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Global Perspectives on Green Business Administration and Sustainable Supply Chain Management

Syed Abdul Rehman Khan

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Syed Abdul Rehman Khan
Tsinghua University, China

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Table of Contents

Detailed Table of Contents

The objective of supply chain sustainability is to create, protect, and grow long-term environmental, social, and economic value for all stakeholders involved in bringing products and services to market. This chapter creates a comprehensive model and solution methods for designing sustainable supply chains. Sustainable supply chains are modeled as network systems with multiple agents, which are evaluated according to multiple criteria. It is usually impossible to optimize all criteria together in a given system. Searching for a better portfolio of resources leads to reshaping of given system boundaries and better criteria values. Supply chain sustainability is also given by creating equilibrium relationships between agents. Biform games are used for searching an equilibrium in sustainable supply chains. Information sharing reduces inefficiencies and material flows, leading to less environmental pollution.

This chapter presents an overview of current research on green practices said to improve global supply chain performance by driving the discussion into four main processes: sourcing, manufacturing, logistics, and customer service. Authors present the importance of sustainable development in supply chain management from environmental and green perspectives. The chapter undertakes a literature review on supply chain management, sustainable performance, and green supply chain. It continues with a discussion of green supply chain practices from different functions' perspectives, as strategic sustainable performance improvement and as a source of competitive advantage for business operations throughout the supply chain. Finally, this chapter identifies research gaps, discusses potential research directions for green supply chain management, and provides recommendations to expand on research to address the shortcomings of the existing literature.

The growth in stakeholder pressures, broader sustainable supply chain management practices, and new economic models such as circular economy, has made sustainability a priority for organizations and their supply chains. To be able to manage their activities, programs, processes, and strategies, organizations have adopted and

field investigating the rise of green purchases. Globally, consumers are increasingly acquiring green products, and this study indicates to an improved understanding of the decision-making process of consumers' green product.

Money laundering is a hot debate discussion among policymakers, as money laundering usually arises due to theft of money or other illegal activity. Such criminal activities damage every stakeholder of the economic cycle, whether it is trade, productivity, or contribution of the financial sector itself. Due to the fact money laundering makes the industrial growth process very slow and undercuts economic activities, which are essential for the development. This chapter explores the nexus between money laundering as a threat to a sustainable development goal from different angles. The discussion reveals that money laundering negatively impacts economic growth, and the fundamental pillar of sustainable development is economic growth. So can we achieve sustainable economic growth and development without controlling money laundering? The authors conclude it is not possible.

With the continuous development of e-commerce in China, the business volume of the express delivery industry is also growing, which brings tens of millions of express package garbage, which not only causes serious waste of resources, but also serious environmental pollution. This chapter analyses the current situation of packaging in express delivery industry, in the "green logistics". The main measures for the green development of express packaging are given below.

This chapter introduces the concept and connotation of the green building supply chain and summarizes its particularity. The author analyses the cooperation of stakeholders in the green building supply chain and discusses how to promote the cooperation of stakeholders in green building supply chain from two perspectives of environment construction and system construction, to further promote the stable development of green building supply chain. The chapter introduces the concept and connotation of the green building supply chain and summarizes its particularity. This chapter analyses the cooperation of stakeholders in the green building supply chain and discusses how to promote the cooperation of stakeholders in green building supply chain from two perspectives of environment construction and system construction, to further promote the stable development of green building supply chain.

Green supply chain and green finance, like effective market means, have played an important role in environmental governance since the reform and opening up in China for 40 years, and have accumulated rich practical experience in many regions and fields. In the new stage of social development and environmental management system construction in the new era, the organic combination of green supply chain and green finance will be very important for speeding up the construction of ecological civilization and achieving the sustainable development of the Chinese nation. This chapter summarizes the current situation and existing problems of green supply chain and green finance, and analyses the reasons why green supply chain finance can be used as a means to break through the bottleneck of environmental management, and creatively puts forward a new model of green supply chain finance with multi-participation, which provides reference for the government, financial institutions, and enterprises to make environmental management decisions.

With the continuous development of China's agricultural economy, the concept of green production has begun to penetrate into the hearts of the people. Exploring a new circulation mode adapted to China's green supply chain of agricultural products is an important way to promote green production in China, and also an important condition to promote the successful transformation and development of China's rural economy. But in the process of building a green supply chain of agricultural products and exploring circulation mode, there are many problems that hinder the development of green industry economy. Therefore, it is necessary for the government to play a guiding role and actively guide farmers to explore green development ways and new circulation mode to meet their own development needs, which provides reference for better optimizing the new circulation mode of agricultural products supply chain in China.

It is the focus of the automobile industry to guarantee the quality of automobiles and meet the requirements of green development. Based on the principle of sustainable development, according to the characteristics of green supply chain and the concept of the whole life cycle of the automobile, the evaluation index system of the green supply chain of the automobile is constructed from five links of design, purchase, production, sale, and recycling. The "green" runs through the whole life cycle of automobile products and evaluates the green supply of automobile products scientifically and accurately. Reference should be provided for the situation.

Most instances like developing technology, scarce sources, and global warming have brought about an ongoing perspective with Sustainable SCM and Green SCM starting from Traditional SCM. Supplier selection in all these processes is a decision-making process playing a significant role in the success of enterprises. The most critical point in this decision-making process is the criteria used in the supplier selection process because they directly affect the selection of supplier that is appropriate for the strategy of the enterprise. In this chapter, the optimal quantity of products to be purchased from suppliers were determined through a solution offer that authors named as compromise optimal system design. For the recommended solution, first, a new model was introduced by arranging Multiobjective Supplier Selection

Foreword

Society has started to realize that living unsustainably is not an option for the human race. The Anthropocene is upon us, where man's actions can cause irreparable changes to our air, land, and water environment. We are now capable of demolishing mountains in only a few years to access Earth's resources. We are able to alter the climate of the entire earth with our actions. We are capable of causing entire species to extinction; never to be seen on Earth again.

These anthropocentric effects are due to our social and economic behaviors. We are currently, as a world, consuming more than one Earth can handle. In fact, if the global consumption rate were the same as some of our most developed regions, it will require up to a dozen Earths worth of resources.

The environmental and resource burdens caused by our activities can be traced to our businesses and industries. They have the greatest environmental impact, all in order to serve our needs. It is the processes and materials they use, how they design our products and services, and how products are stewarded by these companies.

It has only been recently, within the past few decades, that greening our businesses and their supply chains has come to the forefront. The topic includes thousands of studies and publications from across disciplines considering how to make our industry and economies greener.

Yet, the sobering fact is that we are not any greener than we were decades ago; it is hard to break old long-standing behavior. More than ever before, the environment is facing greater stress. Whether the blame rests on growing population or affluence, we are at a critical stage in our civilization. There have been a variety of broad efforts including such topics as the circular economy, post-carbon civilization, degrowth, sustainable development goals, and green and sustainable supply chains to help address these concerns. The timing of these proposals and the length of time we have put effort into them is miniscule compared given the length of time that man has been exploiting the Earth and its environment and resources.

Transformation and transitions to sustainability are required. Unfortunately, many of these efforts have been very slow. Yes, organizations have been espousing that greening and sustainability is core to their visions and existence. The results show otherwise. The adoption of practices, given various political winds playing a role, has been slow.

I am not being alarmist here. The activities to mitigate our man-made environmental damages are occurring; but the impact and pace, has not been reasonable. Action is required.

It is for this reason that the need for this book exists. Yes, we have had many books on this topic, but the struggle for greening our society is a never ending battle while pursuing our wants. Knowing the latest practices and knowledge, and sharing them is essential. We have an obligation, as scholars and concerned citizens of this Earth, to build and share this knowledge in the popular press, social media, as well as in our research publications. The goal is not to let our sustainability defenses down. Our vigilance is important for all human generations.

We need to take action on the many theories, practices, and ideas proposed in this book. It is one book, it cannot cover all the green business and supply chain issues, but it contributes to the body of knowledge. There is only hope that some who can change this world will read the knowledge and wisdom imparted in this book. That some of the ideas presented in it will spark a vision, a vision that can change our world for the better.

There is no doubt that the Earth and the environment will survive. The question we need to ask ourselves is whether man will continue to exist, much less thrive.

Joseph Sarkis
Worcester Polytechnic Institute, USA

Preface

This book is targeted an academic as well as a practitioner audience. On the academic side, it is appropriate for graduate and postgraduate students in the field of supply chain and logistics. It can also serve as a sustainable reference for both concepts as well as providing a methodology for practitioners in consulting and industry.

The scope of sustainable supply chain and green business has continued to grow with a rapid speed, which is reflected in the content of this book. The book has included core aspects of sustainability in the field of supply chain management.

Besides, it is necessary to note that this book has covered the general principles of sustainability and green business that can be applied in any field. I believe that this book will help significantly in the quest of green administration and supply chain to reduce cost and improve service, as well as to keep up-to-date the different facets of sustainable supply chain and green logistics. This book is divided into three sections. In section one, there is total of five chapters with the following titles:

Chapter 1: Product Deletion and Sustainable Supply Chains

Chapter 2: Modeling the Design Phase of Sustainable Supply Chains

Chapter 3: Green practices in supply chain management to improve sustainable performance

Chapter 4: Emergy Analysis and Supply Chains

Chapter 5: Blockchain Characteristics and Green Supply Chain Advancement

This section discussed the concept of sustainability, product deletion, design phases of products and processes for better environmental sustainability, the effect of sustainable practices on organizational performance, and the concept of sustainability value in the blockchain supply chain.

In Section 2, there are four chapters with the following titles:

Chapter 6: Green product innovation and financial resource availability; multi-actor model approach: Experimental Approach

Chapter 7: Nexus between money laundering and Sustainable development goals, A threat for developing Countries

Chapter 8: Current Situation and Solution of Express Packaging under “Green Logistics

Chapter 9: Roles and strategies of 20th and 21st-century women environmentalists: Roles and strategies of 20th and 21st century

This section covered the different modern technology and sustainability-related topics including IoT (Internet-of-things), development of green products and availability of financial resources, and the relationship between money laundering and sustainable development goals, etc.

Finally, the last section covered the following chapters:

Chapter 10: Research on Dynamic Mechanism of Developing Green Logistics in Agricultural Products Logistics Enterprises

Chapter 11: Research on Problems and Countermeasures of Green Logistics Development in China

Chapter 12: Construction of Cooperative Environment and Institution for Green Building Supply Chain Subjects: Construction of Cooperative Environment

Chapter 13: Research on Green Supply Chain Finance Model with Multi-Party Participation

Chapter 14: Construction of New Circulation Model for Green Supply Chain of Agricultural Products in China

Chapter 15: Study on Evaluation Index System of Green Supply Chain for Automobile Products: Study on Evaluation Index System of Green Supply Chain for Automobile Products

Chapter 16: Compromise Optimal System Design For Solving Multi-Objective Green Supplier Selection Problems

Chapter 17: Lean Logistics in thE 2020s and a Case Study About Logistics and Supply Chain Management in Toyota Boshoku Turkey

The last section discussed the different sustainability issues phases by emerging countries particularly China and Pakistan. As both nations have started several projects under the umbrella of CPEC (China-Pakistan-Economic-Corridor) or normally known as “One-Belt-One-Road” initiatives and these projects may influence on environmental and social sustainability on both countries. These chapters discussed the different sustainable practices and strategies adopted by firms on the pressure of customers and government bodies.

Acknowledgment

I would like to thank the many people who helped throughout this process. I thank the reviewers whose suggestions significantly improved the book. I also thank to my parents and teachers for their encouragement particularly Sufi Scholar Sahibzada Asim Maharvi, whose keep my motivation high throughout the journey of my life.

Finally, I would like to thank you, the readers, for reading and using this book. I hope it contributes to all your efforts to improve the performance of companies and supply chains throughout the world. I would be pleased to hear your comments and suggestions for future editions of this text.

Section 1

Chapter 1
Product Deletion and Sustainable Supply Chains

Qingyun Zhu
University of Alabama in Huntsville, USA

Joseph Sarkis
Worcester Polytechnic Institute, USA

ABSTRACT

Products and their associated material, capital, and information are critical flows within supply chains. Supply chain management needs to facilitate product portfolio management. Some example activities include material sourcing, product design and manufacture, product delivery and transportation, product usage, and service. Closing the supply-chain loop, especially for sustainable supply chains, include end-of-life disposal and repurposing activities. Sustainable supply chain development typically focuses on three major dimensions of organizational competitiveness, economic, social, and environmental. Organizations make product deletion continuously. These decisions can profoundly contribute to sustainability. Alternatively, sustainability performance of various supply chain process and product or material flows may also be strategic product deletion reasons. This chapter will review the integration of product deletion with sustainable supply chain management. It will entail the impact of product deletion on sustainable supply chains.

INTRODUCTION

Product management is critical for companies. The past few decades have witnessed dramatic growth in product development and innovations in product category, design

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and other variates. Continuous organizational product addition and product portfolio growth does not translate to profit margin increase. Considering the amount of resources and managerial effort for large product portfolio management, product addition may present a U-shape relationship to firm profit. Highly diverse product portfolios, though, enable firms to satisfy various needs, especially with highly heterogeneous consumer markets. Critically, these larger product families will likely drain resources and capabilities away from profitable products. Large companies often lose track of managing their product portfolio dynamics; not to mention small and medium sized companies with limited resources.

Yet today, product deletion has remained a neglected topic within business research. Existing literature has extensively investigated product addition related decisions, including product line extensions, product proliferation, product innovation, and new product development. Product deletion often occurs in a product's decline stage of its life cycle. It is a viewed as relatively less appealing decision and area of focus to both academics and practitioners. But it can have deep and pervasive competitive implications (Zhu et al., 2018). Product deletion's impact on firm performance, an intuitive while complex relationship, calls for systematic and in-depth investigation.

Firms compete as supply chains today. Products are critical flows on supply chains and supply chains are designed around products. Product deletion decisions have profound implications on supply chains and supply chain performance measurements. These implications should be included in product deletion decision making.

Eliminating or withdrawing weakly performing products from a firm's product portfolio will result in a rationalized product portfolio with lower resources consumption, labor usage, as well as emissions and waste (Bai et al., 2018) on supply chains. The leaner a product portfolio, the more environmentally friendly and socially responsible its supply chain may become. A more rationalized product portfolio will open operational capacity and yield; potentially it will lead efficiency and economic competitiveness. Keeping a low level of product variety, firms can concentrate resources including capital, people and technology to core products, which will enhance the product performance in quality and service and further influence firm image and identity in its market segments.

Sustainability may also cause a product to be deleted (Zhu & Shah, 2018). When economic sustainability of a product portfolio becomes tight, given the restricted amount of financial resources, the firm might consider cutting products that are capital intensive but revenue shrinking. When certain products yield social concerns, for example, products outsourced to locations with child labor issues overseas, firms may delete these products. When some products lead greater hazardous wastes, consumption of depleted resources, or cause other environmental burdens due to growing material consumption, the product might be deleted with green and pro-environmental substitutes.

The chapter will provide an overview of the topic by including background on product deletion, sustainability in supply chains, and their melding. A general series of observations and concerns in managing these simultaneously will also be presented; with examples, where appropriate. Some research directions and concerns will form the fourth section. A concluding section will summarize the chapter.

PRODUCT DELETION

There is no standard definition for product deletion. In the existing literature, strategic outcomes overlap amongst concepts including product deletion, product portfolio rationalization, product portfolio optimization, product design and its dynamics, complexities and varieties. These concepts might not explicitly address product deletion, but they might discontinue or remove certain product units or attributes of products (Avlonitis et al., 2000; Gilliland, 2011; Saunders & Jobber, 1994). Product deletion, alone, is a strategic choice of a firm to discontinue, remove, or withdraw a product from its product line or product family (Avlonitis & Argouslidis, 2012).

Much of the existing product deletion research have developed around an assumption that products under investigation have reached to maturity and are at the declining stage of their lifecycles (S. J. Hart, 1989). It is assumed that product deletion occurs when there is shrinking market value and financial returns for a product.

In practice, diverse organizations such as Heinz, P&G, Kraft, Polygram, and Sony continuously evaluate and provide a reduction of the scope of their product portfolios. In these and other circumstances, product deletion significance is increasing because of shortened product life cycles, customization, and the consumer desire for new products.

Product deletion has been studied as a strategic planning activity compensating with product replacement and new product development.

In this chapter, we extend product deletion to a broader strategic dimension by integrating marketing and finance antecedents to a supply chain network perspective. This chapter will entail how product deletion is considered in supply chain network processes, especially from sustainability performance measurements; and how product deletion will affect supply chain sustainability, not only economically, but also socially and environmentally.

SUSTAINABLE SUPPLY CHAIN MANAGEMENT

The contemporary development of supply chain management (SCM) has changed the way organizations compete (Seuring & Müller, 2008). Companies are no longer individual entities that solely compete on their resources and products but interact and interlock as supply chains that transform comparative resources to interrelated resources amongst relationships. These relationships can be managed using material, transaction, and information flows. Products are important linkages for these relationship developments; even in some service environments.

