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# The Antecedents of the Circular Supply Chain Practices (CSCPs) Adoption in Chinese Manufacturing Companies: Extent of Circular Innovations as Moderator

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*Abstract* – **Adoption of circular supply chain practices (CSCPs) has gained increased consideration in the last few years owing to an increase in environmental concerns, product returns and scarcity of natural resources. This paper is a conceptual paper which aims to investigate the current state of circular supply chain practices and introduces a framework for the implementation of CSCPS in China, and also analysis the extent of circular oriented innovations moderates the relationships between drivers and the adoptions of CSC practices. The outputs of this research work will pave a path for manufacturing companies in China to address and implement GSCPs.**

*Keywords* – **Antecedents; Circular Supply Chain Practices; Circular Innovations**

## I. INTRODUCTION

CE was launched before 1970, took momentum in the late seventies and was promoted by Ellen MacArthur Foundation (EMF), because its ability to help stabilize some of the above-mentioned problems through economic growth from resource consumption was a concrete solution to the emerging resource crunch of the planet [1]. In addition, several major renowned consulting firms such as Accenture, Boston Consulting Group, Ernst and Young, Deloitte and McKinsey have discussed about CE values in improving organizations carbon footprint and potential in GDP growth in future [2]. In an ideal world, CE paradigm means that all the sources are reused, remanufactured, and recycled indefinitely, and resources that cannot be fully salvaged, such as energy, must be derived from renewable sources [3].

In the global content, the circular supply chain has already has always been a cynosure. Circular economy has been rising in western countries and shaping the industries across the world as countries and organisations around the world seek to rebuild overall system health of economic activity with the transition of CE [4]. They added that apart from international organisations, countries around the world are striving for CE due to resource scarcity, increased productivity, environmental concern, economic growth and consumer demand.

CE first gained traction and currently championed by the western world particularly in the European region which most initiatives, achievements, studies and collaboration found among the country members. Marino and Pariso [5] elaborated thirty-five reports issued from 2015 to 2019 on the information of framework regarding circular economy framework, implementation actions, possibilities and opportunities for improvement. The assessment shown that United Kingdom, Germany, France and Italy have the highest average circular investment. Developed nations in Asian region such as South Korea and Japan primarily emphasize on raising public awareness on sustainable consumption and waste prevention. In recent years, India has also started adopting CE practices within energy and waste management sectors. Australia has proposed a Circular Economy Roadmap for the country with a focus on four waste materials namely plastics, tyres, glass and paper. The roadmap will identify opportunities across the supply chain of how waste can be avoided, and materials can be reused or recycled through new technologies, products, services and industries that can likely emerge from taking on a circular economy approach. Japanese environmental policy is based on the Basic Environment Law (BEL) of 1993, which requires the government to develop a Basic Environmental Plan, which is subject to a six-year review [6].

China has experienced rapid industrial, agricultural, and service development during the previous two decades (refer to Figure 1.1). The agricultural sector contributed 7.7% to China's GDP, while industry and the service sector each contributed 37.8% and 54.5 percent of the economic value added, respectively. In 2020, China's total GDP was estimated to be around 101.6 trillion yuan at current prices [7]. Nonetheless, this progress has resulted in a slew of environmental issues [8]. CE was certified by the Chinese government as a national policy for SD in 2002 as a feasible method for sustainable development (SD) in China [9].

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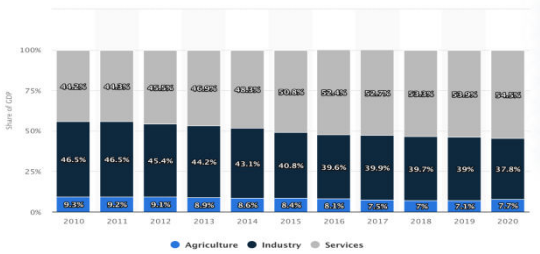


Figure 1.1: Distribution of GDP across economic sectors in China from 2010 to 2020
Source: China Statistical Yearbook, (2020)

China's per capita capacity in resources and the environment, however, is relatively low. In order to achieve a harmonious relationship between the environment and human beings, China's economic structure must be further formatted, and the country's economic growth mode must be altered. China's natural resources, environment, national competitiveness, and security will all be jeopardized if this does not happen [10]. As a result, the CE has been promoted as a new development model to assist China in leapfrogging into a more sustainable economic structure, rather than being perceived as a progressive improvement in environmental policies [11]. The areas that have been covered are shown in Figure 1.2: in addition to resources and waste generation, energy consumption, wastewater discharge problems, and CO2 and SO2 emissions have all been considered as important issues.

