past three years. The questionnaire was modified from [3, 4].
7) SP refers to the social outcomes achieved by textile MSMEs over the past three years. The questionnaire was modified from [3, 4].

4. RESULTS AND DISCUSSION

4.1 Respondent profile

The profile of respondents in this study reflects the diverse characteristics of textile MSMEs in West Java and Central Java (fashion and clothing materials) (Table 1). The majority of respondents were female (56.6%), indicating the significant role of women in the textile industry. By age, the oldest group (49-66 years) dominates with 44.6%, indicating that MSME players in this sector are still dominated by the older generation. This is consistent with the distribution of birth years, where the majority were born between 1943 and 1981 (73.7%).

Table 1. Respondent profile

Respondent	Frequency	Percentage (%)
Gender		
Male	109	43.4
Female	142	56.6
Birth Year		
1943–1960	78	31.1
1961–1981	107	42.6
1982–2001	66	26.3
Age		
18–28 years	55	21.9
28–48 years	84	33.5
49–66 years	112	44.6
Position		
Owner	92	36.7
Manager	91	36.3
Owner and Manager	68	27
Education		
Senior High School	157	62.6
S1	47	18.7
S2	47	18.7
Types of SMEs		
Clothing Materials	123	49
Fashion	128	51
Number of Employees		
2–6 people	170	67.7
7–10 people	81	32.3
Turnover per Year (million)		
10–107.6	78	31.1
107.6–205.2	42	16.7
205.2–302.8	50	19.9
302.8–400.4	32	12.7
400.4–498	49	19.6

In terms of position, there is almost a balance between owners (36.7%) and managers (36.3%), but interestingly, 27.1% are both owners and managers, reflecting the simple business organization structure typical of MSMEs. In terms of education, the majority of respondents have a secondary education background (high school, 62.6%), while only 37.4% have tertiary education, which may affect the level of adoption of digitalization and strategic managerial practices such as CE.

The types of MSMEs are almost equally divided between fashion products (51%) and clothing materials (49%), allowing for proportional comparison in the multigroup analysis (MGA). Most MSMEs have a small number of employees (2 to 6 people, 67.7%), as well as varying annual turnover, with the largest group being in the lowest category (IDR 10 to 107.6 million per year). This data suggests that the textile MSMEs in the study sample are generally small-scale, directly managed by their owners, and in a demographic context that has the potential to be empowered through strategies based on digitalization, green management, and CE.

4.2 Convergent validity and reliability test

The results of validity and reliability testing (Table 2) show that all constructs in the research model have met the criteria for excellent measurement quality, both in the overall sample and in each group of fashion and clothing material MSMEs. All outer loading (OL) values are above the 0.7 threshold, which indicates that each indicator has strong indicator validity for its construct. The Average Variance Extracted (AVE) of all constructs is also well above the minimum limit of 0.5, which indicates convergent validity has been achieved, meaning that more than 50% of the indicator variance is explained by their respective latent constructs. In addition, the very high Composite Reliability (CR) and Cronbach's Alpha (CA) values (the majority close to or above 0.9) indicate that each construct has excellent internal reliability and strong inter-item consistency. Overall, these results ensure that all constructs used in the model are feasible and reliable for further analysis in structural testing and MGA.

Table 2. Convergent validity and reliability test

		Full Sample				Fashion				Clothes Material			
Construct	Items	OL	AVE	CR	CA	OL	AVE	CR	CA	OL	AVE	CR	CA
	BAC1	0.943				0.921				0.967			
	BAC2	0.939				0.930				0.948			
	BAC3	0.945				0.946				0.960			
	BAC4	0.951				0.943				0.964			
	BAC5	0.940				0.926				0.956			
BAC	BAC6	0.956	0.893	0.989	0.988	0.943	0.863	0.986	0.984	0.970	0.927	0.993	0.992
	BAC7	0.948				0.930				0.969			
	BAC8	0.954				0.938				0.973			
	BAC9	0.940				0.927				0.954			
	BAC10	0.941				0.922				0.966			
	BAC11	0.936				0.910				0.965			
	BP1	0.977				0.921				0.969			
BP	BP2	0.911	0.792	0.938	0.926	0.904	0.826	0.950	0.909	0.927	0.821	0.948	0.943
	BP3	0.845				0.899				0.941			
	BP4	0.817				0.911				0.775			
	CEI1	0.955				0.954				0.954			
	CEI2	0.938				0.925				0.947			
CEI	CEI3	0.897	0.875	0.972	0.964	0.929	0.884	0.974	0.967	0.875	0.867	0.970	0.961
	CEI4	0.933				0.948				0.920			
	CEI5	0.953				0.945				0.957			
	DSC1	0.876				0.947				0.841			
DSC	DSC2	0.875	0.866	0.985	0.983	0.948	0.876	0.986	0.984	0.842	0.857	0.984	0.981
	DSC3	0.956				0.917				0.967			