To be able to produce products or provide services, having the necessary resources, processes, and materials is necessary. The term SCM involves both external, upstream and downstream, and internal operations practices (Mentzer et al., 2001). Supply chain principles also relate to the value chain concept. The elements of the value chain include core processes of inbound logistics, operations, outbound logistics, marketing and sales, and service, supported with various non-core organizational functions including sustainability.

Supply chain sustainability has been defined from the triple-bottom-line perspectives of economic, environmental and social sustainability (Sarkis & Zhu, 2018). Sustainable supply chain management (SSCM) advocates that firms should extend their responsibilities to the overall value chain stakeholders including business partners, customers, society, employees and the natural environment (Kusi-Sarpong et al., 2019).

The prime motivation of SSCM is economic sustainability. Economic sustainability is measured upon financial performance metrics with a long-term emphasis. Firms typically operate efficiently, to expect reduced costs and monetary risks, and increased revenues and sustained profits. The fundamental principle of economic sustainability is that firms should aim for business returns in the future not only today.

The rising awareness of social and environmental sustainability is derived from increasing stakeholder expectations for organizational behaviors and business excellence on the social and environmental dimensions (Sarkis, 2001). Social and environmental responsibilities can help in realization of economic capital with continuity. Economic, social and environmental sustainability on supply chains enhances organizational financial returns while adding values to people and planate by preserving natural resources with efficient and lean operations and reduced waste and emissions.

Business practices and their relationships to supply chain sustainability have been widely investigated. Product deletion also impacts supply chain sustainability in various ways and dimensions. We shift our focus to the specific issues facing production deletion and its relationships to supply chain sustainability.

PRODUCT DELETION AND ITS RELATIONSHIPS TO SUPPLY CHAIN SUSTAINABILITY

Material flow, capital flow and information flow of products can be linkages that activate and operate inter-organizational supply chain functions. The deletion or discontinuation of a product or its components can affect supply chain operations of the product, product line, and product family, internal or external to focal firm supply chain networks (Zhu et al., 2018). This section will entail product deletion's relationships to supply chain sustainability from the perspectives of supply chain fundamental activities. These activities include sourcing, operations and manufacturing, distributions and logistics, product usage and service and reverse close-loop activities such as recycling.

In each sub-section below, we will initially focus on some general business and economic sustainability issues. Given that we are focusing primarily on environmental issues, given the topic of the book, we will then consider the environmental sustainability relationships, and where evident social or anthropocentric concerns as well.

Sourcing

Sourcing is a strategic upstream operational activity for making a product. Supplier selection, purchasing, monitoring, communication and relationship management are core sourcing activities on a product's supply chain (Quinn, 1999). Suppliers serve the demand for raw material, external resources, technology and expertise for products.

First, we begin with business and economic sustainability issues in the supply chain and with product deletion. Certain suppliers may feed multiple products with portions of raw materials. If any of these products is deleted, the relationship with the specific supplier may be weakened due to the decreased remaining transactions. In this situation, weaker supplier relationship may result in lessened bargaining power on raw material pricing. This result may further increase the overall cost in sourcing activities on the deleted product's supply chain. It may even may hurt the financial ratios of the entire product portfolio.

If a supplier serves the sourcing need only for the deleted product, this supplier may also be terminated simultaneously. In this case, product deletion results in reduced dependency and stickiness on certain suppliers, which provides increased flexibility in supplier selection alternatives (Gosling et al., 2010).

There are potential economic and business relationship losses with external suppliers. But, the increased capacities can provide benefits. The difficulty is making sure the tradeoff is not so extreme that the long term, strategic relationships, of suppliers to the company are lost.

With product deletion practices, firms can benefit from the rationalized product portfolio with decreased resource consumption and waste management in operational activities (Zhu & Shah, 2018). An optimized product portfolio with desirable product varieties helps reduce the overall demand of raw material, energy input, and waste output to the environment as eliminated products are no longer sourced, manufactured, distributed, consumed or disposed (Zhu et al., 2018).

For example, both suppliers and the buyers may need to store obsolete or unneeded products in inventory. Storing these items takes significant energy and material resources. Deleted products may allow for companies to reduce their inventory requirements saving important natural resources.

The deletion decision may also be related to the type of product being deleted. Sometimes suppliers or products are deleted from further consideration due to poor environmental performance. For example, if a supplier has hazardous or environmentally degrading materials in their supplies for a product, a company may wish to delete the product; especially if a supplier feels it is too burdensome to change over.

Operations and Manufacturing

Product portfolio dynamics relate directly to manufacturing capability and operational capacity (Teece et al., 1997). Existing product portfolio dynamics studies focus on product portfolio complexity and varieties of product units, and the differentiation from other products within a product portfolio. Product deletion, simply reducing the quantity of product variations, provides an explicit and novel angle of managing product portfolio dynamics issues.

When a product is deleted, product portfolios will decrease. The resources and corresponding management from the deleted products will be freed up to ease the tension of operational capacity and manufacturing complexity. Improved manufacturing and operational flexibility will yield to resources efficiency, better product quality and delivery performance for the remaining products within the product portfolio (Patel et al., 2012). These will eventually contribute to improved supply chain service levels. Improved service levels help sustain customer segments with growing integrated sales revenue from the remaining product portfolio (Thomas & Griffin, 1996). Economic sustainability can be effectively achieved and with leaner product portfolios.

However, product elimination means elimination of labor hours, as well. When a product is deleted, some aspects of its operations and manufacturing processes will become obsolete; associated workers and employees will be laid off. This can cause disruptions in other parts of the business, especially given employee morale concerns from volatile work environments where employees risk losing their positions.

If product deletion is not conducted appropriately, it may also cause potential social issues to the community and society. As part of the corporate social responsibility, firms and organizations should consider employees' benefits in product deletion decisions. Real-time decision-making updates and sufficient job training to facilitate transitions should be offered by the company to the employees with regard to product deletion. These are not only social, but business costs that are part of this decision.

Environmentally, there are some benefits. Deleted products can save energy and raw material as manufacturing input. This situation allows for companies to rearrange and reallocate supply chain and internal production resources more efficiently and effectively (Zhu & Shah, 2018).

Decreased manufacturing consumption and operational input will reduce the overall supply chain waste from the entire product portfolio. Deleted products, along with its inventory and finished components, might also be valuable for repurposing activities such as the various "Re's" including recycling, remanufacturing, reclamation and reuse. Although the deleted products may not go to their ultimate purpose, the embedded environmental value of these products may not go to waste if the various Re's are applied.

Collectively, deleted products can be decomposed as resources to fulfill the manufacturing capability of the remaining products in the product portfolio. The resulted supply chain extension including the repurpose activities from the deleted products is likely to benefit the environmental sustainability in the long run. But, in the short run, as mentioned earlier, products that are still in inventory have embedded environmental resources within them; if these products are deleted haphazardly then it is likely that the environmental damages may be worsened. In this situation, organizations need to be wary of the type of material, the amount of resources used, and the environmental characteristics of the deleted product.

For example, a deleted product that contains rare metals and resources that is inventory cannot just be disposed into landfills. Additionally, products may have embedded carbon, water, and other ecological footprints. These environmental resources that are invested may cause unnecessary built up environmental burden if not effectively managed after the deletion decision.

Distribution and Logistics

Distribution design and logistics decisions are dependent on product management (Villas-Boas, 1998). Product deletion will influence distribution and logistics activities, with an impact on supply chain sustainability. Distribution and logistics service for products include selecting and managing distribution channels, warehouses and maintenance, and managing outsource partners such as packaging, retailers, third-party logistics providers. It also involves labor for sorting, collecting inventory, and managing product returns.

Product deletion will cause some business partners to become unnecessary with the limited remaining transactions. For example, distribution centers or logistics providers designed for the deleted products will be obsolete and eventually not be required.

This deletion will result in fewer logistic partners, fewer quantity of delivery trips, fewer warehouses and distribution centers, and lessened product returns and aftersales services. These may due to the reduced product variants such as SKUs. Compact distribution networks and lessened logistics varieties, the overall economic sustainability in distributions and logistics of the supply chain is likely to improve in the long-term perspective with lower distribution and logistics costs, improved distribution efficiency and logistics reliability (Zhu & Shah, 2018).

Social issues also exist as a potential harm to the organizations concerning to the deleted jobs after product deletion. But with fewer distribution centers and logistics load, the environmental footprints of the entire supply chain will decrease. The environmental sustainability will be enhanced owing to product portfolio rationalization in product quantity.

But, in the business and environmental situations, sometimes the efficiency per unit may decrease because of fewer shipments and consolidation considerations.

The characteristics of the products may also play a large role here, as heavier and cumbersome deleted products may provide greater savings than smaller less massive products.

Product Usage and Service

Product deletion has direct impact on product usage and service activities in supply chains. This impact will eventually influence supply chain sustainability as these downstream supply chain activities work closely with customer transactions, benefits and retention.

With a product purchase transaction is complete, supply chain functions extend to product usage and service activities. When product deletion occurs, its associated after-sales attached service will decrease and be eliminated eventually. The deletion of a product may influence marketing factors such as customer satisfaction in this way, but it may also influence more traditional measures such as company reputation and loyalty. These are significant affects that require careful planning with substitute products and materials, including service parts, for customers.

For products that are designed for environment or take-back and recycle purposes, these service activities such as product recycling, waste management, inventory management and reclaiming and remanufacturing will no longer be needed (Chen, 2001). In this perspective, management investment including people and maintenance cost can be saved and freed up for other organizational functions of the remaining products. The rearrangement of capital flow from weak performing products to core retained products will benefit long term economic sustainability.

However, with product deletion, firms may no longer have the responsibility of product after-sales activities including product recycling and resource reclamation, waste management and material remanufacturing, unless required by law. The obsoleted product end-of-life service and lessened extended producer responsibility will hurt firm reputation both socially and environmentally to some extent.

PRACTICE AND RESEARCH ISSUES

The Practice of Product Deletion and Sustainable Supply Chains

In terms of practice, companies make these decisions on a regular basis. Although some organizations will consider these aspects carefully and strategically, many times a haphazard and informal approach is used to *delete* products and product families. This decision process varies due to limited practical experience and limited literature on the topic. Further understanding is required to help further elicit understanding of this phenomenon.

For companies like Procter & Gamble and Unilever, product deletion is one way to maintain competitiveness and continuity (Kumar, 2003). Culling the product portfolio is as strategic as a decision as new product development. These large companies have internal strategies to make their own decisions internally. Little is known as to how they utilize their product data and facilitate the product deletion decision making. No external tools have been revealed to public.

There is extensive knowledge in both academic and practical research and study on product proliferation decisions including product innovation and new product development. Little is known to the majority of practitioners on when and how to withdraw a product from a market, how to manage and repurpose inventory and related products, or how to predict the sustainability performance under different product portfolio scenarios. This situation is especially critical for small and medium sized companies who are usually in a reactive mode as suppliers to larger companies. A critical core number of products or product families, standing for an optimal product portfolio complexity, will lead to a noval business survival solution. User-friendly tools need to be developed to facilitate this critical decision. Many decision methodologies and tools currently exist for sustainable supply chains (Brandenburg et al., 2014) and should be investigated for adjustment the product deletion situation.

Managers need to understand the complexities of these decisions. Not all product deletion decisions are obvious and easy. In some cases the product deletion decision goes well beyond the scope of a brand or product manager. In some cases deleting a product may cause improvement in some sustainability metrics, while hurting others. Further understanding the balance and influences to both the supply chain and various sustainability metrics is needed by managers. Integrating these additional measures into practical decisions further requires that tools and methods for managerial assessment become more accessible.

The background of the decision makers may not be appropriate to fully comprehend the complete set of issues. This lack of understanding is a major concern in getting managers to understand and effectively make product deletion decisions across the supply chain, using various metrics. It may be that the major decision maker in these circumstances may be from one department, such as marketing or even finance. To further understand the intricacies of these decisions definitely requires a multi-functional team to address concerns.

The supply chain is made up of multiple functions including procurement, operations, logistics, and sales and marketing (Mentzer et al., 2001). They also need support from finance, human resources, and information systems departments. All these departments will be affected by a product deletion decision. Just as in new product development, having these multifunctional teams is necessary for product deletion and rationalization decisions. When you add in the additional metrics of sustainability, human resources may play an even larger role, and integrating sustainability and environmental management officers into the decision may even be more critical.

For example, some products may be borderline in terms of the decision to delete or not delete based on traditional metrics such as financial or market share metrics. But, the broader sustainability set of metrics may play a critical role in supporting the maintenance or revitalization of a product; or to kill it. Thus, a more strategic and complete picture, not only internal to the organization, but externally is needed.

The Theory and Research of Product Deletion and Sustainable Supply Chains

In research, product deletion, as an independent research topic, is surprisingly neglected. Related research areas can trace some of the original thoughts of product deletion studies to engineering (e.g. product design), manufacturing (e.g. product manufacturability), operations management (e.g. product portfolio management), marketing (e.g. brand deletion, new product development, product lifecycle management) and strategy (e.g. firm repositioning activities such as image change). There is lack of a systematic paradigmatic integrative definition for product deletion, to differentiate it from other disciplinary concepts. Thus, the field needs to initially come to terms of the definition to be able to start linking it up to supply chain and sustainability management.

The first step is to theoretically understand the field and how it shifts with advances and knowledge from sustainability and supply chain management. For example, are organizational theories that have looked at product development and sustainable supply chains adequate enough? The theories that can help explain and study this long-existing but understudied organizational phenomenon can be quite extensive – see Sarkis et al., (2011), for example; but sometimes there is a need to focus on the opposite of what theories are proposing.

For example, the natural resource-based view of the firm (Hart, 1995) may consider how decisions about management, and new products, processes, contribute to both the financial bottom-line and to other sustainability and triple bottom-line measures. Typically, the decisions have to do with growth and extension of products and services. Would the opposite, culling products and removing processes and actually removing resources add competitiveness to an organization?

This issue can be extended to any theory that seeks to build competitive advantage by going into new markets, introducing new practices, or new products. What if the decision is to actually decrease the organizational footprint and to get rid of products? Would these theories still hold? Can relational theory and the resource-based view, for example, help explain the resulting outcomes from a product deletion decision? These are important theoretical and research questions.

One potential answer to these concerns on whether traditional organizational and supply chain theories can effectively address the product deletion and sustainable supply chain perspective can arise from similar decisions by organizations to do less. In supply chain management the field is predicated on organizations outsourcing activities growing the procurement departments. Can theories applied to 'deleting processes' through outsourcing, be applicable to product deletion?

Another organizational theory that has focused on reduction of activities and organizational footprints is the concept of building and focusing on core competencies. Much strategic literature has posited that organizations should focus on organizational strategy and routines they do well to maintain competitiveness; to shed unnecessary activities and processes (Teece, 2009). The theories to help support and investigate this phenomenon may also be applied to product deletion; especially when sustainability becomes a concern. But, even the core competency literature has rarely investigated the supply chain and sustainability concerns with core competency development.

To help raise awareness of the strategic importance of product deletion, empirical studies need to be conducted. Companies with a long product deletion decision making history could help drive the research. Real data of deleted products from different industries, supply chain stages, product categories, product maturity and product portfolio complexity need to be collected to help model this complex decision. Companies may have different measurements for product deletion results; and supply chain sustainability can be one of them.

The complexities of product deletion will be contextually contingent. That is, there are a number of characteristics that may cause products to be or not be deleted beyond the basic rules-of-thumb, such as low selling or hazardous products. For example, competitive, ethical, organizational, technological, and cultural concerns may be playing an external contingency role. Internally, managerial decision and behavior characteristics, product characteristics, and political support may play contingent roles. How these additional factors adjust the results of product deletion on sustainability of supply chains need investigation.

A simple example is for green products. Deleting a green product with strong sustainability characteristics may actually be worse for environmental performance of the organization (Bai et al., 2018). In our examples, we did not consider that some of the environmental savings from reduced use of resources may be lost by dropping green suppliers whose activities may help other products. These complex interactions need study. It is not just a direct effects issues, but interdependencies in these complex environments. The green supplier selection research is quite extensive (see, for example Govindan et al., 2015; Trapp and Sarkis, 2016); models that incorporate product deletion can also be used with ‘supplier deselection’.

CONCLUSION

Product deletion, a neglected research topic in product management, has strategic impact on supply chain management and supply chain sustainability. The deleted products will free up resources including capital, material, people and time to serve a much leaner product portfolio. The increased resource effectiveness and efficiency will result in enhanced supply chain performance; which can be critical foundation for long term economic returns. However, the common drawback of product deletion is lessened social responsibility for associated product end-of-life activities, jobs and customer segments with potential harm to firm and brand image, which forms potential risks to long term economic sustainability.

The strategic concerns that bringing product deletion to supply chain sustainability include not meeting the needs and expectations of a broader stakeholder community, beyond business partners. Other advantages of supply chain sustainability strategies include maintaining business continuity in the supply chain, having a license to operate, additional revenue generation, and improved company image and long-time social impact and environmental benefits. The critical positive business consequences of product deletion on a company, especially on its sustainable supply chain development, adopting a leaner and more rationalized product portfolio could be a strategic business solution and should not be underestimated.