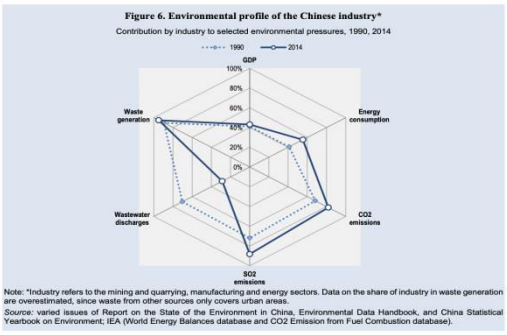


Figure 1.2: The Chinese Industry's Environmental Profile
Source: China's Progress Towards Green Growth an International Perspective, OECD Green Growth Papers (2018)

According to Liu, Li, Zuo, Zhang, and Wang (2009), the purpose of the CE law promoted by the Chinese government is to improve resource efficiency. It appears that the CE has been added into law in China since 2009. However, companies still face challenges of adopt circular supply chain practice [12]. Farooque et al. (2019) concluded that the integration of CE into SCM is the most significant barrier to China's transformation into a CSC, particularly for firms' long-term competitiveness. As a result, the adoptions and various factors that drive and hinder CSC efforts will be the main challenges [13]. The importance of CSCPs prompted the researcher to conduct this research in order to learn more about the subject. By far, few research focuses on the relationship between CSCPs antecedents and the outcomes, therefore, this study is timely.

However, connecting companies to inputs by means of a Circular Supply Chain (CSC) is not easy for many companies, because the shift to CE calls for update on the whole processing in supply chain practices from design to recycle [14]. Given this condition, the CSCPs are a main topic to investigate.

Accordingly, this research is keen to explore the key drivers and barriers of CSCPs adoption. The paper is structured as follows. First is the introduction. A research literature review is developed in the following section. The third section is dedicated to the formulation and explanation of the conceptual framework and hypotheses. Finally, in section four, there is a conclusion and future research.

## II. LITERATURE REVIEW

### 2.1. Circular Economy

Hirsch and Levin [15] defined that circular economy as an umbrella concept: "a broad concept or idea used loosely to encompass and account for a set of diverse phenomena". Several researchers have refined and developed the circular economy as an umbrella concept, including regenerative design [16], performance economy [17], cradle-to-cradle [18], industrial ecology [19]. "CE is the set of organizational planning processes for creating, delivering products, components, and materials at their highest utility for customers and society through effective and efficient utilization of ecosystem, economic, and product cycles by closing loops for all the related resource flows" [20]. Based on the preceding research, there are numerous interpretations of the circular economy idea that address not only material resource management but also a holistic approach to resource efficiency, including sustainable energy sources.

### 2.2. Circular Supply Chain

Various academics have debated the definition of Circular Supply Chain Management [21-24]. In this research, the definition proposed by Farooque was adopted due to the synthesis [22].The following definition of Circular Supply Chain Management (CSCM) was adopted from Farooque et al: "Circular supply chain management is the integration of circular thinking into the management of the supply chain and its surrounding industrial and natural ecosystems. It systematically restores technical materials and regenerates biological materials toward a zero-waste vision through system-wide innovation in business models and supply chain functions from product/service design to end-of-life and waste management" [22]. The majority of previous research has focused on CSCP

case study. Only few studies applied the quantitative approach [23].

### 2.3. Circular Supply Chain Practices (CSCPs) Adoptions

To explore the CSCPs in specific industry is the future research direction. Typical activities include those practices that are plan, source, make, deliver and return.

#### 2.3.1. Plan

"The process Plan's goal is to identify supply chain requirements and balance them against available resources and supply network assets" [25].

#### 2.3.2. Source

"The Source process attempts to schedule product delivery, receive and inspect the goods, transfer the product, and authorize payment to the provider" [25].