	DSC4	0.929				0.923				0.914			
	DSC5	0.940				0.930				0.944			
	DSC6	0.949				0.949				0.954			
	DSC7	0.931				0.920				0.946			
	DSC8	0.939				0.925				0.939			
	DSC9	0.954				0.944				0.958			
	DSC10	0.953				0.956				0.941			
	EP1	0.960				0.932				0.962			
EP	EP2	0.981	0.945	0.981	0.971	0.976	0.932	0.976	0.970	0.977	0.947	0.982	0.972
	EP3	0.976				0.986				0.981			
	GHRM1	0.940				0.950				0.926			
	GHRM2	0.935				0.944				0.928			
GHRM	GHRM3	0.942	0.885	0.975	0.967	0.948	0.894	0.977	0.971	0.929	0.872	0.971	0.963
	GHRM4	0.946				0.954				0.939			
	GHRM5	0.940				0.933				0.946			
	SP1	0.973				0.968				0.974			
SP	SP2	0.964	0.873	0.954	0.930	0.961	0.914	0.970	0.953	0.968	0.828	0.935	0.909
	SP3	0.862				0.940				0.773			

Note: OL = Outer Loading, AVE = Average Variance Extracted, CR = Composite Reliability, CA = Cronbach's Alpha, BAC = Business Analytics Capability, BP = Business Performance, CEI = Circular Economy Implementation, DSC = Digital Supply Chain, EP = Environmental Performance, GHRM = Green Human Resource Management, SP = Social Performance

4.3 Discriminant validity

The results of the discriminant validity test through two approaches—the Fornell-Larcker Criterion and Heterotrait-Monotrait Ratio (HTMT)—show that all constructs in the model have met the discriminant validity requirements, both in the complete model and the fashion and clothing materials subgroup (Table 3). In the Fornell-Larcker criterion, each AVE square root value (shown on the diagonal of the table) is higher than the correlation between other constructs in each row and column, indicating that each construct is sufficiently unique and does not overlap conceptually. Meanwhile, the HTMT values across constructs remain below the conservative threshold of 0.85, confirming that there is no latent multicollinearity problem between constructs. This indicates that variables such as BAC, GHRM, CEI, and performance outcomes (BP, EP, SP) are truly distinct from each other empirically. In particular, these results provide a strong foundation for further structural analysis, including inter-construct relationship testing and MGA in the next phase.

Table 3. Fornell-Larcker discriminant validity test & HTMT ratio

	Complete Model												
	Fornell-Larcker Criterion							Heterotrait-Monotrait Ratio (HTMT)					
	BAC	**BP**	**CEI**	**DSC**	**EP**	**GHRM**	**SP**	**BAC**	**BP**	**CEI**	**DSC**	**EP**	**GHRM**
BAC	0.945												
BP	0.109	0.890						0.113					
CEI	0.126	0.076	0.935					0.127	0.058				
DSC	0.125	0.107	0.150	0.931				0.114	0.099	0.133			
EP	0.104	0.086	0.257	0.284	0.972			0.104	0.086	0.262	0.273		
GHRM	0.142	0.091	0.154	0.240	0.213	0.941		0.145	0.086	0.157	0.229	0.216	
SP	0.133	0.046	0.277	0.200	0.251	0.203	0.935	0.128	0.060	0.275	0.176	0.238	0.195
	Fashion												
	Fornell-Larcker Criterion							**Heterotrait-Monotrait Ratio (HTMT)**					
	BAC	**BP**	**CEI**	**DSC**	**EP**	**GHRM**	**SP**	**BAC**	**BP**	**CEI**	**DSC**	**EP**	**GHRM**
BAC	0.929												
BP	0.020	0.909						0.097					
CEI	0.069	0.175	0.940					0.078	0.061				
DSC	0.055	0.041	0.115	0.936				0.069	0.041	0.108			
EP	0.039	0.245	0.055	0.121	0.965			0.071	0.115	0.047	0.127		
GHRM	0.017	0.027	0.098	0.035	0.148	0.946		0.035	0.040	0.095	0.047	0.135	
SP	0.011	0.024	0.233	0.040	0.100	0.020	0.956	0.038	0.026	0.240	0.066	0.118	0.043
	Clothes Material												
	Fornell-Larcker Criterion							**Heterotrait-Monotrait Ratio (HTMT)**					
	BAC	**BP**	**CEI**	**DSC**	**EP**	**GHRM**	**SP**	**BAC**	**BP**	**CEI**	**DSC**	**EP**	**GHRM**
BAC	0.963												
BP	0.181	0.906						0.143					
CEI	0.164	0.146	0.931					0.166	0.109				
DSC	0.127	0.199	0.345	0.926				0.122	0.171	0.340			
EP	0.236	0.211	0.453	0.382	0.973			0.241	0.184	0.466	0.377		
GHRM	0.241	0.179	0.198	0.377	0.255	0.934		0.241	0.169	0.201	0.373	0.262	
SP	0.227	0.098	0.334	0.298	0.366	0.398	0.910	0.223	0.098	0.300	0.272	0.338	0.390