In this chapter we only touched upon a number of issues and topics. Practice and research need to be further understood and enhanced. We believe that this field is ripe for investigation. This chapter provides an introduction into some of these issues.

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Chapter 2
Modeling the Design Phase of Sustainable Supply Chains

Petr Fiala
https://orcid.org/0000-0002-8517-4979
University of Economics, Prague, Czech Republic

Renata Majovská
University of Finance and Administration, Prague, Czech Republic

ABSTRACT

The objective of supply chain sustainability is to create, protect, and grow long-term environmental, social, and economic value for all stakeholders involved in bringing products and services to market. This chapter creates a comprehensive model and solution methods for designing sustainable supply chains. Sustainable supply chains are modeled as network systems with multiple agents, which are evaluated according to multiple criteria. It is usually impossible to optimize all criteria together in a given system. Searching for a better portfolio of resources leads to reshaping of given system boundaries and better criteria values. Supply chain sustainability is also given by creating equilibrium relationships between agents. Biform games are used for searching an equilibrium in sustainable supply chains. Information sharing reduces inefficiencies and material flows, leading to less environmental pollution.

INTRODUCTION

Supply chain management is a philosophy that provides the tools and techniques enabling organizations to develop strategic focus and achieve sustainable competitive advantage. It presents management with a new focus and way of thinking about

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how their organization exists and operates within the wider business environment. Supply chain management is now seen as a governing element in strategy and as an effective way of creating value for customers. Sustainability in supply chain management has become a highly relevant topic for researchers and practitioners. The objective of supply chain sustainability is to create, protect and grow long-term environmental, social and economic value for all stakeholders involved in bringing products and services to market.

A supply chain is a complex and dynamic supply and demand network of agents, activities, resources, technology and information involved in moving a product or service from supplier to customer. Supply chain structure and behavior is changing dynamically. The suitability of supply chains can be measured by multiple criteria, such as environmental, social, economic, and others.

The evolution of supply chain management recognized that a business process consists of several decentralized firms and that decisions of these different units impact each other's performance, and thus the performance of the whole supply chain. Each unit will attempt to optimize his own preference. Behavior that is locally efficient can be inefficient from a global point of view.

The main objective of the chapter is to analyze the design of sustainable supply chains and to create a comprehensive model and solution methods for designing sustainable supply chains. To effectively analyze and model decision making in such multiple agent situation with multiple criteria where the outcome depends on the choice made by every agent, multiple criteria analysis and game theory is a natural choice. Multiple criteria analysis is useful for assessing sustainability of supply chains. Game theory has become a useful instrument in the analysis of supply chains with multiple agents, often with conflicting objectives.

Standard multiple criteria approaches focus on valuation of already given systems. De Novo approach focus on designing optimal systems. The approach is based on reformulation of the problem by given prices of resources and the given budget. Searching for a better portfolio of resources leads to a continuous reconfiguration and reshaping of systems boundaries. The De Novo approach was adapted for supply chain design. Current business conditions are changing rapidly. New products are evolving faster. Technological innovations bring improvements to the criteria and the better utilization of available resources. This dynamics must be included in the new models. These changes can lead to beyond tradeoff-free solutions.

Equilibrium search in supply chains is a very important problem. Games are used for behavior modeling of supply chains and focus on allocation of resources, capacities, costs, revenues and profits. There are numerous opportunities to create hybrid models that combine competitive and cooperative behavior. The co-opetition concept combines the advantages of both competition and cooperation into new dynamic, which can be used to not only generate more profits but also to change nature of the business environment in benefit of users. Searching for relationships with complementors (competitors whose products add value to other agents) brings ever new opportunities that bring added values. The co-opetition is based on the biform game theory. Biform games combine non-cooperative and cooperative approaches of the traditional game theory and are promising for modeling behavior of the agents in supply chains. It may form a global view of the coordination problem. Other approaches to coordination such as auctions and contracts are possible to model as specific game theory models. New business practices and information technology make the coordination even closer. Information sharing and strategic partnerships of units can be modeled by different network structures. Supply chain partnership leads to increased information flows, reduced uncertainty, and a more profitable supply chain. The cooperation is based on contacts and formal agreements. Information exchange is very important issue for coordinating actions of units.

The proposed procedure captures these concepts and is flexible and open to other concepts and procedures for designing sustainable supply chains.

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BACKGROUND

Supply chain management has generated a substantial amount of interest both by managers (Harrison et al., 2008) and researchers. There are many concepts and strategies applied in designing and managing supply chains (see Simchi-Levi et al., 2008). The expanding importance of supply chain integration presents a challenge to research to focus more attention on supply chain theory (Snyder and Shen, 2011) and modeling (see Tayur et al., 2012). In supply chain behavior is many inefficiencies. The so-called bullwhip effect, describing growing variation upstream in a supply chain, is probably the most famous demonstration of inefficiency and system dynamics in supply chains. Information sharing is a very important issue for coordinating actions of units in the chain (Fiala, 2005).

Sustainability in supply chain management has become a highly relevant topic for researchers and practitioners. Carter and Rogers (2008) perform a large-scale literature review and use conceptual theory building to introduce the concept of sustainability and demonstrate the relationships among environmental, social, and economic performance within a supply chain management context. Seuring (2013) analyzes more than 300 papers on the topic of sustainable (forward) supply chains. Looking at the research methodologies employed, only 36 papers apply quantitative models. This is in contrast to the field of reverse supply chains where several reviews on respective quantitative models have already been provided. The paper summarizes research on quantitative models for forward supply chains. There are three dominant approaches: equilibrium models, multi-criteria decision making and analytical hierarchy process. The paper of Brandenburg et al. (2014) provides a content analysis of 134 carefully identified papers on quantitative models that address sustainability aspects in the forward supply chain. It was found that most were analytically based with a focus on multiple criteria decision making. The tools most often used comprise the analytical hierarchy process or the analytical network process, as well as life cycle analysis.

The authors of this chapter propose a procedure for the design of sustainable supply chains based on multiple criteria analysis and game theory approaches. The proposed procedure combines both approaches and uses specific De Novo multiple criteria optimization procedures and biform games for the solution. The authors propose to divide the biform games into so-called sequential and simultaneous shapes. Other sustainability aspects and the impact of technology development may be included in the model. The principles of co-opetition are used as a combination of cooperation and competition with the inclusion of other agents in the model.

Multiple criteria *analysis* evaluates decision alternatives by *multiple criteria* as part of the decision-making process. It is usually impossible to optimize all criteria together in a given system. The methods are aimed at finding a compromise solution and can be divided according to the method of delivery of additional preferential information into methods: with a-priori, a-posteriori and ongoing information (interactive methods). One of the best-known interactive methods is the STEM (STEp Method). There is extensive literature for multiple criteria analysis (e.g. Steuer 1986, Ehrgott, 2005, Greco et al., 2016). Traditional concepts of optimality focus on valuation of already given systems. A new concept of designing optimal systems was proposed (Zeleny, 2010). Multi-objective linear programming (MOLP) is a model of optimizing a given system by multiple criteria. As a methodology of optimal system design can be employed De Novo programming for reshaping feasible sets in linear systems. Multi-objective De Novo linear programming (MODNLP) problem can be applied for supply chain designing (Fiala and Majovská, 2018).

Many economic problems can be modeled and solved by game theory. The work of John von Neumann and Oskar Morgenstern (1944) is the classic work upon which modern game theory is based. Since then, the extensive literature on game theory was published. For example, books of Kreps (1991) and Myerson (1997) provide a clear and thorough examination of the models, solution concepts, results, applications and methodological principles of game theory. Game theory models analyze situations where players make decisions to maximize their utility while taking into account that other players are doing the same and that decisions, made by players, impact others utilities. Traditional game theory is divided into non-cooperative and cooperative models. In non-cooperative game theory, the players search for Nash equilibrium. The cooperative game theory looks at the set of possible outcomes, studies what the players can achieve, what coalitions will form, how the coalitions that do form divide the outcome, and whether the outcomes are stable and robust. Brandenburger and Stuart (2007) propose biform games as a combination of non-cooperative and cooperative games.

The field of supply chain management has seen, in recent years, a wide variety of research papers that employ game theory to model interaction between players. Cachon and Netessine (2004) provide an excellent survey and state of art especially non-cooperative game techniques. The concept of using non-cooperative agents to formulate allocation mechanisms in a game-theoretical setting is closer to the classical market concept than solutions employing cooperative strategies. Most non-cooperative allocation strategies in distributed systems consist of the following steps:

- The formulation of utility functions for the system participants.
- The formulation of best response strategies.
- The existence of Nash equilibrium is proved in the system of multiple agents.
- Efficiency is measured compared to achievable welfare.

Nagarajan and Sošić (2008) review the existing literature on applications of cooperative games to supply chain management. They also deal with certain methodological issues when modeling supply chain problems. The paper focuses on applications in supply chains with two central questions of cooperative games:

- What are feasible outcomes and how the players in a coalition allocate the outcomes?
- What are stable coalitions?

Brandenburger and Nalebuff (2011) use the term co-opetition, which is consistent with their message that cooperation pays off in some situations, competition in others. They use biform games to develop a set of guidelines that will make it easier to explain the reasoning behind a proposed strategy. They consider a variety of games that allow for mutual benefit for the players. Okura and Carfi (2014) discuss how to use game-theoretical models in co-opetition studies and bridge the gap between co-opetition studies and game theory.

SUSTAINABLE SUPPLY CHAIN

A supply chain is a complex and dynamic supply and demand network of agents, activities, resources, technology, and information involved in moving a product or service from supplier to customer. The supply chain is defined as a network system of clusters with:

- suppliers,
- manufacturers,
- distributors,
- retailers,
- customers,

where

- material,
- financial
- information,
- decision

flows connect participants in both directions. Decision flows mean sequences of decisions among agents (see Fiala 2005).

The supply chain management can be divided into four phases:

Phase One: Design.

Phase Two: Control.

Phase Three: Performance evaluation.

Phase Four: Performance improvement.

These phases are repeated during the dynamic evolution of the environment and the supply chain. The design phase of supply chains plays an important role in supply chain management. This chapter focuses on modeling this design phase.

The proposed approach promotes sustainability of supply chains through the following instruments:

- multiple criteria,
- De Novo optimization,
- technology development,
- biform games,
- concept of co-opetition.

Sustainability of supply chains is evaluated by multiple criteria:

- environmental,
- social,
- economic,
- and others.

Not only 3 basic aspects are included in the model, but other criteria (technological, legal, etc.) can also be used. Two models were used for multiple criteria evaluation of sustainable supply chains. Multi-objective linear programming (MOLP) is a model of optimizing a given system by multiple objectives. Multi-objective De Novo linear programming (MODNLP) is a problem for designing an optimal system by reshaping the feasible set. This approach seeks to find a trade-off free solution and uses only the necessary resources for this solution, limited only by budget. The technological innovations included in the model bring improvements to the desired criteria and the better utilization of available resources. Proposed biform game models provide suitable tools for finding an equilibrium in the agent-system by combining non-cooperative and cooperative approaches. The inclusion of the concept of co-opetition enriches the model with other aspects, including considering the influence of other agents such as competitors and complementors. The searching for equilibrium in a sustainable supply chain is based on a negotiation approach. Information exchange by negotiations reduces inefficiencies and material flows and leads to reduced environmental pollution and costs.

MULTIPLE CRITERIA ANALYSIS

The first component of the proposed procedure is multiple criteria analysis. A standard approach can be used to optimize the given system and De Novo approach to design an optimal system. Both procedures will be shown and illustrated in a case study. The advantages of De Novo approach will be explained.

Optimizing Given Systems

In MOLP problems, it is usually impossible to optimize all objectives together in a given system. Trade-off means that one cannot increase the level of satisfaction for an objective without decreasing this for another objective. Multi-objective linear programming (MOLP) problem can be described as follows

“Max” $z = Cx$

s.t. $Ax \leq b, x \geq 0$ (1)

where C is a (k, n) – matrix of objective coefficients, A is an (m, n) – matrix of structural coefficients, b is an m-vector of known resource restrictions, x is an n-vector of decision variables. For multi-objective programming problems, the concept of efficient solutions is used (see for example Steuer, 1986). A compromise solution is selected from the set of efficient solutions. Many methods are proposed for solving the problem. Most of the methods are based on trade-offs. The interactive method STEM was used or solving the case study.

Multiple Criteria Supply Chain Model

In the next part, a multiple criteria supply chain design problem is formulated. The mathematical program determines the ideal locations for each facility and allocates the activity at each facility such that the multiple objectives are considered and the constraints of meeting the customer demand and the facility capacity are satisfied. The presented model of a supply chain consists of 4 layers with m suppliers, S_1, S_2, … S_m, n potential producers, P_1, P_2, … P_n, p potential distributors, D_1, D_2, … D_p, and r customers, C_1, C_2, … C_n.

The following notation is used:

a_i = annual supply capacity of supplier i, b_j = annual potential capacity of producer j,

w_k = annual potential capacity of distributor k, d_l = annual demand - customer l,

x_{23}^S = fixed cost of potential producer j, f_k^D = fixed cost of potential distributor k,

c_{ij}^S = unit transportation cost from S_i to P_j, c_{jk}^P = unit transportation cost from P_j to D_k,

c_{kl}^D = unit transportation cost from D_k to C_l, e_{ij}^S = unit pollution from S_i to P_j,

e_{jk}^P = unit pollution from P_j to D_k, e_{kl}^D = unit environmental pollution from D_k to C_l,

x_{ij}^S = number of units transported from S_i to P_j, x_{jk}^P = number of units transported from P_j to D_k, x_{kl}^D = number of units transported from D_k to C_l,

y_j^P = bivalent variable for build-up of the fixed capacity of producer j,

y_k^D = bivalent variable for build-up of the fixed capacity of distributor k.

Using the above notations the problem can be formulated as follows:

The model has two objectives. The first one expresses minimizing total costs. The second one expresses minimizing total environmental pollution.

Minimize 2 objectives:

$$z_1 = \sum_{j=1}^{n} f_j^P y_j^P + \sum_{k=1}^{p} f_k^D y_k^D + \sum_{i=1}^{m}\sum_{j=1}^{n} c_{ij}^S x_{ij}^S + \sum_{j=1}^{n}\sum_{k=1}^{p} c_{jk}^P x_{jk}^P + \sum_{k=1}^{p}\sum_{l=1}^{r} c_{kl}^D x_{kl}^D$$

$$z_2 = \sum_{i=1}^{m}\sum_{j=1}^{n} e_{ij}^S x_{ij}^S + \sum_{j=1}^{n}\sum_{k=1}^{p} e_{jk}^P x_{jk}^P + \sum_{k=1}^{p}\sum_{l=1}^{r} e_{kl}^D x_{kl}^D$$

Subject to the following constraints:the amount sent from the supplier to producers cannot exceed the capacity

$$\sum_{j=1}^{n} x_{ij} \le a_i, \quad i = 1, 2, ..., m,$$

the amount produced by the producer cannot exceed the producer capacity

$$\sum_{k=1}^{p} x_{jk} \le b_j y_j, \ j = 1, 2, ..., n,$$

the amount shipped from the distributor should not exceed the distributor capacity

$$\sum_{l=1}^{r} x_{kl} \le w_k y_k, \ k = 1, 2, ..., p,$$

the amount shipped to the customer must equal the customer demand

$$\sum_{k=1}^{p} x_{kl} = d_l, \ l = 1, 2, ..., r,$$

the amount shipped out of producers cannot exceed units received from suppliers

$$\sum_{i=1}^{m} x_{ij} - \sum_{k=1}^{p} x_{jk} \ge 0, \ j = 1, 2, ..., n,$$

the amount shipped out of distributors cannot exceed quantity received from producers

$$\sum_{j=1}^{n} x_{jk} - \sum_{l=1}^{r} x_{kl} \ge 0, \ k = 1, 2, ..., p,$$

binary and non-negativity constraints

$$y_j, y_k \in \{0,1\},$$
$$x_{ij}, x_{jk}, x_{kl} \ge 0, \ i = 1, 2, ..., m, \ j = 1, 2, ..., n, \ k = 1, 2, ..., p, \ l = 1, 2, ..., r.$$

The formulated model is a multi-objective linear programming problem (MOLP). The problem can be solved by some MOLP methods.

Designing Optimal Systems

By given prices of resources and the given budget the MOLP problem (1) is reformulated in the MODNLP problem (2)

“Max” $z = Cx$

s.t. $Ax - b \leq 0, pb \leq B, x \geq 0$ (2)

where b is an m-vector of unknown resource restrictions, p is an m-vector of resource prices, and B is the given total available budget.

From (2) follows

$pAx \leq pb \leq B.$

Defining an n-vector of unit costs $v = pA$, the problem (2) can be rewritten as

“Max” $z = Cx$

s.t. $vx \leq B, x \geq 0$ (3)

Solving single objective problems

Max $z^i = c^i x, i = 1,2,\ldots,k$

s.t. $vx \leq B, x \geq 0,$ (4)

z^* is a k – vector of objective values for the ideal system concerning B.