#### 2.3.3. Make

"The Make process seeks to arrange manufacturing activities, issue materials, make and test, stage products, and deliver items" [25].

#### 2.3.4. Deliver

"The Deliver process includes (among other things): building loads, routing shipments, selecting carriers, receiving product, picking, packing, documenting, shipping, and installing product, and it is further subdivided into the subprocesses deliver stocked product, deliver make-to-order product, deliver engineer-to-order product, and deliver retail product " [25].

#### 2.3.5. Return

"Recently reflects product recalls, returns for maintenance, repair and overhaul of products, and returns of surplus products" [26].

### 2.4. Drivers of Circular Supply Chain Practice Adoption

Drivers are described as enablers or reasons that push organizations to implement CSCP practices in the research. This study will examine the drivers through the lens of Bakry's "STOPE hypothesis" [27]. According to the STOPE framework, the essential drivers are "Strategy, Technology, Organization, People, and Environment." Bakry and colleagues [28]. These five primary drivers are as follows:

#### 2.4.1 Strategy

The first drivers consider strategy. Strategy reflects corporate vision, it may include the general circular economy strategy, operation strategy, generate economic value strategy, reduce cost strategy, recycling strategy and so on in this research [29] .

#### 2.4.2 Technology

Technology is associated with advanced technology, IoT, platform, data analysis technology, blockchain technology and other technology which can be widely used by all kinds of sources and enables the circular supply chain management implementation [30].

#### 2.4.3 Organization

Organization is related to the support from organization. The change of structure and culture in organization make the CE practice in supply chain possible [30].

#### 2.4.4 People

The fourth drive concerned with people, which cover the top managers in enterprise and client for the company and green human resource management [31].

#### 2.4.5 Environmental

The environmental drives can be fall into two categories: natural environment and policy environment. Resource scarcity can be considered as a main enable for companies to consider CE approach. Policy environment considers that policy pressure from legislation, which is the drivers to CSCP [32].

### 2.5. Barriers of Circular Supply Chain Practice Adoption

Many scholars argued the barriers of circular supply chain practice [33-37]. This research divided the barriers into four categories: cultural factors, regulatory factors, financial factors and sectoral factors. The Innovation Resistance Theory is used in this study to examine the challenges to CSCP adoption. As Daily and Huang stated, environmental practices depend on the interaction between organizational culture and management processes with numerous aspects of human resources [38]. In these circumstances, the Theory of the Opposition to Innovation provides a valuable theoretical lens, which suggests that the resistance of an organization to innovative sustainability practices can hinder its integration with SCM. The four impediments will be discussed more below:

#### 2.5.1. Cultural Barriers

Stakeholders have no interest to take part in the circular supply chain or not master the knowledge of CE, which

can be considered as the cultural barriers. Lack of vertical and horizontal collaboration is regarded as barriers [32].

2.5.2. Regulatory Barriers

Regulatory barriers include not only barriers on the general regulation framework such as environmental regulation, circular economy regulations but also the legislation on various specific production processes such as waste management on emissions and hazardous waste disposal or landfill. No strong support to enjoy various tax policies would be the regulatory obstacles [29].

2.5.3. Financial Barriers

There is no price standard for circular supply chain products, which make the CE products pricing become a problem. Adopting the CSCP means the redesign in producing process, and reuse of the waste which cover the technology training for staff and upgrading older equipment for newer, more energy efficient products. It requires a large amount of fund CSCP [39].

2.5.4. Sectoral Barriers

The barrier to adopting CE includes a lack of leadership and bad management. The dedication of top management is a critical connection in improving the implementation of sustainable practices [40].

2.6. Circular Supply Chain Operational Performance

In a circular business model, the supply chain is characterized by the following performance goals: "Minimize the use of materials, water and energy, minimize inventory, minimize waste, maximze the availability of the product" [41].

2.6.1. Resources

"The performance goal of minimizing the use of materials, water, and energy applies to every process in the supply chain, including process recovery. Recovery of a product so that it can be consumed later must be accomplished with as few materials, water, and energy as possible" [37].

2.6.2. Inventory

"In the supply chain of a circular business model, inventory should not be available until there is demand from the end user. Supply and production should occur only when there is a demand" [42].