Note: BAC = Business Analytics Capability, BP = Business Performance, CEI = Circular Economy Implementation, DSC = Digital Supply Chain, EP = Environmental Performance, GHRM = Green Human Resource Management, SP = Social Performance

4.4 Model fit test

The results of the model fit assessment using the Standardized Root Mean Square Residual (SRMR) indicate that the research model demonstrates a very good level of fit (Table 4). The SRMR values for both the saturated model (0.041) and the estimated model (0.048) are well below the recommended threshold (≤ 0.08). This suggests that the discrepancy between the observed and model-implied covariance matrices is relatively small, indicating that the model adequately represents the empirical data. Therefore, the structural model can be considered to have satisfactory goodness of fit and is appropriate for further analysis of the relationships among the constructs.

Table 4. Model fit test SRMR

	Saturated Model	Estimated Model
SRMR	0.041	0.048

4.5 Hypothesis model

The results of hypothesis testing show strong empirical support for all direct and mediation relationships proposed in the research model so that all hypotheses are accepted (H1 to H15 are accepted) (Table 5). In general, all tested paths have significant t values ($t > 1.96$) and positive β (path coefficient), indicating a meaningful and unidirectional influence between variables. This indicates that BAC, GHRM, and DSC play an important role in driving CEI, which in turn has a positive impact on various variables in BS: BP, EP, and SP. This can be seen more clearly in Figure 1.

Specifically, in the direct hypothesis, all three predictors of CEI showed significant influence, with the highest contribution coming from GHRM (β = 0.414; t = 6.057), followed by BAC (β = 0.396; t = 5.862) and DSC (β = 0.310; t = 4.287). This indicates that environment-based and environmentally sound managerial approaches are more dominant in driving CEI. When examined at the group level, the contribution of DSC to CEI was greater in the fashion segment (β = 0.423) compared to clothing materials (β = 0.310), suggesting a variation in the role of DSC depending on the type of industry analyzed.

Meanwhile, the influence of CEI on the three performance variables also proved significant. CEI contributes the most to BP in the full sample (β = 0.476), but the highest contribution generally occurs to EP, especially in the fashion (β = 0.455) and apparel (β = 0.453) segments. This suggests that the implementation of a CE has the most tangible impact on improving environmental sustainability. However, the impact on SP also remains positive and significant, albeit slightly lower (β = 0.277 in the full sample). On the mediation path, it is found that CEI acts as a significant mediator in all indirect relationships. The strongest mediation is reflected in the paths GHRM → CEI → SP (β = 0.532; t = 7.352) and DSC → CEI → SP (β = 0.431; t = 6.846), indicating that HRM policies and digitalization indirectly strengthen the role of circular practices. The differences between subgroups are also interesting to observe. For example, in the apparel segment, the paths BAC → CEI → SP (β = 0.537) and GHRM → CEI → EP (β = 0.424) show stronger effects than in the fashion segment. This signals that the apparel sector is more sensitive to analytics and human capital initiatives in the context of sustainability.