The problems (4) are continuous “knapsack” problems, the solutions are

$$x_j^i = \begin{cases} 0, j \neq j_i \\ B/v_{j_i}, j = j_i \end{cases}, \text{ where } j_i \in \left\{ j \in (1,\ldots,n) \middle| \max_j (c_j^i / v_j) \right\}.$$

The meta-optimum problem can be formulated as follows

Min $f = vx$

s.t. $Cx \geq z^*, x \geq 0$ (5)

Solving the problem (5) provides solution: x^*, $B^* = vx^*$, $b^* = Ax^*$.

The value B^* identifies the minimum budget to achieve z^* through solutions x^* and b^*. The given budget level $B \leq B^*$. The optimum–path ratio for achieving the best performance for a given budget B is defined as

$$r_1 = \frac{B}{B^*}$$

The optimum-path ratio provides an effective and fast tool for the efficient optimal redesign of large-scale linear systems. Optimal system design for the budget B:

$$x = r_1 x^*,\ b = r_1 b^*,\ z = r_1 z^*.$$

Multi-Objective De Novo Supply Chain Model

The De Novo approach can be useful in the design of the multi criteria supply chain. Only a partial relaxation of constraints is adopted. Producer and distributor capacities are relaxed. Unit costs for capacity build-up are computed:

$p_j^P = \dfrac{f_j^P}{b_j}$ = cost of the unit capacity of potential producer j,

$p_k^D = \dfrac{f_k^D}{w_k}$ = cost of the unit capacity of potential distributor k.

Variables for build-up capacities are introduced:

u_j^P = variable for the flexible capacity of producer j,

u_k^D = variable for the flexible capacity of producer k.

The constraints for non-exceeding producer and distributor fixed capacities are replaced by the flexible capacity constraints and the budget constraint:

$$\sum_{k=1}^{p} x_{jk} - u_j^P \le 0, \ \ j = 1, 2, ..., n,$$

$$\sum_{l=1}^{r} x_{kl} - u_k^D \le 0, \ \ k = 1, 2, ..., p,$$

$$\sum_{j=1}^{n} p_j^P u_j^P + \sum_{k=1}^{p} p_k^D u_k^D \le B.$$

The multi-objective optimization can be then seen as a dynamic process. Technological innovations bring improvements to the desired objectives and the better utilization of available resources. The technological innovation matrix $T = (t_{ij})$ is introduced. The elements in the structural matrix A should be reduced by a technological progress.

The problem (2) is reformulated into the innovation MODNLP problem (6)

"Max" $z = Cx$

s.t. $TAx - b \le 0, pb \le B, x \ge 0$ (6)

De Novo approach provides a better solution in multiple objectives and also with lower budget because of flexible capacity constraints. The capacity of supply chain members has been optimized concerning flows in the supply chain and budget.

Case Study

The De Novo approach was tested on a case study. A supply chain is proposed with 3 potential suppliers, 3 potential manufacturers, 3 potential distributors, 3 customers. The chain is evaluated according to 2 criteria, the first criterion is aimed at minimizing total costs and the second one at minimizing overall environmental pollution.

Inputs for the model are as follows:

Capacities $a_i = 100, i = 1, 2, 3; b_j = 100, j = 1, 2, 3;$

$w_k = 100, k = 1, 2, 3; d_l = 50, l = 1, 2, 3.$

Fixed costs $f_1^P .= 110,\ f_2^P .= 100,\ f_3^P .= 120, f_1^D .= 120,$

$f_2^D .= 110,\ f_3^D .= 150.$

Unit transportation costs and unit pollution are shown in Table 1 and Table 2.

This model was solved by different approaches. The first two approaches minimize each criterion separately. The compromise solution is calculated by the traditional STEM interactive approach for multi-criteria problems and the De Novo approach was used. The following are non-zero values of the variables that express the number of units of product shipped between each supply chain layer.

These values are given for each problem-solving approach:

Min z_1: $x_{13}^S = 50, x_{31}^S = 100,\ x_{12}^P = 100,\ x_{31}^P = 50, x_{12}^D = 50, x_{21}^D = 50, x_{23}^D = 50.$

Min z_2: $x_{12}^S = 100, x_{23}^S = 50,\ x_{23}^P = 100,\ x_{31}^P = 50, x_{13}^D = 50, x_{31}^D = 50, x_{32}^D = 50.$

STEM: $x_{11}^S = 58.13, x_{23}^S = 91.87,\ x_{12}^P = 58.13,\ x_{31}^P = 91.87, x_{12}^D = 46.87, x_{13}^D = 45,$
$x_{21}^D = 50, x_{22}^D = 3.12, x_{23}^D = 50.$

De Novo: $x_{23}^S = 62.86, x_{32}^S = 87.14,\ x_{21}^P = 10,\ x_{23}^P = 77.14, x_{31}^P = 62.86,\ x_{12}^D = 50,$
$x_{13}^D = 22.86,\ x_{31}^D = 50, x_{33}^D = 27.14.$

Table 1. Unit transportation costs

	1	2	3		1	2	3		1	2	3
1	5	10	6	1	7	5	9	1	8	3	10
2	8	9	7	2	6	8	4	2	6	5	4
3	3	6	8	3	5	7	9	3	7	3	5

Source: Authors

Table 2. Unit pollution

	1	2	3		1	2	3	e_{kl}^D	1	2	3
1	4	3	8	1	8	7	9	1	8	6	2
2	8	9	2	2	6	8	4	2	8	9	8
3	7	6	8	3	4	7	9	3	5	3	5

Source: Authors

Table 3. Comparison of solution results

	Min z_1	Min z_2	STEM	De Novo
z_1	2460	3490	3070	3000
z_2	3100	1800	2030	2000
B	460	490	460	365.71

Source: Authors

The criteria values z_1 a z_2 and budget B are compared according to these solutions. De Novo solution is better in all values than the STEM solution. De Novo approach provides better solutions on both criteria and also with a lower budget due to flexible capacity constraints. The capacities of supply chain members have been optimized for flows in the supply chain and budget. The comparison of results is shown in Table 3.

EQUILIBRIUM SEARCHING BY BIFORM GAMES

The second component of the proposed procedure is searching for equilibrium. Most supply chains are composed of independent agents with individual interests and preferences. Biform games are used for searching an equilibrium in sustainable supply chains. A biform game is a combination of non-cooperative and cooperative games for searching an equilibrium. The authors propose to divide biform games into sequential and simultaneous shapes.

Sequential Biform Games

The sequential biform game is a two-stage game: in the first stage, players choose their strategies in a non-cooperative way, thus forming the second stage of the game, in which the players cooperate. First, suppliers make initial proposals and take decisions. This stage is analyzed using a non-cooperative game theory approach. The players search for Nash equilibrium by solving the next problem.

An n-player non-cooperative game in the normal form is a collection

$$\left\{N=\{1,2,\ldots,n\};X_1,X_2,\ldots,X_n;\pi_1(x_1,x_2,\ldots,x_n),\pi_2(x_1,x_2,\ldots,x_n),\ldots,\pi_n(x_1,x_2,\ldots,x_n)\right\}, \tag{7}$$

where N is a set of n players; X_i, $i = 1, 2, \ldots, n$, is a set of strategies for player i; $\pi_i(x_1,x_2,\ldots,x_n)$, $i = 1, 2, \ldots, n$, is a pay-off function for player i, defined on a Cartesian product of n sets X_i, $i = 1, 2, \ldots, n$.

Decisions of other players than player i are summarized by a vector

$$\mathbf{x}_{-i} = \left(x_1, \ldots, x_{i-1}, x_{i+1} \ldots, x_n\right). \tag{8}$$

A vector of decisions $\left(x_1^0, x_2^0, \ldots, x_n^0\right)$ is Nash equilibrium of the game if

$$x_i^0\left(\mathbf{x}_{-i}^0\right) = \underset{x_i}{\operatorname{argmax}}\, \pi_i\left(x_i, \mathbf{x}_{-i}\right) \forall i = 1, 2, \ldots, n. \tag{9}$$

Nash equilibrium is a set of decisions from which no player can improve the value of his pay-off function by unilaterally deviating from it.

Then, players negotiate among themselves. In this stage, a cooperative game theory is applied to characterize the outcome of negotiation among the players over how to distribute the total surplus. Each player's share of the total surplus is the product of its added value and its relative negotiation power. Distribution of the total surplus to players can be given by Shapley values (14).

The cooperative game theory looks at the set of possible outcomes, studies what the players can achieve, what coalitions will form, how the coalitions that do form divide the outcome, and whether the outcomes are stable and robust.

The maximal combined output is achieved by solving the following task

$$\mathbf{x}^0 = \underset{\mathbf{x}}{\operatorname{argmax}} \sum_{i=1}^{n} \pi_i\left(x_i\right). \tag{10}$$

When modeling cooperative games is advantageous to switch from the game in normal form to the game in the characteristic function form. The characteristic function of the game with a set N of n players is such function $v(S)$ that is defined for all subsets $S \subseteq N$ (i.e. for all coalition) and assigns a value $v(S)$ with following characteristics:

$$v(\varnothing) = 0\,,\; v\left(S_1 \cup S_2\right) \geq v\left(S_1\right) + v\left(S_2\right), \tag{11}$$

where S_1, S_2 are disjoint subsets of the set N. The pair (N, v) is called a cooperative game of n players in the characteristic function form.

Allocation mechanisms are based on different approaches such as Shapley values, contracts, auctions, negotiations, etc. A particular allocation policy, introduced by Shapley (1953) has been shown to possess the best properties in terms of balance and fairness. So called Shapley vector is defined as

$$\mathbf{h} = (h_1, h_2, ..., h_n), \tag{12}$$

where the individual components (Shapley values) indicate the mean marginal contribution of i-th player to all coalitions, which may be a member. Player contribution to the coalition S is calculated by the formula:

$$v(S) - v(S - \{i\}). \tag{13}$$

Shapley value for the i-th player is calculated as a weighted sum of marginal contributions according to the formula:

$$h_i = \sum_S \left\{ \frac{(|S|-1)!(n-|S|)!}{n!} . \left[v(S) - v(S - \{i\}) \right] \right\}, \tag{14}$$

where the number of coalition members is marked by symbol $|S|$ and the summation runs over all coalition $i \in S$.

Confidence indices $0 \le \alpha^i \le 1$, for all $i = 1, 2, \ldots$, n, are introduced. The indices show players' anticipation of the pay-off they will receive in the cooperative stage, i.e. the proportion of the difference between the maximum and minimum core allocation achievable for players. Confidence indices of the players provide the link between the non-cooperative and cooperative stages of the biform game.

Simultaneous Biform Games

The simultaneous biform game is a one-stage model where combinations of concepts for cooperative and non-cooperative games are applied. The combinations will be changed according situations in problems. At this stage, multi-round negotiations take place. The first problem is a classification of situations. The situations are affected by:

- which players can cooperate,
- to what scope they can cooperate.

If all players can cooperate fully, then a standard cooperative model (10) can be used with subsequent distribution of the result according to the Shapley values (14). If no one can cooperate even in a partial content, a standard non-cooperative model (9) is used.

The general simultaneous biform games are based on negotiation process with multiple criteria (see Fiala, 1999). The pressure negotiation concept is based on the assumption that each negotiating subject decides under pressure of objective context, subject to a variety of internal and external pressures. The scope of cooperation is determined by the various constraints that result from the fact that players are under internal and external pressures. The scope of cooperation is dynamic and changes over time. The effects of pressures will be reflected in restrictive conditions.

Negotiating subject is under pressure, for example, if he wants to reach a consensus, he is aware of prices for delayed decisions; other negotiating subjects influence their behavior, etc. The pressure is a term that includes internal values and external influences and determines the decision-making process. Assume that the pressure does not affect the selection of decisions directly but through a set of conditions that have to be satisfied. Then the effects of pressure can be considered, which is reflected in changes in the set of constraints. This leads to a change of the set of acceptable negotiating subjects' decisions and a change of the negotiation space and can lead to a consensus.

Negotiation Model

Suppose n negotiation participants. Denote X as decision space for the negotiating process. Elements of this space are decisions $\mathbf{x} \in X$, which are vectors whose components represent the parameters of the decision. A consensus decision $\mathbf{x}^*$ should be chosen from the decision space X. The traditional game concepts assume a fixed structure and fixed sets of strategies. Sets of strategies will be taken as dynamic $X_i(t)$, for players $i = 1, 2, \ldots, n$, depending on the discrete time periods $t = 1, 2, \ldots, T$. Dynamic evaluations of strategies will be also considered.

Each participant evaluates decisions by multiple criteria and compares the decisions with the target values. Multiple criteria analysis from the first component of proposed procedure is applied. The criteria are in the form of criteria functions, that all participants want to optimize their values. Each participant in negotiations may have a different number of criteria. Denote $\mathbf{f}^1(\mathbf{x})$, $\mathbf{f}^2(\mathbf{x})$, ..., $\mathbf{f}^n(\mathbf{x})$ vector criteria functions that transform decision $\mathbf{x}$ into the vectors of target values $\mathbf{y}^1$, $\mathbf{y}^2$, ..., $\mathbf{y}^n$ of the target spaces of the participants Y^1, Y^2, ..., Y^n. These achievements, however, the participant tries to not reveal his interests and his strategy to all players. Own negotiations and exchanges of information between participants are happening in the decision space.

The negotiation process can be represented by dynamic models. Individual time moments correspond to rounds of negotiation, in which the current joint problem representation shows the degree of consensus or conflict between the parties to the negotiations. Developments of problem representations can be described as a search for consensus through the exchange of information between participants. The negotiation process is dynamic, and suppose that there is at discrete time points $t = 1, 2, ..., T$. At the time T the process is completed by finding a trajectory to time horizon T. Negotiation process over time can be modeled as a gradual change of the negotiation space, which is a subset of the decision space containing acceptable decisions of participants in the negotiation time until a single element negotiation space is reached.

For each participant, a set of acceptable decisions is formulated, which is a set of decisions that are permissible and acceptable in terms of the required aspiration levels of criteria functions. The aspiration levels $\mathbf{b}^i(t)$, $i = 1, 2, ..., n$, $t = 1, 2, ..., T$, of criteria functions represent opportunities for added values. At the beginning of the negotiations it has the form

$$X_i(0) = \{\mathbf{x};\ \mathbf{x} \in X,\ \mathbf{f}^i(\mathbf{x}) \leq \mathbf{b}^i(0)\},\ i = 1, 2, ..., n. \tag{15}$$

Then the negotiation space is defined at the beginning of the negotiations as an intersection of sets of acceptable decisions of all participants in negotiations

$$X_0(0) = \bigcap_{i=1}^{r} X_i(0) \tag{16}$$

If the negotiation space $X_0(0)$ is a single element set, then the negotiation problem is trivial. This element is the consensus. Negotiation problem becomes interesting when the negotiation space is empty or contains more than one element. In the first case, participants have to reduce some or all of the aspiration levels of criteria functions but participants are involved in the reduction of certain criteria more and other less. In the latter case, each element of the negotiation space is acceptable to all participants but different elements are evaluated differently, because they meet the criteria of the participants on different levels. Further negotiations are conducted in time points $t = 1, 2, ..., T$, and should lead to a consensus decision, to achieve single-element negotiation space $X_0(t)$.

Concept of Pressure

This pressure negotiation concept is based on the assumption that each participant decides under pressure of objective context, subject to a variety of internal and external pressures. The participant is under pressure, for example, if he wants to reach a consensus, he is aware of prices for delayed decisions; other participants influence their behavior, etc. The pressure is a term that includes internal values and external influences and determines the decision-making process. Assume that the pressure does not affect the selection of decisions directly but through a set of conditions that have to be satisfied. Then the effects of pressure are considered, which is reflected in changes in the set of constraints. This leads to a change of the set of acceptable participants' decisions and a change of the negotiation space and can lead to a consensus.

Pressures acting on the aspiration levels of criteria functions that change in time points $t = 1, 2, ..., T$, and thus change the set of acceptable decisions

$$X_i(t) = \{\mathbf{x};\ \mathbf{x} \in X,\ \mathbf{f}^i(\mathbf{x}) \leq \mathbf{b}^i(t)\},\ i = 1, 2, ..., n. \tag{17}$$

Changes of aspiration levels are described by a vector of values $\mathbf{p}^i(t)$ at time t ($\mathbf{p}^i(0) = \mathbf{0}$)

$$\mathbf{b}^i(t) = \mathbf{b}^i(t\text{-}1) + \mathbf{p}^i(t). \tag{18}$$

Vector $\mathbf{p}^i(t)$ describes the changes in aspiration levels of the i-th participant at time t. Vector $\mathbf{p}(t)$ describes the changes of all aspiration levels for all participants at time t, this vector has as many components as there are together all soft constraints. By joining points $\mathbf{p}(0), \mathbf{p}(1), ..., \mathbf{p}(T)$ yields a continuous vector function $\mathbf{p}(t)$ defined on the interval $< 0, T >$, which is called trajectory of pressures and represents tactics.

Applications of Biform Games

Three examples of using biform games in supply chains are presented: profit allocation games, concept of co-opetition, environmental negotiation.