2.6.3. Waste

"Waste refers to resources (materials, water, energy, and land) that are extracted, produced, and used without being valuable to the ultimate consumer. Waste happens at all stages of the product life cycle: products are created but not sold; products are sold but not returned; products are returned but not recovered; and products are recovered but not used as input for production or resold to end users" [22].

2.6.4. Availability of the Product

"The longer a product is on the market, the fewer resources are required to create a new product. The usage of resources is prevented by increasing the product's availability" [43].

2.7. Circular Oriented Innovations as Moderator

"Circular oriented innovation (COI) is therefore defined here as the coordinated activities that integrate CE goals, principles, and recovery strategies into technical and market-based innovations, such that the circular products and services that are brought to market purposively maintain product integrity and value capture potential across the full life cycle" [3]. Achieving Circularity need to be understood from the system view. Circular oriented innovation broadens the scope of innovation to include the ecosystem, in addition to a product or service and a business model (Figure 2.1). In the perspective of the ecosystem, a company views its product or service, its business model and the broader ecosystem [44].

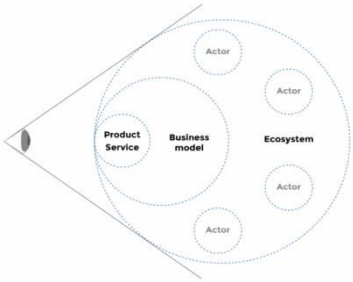


Figure 2.1 Circular Business Model
Source: Konietzko, Bocken, & Hultink, (2020)

## III. CONCEPTUAL FRAMEWORK

The objective of this research is to investigate the current state of circular supply chain practices and introduces a framework for the implementation of CSCPS in China. In addition, this research is also to determine the extent of circular oriented innovations moderates the relationships between drivers and the adoptions of CSC practices. From explanations of research objective and the existing literature review, several hypotheses are formulated as follows which are also described in the conceptual framework in Figure 3:

H1= Drivers of CSC have a significant positive impact the level of adoptions of CSC practices.
H2= Barriers of CSC have a significant negative impact on the level of adoptions of CSC practices
H3= Extent of circular oriented innovations moderate the relationships between drivers and the adoptions of CSC practices.
H4= Extent of circular oriented innovations moderate the relationships between barriers and the adoptions of CSC practices.

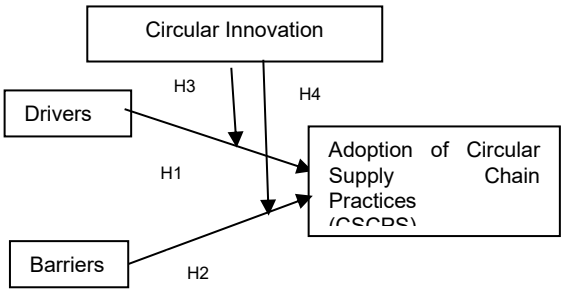


Figure 3. Conceptual Framework

3.1 Effects of the Drivers on CSC Practices

This research proposes one hypothesis that five drivers (Strategy, Technology, Organization, People, and Environment) have a significant positively impact the level of adoptions of CSC practices. For a new conceptualization of CSC drivers, literatures were reviewed and analysed qualitatively by content for the purpose of identifying common ways of defining the drivers for CSCPs adoptions. Different conceptualisations of drivers for circular economy adoptions were compiled, and the most applied was on TOE [45]. The previous literature review shows that the STOPE theory provides a theoretical support on this hypothesis. According, this study hypothesizes that:

**H1= Drivers of CSC have a significant positively impact the level of adoptions of CSC practices.**

Strategy reflects corporate vision, it may include the general circular economy strategy, operation strategy, generate economic value strategy, reduce cost strategy, recycling strategy and so on in this research. Holding the using circular economy strategy will drive the circular supply chain management implementation [29]. Specifically, operating the leasing and service strategy can drive the CSCP. It means that company do not sale the durables directly, they lease the durables and provide a service to the customer [4]. The strategy involves generate economic value from production side streams and emissions [30]. Some enterprises prefer to adopt CSCPs because they pursue the goal of reducing the cost and increase the benefit [46]. The strategy of increasing revenue by recycling and remanufacturing approaches in supply chain is the key driver to attract the organization implement CSCP [29], which is also be discussed by Ctrz [47] and Gusmerotti [48].According, this study hypothesizes that:

**H1a= Strategy factor of CSC has a significant positive impact on the level of adoptions of CSC practices.**

Technology is associated with advanced technology, IoT, platform, data analysis technology, blockchain technology and other technology which can be widely used by all kinds of sources and enables the circular supply chain management implementation [30]. Wang et al pointed out that blockchain technology can promote to deal with the complexities of circular supply chain management [49]. Other research argued that digital technologies also can promote the widespread use of circular economy [36]. Previous studies reveal that technological factor is one of the drivers for adoption of CSCPs. According, it is hypothesized that:

**H1b= Technological factor of CSC has a significant positive impact on the level of adoptions of CSC practices.**

Organization is related to the support from organization. The organization drivers include Long-term revenue generation, improving the efficiency of materials and energy use in supply chain and increasing the value of products by increasing the quality. Ilić & Nikolić explained that improving the efficiency of materials means that implementing circular economy in supply chain could increase the long-term revenue generation through effective recycling and remanufacturing activities [50]. Su et al. indicated that circular economy is a strategy that can improving the efficiency of materials and energy use in supply chain from the organizational level [8]. Ilić & Nikolić argued that products developed in circular way will have a longer lifetime and will automatically increase their value for the organization [50].All this organizational support show that organizational factor can be regarded as one of the drivers for adoption of CSCPs. According, it is hypothesized that:

**H1c= Organisational factor of CSC has a significant positive impact on the level of adoptions of CSC practices.**

The people factor covers the top managers in enterprise and client for the company. If managers in organization consider the CSCP application is a way to fulfil the social responsibility to the whole society, which can be a driver [51]. Customer awareness also push the enterprises to adopt CSCP [52]. Literature shows that pressure from customer has positive impact in the implication of CSCP [29]. Previous studies reveal that people factor is one of the drivers for adoption of CSCPs. According, it is hypothesized that:

**H1d= People factor of CSC has a significant positive impact on the level of adoptions of CSC practices.**

The environmental factor includes the natural environment and policy environment. With the worsen of

global up warming and climate changing, it becomes urgent to take the natural environmental protection into account during the CSCP, the need for renewable energy became paramount [29]. Resource scarcity can be considered as a main enable for companies to consider CE approach [30]. Cruz also argued the pressure on environment and resource constraints situation [47]. Policy environment considers that policy pressure from legislation, which is the drivers to CSCP [32]. Previous studies point out that environmental factor is one of the drivers for adoption of CSCPs. According, it is hypothesized that:

**H1e= Environmental factor has a significant positive impact on the level of adoptions of CSC practices.**

3.2 Effects of the Barriers on CSC Practices

Many scholars argued the barriers of circular supply chain practice [33-37]. This research divided the barriers into four categories: cultural factors, regulatory factors, financial factors and sectoral factors. Based on the previous research [13, 32, 39, 51], barriers of CSC hinder the adoption of CSCPs. According, this study hypothesizes that:

**H2= Barriers of CSC have a significant negative impact on the level of adoptions of CSC practices.**

Regulatory barriers include barriers on the general regulation framework such as environmental regulation, circular economy regulations and the legislation on various specific production processes such as waste management on emissions and hazardous waste disposal or landfill. There is lack of a standard assessment for circular economy practice. The related laws have not been sufficiently implemented. Without the strong support from regulatory side, it is difficult to force the company take part in CSCPs [29]. According, it is hypothesized that:

**H2a= Regulation's factor of CSC has a significant negative impact on the level of adoptions of CSC practices.**

Adopting the CSCP means the redesign in producing process, and reuse of the waste which cover the technology training for staff and upgrading older equipment for newer, more energy efficient products. It requires a large amount of fund. High investment costs in adopting CSCP is the barriers for most of the companies. Financial issues have hindered the small- and medium-sized enterprises to take part in CSCPs [51]. According, it is hypothesized that:

**H2b= Financial factor of CSC has a significant negative impact on the level of adoptions of CSC practices.**

Cultural Factor includes the interest of enthusiasm to adopt CE in supply chain and collaboration issue. Lack of vertical and horizontal collaboration is regarded as barriers [53]. Lack of collaboration between business functions are also included in barriers. To realize the CE goal, different units in one company such as IT department, sales department and marketing department need to work together [54]. Cultural issues have hindered the enterprises to take part in CSCPs [32]. According, it is hypothesized that:

**H2c= Cultural factor of CSC has a significant negative impact on the level of adoptions of CSC practices.**

Sectorial barriers include low leadership and management on CE, technical challenges about material recovery and lacking standardization. Su et al. highlighted that low leadership and poor management is the barrier in adopting CE in supply chain [8]. Adopting the CE require the managers can build consensus to lead staff focus on change. Change will not be achieved if enterprises are lack of strong leader and efficient management. Hart et al, argued that companies will face the challenges on technology such as recovery and reuse technology. However, lack of standardization on recycling and reusing will hinder the process of pushing forward the CE reform. Sectorial barriers have hindered the enterprises to take part in CSCPs [32]. According, it is hypothesized that:

**H2d=Sectorial factor of CSC has a significant negative impact on the level of adoptions of CSC practices.**

3.3 Moderating effect of Circular Oriented Innovations

Brown et al. defined that "Circular oriented innovation (COI) is defined as the coordinated activities that integrate CE goals, principles, and recovery strategies into technical and market-based innovations, such that the circular products and services that are brought to market purposively maintain product integrity and value capture potential across the full life cycle" [3].Achieving Circularity need to be understood from the system view. Konietzko et al. find that circular innovation is a significant channel to link the drivers with the adoptions of CSCPs [44]. By analysing CE literature, Brown et al. pointed out that the circular economy drivers for circular oriented innovation can be divided into two dimensions, the hard dimensions include the markets and technologies factors. The soft dimensions include the social, cultural, institutional and regulatory factors [3]. Some factor of the circular economy drivers for circular oriented innovation is connected with the drivers of CSCP. According, it is hypothesized that:

**H3= Extent of circular oriented innovations moderate the relationships between drivers and the adoptions of CSC practices.**

By analysing CE literature, Brown et al. pointed out that the circular economy barriers for circular oriented innovation also can be divided into two dimensions, the hard dimensions include the markets and technologies factors [3]. The soft dimensions include the social, cultural, institutional and regulatory factors. Some factor of the circular economy barriers for circular oriented

innovation is connected with the barriers of CSCP. According, it is hypothesized that:

**H4= Extent of circular oriented innovations moderate the relationships between barriers and the adoptions of CSC practices.**

## IV. CONCLUSION

This research proposes a conceptual model of the relationship between drivers and barriers with the adoption of circular supply chain. this is the first research to look into and prioritize the drivers and impediments to CSCP adoption in the context of Chinese manufacturing firms. It is hoped that the results of this research can enrich knowledge regarding drivers, barriers, circular supply chain and circular innovation. The research highlights the drivers and impediments to CSCP adoption. This can help to our understanding of how CSCPs are disseminated throughout organizations in China. The study reveals the concept, relevance, and effects of CSCP adoptions, which can help managers understand the significance and value of CSC in general. This research also provides novelty by combining the circular innovation into a conceptual framework. This research can be helpful for companies. It identifies the primary drivers of CSCP adoption. As a result, it can improve managers' and policymakers' awareness of the motivators for CSCP adoption in firms. Based on the major factors or motivators identified, this insight can assist managers in developing suitable policies for CSCP adoptions. The study also reveals barriers for the adoption of CSCPs adoptions, hence, it can help to let the managers aware the challenges from a macro perspective, which consisted of rules and regulations, financial, cultural and sectorial that may unintentionally hinder the CSCPs adoptions.

However, some of the limitations in this research are as follows. First, this research is limited to examining CSCPs in manufacturing, while different industry has different characteristics, the drivers and barriers may be different because industry differences are significant. Thus, that future studies should expand the scope of research not only to limit to manufacturing sector. Second, this research is limited to the conceptual framework. Future research should be able to test the conceptual framework developed in this study using quantitative methods. It is possible that future researchers will use qualitative methods to obtain more comprehensive results.

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