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A Preliminary Findings of Risks in Adopting Circular Economy Initiatives in Indonesia: Supply Chain of Plastic Industry

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The circular economy aims to utilize natural resources and reduce the large amount of waste that impacts the environment. Although many studies had identified various advantages of adopting a circular economy, only a few studies have investigated the risks of adopting a circular economy context. Therefore, to fill this research gap, this study proposes a preliminary risks assessment of adopting circular economy initiatives in the Indonesian plastic supply chain. First, this study performed a literature review to identify risk criteria in the plastic manufacturing supply chain's circular economy initiative. Second, it continued by interviewing the experts to validate the identified risks. Right experts are involved in rating the criteria on a four-point Likert scale. From expert appraisal, this study established eight risk categories and 31 specific risks for further analysis.

CCS CONCEPTS •Social and professional topics~Professional topics~Computing industry~Industry statistics •Networks~Network performance evaluation~Network performance modeling

Keywords and Phrases: Circular economy, risk, plastic industry

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1 INTRODUCTION

In the linear economy, producers extract natural resources to continually produce new products, assuming that natural resources are limitless. The linear economy impacts depletion of resources, social impacts, environmental pollution, and unmanaged waste [11]. For example, People use plastics in everyday life. The use of plastic has reached 300 million tons of plastic with 50% for packaging and about 1% for shopping bags. Plastics take 1,000 years to degrade. If the use of plastic is not considered, it will cause unmanaged plastic waste [10]. An approach is needed to maintain the product life cycle while maintaining environmental sustainability [3].

The circular economy is a concept to maintain environmental sustainability, economic benefits, and business profitability [4]. Circular economy goals consist of reducing waste, reduce resource consumption, exploiting resources, and increasing energy use [5]. In the plastic industry, some steps that can be taken to reduce unmanaged plastic waste include efficient use of materials, production of reusable goods, production of recyclable goods, production of biodegradable plastics, and development of plastic recycling, and encourage the use of waste as alternative energy for industry [21].

Adopting a circular economy might pose risks for the incoming profitability and environmental preservation [7]. It is necessary to manage risks to the application of a circular economy for companies [17]. Throughout the

supply chain, risks need to be evaluated to improve effectiveness and efficiency. With risk management, companies will be able to maintain the adoption of the circular economy concept. Here, risks could arise invisible or not activities, both from the production and collection of recycled products [4].

The risks that may arise will affect the supply chain performance in implementing a circular economy. Many studies discuss risks in the circular economy's supply chain based on industrial green supply chain management [2]. An in-depth study is needed to be related to the analysis and assessment of risks caused by Indonesia's circular economy initiatives. Only a few discuss risks arising from the adoption of the circular economy [4,13] in Indonesia. Therefore, this study will identify the risks that stakeholders need to consider in a circular economy initiative. Analyzing the circular economy risk is critical to creating a strategy to increase the plastics industry's circular economy initiative. Creating a strategy to increase circular economy initiative is important to make sustainability of the plastic industry.

2 LITERATURE REVIEW

In this section, a systematic literature review utilizes explicit, thorough methods to define, choose, evaluate and synthesize a set of past studies on analyzing risks in adopting circular economy initiatives.

2.1 Sustainable Development Goals

World leaders, including Indonesia, agree on the Sustainable Development Goals (SDG), which contain 17 goals and 169 targets [24]. World leader expects, will achieve the Sustainable Development Goals (SDGs) by 2030 [12]. The SDG goals aim to improve people's economic welfare (Goals 1,2,3,4 and 5), develop the sustainability of people's social life (Goals 7, 8, 9, 10, and 17), create the quality of the environment (Goals 6, 11, 12, 13, 14 and 15) and ensures fairness and the implementation of management governance (Goal 16)[24].

Responsible production and consumption (Goal No 12) are among the 17 Global Goals in Sustainable Development Goals. Its goal is to improve resource efficiency and reduce waste and toxic pollutants. Encouraging industry, business, and consumers to recycle and reduce waste is very important [10]. The plastic industry is one industry that needs to apply this concept. The application of the circular economy principle will assist in achieving the target.

2.2 Circular Economy in Plastic Supply Chain

The circular economy aims to utilize natural resources, raw materials, and industry components [15]. Plastic is one of the five priority products for the application of the circular economy concept. Many people use plastic as packaging because Plastics are lightweight, durable, and flexible. Plastics need to be returned to their production cycle continuously to maintain environmental sustainability. Only a small percentage of plastic packaging is recycled [14].

