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The Role of Big Data in Circular Supply Chain Practices and Corporate Sustainability Performance

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Abstract
The green industry is a national priority target, with one of the indicators being the application of a circular economy. The application of a circular economy to the entire supply chain process is an effort to extend the service life of materials so that sustainability arises. The application of circular supply chains needs to be supported by digital technology to improve processes. This study aims to analyze the effect of circular supply chain practices on corporate sustainability performance and the moderating effect of Big Data. The hypothesis testing using SEM analysis tools. The number of samples used was 140, who are currently working or have worked in companies that have implemented a circular economy. The results of the study show that Circular Supply Chain Practices do not influence on Corporate Sustainability Performance, so the moderating effect of Big Data is not supported. Therefore, managerial parties need to implement a circular supply chain in the company's business processes. Managers need to provide technical training related to designing environmentally friendly products and educational strategies to customers regarding the application of a circular economy. Nonetheless, this study also has limitations, in that it consists of only one variable, Circular Supply Chain practices, which affect Corporate Sustainability Performance. Thus, the next researcher should add other variables that can affect Corporate Sustainability Performance, such as the purchasing realized absorptive capacity variable.

Keywords: Circular Supply Chain Practices ; Corporate Sustainability Performance; Big Data Driven Supply Chain

1. Introduction

The development of the green industry is a national priority target as one of the indicators for implementing a circular economy in sustainable industrial development (Narasi RPJMN 2020-2024). A circular economy has several benefits, from an economic perspective it has the potential to increase National PDB (Product Domestic Bruto) IDR 593 trillion - 638 trillion in 2030. From an environmental perspective, a circular economy can reduce CO2-Eq emissions by 126 million tons and reduce water use by 6.3 billion cubic meters. Meanwhile, from a social perspective, it is estimated that the average household in Indonesia can save IDR 4.9 million/year and create 4.4 million new jobs (Bappenas, 2021).

A circular economy is not only about waste management but intervenes in the entire supply chain thereby reducing damage caused by linear supply chains (Bappenas, 2021). Supply chains support the implementation of a circular economy (Hazen et al., 2020). The effect of implementing a circular supply chain supports the sustainability performance of a company (Le, 2022).

The implementation of a circular supply chain needs to be facilitated by digital technology to improve processes, one of which is big data (Bappenas, 2021). Big data and big data analytics have an important role in supply chain sustainability (Le, 2022) and are closely related to the circular economy (Del Giudice et al., 2020). This research needs to be carried out because there is no research on the role of big data supply chains in circular supply chain relationships and company sustainability performance.

Sustainability SCM and circular economy are studied as separate concepts (Hussain & Malik, 2020). However, recently several studies have found a positive relationship between the two concepts. The implementation of Circular Supply Chain Practices is intended to create environmental, social, and economic balance (Dey et al., 2020). This indicates that there is a close link between circular economy practices and sustainable supply chain practices (Mastos et al., 2021). Implementing a circular supply chain improves company performance regarding the circular economy (Zeng et al., 2017). Previous research states that there is a close relationship between circular economy practices and sustainable supply chain practices. The implementation of a circular supply chain improves company performance related to the circular economy, in this case, sustainability performance. Other research finds that circular economics is one of the tools to achieve sustainable development but does not have economic and social benefits for companies (Walker et al., 2022). This inconsistency needs to be investigated.

Big Data is one way to organize and analyze supply chain processes to improve supply chain performance (Yu et al., 2018). In-depth information obtained from big data or big data analytics can help companies create a circular economy business system (Gupta et al., 2019). In terms of supply chains, big data can increase productivity and growth and impact overall company performance.

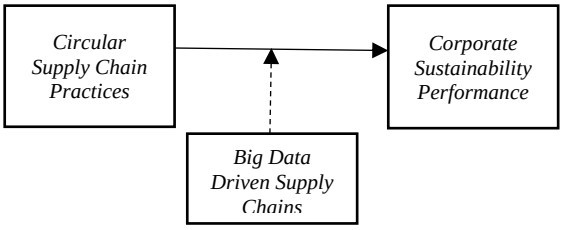

Figure 1. Influence Circular Supply Chain Practices to Corporate Sustainability Performance moderated Big Data Driven Supply Chains
Source: (Agyabeng-Mensah et al., 2023; Del Giudice et al., 2020; Le, 2022)

2. Research Methods

This study uses an instrument from a previous reseacher to measure existing variables (Agyabeng-Mensah et al., 2023; Del Giudice et al., 2020). This research uses testing hypothesis research to test existing hypotheses with explanations about the connection or difference between two or more variables with SEM analysis. Study This test linkages between Circular Supply Chain Practices and Corporate Sustainability Performance and effects moderation Big Data. The amount of sample used was 193 respondents with respondents who have applied economy circular was 140 respondents can seen in Table 1.