Overall, these results suggest that CEI plays a central role as the main mediating mechanism in bridging various variables (BAC, GHRM, DSC) toward achieving triple-bottom-line performance (economic, environmental, and social). Thus, organizations that want to strengthen sustainability need to strategically integrate BAC, GHRM, and DSC into their CE practices. These findings support the importance of circular-oriented transformation as a cross-functional value-added strategy.

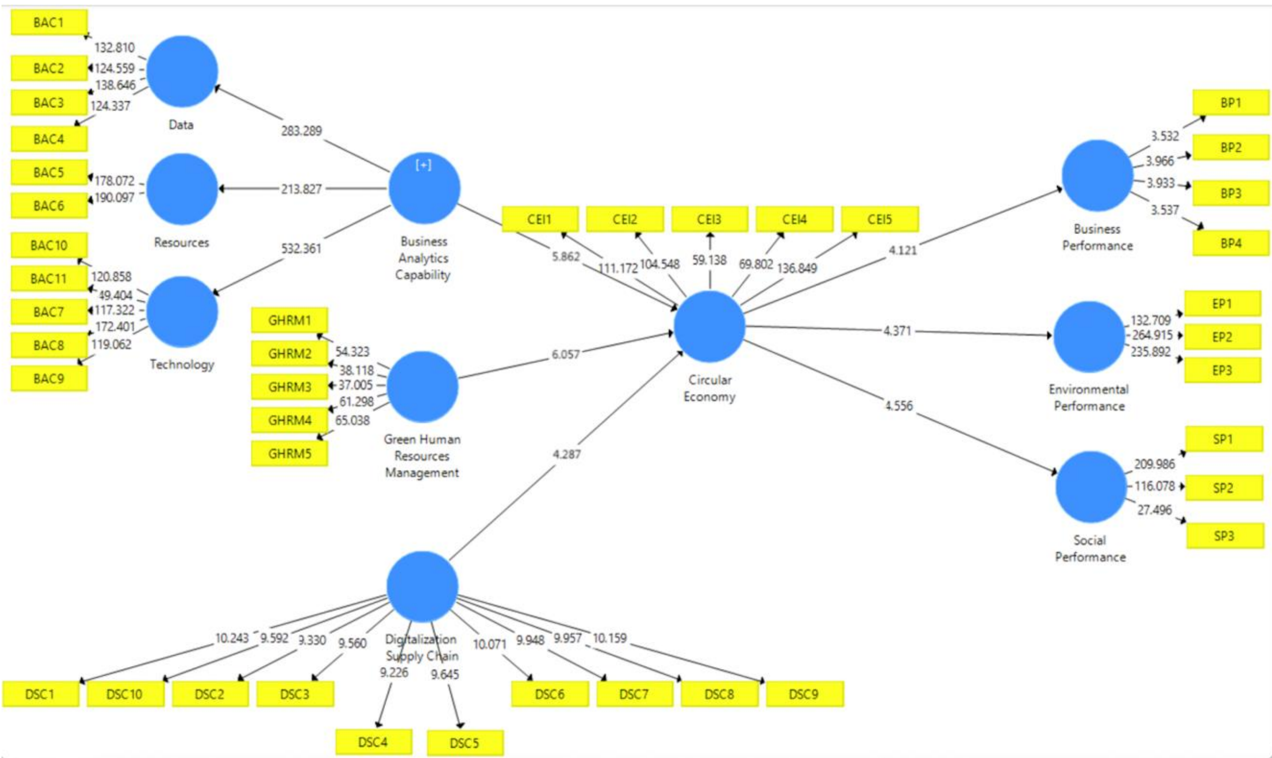

Figure 1. Inner model (bootstrapping t-statistics)