Several long-term considerations are related to adopting the circular economy to the industry, including changes in business models, supplier partnerships, reverse logistic models, and technical considerations related to product remanufacturing [23]. Some of these changes can pose a risk to Industries that implement a Circular Economy. The risks that arise in applying a circular economy affects supply chain effectiveness. Many studies have discussed the risks in the supply chain based on industrial sustainability, but only a few have discussed the risks of applying the Circular Economy. There is still little research that discusses risk priorities due to applying the Circular Economic in Indonesian Industry [23].

2.3 Supply Chain Risk Management

Huang et al. [8] researched risk analysis and evaluation on the concept of green supply chain management. This research begins by focusing on the characteristics of green supply chain management, then analyzing the

fundamental risk sources that occur in the green supply chain management concept than creating a risk evaluation system by classifying the risks by conducting quantitative analyzes on the risks arising from green supply chain management and supported using comprehensive evaluation methods in various situations and conditions. Barua et al. [17] prioritize green supply chain management risks to prioritize green supply chain management problems. Ethirajan et al. [4] developed a conceptual model prioritizing risks resulting from applying the circular economy to India's PCB manufacturing industry to make a strategy for implementing a circular economy [4].

The risk occurs because of the uncertainty in the future. In a supply chain where everything is interrelated, one can transfer the risk. Kumar et al. [17] classified risk in GSC into eight risks category: information risks, product recovery risks, financial risks, environmental and social risks, process risks, government and organization risks, demand risks, and supply risks. Risk analysis of circular economy initiative using a risk analysis framework in the green supply chain as researched by Ethirajan et al. [4]. This study also uses some literature that studies risk analysis in Table 1 to get main risk criteria and specific risk.

Table 1 The List of Risk from References

Author	Title	Main Risk
Truong Quang [27]	Risks and performance in the supply chain: the push effect [27]	Supply Risk, Operational Risk, Demand Risk, Finance Risk, Information risk, external risk, generic risk
Wang [32]	A hierarchical fuzzy TOPSIS approach to assess improvement areas when implementing green supply chain initiatives [32]	Manufacturing, Purchasing, Logistic, Marketing
Mangla [18]	Risk analysis in green supply chain using fuzzy AHP approach: A case study [18]	Operational Risk, Supply Risk, Financial Risk, Demand Risk
Rostamzadeh [35]	Evaluation of sustainable supply chain risk management using an integrated fuzzy TOPSIS- CRITIC approach [35]	Environmental risk, organizational risk, sustainable supply risk, production/manufacture, distribution risk, sustainable recycling, IT-related risk
Mangla [19]	Benchmarking the risk assessment in a green supply chain using the fuzzy approach to FMEA: Insights from an Indian case study [19]	Supply of virgin and secondary raw material, production, assembly, and packaging, Used Product Collection and handling of used products, sorting and inspection
Kumar [13]	An integrated methodology of FTA and fuzzy AHP for risk assessment in green supply chain [13]	Information Technology, Financial Risk, Supply risk, process risk, government interference risk, social and environmental risk, Demand Risk, product recovery risk
Yang [33]	Assessment of green supply chain risk based on circular economy [33]	organizational risk, system control risk, market environment, supply risk, demand risk
Mangla [17]	Prioritizing the responses to manage risks in the green supply chain: An Indian plastic manufacturer perspective [17]	Operational Risk, Supply Risk, Product Risk, Product Recovery Risk, Financial Risk, Demand Risk, Government, and Organizational Related Risk
Ethirajan [4]	Analyzing the risks of adopting circular economy initiatives in manufacturing supply chains [4]	Operational Risk, Financial Risk, Environmental Risks, Strategic Risks, Quality Risks, Reputational Risks, Compliance Risks

3 METHODOLOGY

This study performed a literature review to identify risk criteria in the circular economy initiative in the plastic manufacturing supply chain Figure 1. After obtaining the risk from the literature, risk validation occurs through

the interview stage. This interview to determine the validated risk of adopting the circular economy initiative. This study used content validation to eight panels of an expert in Table 2.