Table 1. Total Respondents Implementing a Circular Economy

No	Amount Respondents	Percentage	Information
1	140	73%	True. My company applies a circular supply chain.
2	53	27%	No. My company applies a circular supply chain.
Total	193	100%	

Source: Data Processing Results

Data used in the study is a primary data spread questionnaire in a way directly to the intended target respondents by criteria that are already applied economy circular. Taking a sample uses purposive sampling Because necessary information can be obtained from a group target and not everyone can give information (Uma Sekaran & Roger Bougie, 2016).

Table 2. Respondent Profile According to the Department

No	Department	Amount Respondent	Percentage
1	Accounting	2	1,4%
2	Data	2	1,4%
3	Engineering	4	2,9%
4	HCGA	2	1,4%
5	Hospitality	2	1,4%
6	Internal Audit	4	2,9%
7	Finance	4	2,9%
8	Lab and waste	2	1,4%
9	Logistics	16	11,4%
10	Management	4	2,9%
11	Operasional	18	12,9%
12	Marketing	54	38,6%
13	Procurement	10	7,1%
14	Production	6	4,3%
15	Projects	2	1,4%
16	Sales	2	1,4%
17	Software Specialist	2	1,4%
18	Systems	2	1,4%
19	Warehouse	2	1,4%
	Total	140	100%

Source: Data Processing Results

Based on Table 2 results frequency from whole respondents based on department dominated by respondents from department marketing of 38.6% or as many as 54 respondents. Then followed by the respondent from the department operational of 12.9% or as many as 18 respondents. Next, respondents from the logistics department by 11.4% or as many as 16 respondents. Then, respondents from the Procurement department by 7.1% or as many as 10 respondents. After that, respondents from department production of 4.3% or as many as 6 respondents. Furthermore respondents from Engineering, Internal Audit, Finance, and Management departments each at 2.9% or as many as 4 respondents. Then respondents from departments of Accounting, Data, HCGA, Hospitality, Lab and waste, Project, Sales, Software specialist, Systems, and Warehouse each by 1.4% or as many as 2 respondent.

Table 3. Respondent Profile According to Position

No	Position	Amount Respondent	Percentage
1	Employee	82	58,6%
2	Middle Manager	36	25,7%
3	Executive and Top Level	22	15,7%
	Total	140	100%

Source: Data Processing Results

Based on Table 3 results frequency from whole respondents based on position dominated by respondents with position employees of 58.6% or as many as 82 respondents. Followed by the respondent from position middle managers by 25.7% or as many as 36 respondents. Then, respondents from position executive and top-level managers 15.7% or as many as 22 respondents.

Table 4. Respondent Profile According to Age

No	Age	Amount Respondent	Percentage
1	20-30 years	56	40%
2	31-40 years	56	40%
3	41-50 years	28	20%
	Total	140	100%

Source: Data Processing Results

Based on Table 4 results frequency from whole respondents based on age, the number of respondents with 20-30 years old same with aged 31-40 years respectively 40% or as many as 56 respondents. Furthermore, respondents aged 41-50 years by 20% or as many as 28 people.

Tabel 5. Respondent Profile According to Recent Education

No	Last Education	Amount Respondent	Percentage
1	SMA/SMK/Equivalent	8	5,7%
2	Diploma	12	8,6%
3	Bachelor	96	68,6%
4	Postgraduate	24	17,1%
	Total	140	100%

Source: Data Processing Results

Based on Table 5 results frequency from whole respondents based on Last Education dominated by respondents with Bachelor's education was 68.6% or as many as 96 respondents. Followed by the respondents with Postgraduate Education of 17.1% or as many as 24 respondents. Then, respondents with a Diploma Education of 8.6% or as many as 12 respondents. Furthermore respondents with high school/vocational/ equivalent education of 5.7% or as many as 8 respondents.

This study uses a validity test to see the suitability between statement items with variables that will be measured as well as to confirm respondents' understanding of the meaning of the statement items used, so the accepted answer will reflect the actual situation. Validity test related to what extent size can represent a draft from something study (Hair et al., n.d.). Therefore that is, the more valid it is indicator so the more appropriate indicator the in measure something variable. A validity test was done with processed 140 samples with output factor loading and tools analysis form factor analysis.