Profit Allocation Games

Profit allocation in supply chains can be formulated as a sequential biform game (Fiala, 2016a). The problem is formulated as a supply chain with layers of suppliers, producers, retailers and customers. Suppliers form a layer with m agents and provide m types of resources to producers. The layer of producers is represented by n agents. These agents produce one type of product. The production is characterized by consumption of m resources to produce one unit of the final product. Each production agent is characterized by its available production resources. The resource capacity constraints compare the total availability of resources in the production layer with total consumption of resources to produce total number of q units of products. Producers send the products to retailers. Retailers meet price-dependent stochastic demand of customers. This problem is solved by two-stage procedure based on combination of no-cooperative and cooperative game approaches.

The first stage solves problems by price-dependent stochastic demand of customers:

- How to get maximal profit from customers.
- How to allocate the maximal profit between retailers and producers.

The problems are solved by non-cooperative manner. A Stackelberg game is formulated between the layer of producers and the layer of retailers as a newsvendor problem with pricing. Retailers seek to maximize total profit from the sale and try to align goals with producers on a contract basis and share the total profit with them. The maximization of the profit is by the resource capacity constraints. The equilibrium point (p^0, q^0) is given by values of total number of q production units and optimal price p.

A specific buyback contract is used for coordination. The layer of producers as leader proposes the wholesale price w and the buyback price b. The layer of retailers as follower accepts the prices to coordinate the system. The allocation of the total profit between retailers and producers is given by splitting parameter λ ($0 \leq \lambda \leq 1$). The value of the parameter λ is negotiated by retailers and producers.

In the second stage, producers address the following issues:

- How the determine the optimal coalition structure.
- How to allocate the profit among the members of the optimal coalition.

The problems are solved by cooperative manner. These agents compete to be members of a coalition and are willing to cooperate to produce products and sell them to customers through retailers. The optimal coalitions are determined according to the maximal profit concerning the resource capacity constraints for the coalition. The maximal profit is allocated among the members of the coalitions by Shapley values. Shapley value has been shown to possess the best properties in terms of balance and fairness.

Concept of Co-Opetition

Concept of co-opetition is applied in supply chains. The co-opetition business model has PARTS of a business strategy - five dimensions a company can use to identify strategies that change the game: Players, Added value, Rules, Tactics, and Scope. The players are the traditional agents in supply chains, competitors and complementors (competitors whose products add value). An important part of the game is to learn which variables will influence the players to either compete or cooperate. Added values are given through complementors. Rules structure negotiations among agents. Tactics are actions taken to shape other agents' perceptions. Scope means recognizing the links between games through Players, Added values, Rules, and Tactics. The

Players negotiate under pressure with their Tactics by given Rules with changing Scope when searching for Added values.

The relationship between the firm and the direct competitors is non-cooperative. The relationship between the firm and the complementors in a search for common added values is cooperative. The relationship between the firm and the suppliers can be partly cooperative; for some criteria cooperative (e. g. reducing pollution), for others non-cooperative (e. g. price).

Environmental Negotiation

Search for environmental coalition projects to reduce pollution can be modeled as a simultaneous biform game. Coalitions of polluters proposes projects to environmental authority that must simultaneously capture external and internal pressures. External pressure is determined by the limits of authority for granting subsidies. For each polluter, the internal pressure is due to the need to cover the cost of reducing pollution.

An authority and polluters are looking for coalition projects to reduce pollution (Šauer et al., 2015). The relationship between the authority and the polluters is non-cooperative. The authority wants to provide as little subsidy as possible to the required reduction of pollution. Polluters are trying to get as much subsidy but are under external pressure that if their subsidy demands are too high, do not get any subsidy. The relationship among the polluters can be partly cooperative (to get subsidy) and partly non-cooperative (to maximize surplus for individual polluters). Polluters are under internal pressure to get a sufficient portion of the subsidy for themselves.

FUTURE RESEARCH DIRECTIONS

Sustainable supply chain management (SSCM) is at the forefront of the interests of researchers and practitioners. This discipline will evolve concerning dynamic and uncertain changes in the ecological, social and economic environments. SSCM models should reflect these trends. Based on the literature review, the following future research directions future can be expected:

- Emphasize the dynamic nature of the models.
- Include uncertainty in the models.
- Provide risk analysis.
- Include the development of new technologies in the models.
- Provide a more consistent analysis of sustainability factors.
- Consider the influence of other agents in the models.
- Perform a more consistent empirical research.

- Apply the complex adaptive system (CAS) approach.

The first four trends are focused on environmental impact. Modeling of supply chain design is not a simple matter, it is necessary to combine random elements with expert evaluation and parameter adjustments in dynamic and uncertain environment changes. Developments are sometimes difficult to estimate. Some companies significantly expanding capacity, while others weaken. New start-ups are involved in supply chains. As product life cycles are shortened, new industries emerge, supply chains grow, creating new relationships between firms that cooperate to meet demand. The findings suggest that SSCMs focus primarily on deterministic approaches that do not adequately capture uncertainty in supply chains. An increase in models based on stochastic modeling techniques and fuzzy approaches can be expected. Supply chain processes are carried out at risk, therefore a quantitative risk analysis is also required. New technologies affect this environment and are also affected by this environment.

The other two trends are focused on the internal aspects of the chains, such as the number of sustainability factors and the relationships between them and the number of agents and the relationships between them. The interrelationships between basic sustainability factors are scrutinized in greater detail in order to avoid targeted optimization of selected sustainability criteria. Life-cycle assessment based approaches and impact criteria clearly dominate in environmental factors. Social factors of sustainability is not taken into account very much. Other types of factors (technological, legal, ...) should also be considered. In addition to the traditional supply chain agents, other should be considered. The influence of pressures and incentives of external stakeholders should be taken into account.

There has been only limited empirical research in recent publications. This research is needed both in terms of monitoring the real behavior of agents for their capture in models, as well as verifying models in practice.

Supply chains are becoming increasingly complex. It is difficult to capture all views into one comprehensive model for broader application areas. Comprehensive modeling approaches are most often employed on intra-organizational levels whereas broader application areas are assessed by less complex models. One option is to use the complex adaptive system (CAS) approach. In CAS systems, complex behavior emerges as a whole pattern as the result of the interaction of large numbers of simple components, and the system is able to cooperate, adapt, learn and evolve, improving its performance over time.

CONCLUSION

This chapter proposes and discusses the procedure for designing sustainable supply chains. The procedure takes into account multiple agents in the system and multiple evaluation criteria to solve the design problem. The procedure is flexible enough. It is generally open to other types of criteria and other types of agents. De Novo approach was applied for multiple criteria supply chain design problem and provides better solution than traditional approaches applied on fixed constraints. The approach is not oriented towards the optimization of some criteria but seeks for a trade-off free solution by reformulating resource constraints only limited by the budget. The resources are saved by drawing only in the amount necessary to reach a balanced solution. The multi-criteria approach is applied in seeking equilibrium for interested agents using biform game procedures. Biform games combine cooperative and non-cooperative approaches of game theory. The authors proposed to divide biform games into sequential and simultaneous shapes and to use a pressure negotiation model for simultaneous games. The concept of co-opetition brings other aspects into design of sustainable supply chains, including other agents such as competitors and complementors. The procedure is open to complement other concepts and approaches, for example, allocation mechanisms can be based on different approaches such as Shapley values, contracts (Fiala, 2016a), auctions (Fiala, 2016b), and negotiations (Fiala, 1999). A combination of these concepts and approaches can be a powerful instrument for designing supply chains. The complex structure of the model can be captured using graph theory in a system consisting of an environment in which agents (nodes) create interactions (edges) and flows directed to meet the global demand. Some future research trends orf sustainable supply chain management have been suggested. The proposed procedure tries to capture at least partially some of these trends.

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KEY TERMS AND DEFINITIONS

Biform Games: Biform games combine non-cooperative and cooperative models of the traditional game theory.

Co-opetition: A business strategy that goes beyond the rules of competition and cooperation to combine the advantages of both.

De Novo Optimization: An approach for designing an optimal system by reshaping the feasible set. Use only the necessary resources that are bound only by budget.

Multiple Agents: Independent members of the supply chain with their individual interests and preferences. Conflict of interests can be modeled using game theory.

Multiple Criteria Analysis: A decision-making analysis that evaluates decision alternatives by multiple criteria as part of the decision-making process.

Supply Chain: A complex and dynamic network of agents (suppliers, producers, distributors, retailers, and customers), activities, resources, and technology involved in moving a product or service from suppliers to customers. The agents are interconnected by material, financial, information, and decision flows.

Supply Chain Management: A process that provides the tools and techniques enabling organizations to develop strategic focus and achieve sustainable competitive advantage. The process can be divided into four phases: design, control, performance evaluation, and performance improvement.

Supply Chain Sustainability: A holistic view of supply chain processes that addresses the environmental, social, economic and other aspects of a supply chain's components.

Chapter 3
Green Practices in Supply Chain Management to Improve Sustainable Performance

Rebeca B. Sánchez-Flores
https://orcid.org/0000-0003-4399-8424
Universidad Autónoma de Baja California, Mexico

Samantha E. Cruz-Sotelo
https://orcid.org/0000-0001-8224-0101
Universidad Autónoma de Baja California, Mexico

Sara Ojeda-Benitez
https://orcid.org/0000-0003-3295-4514
Universidad Autónoma de Baja California, Mexico

ABSTRACT

This chapter presents an overview of current research on green practices said to improve global supply chain performance by driving the discussion into four main processes: sourcing, manufacturing, logistics, and customer service. Authors present the importance of sustainable development in supply chain management from environmental and green perspectives. The chapter undertakes a literature review on supply chain management, sustainable performance, and green supply chain. It continues with a discussion of green supply chain practices from different functions' perspectives, as strategic sustainable performance improvement and as a source of competitive advantage for business operations throughout the supply chain. Finally, this chapter identifies research gaps, discusses potential research directions for green supply chain management, and provides recommendations to expand on research to address the shortcomings of the existing literature.

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INTRODUCTION

In the last two decades, industrialization has contributed to environmental issues including decreased air quality, climate change, and air pollution-related problems (Khan, Zhang, Golpîra, & Dong, 2018). Additionally, customer pressure, governmental policies, non-governmental organizations (NGOs), society, and industry itself have influenced organizations to implement green practices in their supply chain and business operations (Tebaldi, Bigliardi, & Bottani, 2018). Furthermore, increasing regulations and public awareness have motivated organizations to minimize economic, environmental and social risks in supply chains (Josef-Peter Schöggl, M. M. C. Fritz, & R. J. Baumgartner, 2016b).

The need for sustainable performance improvement in organizations has been accomplished through sustainable supply chains. Where a green supply chain (GSC) plays a key role in sustainability to improve performance (Silva, Gomes, & Sarkis, 2019), motivating organizations to implement green practices throughout each process involved in the procurement of materials, manufacturing, logistics including distribution and warehousing, and customer service as being part of the supply chain (Chopra, 2018). Therefore, green supply chain management (GSCM) has become a critical strategy for protecting and minimizing the supply chain operations negative impact on the environment (Boutkhoum, Hanine, Boukhriss, Agouti, & Tikniouine, 2016; Silva et al., 2019). Within this context, Khan and Dong (2017b) investigated the impact of green supply chain practices on manufacturing companies' economic and environmental performance, and they found product eco-design, green purchasing of components and raw materials, green transportation and distribution, and cooperation with customers have a significant positive effect on environmental performance. On the other hand, Khan, Sharif, Golpîra, and Kumar (2019) investigated the relationship between green logistics practices, and sustainability in Asian emerging economies. The results suggested that logistics operations are positively related to income per capita, manufacturing added value and trade openness; nevertheless it has a negative impact on social and environmental concerns such as: climate change, global warming and carbon emissions. Their conclusion highlights the importance of green practices in improving a country economic, environmental and social performance. GSCM proposes to help manufacturing firms in their economic development, as well as their environmental and social commitments; while encouraging green practices and enhancing business performance (Yu, Golpîra, & Khan, 2018).

The first sustainable supply chain (SSC) investigations included topics such as green supply chain, the triple bottom line (TBL) and logistics operations (Ashby, Leat, & Hudson-Smith, 2012), where suppliers' involvement and other stakeholders' participation stimulated sustainable development (Kashmanian, 2015). Additionally, the growth of supply chain competition, demand patterns changes, and stakeholders' pressures have driven sustainable practices adoption (Gopal & Thakkar, 2016a). Furthermore, industry experts have expressed the need to increase the knowledge on SSC practices, as a source of competitive advantage for organizations (Jia, Diabat, & Mathiyazhagan, 2015). Even to compete between supply chains, demands the implementation of practices that will build and enhance performance, hence making imperative green sustainability at a supply chain level (S. Khan, Jian, Yu, Golpîra, & Kumar, 2019). Zhang, Golpîra, and Khan (2018) examined green practices and found their adoption in logistics and business operations as a source of opportunities for building competitive advantages against competitors.

This chapter presents the importance of green supply chains practices in improving sustainable performance. Additionally, the chapter provides theoretical perspectives on supply chain management, sustainable performance and green supply chain. It then continues into the discussion on current green practices and strategies as a source of competitive advantage in key supply chain functions. In addition, it highlights sustainable performance improvement from a green supply chain management approach. Finally, this chapter identifies research gaps, discusses potential research directions, and provides recommendations to grow on research, addressing the shortcomings of existing literature.

Consequently, this chapter presents the growing need to adopt and implement green practices in supply chains and business operations, to improve organizational performance, and meet customer expectations, stakeholders' interest, and governmental policies. It presents guidelines on green practices to researchers, experts and practitioners, to enhance sustainable development. In conclusion it offers current literature and research on green practices from a supply chain perspective, as a source for global business and manufacturing operations improvement.

BACKGROUND

As pressures from customers, government, NGO's, and supply chain stakeholders build to force organizations to adopt, implement and improve environmental-friendly processes, products and services, industries must take into consideration a green approach on business operations. Additionally, society has increased pressure on organizations to embrace environmentally friendly initiatives due to the growing awareness of climate change (Banasik, Bloemhof-Ruwaard, Kanellopoulos, Claassen, & Van der Vorst, 2018). As a result, due to increase in customer environmental awareness, competitiveness and strict governmental policies, the approach of incorporating GSCM to conserve resources and sustainable production, is gradually becoming more imperative for organizations (Mangla, Kumar, & Barua, 2015).

As a consequence, growing environmental awareness is forcing firms to include environmental sustainable objectives on their agenda and engage on green initiatives throughout their supply chains (Al-Sheyadi, Muyldermans, & Kauppi, 2019).

Supply Chain Management and Sustainable Performance

Competition between companies has moved from being firm to firm to supply chain vs supply chain, this is a change in the nature of competing for the market (Masoumik, Abdul-Rashid, & Olugu, 2014). The supply chain now "plays a significant role in the end-to-end business processes" (Syed Abdul Rehman Khan et al., 2018). As a result, SCM encompasses all stages of product's life cycle from design, manufacturing and distribution to the use of products by the end users, and its disposal at the end of product's life cycle (Borade & Bansod, 2007). Nowadays, to satisfy customer growing future needs, supply chains are challenged to improve performance throughout their operations and eliminate inefficiencies in global markets (Banasik et al., 2018).

On the other hand, sustainability, as part of business management and operations, integrates the economic, environmental and social responsibility (Bai, Kusi-Sarpong, Badri Ahmadi, & Sarkis, 2019). Sustainable performance involves these three responsibilities in delivering business activities throughout the organization. The World Commission on Environment and Development published the report *Our Common Future*, which defines sustainability as the use of resources to meet the needs of the present generation without compromising the ability of future generations to meet their own needs (WCED, 1987). Additionally, in 2002, the World Summit on Sustainable Development (WSSD) promoted green policies in industry and stressed special importance on environmental responsibility (United Nations, 2002). As a result, how sustainable performance should be measured becomes crucial for businesses (Tietz Cazeri, Anholon, Quelhas, Cooper, & Novaski, 2017), and working together within the whole supply chain can provide the means to achieve sustainability performance improvement.

Therefore, in literature research and business operations, integrating supply chain management and sustainability, resulted in the sustainable supply chain management (SSCM) concept. Seuring and Müller (2008) reviewed and classified SSCM literature, including green initiatives, and presented an overview of state of the art on the topic. They defined SSCM as "the management of material, information and capital flows as well as cooperation among companies along the supply chain while taking goals from all three dimensions of sustainable development, i.e., economic, environmental and social, into account which are derived from customer and stakeholder requirement" (p. 1700). Pagell and Wu (2009) stated "to be truly sustainable a supply chain would at worst do no net harm to natural or social systems while still producing a profit over an extended period of time; a truly sustainable supply chain could, customers willing, continue to do business forever" (p. 38). Myerson (2015) defined supply chain sustainability as "the management of environmental, social and economic impacts, and good governance practices throughout the lifecycles of goods and services" (p. 171).