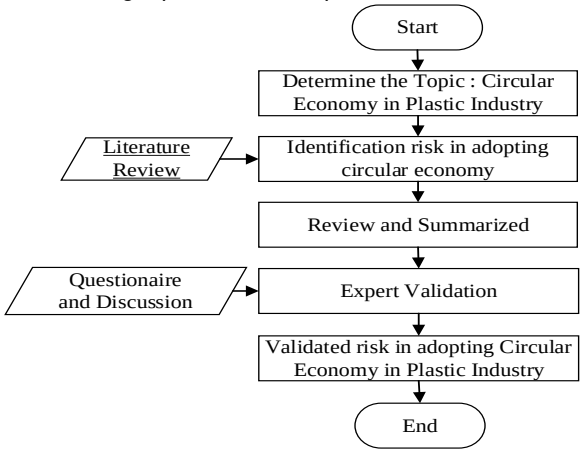

Figure 1 Flow Chart of Methodology

This study used the relevance ratings from the expert panel to assess content validity. The content validity used to construct item-level content validity (I-CVIs) and scale-level CVIs (S-CVIs) [26]. Content validation measures the items in the instrument representing a research concept. Content validation measures the relevance of the content based on expert judgment [20]. The experts judge the instrument questionnaire items on four integer scales (Not relevant, somewhat relevant, moderately relevant, and highly relevant) [26]. Lynn [9] recommends using a minimum of three experts, but more than ten may not be necessary. Item-CVI calculation from expert appraisal if the expert gives a rating of 3 or 4 (scale of 3-4 = relevant and 1-2 = irrelevant) [20]. In equation 1, The Item-CVI number divided by the total number of experts [9]. In equation 2, The Scale-CVI number divided by the total number of items [26].

$$I - CVI = \frac{Expert\ Agreed}{Number\ of\ expert} \qquad (1)$$

$$S - CVI = \frac{\sum I-CVI}{Number\ of\ Item} \qquad (2)$$

Table 2 The List of Experts

Experts	Background	Experience
Expert 1	Director of Recycler Company	5-10 Years
Expert 2	Sustainability Engineer	5-10 Years
Expert 3	Director of Recycler Company	20-25 Years
Expert 4	Plastic Industry Association	20–25 Years
Expert 5	Circular Economy Expert	5-10 Years
Expert 6	Manager of Recycler Company	5 – 10 Years
Expert 7	Directorate General of The Ministry	20 – 25 Years
Expert 8	Waste Management Society	10-15 Years

When there is more than five experts, there are only a few expert approval (for example, if there are six experts, I-CVI must be at least 0.83, only 1 expert disagrees). Table 3 shows the research approach that contains a list of multiple assessments to assess the relevant risk items with varying numbers of experts and deals. Based on Polit et al. [20,9], an I-CVI among 6–10 reviewers of at least 0.78 is considered valid (Table 2). This study used the I-CVI with “good” evaluation or value of I-CVI is 0.75, which means from eight panel of

experts, six experts should rate an item ‘quite relevant’ or ‘highly relevant’[9]. If six of eight experts agreed, then the risk from literature is essential and acceptable.

Table 3 I-CVIs Value with Different Agreement of Expert [9]

(1) N (Panel Size)	(2) Number giving rating of 3 or 4	(3)[a] I-CVI	(4)[b] Pc	(5)[c] K*	(6)[d] Evaluation
6	6	1.00	0.016	1.00	Excellent
6	5	0.83	0.094	0.81	Excellent
6	4	0.67	0.234	0.57	Fair
7	7	1.00	0.008	1.00	Excellent
7	6	0.86	0.055	0.85	Excellent
7	5	0.71	0.164	0.65	Good
8	8	1.00	0.004	1.00	Excellent
8	7	0.88	0.031	0.88	Excellent
8	6	0.75	0.109	0.72	Good
9	9	1.00	0.002	1.00	Excellent
9	8	0.89	0.014	0.89	Excellent
9	7	0.78	0.070	0.76	Excellent

[a]I-CVI indicates item-level content validity index [9]
[b]pc (probability of a chance occurance) was computed using the binomial random variable formula, with one specific outcome: pc = [N!/A!(N-A)!}*5N where N= number of experts and A= number agreeing on a good relevance [9] .
[c]k*= kappa designating agreement on relevance: k*= (I-CVI-pc)/(1-pc) [9].
[d]Evaluation criteria for kappa, using guidelines described n Cicchhetti and Sparrow [9] and Fleiss [9]: Fair = k of 0.040 to 0.059; Good = k of 0.60-0.74; and Excellent = k>0.74[9].