Variables studied in this research will be measured using existing instruments used by researchers previously that is instruments Circular Supply Chain Practices (Agyabeng-Mensah et al., 2023), Corporate Sustainability Performance (Agyabeng-Mensah et al., 2023), and Big Data Driven Supply Chain (Del Giudice et al., 2020). Instruments used to measure variables tested their validity and reliability. The amount of samples studied will influence mark factor loading will used as a regulatory limit taking decisions on validity tests, with thereby because amount of samples used in this research as many as 140 respondents mark factor loading becomes limited is 0.50 (Hair et al., n.d.). Validity test results attached to the table of Validity, Reliability, Mean, and Standard Deviation Test Results show that mark factor loading from every indicator is bigger than 0.50, so the indicators used to measure the variables Circular Supply Chain Practices, Corporate Sustainability Performance, and Big Data Driven Supply Chains declared valid or appropriate in measure variables studied. Instrument measurement is called reliable if the own mark Cronbach alpha is bigger than 0.6 (Uma Sekaran & Roger Bougie, 2016). Instruments that measure the variables Circular Supply Chain Practices, Corporate Sustainability Performance, and Big Data Driven Supply Chain like attached to the table of Validity, Reliability, Mean and Standard Deviation Test Results mark Cronbach alpha bigger from 0.6 so all over instrument stated reliable or there is internal consistency between indicator in measure same concept.

The next measurement is a model suitability test attached to the table of Model Suitability Test Results (goodness of fit model). Test results goodness of fit show the p-value is 0.00 so can be said poor fit. Testing goodness of fit can done by seeing RSMEA values have the mark of 0.14 with condition ≤ 0.1 so can conclude goodness of fit. Then done measurement incremental fit measure with the IFI value is 0.91 and the CFI is 0.91 so can said goodness of fit Because the fulfil condition is> 0.9. Meanwhile, TLI has a value of 0.88 and NFI of 0.85 so can said that TLI and NFI are poor of fit because their mark under conditions. The last type of measurement is the parsimonious fit measure using mark normed chi-square (CMIN/DF) is 2.34 so can say goodness of fit fulfills criteria between 1 to 5.

Models can be considered worthy and acceptable used if one or more criteria of goodness of fit are fulfilled. Based on from results testing the feasibility of the existing model using Absolute Fit Measures, Incremental fit measures, and Parsimonious Fit Measures obtained 4 measurements with the conclusion of goodness of fit so that testing hypothesis can next because the model test can said worthy.

3. Results and Discussion

3.1. Test Result

Table 6. Test Results Hypothesis 1

Hypothesis	Estimate	p-value	Decision
H1: Circular supply chain practice influential positive to corporate sustainability performance	0,001	0,986	Not supported

Source: Data Processing Results

Based on Table 6 results testing the first hypothesis shows Circular Supply Chain Practices'

influence positively on Corporate Sustainability Performance with a p-value is 0.986 > 0.05 so hypothesis not supported (Ho accepted, Ha rejected). This thing means can be concluded that Circular Supply Chain Practices do not influence Corporate Sustainability Performance.

Variable Big Data Driven Supply Chain can role as variable moderation if fulfills some criteria. The criteria must significantly influence variable Circular Supply Chain Practices to variable Corporate Sustainability Performance.

Table 7. Test Results Hypothesis 2

Hypothesis	Estimate	p-value	Decision
H2: Big Data Driven Supply Chain moderate influence Circular supply chain practices to corporate sustainability performance.	0,004	0,000	Not Supported

Source: Data Processing Results

The second hypothesis is to test the moderating effect of Big Data Driven Supply Chain on the influence of Circular Supply Chain Practices and Corporate Sustainability Performance. From Table 7 you can see that the Big Data Driven Supply Chain's influence is significant (p-value=0.000). However, hypothesis 1 does not support the influence of Circular Supply Chain Practices on Corporate Sustainability Performance. So Big Data Driven Supply Chain does not moderately influence Circular Supply Chain Practices on Corporate Sustainability Performance.

3.2. Discussion

Circular Supply Chain Practices do not influence Corporate Sustainability Performance

The results of the research show that variable Circular Supply Chain Practices do not support Corporate Sustainability Performance. This result does not support the previous study stating Circular Supply Chain Practices are influential positively on Corporate Sustainability Performance (Agyabeng-Mensah et al., 2023). Perception respondents from testing mean like attached to the table of Validity, Reliability, Mean and Standard Deviation Test Results show results approach scale highest However pattern distribution of data on each respondent not same for each variable testing. From 140 respondents 38 respondents answered the questionnaire with consistency for each variable testing. The majority of respondents give a small score for variable application circular supply chain.