Furthermore, Tebaldi et al. (2018) provided a literature review on sustainability as a critical part of supply chains operations, and confirmed the increasing trend in research on sustainable innovations as an integrated part of SSCM. Sunil Luthra, Garg, and Haleem (2015) stated that SSCM is a competitive advantage. Koberg and Longoni (2019) provided a synthesis of key elements of sustainable supply management from a global perspective. They concluded SSCM configurations, this is the structural arrangement of actors and linkages among them, and governance mechanisms which involve focal firms' coordination on sustainable initiatives; prevail as the key elements in global supply chains. Kannan, Jabbour, and Jabbour (2014) concluded that amongst the practices with the highest influence on SSC performance are: product design which reuses, recycles or recovers materials, components or energy; and the design of products that avoids or reduces the use of toxic or dangerous materials, as well as the compliance with environmental legal requirements and audit programs. These practices reach green initiatives and complement the endurance of a green supply chain.

Green Supply Chain Management

GSCM is a subject of growing interest amongst academics and practitioners. Research has been conducted to evaluate GSCM practices and investigate their strategic benefits in terms of environmental and economic performance, and competitiveness (Masoumik, Abdul-Rashid, Olugu, & Ghazilla, 2015).

The term "green supply chain management" developed as a concept which linked sustainability, and its environmental practices, into SCM (Ahi & Searcy, 2013). In other words, the integration of environmental management into supply chains is GSCM (Min & Kim, 2012). Srivastava (2007, pp. 54-55) defined GSCM as:

Integrating environmental thinking into supply chain management, including product design, material sourcing and selection, manufacturing processes, delivery of the final product to the consumers, as well as end-of-life management of the product after its useful life.

Luthra, Garg, and Haleem (2014) highlighted the importance of the economic criteria in GSCM when defining it as executing environmental management practices in supply chains while in observance of the economic criteria. Luthra, Kumar,

Kumar, and Haleem (2011) emphasized green purchasing, green manufacturing, green packing, green distribution and marketing as being part of GSCM. Also, Srivastava (2007) involved green purchasing, green manufacturing, green material management, green distribution, green marketing and reverse logistics as part of GSCM practices.

This "green" approach involves suppliers, manufacturers, and customers in a supply chain, working together in developing and implementing environmental practices (Gnoni, De Felice, & Petrillo, 2011). GSCM comprehends the establishment of strategies and methods to incorporate ecological design and cost awareness from the start of product design, aiming to reduce waste, and eliminate or decrease negative environmental and economic impact (Despeisse, Mbaye, Ball, & Levers, 2012). Furthermore, GSCM can be observed as a chain of companies collaborating in green practices to achieve sustainable performance. Adding the term 'green' to supply chain management (SCM) integrates environmental emphasis in all processes of the supply chain (Srivastava, 2007).

Ahi and Searcy (2013) published a literature review paper focusing on current definitions for GSCM; and they found no integrated definition among the different terms. Still, the concept of GSCM is in development and its implementation has been limited (Liu & Chang, 2017). Additionally, Ahi and Searcy (2015) research identified and analyzed metrics in GSCM and SSCM, resulting in more than 2,000 metrics identified and most of the performance indicators not being repetitive, which indicated a lack of agreement on how performance should be measured in GSCM and SSCM. Banasik et al. (2018) research found that numerous indicators are used to account for eco-efficiency, indicating the lack of standards.

Designing efficient and effective green supply chains involves the multiple dimensions of sustainability while taking into account specific characteristics of products and their supply chain, i.e. to identify green production options (Banasik et al., 2018).

Organizations are in need to address sustainability initiatives as part of their competitiveness. Therefore, Green Supply Chain Management (GSCM) has received increasing attention (Tietz Cazeri et al., 2017).

The successful accomplishment of GSC business operations is relatively difficult due to the involvement of different risks, especially the operational risks. These risks have a tendency to disturb the GSC functioning, and thereby, decrease the ecological and economic performances. Therefore, the identification of risks and their analysis in the GSC context is critical to reduce their negative consequences (Mangla et al., 2015). Tundys and Wiśniewski (2018) reviewed tools and methods used to evaluate green supply chains performance, being the top ones: Key Performance Indicators (KPI), Life Cycle Analysis and Costing, Environmental Responsible Product

Assessment (ERPA), Material Flow Analysis (MFA), and Sustainable Balanced Scorecard among others.

Consequently, GSCM has received attention in last few years (Luthra, Qadri, Garg, & Haleem, 2014), and due to society awareness, economic, environmental or legislative reasons, the necessity of GSCM has increased (Khan et al., 2019; Luthra et al., 2011).

GREEN SUPPLY CHAIN PRACTICES

Due to an increased awareness and significant environmental pressures from stakeholders, organizations have begun to incorporate green practices into their daily operations (Kannan et al., 2014). Additionally, increasing pressures from government, NGO's, and society are forcing industries to implement GSCM practices; where a successful implementation is vital for businesses to improve economic and environmental performances, and to ensure sustainability in the organization (Gandhi, Mangla, Kumar, & Kumar, 2015). Gandhi et al. (2015) prime objective of their research was to evaluate the key factors relevant to the successful implementation of GSCM initiatives in manufacturing industry in Indian. The results indicated that top management commitment, human technical expertise, and financial factors, played the highest roles for accomplishing the successful GSCM adoption. Liu and Chang (2017) proposed a closed-loop approach as the strategic method to implement GSCM practices successfully. Data was collected from 296 Chinese manufacturers and the results showed that closed-loop approach and GSCM positively impact on environmental and economic performance, and that a closed-loop approach has a positive effect on the level of implementation of GSCM. Boutkhoum et al. (2016) developed a framework for a better understanding of sustainable strategies by the identification and evaluation of GSCM practices to be implemented by industrial organizations. Masoumik et al. (2015) developed a conceptual model for strategically prioritizing GSCM initiatives and their implementation.

Bhardwaj Broto (2016) study suggested that the main drivers of GSCM include the environmental and the green human resource management policies of an organization, by providing the means, guidelines and training for adopting sustainable practices. On the other hand, Sunil Luthra et al. (2011) study aimed to develop a structured model of the barriers to implement GSCM in Indian automotive industry. This study contributed to identify and prioritize such barriers and helped to understand their interdependence. Kannan et al. (2014) results showed main criteria to developing GSCM practices are: senior management commitment, product designs that reduce, reuse, recycle, or reclaim materials, components, or energy, and that avoid or reduce hazardous material use; legal environmental requirements and auditing programs compliance.

Khan and Dong (2017a) highlighted green practices such as: green procurement, green manufacturing, green reverse logistics, and the use of green energy in business operations to promote sustainable development and decrease environmental deterioration. Other green practices comprises eco-product design, including initiatives relating to product design for environmental objectives, including reuse, recycling, and waste and emission reduction (Masoumik et al., 2015). Additionally, the implementation of lean manufacturing tools as part of green practices has become a key factor to gain environmental competence, and the reduction on environmental deterioration, through a more efficient use of materials and resources (Mohammaddust, Rezapour, Farahani, Mofidfar, & Hill, 2017).

Innovation in processes and technologies is another sustainable practice and source of competitive advantage in industry (Kusi-Sarpong, Gupta, & Sarkis, 2019; Tebaldi et al., 2018). Costantini, Crespi, Marin, and Paglialunga (2017) concluded that implementing ecological technologies is the most cost-effective way to minimize negative environmental impact without compromising the economic competitiveness. Kannan et al. (2014) also presented the acquisition of green technologies as a sustainable practice and as a potential performance improvement action. Khan, Golpîra, and Yu (2018) examined the impact of advanced technology and green vehicles on supply chain in Mexican manufacturing firms. The results showed advanced information technology as an important player in supply chain performance improvement through a greater-level of information sharing between supply chain partners and improved communication, reducing discrepancies and errors throughout the chain. Onu and Mbohwa (2018) discussed the benefits and barriers towards GSCM achievement from a technological perspective, using information technology and techniques to preserve energy as the focal discussion.

Schöggl, Fritz, and Baumgartner (2016a) conducted a research in regards to environmental practices that impact sustainable performance. This research identified the management of waste, gas emissions, and the use of hazardous substances as the primary influencers. Gopal and Thakkar (2016b) investigated supply chain sustainable practices and concluded that these practices help reduce environmental degradation, but also have social and economic implications. Additionally, the research carried out by Gopal and Thakkar (2016a) showed the adoption of environmental practices can result in significant improvement in economic performance, these practices include: reduction in energy and resource consumption, as well as emissions and solid waste. Jabbour, Frascareli, and Jabbour (2015) examined the adoption of GSCM practices, including green sources, affects environmental and operational performance. A multiple-case study was conducted using Brazilian firms, and the results indicated that the GSCM practice of "internal environmental management" has the greatest positive outcome on environmental performance indicators, and that the GSCM practice of "cooperation with customers" has the highest positive impact on operational performance indicators. Green, Zelbst, Bhadauria, and Meacham (2012) found environmental collaboration and monitoring practices, among supply chain partners, lead the improvement on environmental and organizational performance. Moreover, they discussed innovative green practices as strategies and source of competitive advantage for business operations throughout the supply chain. Green Jr, Zelbst, Meacham, and Bhadauria (2012) collected data from 159 manufacturing managers, reflecting the degree to which their organizations work with suppliers and customers to improve supply chain environmental sustainability. The results showed the adoption of GSCM practices by manufacturing organizations leads to improved environmental performance and economic performance, which, in turn, positively impact operational performance. Nonetheless, there is insufficiency empirical research supporting a direct relationship between GSCM practices and the improvement of environmental performance, hence becoming a barrier for manufacturing enterprises in trying to justify GSCM practices implementation (Zhu, Sarkis, & Lai, 2012).

Compliance with environmental regulations, norms and audit programs are other green practices presented by researches. Industries are being obliged to meet environmental regulations by NGOs and society (Demartini, Pinna, Aliakbarian, Tonelli, & Terzi, 2018; Saeed & Kersten, 2019). In this regard, Morali and Searcy (2013) showed the importance of industry compliance to standards and regulations, primarily those related to the performance of suppliers in the environmental area. Therefore, the last couple of decades, environment development and conservation has received much attention globally among academics and industry, and research has being conducted to explore sustainable practices to protect it (Khan, 2019).

Green Sourcing Practices

Global sourcing is being used as a corporate strategy, and as s competitive edge (Khan et al., 2018). However, environment is being negatively affected by it, due to increased transportion (Syed Abdul Rehman Khan, Dong, & Yu, 2016). As a result, sustainable supply chains, have taken green sourcing practices as part of its operations, to overcome the negative environmental impact and encourage sustainable development.

Islam, Tseng, Karia, and Lee (2018) researched green supply chain management practices to select green suppliers. Khaksar, Abbasnejad, Esmaeili, and Tamošaitienė (2016) assessed the relationship between green innovation, green supplier, environmental performance, and competitive advantage. Islam, Turki, Murad, and Karim (2017) concluded that sustainable practices such as: environmentally responsible purchasing, adoption of green procurement practices, reuse of natural resources, have enhanced sustainable development by demonstrating to increase industry competitiveness, protect natural resources, transform markets, improve financial performance and drive job creation. Diab, AL-Bourini, and Abu-Rumman (2015) showed there is a positive impact between green procurement, and quality-operational. The results showed there was a relationship between green supply chain management practices and organizational performance, being the highest related to the environment, such as: internal environmental management, warehousing and green building, green purchasing, and collaboration with customers on environmental issues.

Indicators identified as green sourcing include: the use of renewable resources, including recycled, reused and returned materials; suppliers selection and evaluation; reduction of hazardous waste; and compliance with environmental regulations (Costantini et al., 2017; Schöggl et al., 2016a). Greening upstream involves practices such as: green purchasing, materials management, and collaboration with suppliers in environmental improvement programs (Masoumik et al., 2015; Pimenta & Ball, 2015). Bhardwaj Broto (2016) highlighted sustainable criteria for supplier selection, as a key driver to sustainable development, since it was found to enhance the outcomes of sustainability. Kannan et al. (2014) researched green supply chain practices in Brazilian electronic businesses when selecting suppliers, as critical factors for overall companies successful sustainability achievement. Furthermore, companies have chosen suppliers based on the supplier's capability to adopt or effective implementation of GSCM practices (Kannan et al., 2014).

Green Manufacturing Practices

Green manufacturing practices comprise the optimization of manufacturing processes to reduce waste and emissions (Masoumik et al., 2015). According to Mangla et al. (2015) GSCM may support a manufacturer in adopting sustainable practices and could contribute to the preservation of resources.

Manufacturing in supply chain management entails implications in green practices, including: green technology management, energy and resources consumption, emissions, generation of waste, and compliance with environmental regulations (Ahi, Jaber, & Searcy, 2016; Schöggl et al., 2016b; Vanalle, Ganga, Godinho Filho, & Lucato, 2017). As a consequence, green practices include product and process design to minimize waste and material costs, as well as the reduction of energy and resource consumption (Zhu, Sarkis, & Lai, 2013). These practices also involve material recycle, reuse, and rework (Ahi & Searcy, 2015), and the use of renewable energies in manufacturing processes (Ahi & Searcy, 2015; Schöggl et al., 2016b). Pimenta and Ball (2015) presented examples of upstream supply chain environmental sustainable practices in manufacturing and concluded that: purchasing, suppliers evaluation and collaboration, are critical for sustainable development. Khan et al. (2019) research on green business practices impact on organizational performance, concluded that green manufacturing, green purchasing and ecological design of products enhance economic performance of firms. Zhu et al. (2012) results showed it is critical for manufacturers to coordinate the internal and external aspects of implementing GSCM practices to secure performance improvement and benefits. As a result, coordinating internal and external GSCM practices to achieve performance improvement is an important task of the manufacturing operations strategy.

As customer requirements develop, it is necessary to carry out studies on GSCM success factors identification and their evaluation in the manufacturing sector (Gandhi et al., 2015). Environmental pressures have caused GSCM to emerge as an important corporate environmental strategy for manufacturing organizations. For manufacturers to fully realise the performance potentials of GSCM, they need to integrate internal GSCM practices with external GSCM practices such as collaboration with suppliers and customers (Zhu et al., 2012).

Green Logistics Practices

Logistics performs a key role in supply chain management, it has the function of integrating a global supply chain; which includes activities such as: transport, freight, information sharing, inventory management, warehousing, and distribution (Khan et al., 2018). Green Logistics refers to *"minimizing the ecological impact of logistics"* (Myerson, 2015, p. 171), which includes the distribution, warehousing and transportation of goods from one point to another.

D'Amore and Bezzo (2016) analyzed the environmental impact of distribution and transportation, and developed a quantitative tool to improve economic and environmental performance under different supply chain configurations. Colicchia, Creazza, Dallari, and Melacini (2016) presented a frame-work on transportation and warehousing environmental impact, which demonstrated that a minor distribution cost increase and network optimization can provide a major improvement on environmental performance. Basu, Subramanian, Gunasekaran, and Palaniappan (2017) proposed a model which includes environmental factors when procuring truckloads, in automotive and logistics companies. The resutls showed carbon footprint, route optimizationation and on time delivery, as having the highest impact on procurement decisions, which represented the environmental sustainability factor.

Khan et al. (2018) examined the effect of green transportation, green distribution and green purchasing on organizational performance in Pakistani companies. The findings showed that green transportation and green distribution operations have a positive and significant relationship to the overall enhancement of organizational performance. Interesting to note that their results showed a negative impact from green purchasing, they concluded this is mainly due to expensive green components and materials as compare to non-green, since there is no advantage from government on tax exemptions or low import duties, to promote green purchasing. Khan and Dong (2017a) analyzed the relationship between environmental and economic indicators with green logistics performance. The results indicated renewable energy and green logistics have a positive relationship, increasing environmental sustainability and enhancing economic activities. However, fossil fuel showed a negative correlation with green logistics operations, affecting the environment and hence economic results.

Other green distribution and warehousing indicators include: energy consumption and savings, gas emissions, choice of means of transportation and cost (Costantini et al., 2017; Vanalle et al., 2017). Furthermore, the use of ecological distribution, transportation and logistics systems; use of renewable energies and reduction of emissions programs in any transportation mode are key green practices in logistics as part of supply chain management (Esfahbodi, Zhang, Watson, & Zhang, 2017; Gualandris & Kalchschmidt, 2016). A green supply chain places more emphasis on the processes related to a product's life, with specific emphasis on the logistics functions (transportation, warehousing, and packaging), and their impact on the environment (Tundys & Wiśniewski, 2018). Zhang, Khan, Kumar, Golpîra, and Sharif (2019) analyzed the association between tourism, environmental degradation, and logistics operations in Thailand. The research results showed there is a positive correlation between inbound tourism and logistics operations, due to the easy access to tourist destinations. However, as a result there is a negative relationship between inbound tourism and fossil fuel and carbon emission. The research conclusion highlighted the importance of logistics operations, with a focus on transportation, to enhance environmental sustainable development. Also, the research emphasized the need to enforce green practices in logistics and transport-related operations by government authorities, in the search of mitigating harmful effects on environment.

Therefore, within a green distribution and warehousing context, green transportation (internal or external) improves environmental performance and reduces the supply chain cost, generating a competitive advantage through the usage of renewable energy, enriched customer satisfaction, and positive business image creation (S. Khan et al., 2018).