4 RESULT AND DISCUSSION

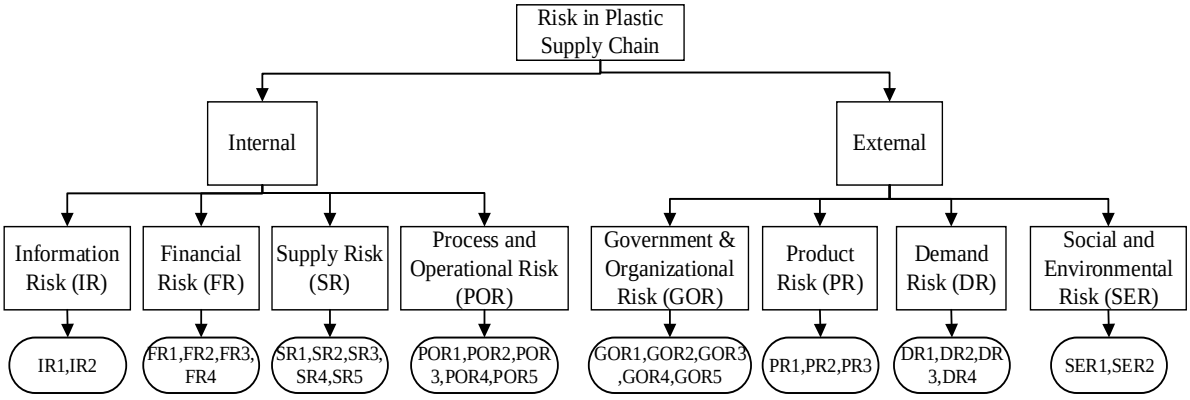

Figure 2. Hierarchical Structure for analyzing the risks in Adopting Circular Economy Initiative (adopted from [14])

The hierarchical structure for analyzing the risks in a circular economy has three-level from the literature (Figure 2) [28]. At the first level, namely the risk category of implementing a circular economy, the second level is the main risk criteria; the third level is the specific risk with an interrelated impact. From the literature, there are eight risk categories and specific risks in a circular economy. Mangla et al. [18] classified risk categories in the supply chain as internal and external risks. Internal risk is classified into information risk, financial risk, supply risk, and process and operational risk [17]. External risk is classified into government and organizational risk, social and environmental risk, demand risk, and product risk [17].

Wang [30] suggested that the supply chain risks are interconnected and affect each other from criteria to criteria and sub-criteria to sub-criteria. The risk interaction analysis occurs through expert validation [9]. From

a literature study and expert validation, this study obtained a risks network. It means there is an interrelationship between the criteria and sub-criteria for the considered risks in the network [28]. This study found the relationship between the risks in Figure 3. The S-CVI value calculated was found to be 0.8145, representing acceptable and relevant literature's risks in the network.

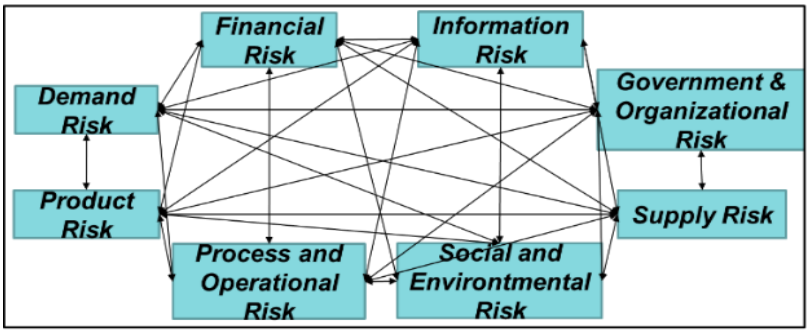

Figure 3. Interrelated Main Risk in Adopting Circular Economy Initiative (adopted from [17])

4.1 Demand Risk

The manager needs to pay attention to demand risk to get benefits from the circular economy initiative. The stable demand for an eco-friendly product in the market will affect a company's business change [29]. After content validation, there are four relevant specific demand risks in the Indonesian plastic industry in a circular economy context (Table 4).