Implementation economy circular readiness instrument law is factor determinative (Holman Fasa, 2021). Some countries that have integrated draft economy circulars into the country laws are Germany, Japan, China (Geissdoerfer et al., 2017), and Ghana (Ahinful & Tauringana, 2019). Studies previously used object research in Ghana (Agyabeng-Mensah et al., 2023). Regulations related application of Environmental Management in industry in Ghana already started in 1994 through the Environmental Protection Agency Act 1994 (Act 490) followed by several other related regulations (Ahinful & Tauringana, 2019). Whereas application economy circular in Indonesia is yet loaded in provision legislation (Holman Fasa, 2021). Regulation-related legislation in Indonesia's Economic Circular is still nature multisector not yet nature single and integrative (Holman Fasa, 2021). Based on the explanation hypothesis is not supported because of the difference object study.

4. Conclusion

Based on the results of research and previous discussions, it can be concluded that Corporate Sustainability Performance cannot be influenced by Circular Supply Chain Practices. So managerial implications that can be used as input to support company sustainability include:

1. Managerial parties need to implement a circular supply chain in the company's business processes because it has a positive impact on the company's sustainability (Agyabeng-Mensah et al., 2023; Del Giudice et al., 2020; Le, 2022);
2. Managers need to provide training about designing environmentally friendly products and educational strategies to customers regarding implementing a circular economy.

This research also has limitations, in that it only consists of one variable, Circular Supply Chain Practices which influence Corporate Sustainability Performance. So, future researchers should add other variables that can influence Corporate Sustainability Performance, such as the purchasing realized absorptive capacity variable (Difrancesco et al., 2022).

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ATTACHMENT
Validity, Reliability , Mean, and Standard Deviation Test Results

No	Statement	Factor Loading	Croncbach Alpha	Information	Mean	SD
Circular Supply Chain Practices						
1	Our firm exchanges information with suppliers on circular economy	0,914	0,937	Valid and Reliable	4,01	1,07
2	Our firm's manufacturing processes consider circular economy practices	0,886			4,24	0,91
3	Our firm designs products for circular economy	0,799			3,98	1,06
4	Our firm considers circular economy in sourcing materials	0,919			4,14	0,86
5	Our firm collaborates with suppliers on circular economy	0,914			4,16	0,89
6	Our firm exchanges information with customers on circularity	0,838			3,94	1,06
Corporate Sustainability Performance						
1	Our firm has improved environmental performance (i.e. reduced air and water pollution and solid waste)	0,885	0,877	Valid and Reliable	4,44	0,75
2	Our firm's market performance has increased	0,876			4,31	0,75
3	Our firm has improved social performance (i.e. employee and community health and safety)	0,898			4,38	0,92
4	Our firm has increased profitability (i.e. net profit and return on investment)	0,763			4,33	0,74
Big Data Driven Supply Chain						
1	Our database is multi-faceted, cross-functional across departments, consistent and interoperable	0,755	0,904	Valid and Reliable	4,27	0,87
2	Our database is kept up to date with information from the market and customer needs, which can be accessed by stakeholders for necessary improvement	0,771			4,24	0,89
3	We practice demand forecasting and supply planning involving stakeholders	0,734			4,26	0,83
4	We practice lean manufacturing and virtual manufacturing for process clarity, dashboard development and bottleneck visualization	0,859			4,37	0,80

Goodness of Fit Model

Type Measurement	Measurement	Value	Level of Acceptance	Conclusion
Absolute fit measures	*P*	0,00	≥ 0,05	*Poor of Fit*
	RMSEA	0,14	≤ 0,1	*Goodness of Fit*
Incremental fit measures	IFI	0,91	≥ 0,9 or close to 1	*Goodness of Fit*
	NFI	0,85	≥ 0,9 or close to 1	*Poor of Fit*
	TLI	0,88	≥ 0,9 or close to 1	*Poor of Fit*
	CFI	0,91	≥ 0,9 or close to 1	*Goodness of Fit*
Parsimonius fit measure	CMIN/DF	2,34	Lower limit 1, upper limit 5	*Goodness of Fit*

Note: Probability (p); Root Mean Square Error of Approximation (RMSEA); Incremental Fit Index (IFI); Normed Fit Index (NFI); Tucker Lewis Index (TLI); Comparative Fit Index (CFI).