Green Customer Services Practices

Customer service sustainable practices comprise: collaboration, on-time delivery, service quality, demand management, and environmental commitment (Ahi & Searcy, 2013). Lopes de Sousa Jabbour, Vazquez-Brust, Jose Chiappetta Jabbour, and Latan (2017) examined whether or not customers cooperate in organizations' environmental performance, how customers can collaborate with organizations in order to improve their environmental performance, and how green purchasing has an effect on environmental performance. The research concluded that customers can be seen as partners in order to improve environmental management of companies, and it was identified that suppliers and customers are critical in supporting the organizations environmental performance improvement. Additionally, due to increasing sustainability adoption by organizations, it is assumed that customers would be more willing to cooperate with organizations in terms of green operations (Lopes de Sousa Jabbour et al., 2017). Furthermore, customers can influence industrial operations, through the usage of information technology and be a direct player towards sustainable development (Onu & Mbohwa, 2018).

The factors to be considered to make GSCM initiatives strategically beneficial have rarely been discussed, and there has been little discussion in the literature showing how the external and internal drivers can interactively affect business managers' decisions in selecting green strategies and initiatives for implementation (Masoumik et al., 2015). Other green practices is the greening post-use, referring to the environmentally related actions at the product's end-of-life. It involves activities such as material recycling and product recovery (Masoumik et al., 2015).

Marketing innovation to reach customer can considered sustainable practices, therefore deserving particular attention from a "green" perspective. In fact, there is a growing trend for customers to look for green products and services; in this sense, marketing innovations could attract clients and become a strength for both environment and economic reasons (Tebaldi et al., 2018)

SUSTAINABLE PERFORMANCE IMPROVEMENT

Green supply chain management (GSCM) has become the driver of sustainable strategy. This topic has been gaining increasing attention within both academia and industry for making the industry competitive (Bhardwaj Broto, 2016).

Khan and Dong (2017b) researched the impact of certain factors to green supply chain practices and organizational performance in the context of Pakistan manufacturing firms. The results showed eco-design and green information systems as the greatest green practices to positively impact the organizations performance. Geng, Mansouri, and Aktas (2017) study investigated the relationship between GSCM practices and firm performance in the manufacturing sector in Asian emerging economies (AEE). The results revealed that the GSCM practices lead to better performance in four topics: economic, environmental, operational, and social performance. Furthermore, the results indicated that industry type, firm size, and ISO certification, influence several of the GSCM practice-performance relationships. Syed Abdul Rehman Khan (2019) examined the role of poverty and logistics operations in environmental degradation, and found there is a significant positive relation between them. This study provided useful information to improve environmental sustainability through the implementation of green practices, and usage of renewable energy sources. Gnoni et al. (2011) proposed a systematic approach to evaluate supply chain environmental performances. Strategic and operative decisions were involved when evaluating priorities to support environmental sustainability in a supply chain for strategic evaluation of SC environmental sustainability. The tool was validated in a real case study concerning a glass production supply chain, and has been confirmed as an efficient one. Khaksar et al. (2016) evaluated the relationship between green innovation, green supplier, environmental performance, and competitive advantage in Iran cement industry, and showed a positive significant relationship between green innovation, competitive advantage and environmental performance.

Qorri, Mujkić, Gashi, and Kraslawski (2018) investigated the impact of GSCM practices on firm performance. The results showed that the relationship between GSCM practices and firm performance is positive and significant, providing empirical evidence to practitioners and academics. Similarly, the findings indicated GSCM practices have a positively and significantly influence on environmental, social, operational and economic performance; however this relationship is moderated by geographical region, industry type and firm size. S. Luthra et al. (2014) study aimed to identify critical success factors to improve GSCM performances from three perspectives: environmental, social and economic performance, relevant to Indian automobile industry. This study helped supply chain managers to understand how they may improve environmental, social and economic performance.

Research also has payed attention to the connection between green supply chain practices and competitive advantages, and has become a subject of growing interest amongst academics, industry and practitioners. Masoumik et al. (2014) undertook a comprehensive review to evaluate green supply chain practices to achieve sustainable competitive advantages, and introduced four factors which positively influence this relationship, these are: internal environmental management, environmental proactivity, strategic alignment, and capability-based management.

Realizing that sustainability can drive the improvement of business through cost savings, improved market share, and stronger brand images, has motivated companies to take environmental friendly initiatives as strategic actions (Min & Kim, 2012). This incorporation of environmental practices in supply chain operations, has become essential for performance improvement due to both customer and legislative compliance for green products requirements (Gnoni et al., 2011). Where environmental performance refers to the impact of a company on natural systems, such as energy and water consumption (Ahi & Searcy, 2015). Al-Sheyadi et al. (2019) examined the collective impact of internal and external GSCM practices in environmental performance. The findings showed that complementarities between GSCM practices lead to a better performance than individual best practices do. Nonetheless, a variety of conceptualizations of GSCM practices can be observed in existing literature and there is evidence of diverse results relating GSCM practices to firm performance (Qorri, Mujkić, Gashi, et al., 2018).

Measuring Performance

It seems there is an increasing concern in measuring SSC performance, becoming a key element for global competition (Tundys & Wiśniewski, 2018). Furthermore, sustainability measurement in supply chains is a key driver to competitiveness (Qorri, Mujkić, & Kraslawski, 2018), since sustainability is being considered an essential part of the organizations supply chain strategies in achieving competitive advantage (Khan, Kusi-Sarpong, Arhin, & Kusi-Sarpong, 2018).

The methods and tools for the performance measurement and evaluation of green supply chains are key elements for the design and operation of these types of supply chains (Tundys & Wiśniewski, 2018). Malviya and Kant (2015) presented a review of literature on performance measurement. The purpose of this research was to examine the status of GSCM, where a range of online databases from 1998 to 2013 were searched containing the word "green supply chain" in their title and in the phrases to provide a comprehensive listing of journal articles. The findings showed that survey research provides greater credibility and that the trend in survey research is moving from exploratory to model building and testing. Furthermore, research regarding organizational practices, environmental issues, process, performance and sustainability were found to be most widely published topics within the GSCM field. Tundys and Wiśniewski (2018) provided a critical review of tools and methods used in literature to evaluated green supply chains performance, this analysis showed a review of the methods with an indication of their theoretical and practical character. Additionally, a list of definitions for green and sustainable supply chains were presented, emphasizing their differences. Qorri, Mujkić, and Kraslawski (2018) studied 104 peer-reviewed articles on sustainable supply chain management and green supply chain management, the results showed various measurement approaches used to evaluate sustainability in different supply chain echelons and industrial sectors. This analysis provided different methods to measuring sustainability performance of supply chains, presenting insights on metrics selection, and supply chain configuration.

Therefore, as a result of environmental concerns, laws and regulations, economic benefits, and business image building, more attention is being paid to GSCM; and firms have started adopting green practices from a global supply chain perspective (Khan et al., 2019).

FUTURE RESEARCH DIRECTIONS

Research on green practices from a supply chain management perspective can provide knowledge generation and guidance to practitioners, industrial companies, and academics, therefore future research should contemplate green practices for the entire supply chain.

Empirical case studies from a green environmental thinking approach throughout the supply chain, is a topic of research opportunity. Another area of future investigation includes developing countries green practices, due to its potentiality for sustainable development. Also, research in regards to green practices effect on supplier performance and logistics operations improvement can offer direction for overall supply chain performance enhancement. It is also important to research environmental regulations and international standards; including future trends, and how these will influence organizational green practices throughout the supply chain. Additionally, other gaps to be researched are the metrics and measures within GSCM, which will drive performance improvement.

In regards to GSCM practices, there is still a gap in research in regards to potential benefits from sustainable performance improvement in industry, and in particular from green supply chain practices. Future studies should investigate how GSCM practices impact organizations sustainability performance. Similarly, the implementation of GSCM practices and their performance outcomes are topics for future research. This may include the design and implementation of environmentally friendly management systems and assessment tools for green supply chain.

These areas of investigation provide the opportunity to researches, practitioners, academics and organizations to knowledgeable on current green practices, and better understand these practices effect to continuous improvement on supply chain operational activities and competitive advantage.

CONCLUSION

Sustainable practices directly impact supply chain performance as an integrated entity and at each of its primary operations previously discussed: sourcing, manufacturing, logistics, and customer service. These functions are considered key elements in supply chain management and are critical to performance improvement within an organization. Furthermore, GSCM has shown a direct connection to enhance sustainable development, by increasing competitiveness, improving environmental protection, and providing the foundation for social responsibility.

This chapter presented an overview of green supply chain practices being said to improve organizational performance. As an introduction, existing literature was selectively presented to provide concepts and importance of GSCM and sustainability development. A background on supply chain management and sustainable performance, as well as green supply chain was discussed. Following, sourcing, manufacturing, logistics, and customer service green supply chain practices were presented. Additionality, sustainable performance improvement as a source of competitive advantage was highlighted, as well as green practices as a driver for performance improvement; and a discussion on measuring performance followed. Further research directions resulting from this chapter were presented, emphasizing green practices in supply chain management as a basis to do business and enhance positive results and performance, while encouraging sustainability development.

This chapter confirms green practices as a key strategy to enhance performance in supply chain management, and as a business source for: operational results improvement, sustainable development, and achievement of competitive advantage.

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KEY TERMS AND DEFINITIONS

Competitive Advantage: Superior characteristic versus competition, which customers values and is willing to pay for it.

Green Practices: Environmental friendly actions, which can help to environment protection and sustainability development.

Performance Improvement: Measurable development throughout business functions and key processes, focused on successfully achieving positive results.

Supply Chain Management: The process of planning, organizing and control of demand and supply network operations to meet customer needs, and organizational goals.

Sustainability or Sustainable Development: An equilibrium or balance of priorities that may exist between social responsibility, environment care and economic viability, making sure needs are met and will constantly be met in the future.

Sustainable Practices: Actions carried on from an economic, social or environmental perspective to accomplish a specific result or benefit.

Sustainable Supply Chain: The implementation and practice of economic, environmental and social aspect in all activities related to a supply chain, and where business processes are aligned to achieve sustainable development.

Chapter 4
Emergy Analysis and Supply Chains

Lojain Alkhuzaim
Worcester Polytechnic Institute, USA

Joseph Sarkis
Worcester Polytechnic Institute, USA

ABSTRACT

The growth in stakeholder pressures, broader sustainable supply chain management practices, and new economic models such as circular economy, has made sustainability a priority for organizations and their supply chains. To be able to manage their activities, programs, processes, and strategies, organizations have adopted and developed performance measures. Unlike other performance measures, emergy analysis quantitatively provides a real value for the work of nature to evaluate performance beyond the traditional measures that have been traditionally presented in the supply chain literature. This chapter offers an introductory explanation of how and what emergy analysis can offer in evaluating the environmental performance of supply chains. It will also consider not only the capabilities of emergy analysis but also the limitations and much-needed research to advance both fields, EA and SSCM.

INTRODUCTION

Sustainability issues have stimulated new ways of thinking with emerging concepts. These concepts help to investigate and evaluate the efficiency and effectiveness of business and corporate environmental performance. Stakeholder forces over the past few decades have caused organizations to reconsider environmental issues and

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how they are addressed. Demand for environmental assessment tools to alleviate the environmental stress associated with expeditious industrialization has been one result.

The integral relationship between business and the natural environment have evolved to include not only individual organizations, but supply chains. Sustainable supply chain management (SSCM) practices can more broadly deal with the triple bottom line (3BL) dimensions (economic, social and environment) to broad based performance standards (Beske-Janssen et al., 2015). Seuring and Müller (2008) defined SSCM as the integration of the triple bottom line dimensions in managing material, information and capital flows by effective cooperation among supply chain partners.

Similarly, focusing more on the environmental and economic dimensions, the circular economy (CE) has also grown in importance globally to deal with different environmental concerns. Much of CE is related to waste effluents with a focus on improving the efficiency of used-resources to achieve better economic performance (Ghisellini et al., 2016). CE as a business model that keeps materials and components within a closed loop can help organizations achieve the highest utilization of these resources (Webster, 2017). There has also been a strong linkage between SSCM or green supply chain management and CE (Liu et al., 2018).

The growth in stakeholder pressures, broader SSCM practices, and new economic models such as CE, has made sustainability a priority for organizations and their supply chains. To be able to manage their activities, programs, processes, and strategies, organizations have adopted and developed performance measures. Performance measures that can evaluate the efficiency and effectiveness of supply chains have been one of these areas. Supply chain performance measures (SCPM) can be designed to address a single dimension or integral aspects of the 3BL (Beske-Janssen et al., 2015). However, environmental sustainability performance is the dominant focus of this chapter; especially emergent corporate and SSCM environmental performance measurement.

Although supply chain sustainability performance has gained in importance since its broad introduction into the literature about 15 year ago (Hervani et al, 2005), substantially more work and development are needed. One of the emerging assessments and performance tools that has gained increasing attention and can be useful in providing a comprehensive evaluation of the environmental performance of the supply chain is emergy analysis (EA); emergy with an "m".

With increasing complexity and a shift to global supply chains, evaluating the environmental performance across different geographical boundaries can be a difficult task for stakeholders in the supply chain. Unlike other environmental assessment tools and performance measures, EA quantitatively provides a real value for the work of nature -- sun, wind, geothermal heat and rain -- in addition to that of humans in producing products and services. It considers the 'donor' value of the environment into various activities of commerce and society and their systems.

Theoretically, emergy was initially discovered as a thermodynamics and general systems theory and defined as the cumulative available energy that was consumed directly or indirectly to produce a product or a service (Odum, 1996). EA and SSCM can be integrated to create a robust environmental assessment tool to evaluate its performance beyond the traditional measures that have been traditionally presented in the supply chain literature. This chapter offers an introductory examination of how and what emergy analysis can offer in evaluating the environmental performance of supply chains. It will also consider not only the capabilities of emergy analysis, but also the limitations and much needed research to advance both fields, EA and SSCM.

BACKGROUND

Sustainable Supply Chain Management Background

With the increasing consumption of natural resources, the world is facing natural resources scarcity issues. Production and consumptions systems require reconsideration in this environment; or at least careful monitoring. Meeting aggregate customer demand by organizations is a critical activity for businesses and decision makers; this basic business requirement has led to the development of some effective concepts to facilitate these decisions. For instance, originating in the early 1980's, supply chain management is responsible for managing material and information flows to produce a product or a service by organizing a series of activities linking up- and downstream parties within the supply chain (Lambert, 2008, p.2). To further simplify the definition of supply chain it is important to identify the main players in the value chain which typically consists of multiple firms and final users.

Taking the supply chain to a more inclusive level requires the consideration of multiple stakeholders in the value chain inside and outside the boundaries of the focal firm. In other words, the growing complexity of supply chains operations and functions can sometimes be the cause of internal (i.e. employees) and external (i.e. government, NGOs and society) stakeholders' pressures that might drive some substantial changes to the supply chain (Nawrocka, 2008).

The concept of SSCM had then evolved. SSCM seeks to capture all the activities performed within the supply chain to improve not only the economic performance but also environmental and social performance. This has been defined as the 3BL.

The most common definition of sustainability describes it as development that meets the needs of the present without compromising the ability of future generations to meet their own needs (World Commission on Environment and Development, 1987, p. 8). This can be viewed as the inter-generational philosophy of sustainability. There is also the 3BL definition. Expanding both these concepts to the supply chain results in SSCM (Seuring and Mueller, 2008).

Integrating sustainability practices within the supply chain has become a priority in its design and execution. It seeks to achieve a superior economic performance while meeting environmentally conscious market and stakeholder requirements. Socially, its goal is to also maintain high social and ethical standards.

In theory, sustainability requires the reconciliation of the 3BL dimensions. Studies within the SSCM literature provide a wide overview of some various topics. However, the economic dimension has always been the primary focus of researchers considering the attractiveness of the financial gains resulted from incorporating sustainability practices within the supply chain.

Alternatively, social issues are still underrepresented due to difficulties associated with defining and molding the social aspects of sustainability (Dempsey et al., 2011, Seuring, 2013). For instance, the initial goal for firms seeking sustainability is cost reduction which has been the dominant criteria for the economic dimension (Seuring, 2013). Also, a recent review conducted between 2000 and 2015 revealed that the economic dimension is still dominating the SSCM literature (Rajeev et al., 2017).

Economic and environmental dimensions are integrated within the SSCM and green supply chain management literature. Many studies have focused on assessing sustainable performance (economic and environmental) of specific industries especially those with intensive energy consumption. Logistics operations are an example of highly polluting industries when incorporated with unsustainable practices and underdeveloped infrastructure (Khan, 2019). In this regard, Yu et al. (2018) tested the relationship between environmental and economic sustainability and green logistics performance. Using an ordinary least square (OLS) statistical technique, they found a strong positive correlation between green logistics and eco-friendly practices (i.e. green energy sources). While greenhouse gas emissions and carbon emissions were found to be negatively correlated with green logistics.

For a successful implementation of sustainable practices, the three pillars of sustainability (environmental, economic and social) should be integrated to maintain long-term sustainable performance (Ahi and Searcy, 2013). EA may help somewhat integrate the three elements; although it is most effective for environmental resources management.