Table 4 Demand Risk

Specific Risk	Indicator	In agreement (n)	I-CVI
Customer loyalty [4]	There is a lack of customer trust in the product due to Changing a product from used 100% virgin material into recycled materials. Need to increase added-value for recycling product.	6	0.75
Demand Instability and Bullwhip Effect [4]	Uncertain Demand for the recycled product made difficult to determine the level of inventory.	6	0.75
Outbound Logistic [17]	Outbound Logistic that aims to distribute recycled products not yet cohesive.	6	0.75
Consumer Knowledge [4,25]	The lack of consumer knowledge about the advantage of using recycled products is to increase the sustainability of plastic. The lack of consumer knowledge to return plastics into its cycle.	6	0.75

4.2 Social and Environmental Risk

Table 5 Social and Environmental Risk

Specific Risk	Indicator	In Agreement (n)	I-CVI
Environmental Impact [4,5]	The processing process in the plastic recycling industry has different environmental impacts depending on the type of processing. Additional costs required due to the environmental impacts of plastic recycling	6	0.75
Social Responsibility [4,5]	The low level of social responsibility in handling waste starts from consumers who think plastic waste is the government's responsibility, and the government considers plastic waste to be the producers' responsibility.	7	0.875

Environmental and social aspects need to be considered in the Green Supply chain management of the plastic industry. Managers should mitigate social and environmental risks in the supply chain of the circular economy

context. Environmental risks include those caused by processes, operations in recycling activities. Social responsibility because the impact of operational activities on the community can be a barrier to business. After content validation, there are two relevant social and environmental risks in the Indonesian plastic industry in a circular economy context (Table 5).

4.3 Supply Risk

The supply of eco-friendly materials (raw or recycled materials) in applying the circular economy concept is important [12]. According to Mangla et al. [17], instability in the supply of raw materials will become an obstacle to operational. The inadequate supply will reduce the company's profits [4]. After content validation, there are five relevant specific supply risks in the Indonesian plastic industry in a circular economy context (Table 6).

Table 6 Supply Risk

Specific Risk	Indicator	In agreement (n)	I-CVI
Supplier [17]	Difficult to find recycled material collector suppliers that can supply large amounts of recycled materials.	7	0.875
Raw Material Quality [16,19,25]	Recycled raw materials mixed with other types of materials. Different quality of material supply from different collection centers (landfills, household waste, Etc.). Different quality of material type from the different product (bottle, plastic glass, etc.)	7	0.875
Availability of Raw Materials [4,25]	The lack of recycled plastic raw materials is because most plastics are mixed with other waste. Only a small portion of plastic waste is separated at the garbage collection point.	7	0.875
Waste Management [16,19]	Waste Management (collection) is still not good. There is unmanaged plastic waste so that many do not return to the cycle	8	1
Inbound and reverse Logistics [19]	There are complex inbound and reverse logistics for recycled plastics, starting from plastic waste collectors, collectors, the waste separator industry to the recycling industry.	8	1

4.4 Financial Risk

Financial risk plays a vital role in the application of an efficient circular economy concept. Good cash flow in the company will cause the industry to be interested in the circular economy concept [8]. Managers need to make efforts in an effort and reduce the risk of financial risks. After content validation, there are four relevant specific financial risks in the Indonesian plastic industry in a circular economy context (Table 7).

Table 7 Financial Risk

Specific Risk	Indicator	In agreement (n)	I-CVI
Economic change [4]	Economic changes due to inflation and world oil prices have caused uncertainty in the plastic recycling industry.	6	0.75
Tax [4]	No tax relaxation policy supports plastic manufacturing regarding the recycling industry.	8	1
Incentive [4]	There is a high cost due to minimum economies of scale. There are no incentives to promote the adoption of a circular economy initiative to each stakeholder. Stakeholder needs some Incentives to increase the performance.	6	0.75
Cost [4]	The cost of collecting, separating, processing, etc., in plastic recycling processing, is relatively high.	8	1

4.5 Process and Operational Risk

Process, operations, methods, labor, operational systems cause process and operational risk [31]. A manager should manage operational risk in the context of the plastics industry's circular economy. To have an efficient

GSCM concept, the technology used needs to be improved and developed so that operations and processes run smoothly [29]. After content validation, there are five relevant specific processes and operational risks in the Indonesian plastic industry in a circular economy context (Table 8).