Table 5. Structural model path coefficient

Hypothesis		Full Sample		Fashion		Clothes Material	
		β	T-value	β	T-value	β	T-value
H1	BAC → CEI	0.396	5.862*	0.274	3.134*	0.312	3.858*
H2	GHRM → CEI	0.414	6.057*	0.301	2.918*	0.354	3.355*
H3	DSC → CEI	0.310	4.287*	0.423	3.624*	0.310	3.259*
H4	CEI → BP	0.476	4.121*	0.415	2.354*	0.446	5.809*
H5	CEI → EP	0.257	4.371*	0.455	4.260*	0.453	6.150*
H6	CEI → SP	0.277	4.556*	0.233	2.886*	0.334	4.724*
H7	BAC → CEI → BP	0.307	5.721*	0.213	7.139*	0.316	3.568*
H8	BAC → CEI → EP	0.525	8.885*	0.504	5.379*	0.351	6.941*
H9	BAC → CEI → SP	0.227	5.446*	0.417	5.713*	0.537	6.696*
H10	DSC → CEI → BP	0.408	6.098*	0.421	8.642*	0.445	7.840*
H11	DSC → CEI → EP	0.328	10.593*	0.407	4.068*	0.441	8.824*
H12	DSC → CEI → SP	0.431	6.846*	0.417	5.713*	0.403	6.223*
H13	GHRM → CEI → BP	0.409	8.966*	0.318	4.221*	0.408	9.074*
H14	GHRM → CEI → EP	0.329	5.538*	0.306	5.438*	0.424	8.794*
H15	GHRM → CEI → SP	0.532	7.352*	0.424	5.483*	0.318	3.579*

Note: *sign < 0.05
BAC = Business Analytics Capability, BP = Business Performance, CEI = Circular Economy Implementation, DSC = Digital Supply Chain, EP = Environmental Performance, GHRM = Green Human Resource Management, SP = Social Performance

4.6 Multigroup analysis

The results of the MICOM (measurement invariance of composite models) test for compositional invariance showed that the correlations between the variables in the model were relatively stable across the different groups (Table 6). All p-values for the permutation test are above the significance limit of 0.05 ($p > 0.05$), which means that there are no significant differences in the relationships between variables between the subgroups analyzed (fashion and clothing materials). This indicates that the composition of relationships between variables can be considered invariant or unchanged between groups, which supports using the same model for both groups without worrying about deep structural differences. In other words, despite differences in industry characteristics, the mechanism of relationships between variables remains consistent, allowing for valid comparisons between the groups under study.

The results of the composite equality of mean values and variance test in Table 7 show that there is no significant difference between the Fashion and Clothing Materials groups, both in terms of means and variances. For most variables, the p-value is greater than 0.05, which means that the difference in means between the two groups is not statistically significant (e.g., BAC with a p-value of 0.456 and CE with a p-value of 0.336). The same applies to the variance, which shows similarity in variability between the groups. Overall, this indicates that the model structure can be applied well to both groups without the need for further adjustments regarding differences in means or variances, thus strengthening the validity of the tests and comparisons between the two groups.

Table 6. Compositional invariance

	Original Correlation	Correlation Permutation Mean	5.00%	Permutation P-Values
BAC	1.000	1.000	1.000	0.336
BP	0.998	0.997	0.997	0.666
CEI	1.000	1.000	0.999	0.368
DSC	0.997	0.996	0.996	0.418
EP	0.999	1.000	0.999	0.706
GHRM	0.999	0.999	0.999	0.538
SP	0.999	0.998	0.998	0.448

Note: BAC = Business Analytics Capability, BP = Business Performance, CEI = Circular Economy Implementation, DSC = Digital Supply Chain, EP = Environmental Performance, GHRM = Green Human Resource Management, SP = Social Performance

Table 7. Composites equality of mean values and variance

	Mean Original Difference Clothes Material - Fashion	Mean Permutation Mean Difference Clothes Material - Fashion	2.5%	97.5%	P-Values	Variance Original Difference Clothes Material - Fashion	Variance Permutation Mean Difference Clothes Material - Fashion	2.5%	97.5%	P-Values
0	-0.105	-0.008	-0.257	0.229	0.310	-0.133	0.005	-0.340	0.368	0.456
BP	-0.069	-0.009	-0.257	0.235	0.788	0.131	0.009	-0.303	0.315	0.414
CEI	-0.095	0.003	-0.276	0.249	0.294	0.133	-0.004	-0.259	0.252	0.336
DSC	-0.165	0.000	-0.253	0.260	0.210	0.143	0.002	-0.286	0.296	0.336
EP	0.017	0.005	-0.234	0.242	0.378	-0.028	-0.002	-0.217	0.210	0.774
GHRM	0.029	0.004	-0.219	0.231	0.378	0.049	-0.007	-0.301	0.282	0.752
SP	0.004	0.002	-0.253	0.263	0.738	-0.042	-0.007	-0.245	0.235	0.770

Note: BAC = Business Analytics Capability, BP = Business Performance, CEI = Circular Economy Implementation, DSC = Digital Supply Chain, EP = Environmental Performance, GHRM = Green Human Resource Management, SP = Social Performance