Table 8 Process and Operational Risk

Specific Risk	Indicator	In agreement (n)	I-CVI
Processing Ratio [1]	Raw materials contaminated with other materials can reduce the amount of output of finished materials	6	0.75
Safety [19]	Recycled plastic processing equipment does not have good safety standards	6	0.75
Green Equipment Specifications [4]	It is necessary to have equipment with specific specifications to process recycled plastics.	6	0.75
Production Capacity [19]	Ineffective machine capacity for use in recycled plastic production. The change of government policy makes capacity change due to demand change.	6	0.75
Maintenance [17]	Machine maintenance is becoming more frequent to process recycled plastics.	6	0.75

4.6 Product Risk

Managers need to pay attention to product risks in the plastic recycling process. This risk is related to the different types of quality plastics as recycled raw materials. The difference in the origins of recycled plastics also creates some change in the product. The difference in quality will affect the results of products that usually use 100% virgin material. After content validation, there are four relevant specific product risks in the Indonesian plastic industry in a circular economy context (Table 9).

Table 9 Product Risk

Specific Risk	Indicator	In agreement (n)	I-CVI
Standardization [16,17]	The lack of Government policies in setting plastic standards. There are still different views on plastics.	6	0.75
Feed Stock [16,17]	A lack of the quality of the raw material to be processed. There are contaminant ingredients that cause process instability. There is a color difference in the material. Colorless material is preferred.	8	1
Product Recalls [4,17]	The instability of the quality of the processing results can cause product recall.	6	0.75

4.7 Information Risk

Parast, Mahour M. [22] suggests that the information risk affects the other supply chain risks. Supply chains require an adequate flow of materials, money, and information services to serve business needs [6]. Information exchange reduces the impact of supply chain disruptions. The risk-sharing mechanism deals with the sharing of obligations and responsibilities between stakeholders in the supply chain. After content validation, there is two relevant specific information risk in the Indonesian plastic industry in a circular economy context (Table 10).

Table 10 Information Risk

Specific Risk	Indicator	In Agreement (n)	I-CVI
Information Transparency [4,19]	The lack of transparency of information between stakeholders causes differences in perceptions. Lack of transparency of information on all product information to all stakeholders.	7	0.875
Supporting Information Systems [4,19]	Information systems have not been widely used for the recycling industry, which facilitates the governance of the recycling industry	6	0.75

4.8 Government & Organization Risk (GOR)

Mangla et al. [17] developed a risk category related to Government and Organizations Risk (GOR) in implementing a circular economy. The government and organizations affect the plastic industry business. There are some risks such as failure or bad government policy and direction in terms of support for the government environment. After content validation, there are five relevant specific government and organization risks in the Indonesian plastic industry in a circular economy context (Table 11).

Table 11 Government and Organizational Risk

Specific Risk	Indicator	In Agreement (n)	I-CVI
Coordination [4]	A lack of Coordination of Government to Government. A lack of Coordination of Government to Business. A lack of Coordination of Business to Business. A lack of Coordination of Business to Consumer. A lack of Coordination of Government to Consumer.	6	0.75
Strategic Plan [34]	The objective of implementing a circular economy is still failing. The all stakeholder strategic plan is still weak. The strategic plan of circular economy is implemented at the micro and local organizations. the adoption of a circular economy strategy is necessary on a macro scale	6	0.75
Partnership [22]	Lack of socialization to stakeholders about the importance of implementing the circular economy concept as a form of sustainable industry	6	0.75
Business Model [19]	The primary business model in the industry is still focused on making, distributing, and making waste. Need to a reorientation of the business model	7	0.875
Management Commitment [16,19]	There is a lack of support from management to adopting a circular economy. (management commitment government).	6	0.75

5 CONCLUSION

A small risk in one part of the supply chain will affect others in organizations in the Circular economy context. This research found eight main risks in the plastic supply chain in the circular economy context. After the Content validation process, this study found 31 relevant risks in the plastic supply chain in a circular economy context with a minimum I-CVI value is 0.75 and S-CVI is 0.8145. It means all specific risk from literature was acceptable and relevant in adopting the circular economy initiative. This study's limitation is only identified, classifies, and validates risks in the plastic industry's supply chain in a circular economy context. Analyzing the interrelation and the effect of risk can be conducted in future studies using the Dematel-based ANP method (DANP) to prioritize and mitigate the most significant risks. Analyzing the circular economy risk is critical to creating a strategy to increase the plastics industry's circular economy initiative. Creating a strategy to increase circular economy initiative is essential to make sustainability of the plastic industry. Further study may apply risk analysis to other industries to increase sustainability by implementing a circular economy initiative such as iron manufacturing, aluminum manufacturing, paper manufacturing, Etc.

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