Table 8. Multigroup analysis

	Path Coefficients Clothes Material Diff - Fashion	P-Value Original 1-tailed Clothes Material vs Fashion	P-Value New Clothes Material vs Fashion
BAC → CEI	0.038	0.381	0.762
CEI → BP	0.321	0.107	0.214
CEI → EP	0.399	0.048	0.310
CEI → SP	0.100	0.179	0.357
GHRM → CEI	0.433	0.426	0.549
DSC → CEI	-0.047	0.645	0.709

Note: BAC = Business Analytics Capability, BP = Business Performance, CEI = Circular Economy Implementation, DSC = Digital Supply Chain, EP = Environmental Performance, GHRM = Green Human Resource Management, SP = Social Performance

In the MGA test comparing the differences in pathways between the Clothing Materials and Fashion sectors (Table 8), most of the pathways did not show significant differences. For example, the path BAC → CEI showed no significant difference between the two sectors, with a very high p-value (0.762). This confirms that the influence of BAC on CEI is consistent across both sectors. Other pathways, such as CEI → BP and CEI → EP, also showed no significant differences after further analysis, with higher p-values in the new tests (0.214 and 0.310, respectively). Overall, despite the difference in coefficients between the two sectors, the analysis results show that the relationships between the variables are relatively similar, with no significant differences indicating strong sectoral differences in influence. This explanation also rejects hypothesis 16.

5. DISCUSSION AND IMPLICATIONS

The research results prove that BAC has a significant positive effect on CEI (H1 accepted). These results reinforce the theory that business decisions should be based on data derived from the technology and business applications utilized by the company [3, 10, 11]. Findings from Kristoffersen et al. [6] explained that BAC can accelerate companies in implementing a circular economy [6, 37]. In addition, BAC can support companies to have data options that previously did not exist so that companies can respond more quickly, effectively, and efficiently [21, 34]. Companies can make optimal use of their resources by making adjustments to their business strategies [6, 22-24, 35, 36], including textile MSMEs in Central and West Java Provinces. With the BAC, it is expected that textile MSMEs, especially in fashion and clothing, can implement the CE appropriately so that there is no waste of resources, both tangible and intangible resources, to increase company value, especially in competitiveness, company reputation, financial performance, and EP.

The research results prove that GHRM has a significant positive effect on CEI (H2 accepted). This supports the research results from Jabbour et al. that CEI can be linked and synergized with the existing GHRM stages in each company. GHRM practices such as recruitment, training, assessment, and incentives can support the development of a green organizational culture. Companies must emphasize leadership, message credibility, coworker involvement, and employee empowerment; when these conditions are fulfilled, EP can improve. When HRM practices are implemented in an integrated configuration (recruitment and selection, orientation, training and development, placement, performance appraisal, and compensation), they enhance employee awareness and commitment to sustainable business (BP, EP, and SP) with CEI acting as a mediating mechanism. Achieving this requires the active involvement of all stakeholders, including government and society, who must serve as agents of change and promoters of BS. These findings also confirm Corsini's recommendation that, in shaping circular production and consumption, stakeholders do not distinguish between CEI in clothing and fashion with respect to the roles of BAC, GHRM, and DSC in driving BS. Consumers expect companies to adopt pro-circular behaviors and to integrate circularity principles comprehensively rather than partially.

GHRM itself in textile MSMEs in Central and West Java Provinces should be an HR practice based on green management. When each stage of GHRM has been implemented properly and appropriately by textile MSMEs in Central and West Java Provinces, it will directly impact the implementation of CE. This means that when green GHRM practices occur, leaders and employees should already be aware of the importance of green behavior and orientation in every GHRM practice activity. When this condition occurs, it will be easier to implement CE in the company to improve BP, EP, and SP [38]. GHRM practices are recommended as part of the sustainability strategy and CEI [16, 17] so that when properly implemented, they can have an impact on BS.

Unfortunately, some managers sometimes ignore the strategic role of GHRM in improving CEI. Therefore, in the future, textile MSMEs in Central and West Java provinces should integrate every activity of GHRM practices and CEI. This requires support from various parties, including top management commitment, motivation from each party, and a conducive organizational culture [38-40].

The research results prove that DSC has a significant positive effect on CEI (H3 accepted). Digitalization is one of the important keys to the successful implementation of a CE [12, 13, 44], even in the context of MSMEs. The private sector and the government need to synergize strategically in implementing the CE [30]. Several technologies have been used by various countries in conducting waste management [31, 45], including a focus on DSC.

The implementation of DSC in the context of CE can be used by textile MSMEs to operate efficiently because it can identify and optimize the resources used. This is suggested by previous scholars [12, 44, 46-48] that companies can more easily control the company business chain. Properly conducted DSC can be used in improving supply chain efficiency; hence, the supply chain can be more agile so that in the long run it can increase stakeholder loyalty [52, 53] and at the same time have a very significant impact on long-term BS [32, 33, 49, 51]. The research results prove that CEI can have a positive influence on BP, EP, and SP. Likewise, CEI can mediate the influence between variables (including all variables studied, namely BAC, GHRM, and DSC) on BP, EP, and SP (H4 to H15 accepted).

Textile MSMEs have to be able to design the implementation of CE carefully and meticulously. This is important so that textile MSMEs can evaluate the performance of each business process. When this has been done precisely and carefully, the hope is to reduce the waste of resources and manage waste perfectly [6, 7, 54-59]. There are some significant positive impacts when CEI is applied appropriately and carefully so that it can have an impact on BP, EP, and SP. Some important indicators of BS are production efficiency and environmental cost efficiency [60, 61], reuse of materials for production processes, and reduction of industrial waste, hazardous gases, and other environmental damage [62-68]. Likewise, sustainable SP indicators [70-72, 75] are creating new job opportunities, increasing a sense of community, having a social responsibility to the wider community, and hopefully providing more togetherness [67, 68, 70, 71].

The discussion that has been presented also confirms that CEI does indeed mediate the influence of each BAC, GHRM, and DSC on BS. BAC, GHRM, and DSC should be considered in the company's business model when the company implements CE in accordance with the advice of various management experts to increase BS [5, 16, 17, 18, 39, 40].

The results of the study found that there is no significant difference in the relationship between variables (covering all variables studied, namely BAC, GHRM, and DSC) between the subgroups studied (both fashion and clothing materials) in CEI (H16 rejected). Owners/managers of textile MSMEs should be able to take responsibility not only for administrative matters but also serve as catalysts of organizational learning and innovation, especially related to CEI. For CEI to be successful in the future, MSMEs need to; provide time, energy and resources for learning activities; design and provide an incentive system for sharing CE knowledge to employees consistently; ensure the sustainability of CEI through continuous training and development; develop a digitization infrastructure that supports collaboration between agencies to create knowledge exchange between units; strengthen a culture that is conducive to encouraging learning; provide knowledge exchange facilities between units if available; build internal networks across and between units to share best practices related to CE; integrate knowledge related to CE into strategic decision making; and conduct regular monitoring and evaluation of the effectiveness of the CE program. This is important so that textile MSMEs can create a safe environment for experimentation and open discussion regarding future CEI with various parties. It is hoped that the impact in the long run will be able to improve BS.

6. CONCLUSIONS

CE practices carried out relatively still use conventional practices and are not comprehensive. This is because the MSMEs studied have limited resources, including human resources. In HRM practices, what is important is that MSMEs focus on a touch of green management (green orientation) in every practice, such as training, performance appraisal, and compensation based on GHRM practices. Another limitation is in DSC practices, where the most important thing is only emphasizing the use of DSC in certain aspects, such as the adoption of digital product sales, partial implementation in digital operations, and using digitalization in aspects of service to customers and suppliers.

Therefore, the emphasis on CEI is expected to help textile MSMEs to play a role in mediating business capabilities, GHRM practices, and DSC in improving sustainable business. In the practice of CE, it also turns out that MSMEs still apply the most important simple principles, namely reducing synthetic raw materials used in production, distribution, and marketing as much as possible; utilizing leftover materials; recycling existing materials; and engineering in redesigning the use of the remaining existing raw materials.

In the future, research should use mixed methods because researchers will be able to get a more complete and in-depth understanding of the empirical phenomena at hand and can find better solutions. The longitudinal approach is highly recommended because researchers can have a more accurate picture and results of the research theme and can determine and analyze the causal relationship between the antecedents and consequences of CEI. This is because researchers can make repeated and continuous measurements over a long period of time and even years. Therefore, it is also necessary to consider cost and time and to manage the research effectively. The research area only covers two provinces, namely Central Java and West Java. Therefore, the results of the study cannot be generalized because the variation in resources owned by textile MSMEs in the two regions is different.

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