Performance Measurement in Supply Chains

The last decade has seen an increase in the individual, organizational and governmental awareness with regard to sustainable practices, which in turn formed a powerful force towards change (Taticchi, et al., 2015). Understanding the importance of sustainable practices in improving the quality of life for all the stakeholder in the supply chain motivated researchers to develop specific measures designed to evaluate such practices.

In general, to be able to manage their activities, programs, processes, and strategies, organizations have adopted and developed performance measures. Performance measures that can evaluate the efficiency and effectiveness of supply chains have been one of these areas. One of the frequently used definitions of performance measures (PM) describes them as quantifying the efficiency and effectiveness of actions (Neely et al., 1995).

Within the SSCM field, performance measures have evolved and revised to cope with the growing competitive environment. Decision makers are pressured to proactively manage the changes in the business environment which requires comprehensive evaluation of a firm's performance (Nudurupati et al., 2011). It is essential to note the importance of using multi-dimensional PMs that are able to assess both financial and non-financial performance for continuous sustainable improvement (Taticchi, et al., 2015; Schaltegger et al., 2014).

Within the context of SSCM, the PMs literature distinguishes between two main types of PMs, namely traditional (conventional) and contemporary (balanced) PMs (Kaplan and Norton, 1992, Schaltegger and Burritt, 2014). Since traditional measures such as ROI and gross margin (Van Hoek, 1998) focus solely on the financial performance, their effectiveness is questionable. It has been argued by many researchers that the limitations of traditional measures hinder potential growth and thus called for the use of more balanced performance measures (Johnson and Kaplan, 1987, Ghalayini & Noble, 1996. Alternatively, contemporary (balanced) PMs focus on both financial and non-financial measures which is more adequate in assessing the various aspects of supply chains (Kaplan and Norton, 1992).

Recently, studies have integrated more innovative approaches for measuring the sustainability of supply chains by incorporating the 3BL as the main assessment indicators. However, studies that have simultaneously integrated the three pillars of sustainability (economic, social and environment) are still limited (Taticchi, et al., 2015).

Some of the PMs are revised to address a specific dimension such as using Life Cycle Assessment (LCA) to evaluate the corporate environmental performance (Gold et al., 2010). Supply Chain Operations Reference (SCOR) model is another tool that is utilized as an economic-oriented strategic decision-making tool that is used to assess supply chain's performance based on four business processes, namely, plan, source, make and deliver (Bai and Sarkis, 2014).

Although existing PMs have fundamentally contributed to the advancement of the SSCM field and the improvement of corporate sustainability the need for innovative and comprehensive measures is still growing. Also, given the relatively complex set of potential measures that are available, a metric that can bring together the various dimensions of sustainability can prove valuable. It is with this issue in mind that a very comprehensive measure, that can incorporate social, economic, and environmental systems can prove valuable. This is where emergy analysis can show its true value.

Emergy Analysis

With the increasing complexity and the shift to globalize supply chains, evaluating the environmental performance across different geographical boundaries can be a difficult task. Many challenges can come to surface as supply chains expands globally. One of these challenges is transportation management as more energy is required and more CO2 emissions are released (Khan et al., 2017a).

Although supply chain sustainability performance has gained in importance since its broad introduction into the literature about 15 year ago (Hervani et al, 2005); substantially more work and development are needed.

One of the emerging assessments and performance tools gaining increasing attention in the general ecological indicators research community is emergy analysis. EA can be useful in providing a comprehensive evaluation of the environmental performance of the supply chain.

Introduced by Odum (1996) as a thermodynamics and general systems theory, EA is an assessment tool that quantifies the accumulative available energy consumed directly or indirectly to produce a product or a service.

Unlike other environmental assessment tools and performance measures, EA quantitatively provides a real value for the work of nature -- sun, wind, geothermal heat and rain -- in addition to that of humans in producing products and services. It considers the ‘donor’ value of the environment into various commerce and society activities, and their systems.

EA overcomes the limitation of having different units and flows and transforms all the energy flows into solar emjoules (sej) (Song et al., 2014, Corcelli et al., 2018). It uses solar energy as the unique measuring unit to normalize different inputs and outputs of materials, products and services (Odum,1996).

EA provides decision makers with various indicators that are able to review any given system from multiple dimensions. Emergy based indicators are a set of metrics and ratios used to measure the environmental impact along the production process beginning from resource generation to finished product (Odum, 1988).

Odum defines the solar emergy consumed to produce one joule of a product or a service as Solar Transformity (1988, 1996). Solar transformity measures the intensity of the support provided by the natural system to the final product. It is also considered as an indirect measure of “product renewability” and acts like a memory of past environmental contribution that have led to the production of the final product (Brown and Ulgiati, 1997).

The higher the transformity is the more energy and environmental activities needed to produce a resource. Transformities are calculated by dividing the total emergy by the actual energy used in the system under study. In fact, transformities are very essential in quantifying the total emergy as follow:

Total Emergy= Transformity * Available energy

In terms of units, the total emergy is measured in solar emergy joules (sej) whereas transformities are measured in solar emergy joules per joule of product (sej/J) (Brown and Ulgiati, 1997).

EA can be illustrated by diagrams to depict the system under study in terms of all forms of energy consumed during the production of the final product or service (Fig.1). An emergy diagram contains symbols of sources, flows, storages, interactions and transactions (Brown, 2014). All these components are positioned within a closed system boundary to show how energy, materials and information interact. Sources are categorized as follows:

1- Indigenous Renewable Sources (R) such as sun, wind, rain and solar radiation;
2- Indigenous Non-renewable Sources (N) such as ground water and biomass and topsoil;
3- Imported (purchased) resources (IM) including renewable (IM_R) and non-renewable (IM_N) flows imported from outside the boundaries of the system of interest such as fuel, machinery and chemicals;
4- Direct labor (L) and indirect labor in the form of services (S);
5- Waste (W).

Other emergy notation includes:

U: the total emergy (U=R+N+IM)

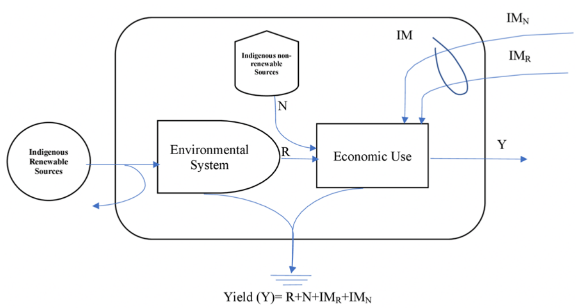
Y: system's output or yield (i.e. product, service and emissions) (Ren et al., 2015).

UEV (transformity): is the unit emergy value (UEV= U/Y).

An example emergy diagram is shown in Figure 1. It illustrates the main components of a system under study. It contains flows of input and output accounting for indigenous renewable sources (R), indigenous non-renewable sources (N) and the imported (purchased) from outside the system. The diagram also identifies interactions between system's components up until the production of the final product. Dispersed energy represents the energy that is no longer capable of providing work to the system and thus sinks through the bottom pathway as heat (Odum, 1996).

After calculating the total emergy of the flows feeding the system under study, emergy based indicators are used as the measure of environmental and sustainability performance of the system of interest. Furthermore, emergy based indicators are

Figure 1. Emergy based indices



important inputs to support policy making processes as they describe the dynamics of the system of interest.

Emergy provides a wide set of indicators that allow researchers and policy makers to choose from based on their ultimate goal. Environmental loading ratio (ELR) measures the amount of environmental burden caused by production processes. ELR is calculated as the ratio of the sum of Indigenous non-renewable resources (N) and imported emergy (IM) to the renewable resources (R) [(N+IM)/R] (Ulgiati et al., 1994). A high ELR indicates a high environmental pressure and is a sign for harmful environmental practices.

The emergy Yield Ratio (EYR) is an indicator of ability of a process to make use of local resources by investing in non-local resources. It provides an understanding of the support a process can offer to the local economy by exploiting local resources. EYR is calculated by dividing the sum of all resources used in the production (renewable, non-renewable and imported) to the imported emergy [(R+N+IM)/IM].

The emergy investment ratio (EIR) is a measure of the "utilization level" of the used emergy (Ren et al., 2015). It indicates whether a process is effectively using the invested emergy. It is the ratio of the imported emergy (IM) (renewable and non-renewable) to the natural inputs (R+N) [(IM/(R+N)]

The Emergy sustainability index (ESI) is a measure of the sustainability of a process, product or service. ESI is considered as an aggregate measure as it is the ratio of the contribution of a process to the local economy (EYR) to the amount of its environmental loading (ELR) [(EYR/ELR]. Brown and Ulgiati (2002) provided a reference for ESI to evaluates the sustainability level of a particular process or product as follow:

- ESI<1 → represents a non-sustainable process (product) in the long term with high environmental pressure;
- ESI>1 → represents a long-term sustainable process (product);

- 1<ESI<5 → represents a moderate level of sustainability.

Percent renewable (%R) is another sustainability indicator that divides the renewable resources (R + IM_R) by the total emergy (U). Comparing multiple alternatives, a high percentage indicates a more sustainable system. Also, %R is an indicator of a system ability to endure economical pressure (Brown and Ulgiati, 2004, Cavalett et al., 2006). %R= (R+IMR)/U.

While EA is an environmental assessment tool, it provides a number of monetary measures from an ecological point of view.

The emergy exchange ratio (EER) is the ratio of emergy embodied in the money invested to the embodied emergy of the sold product. EER=[($\$_{income}$)* $(sej/\$)_{world}$]/U (Asamoah et al., 2017). A value less than 1 indicates that the emergy of the product exceeds the t emergy of the money. This begins to include economic valuation along with other sustainability measures.

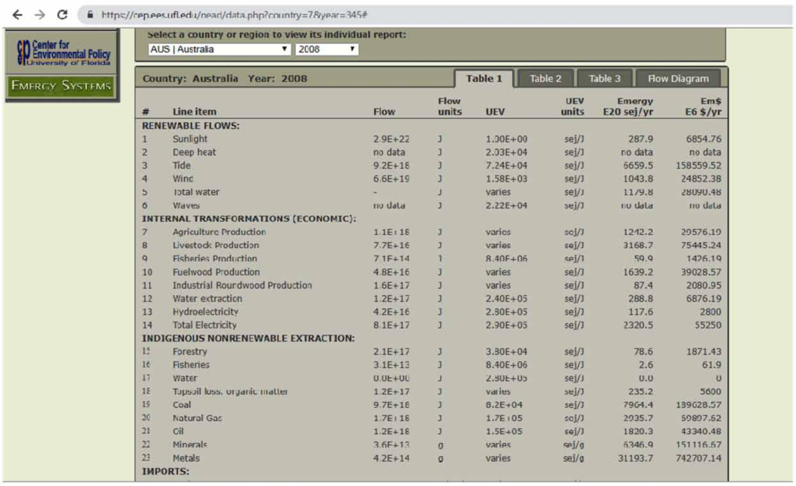
To be able to develop these various measures an emergy database of values for activities, systems, resources and regions in the world is publicly available. The National Environmental Accounting Database (NEAD) is used to inform various tables and calculations completed at the national level based on units. The database, under continuous updating is available at: https://cep.ees.ufl.edu/nead/. An excerpted data set and screenshot of the site appears in Figure 2. This data is for Australia using the 2008 database. The data includes three detailed tables base on line items and flows and scores. In many cases a flow diagram is also part of the database.

EA allows for a comprehensive environmental assessment from two different perspectives. First, by using Emergy-based indicators, multiple alternatives can be evaluated based on the results obtained from calculating the appropriate emergy indictors. Then, eliminating the alternative with the least prominent results (Corcelli et al., 2017). Alternatively, emergy-based indicators are useful as time assessment tools where indicators are measured over time to describe a certain pattern or to identify key resources (Song at al., 2014). The first approach is for decision making purposes, the second for benchmarking; both can be used for planning and management purposes.

EXAMPLES OF SUSTAINABLE SUPPLY CHAINS, PERFORMANCE MANAGEMENT, AND EMERGY INTEGRATION

From an SSCM perspective, increasing consumption of natural resources -- non-renewable -- is a global challenge; aggravating scarcity issues. Despite recent initiatives to encourage adopting eco-friendly practices in manufacturing, resource overuse and waste generation remain serious industrial greening concerns. The

Figure 2: An example set of emergy assessment data from the National Environmental Accounting Database located at the University of Florida



#	Line item	Flow	Flow units	UEV	UEV units	Emergy E20 sej/yr	Em$ E6 $/yr
RENEWABLE FLOWS:							
1	Sunlight	2.9E+22	J	1.00E+00	sej/J	287.9	6854.76
2	Deep heat	no data	J	2.03E+04	sej/J	no data	no data
3	Tide	9.2E+18	J	7.24E+04	sej/J	6659.5	158559.52
4	Wind	6.6E+19	J	1.58E+03	sej/J	1043.8	24852.38
5	Total water	-	J	varies	sej/J	1179.8	28090.48
6	Waves	no data	J	2.22E+04	sej/J	no data	no data
INTERNAL TRANSFORMATIONS (ECONOMIC):							
7	Agriculture Production	1.1E+18	J	varies	sej/J	1242.2	29576.19
8	Livestock Production	7.7E+16	J	varies	sej/J	3168.7	75445.24
9	Fisheries Production	7.1E+14	J	8.40E+06	sej/J	59.9	1426.19
10	Fuelwood Production	4.8E+16	J	varies	sej/J	1639.2	39028.57
11	Industrial Roundwood Production	1.6E+17	J	varies	sej/J	87.4	2080.95
12	Water extraction	1.2E+17	J	2.40E+05	sej/J	288.8	6876.19
13	Hydroelectricity	4.2E+16	J	2.30E+05	sej/J	117.6	2800
14	Total Electricity	8.1E+17	J	2.90E+05	sej/J	2320.5	55250
INDIGENOUS NONRENEWABLE EXTRACTION:							
15	Forestry	2.1E+17	J	3.30E+04	sej/J	78.6	1871.43
16	Fisheries	3.1E+13	J	8.40E+06	sej/J	2.6	61.9
17	Water	0.0E+00	J	2.30E+05	sej/J	0.0	0
18	Topsoil loss, organic matter	1.2E+17	J	varies	sej/J	235.2	5600
19	Coal	9.7E+18	J	8.2E+04	sej/J	7964.4	189628.57
20	Natural Gas	1.7E+18	J	1.7E+05	sej/J	2935.7	69897.62
21	Oil	1.2E+18	J	1.5E+05	sej/J	1820.3	43340.48
22	Minerals	3.6E+13	g	varies	sej/g	6346.9	151116.67
23	Metals	4.2E+14	g	varies	sej/g	31193.7	742707.14
IMPORTS:							

main challenge is to increase the efficiency of used resources by maximizing their utilization rate to reduce waste as much as possible; or shift towards renewable resources with lessened environmental degradation concerns.

The integration of SSCM and the concept of circular economy (CE) are possibilities in this case. Emergy analysis can help.

Researchers have been urged to widen the scope of studies addressing the different angles of TBL dimensions by integrating multiple dimensions. This section further introduces possible integration between SSCM, CE and EA focusing on performance measures aspects of sustainability in the supply chains.

CE is a business model that keeps materials and components within a closed loop to help organizations achieve the highest utilization of these resources (Webster, 2017). The primary goal of CE is maximizing environmental and economic benefits by reusing waste to produce new products.

Considering the dynamic nature of EA that is able to deal with both upstream and downstream activities, it is well suited to be a performance measure for circular activities. EA is capable of capturing supply chain activities beginning from resource generation phase to the final product/service phase (Geng et al., 2013). CE is heavily dependent on SSCM practices.

Corcelli et al. (2017), used EA to assess the effectiveness, efficiency and sustainability of papermaking processes starting from virgin pulp (upstream) to the final product which is paper (downstream). They used emergy-based indicators to evaluate the sustainability of three different forest management scenarios-

Eucalyptus, Spruce/Pine and Poplar- as the sources for raw material supply in three regions- Sweden, Italy and Brazil. They compare the amount of energy and past environmental activities (transformities) consumed in the three-tree species, Spruce and Pine was the most sustainable option among the other types as it required the lowest transformations.

Emergy and CE have been integrated mostly within Macro level to assess the sustainability of a particular region (Liu, et al., 2018). In this sense, Ren et al. (2010) used emergy analysis as an environmental strategy to evaluate circularity of five scenarios in the Chinese paper industry. Using Emergy-based Indices, they find that adopting CE policies in the Chinese paper industry needs “a scientific technical” structure and specific economic gains.

Other studies covered a different level of analysis. For instance, Geng et al. (2010) used EA to evaluate the eco-efficiency of Dalian Economic Development Zone (DEDZ) in China as a case study focusing on the industrial park level. They used emergy-based indicators, (i.e. ELR and EYR) to evaluate the current development situations of DEDZ. The results offered new ventures for sustainable development through recycling and byproduct initiatives to help stakeholders and administrators in the decision-making process.

Using EA as a tool to measure the efficiency and sustainability of a system is very promising. EA has the ability to directly differentiate between products originated form linear and non-linear supply chain using emergy-based indicators (Marvuglia et al., 2018). Also, when evaluating the supply chain, information is an important flow that can determine the level of circularity which EA is designed to account for and measure. EA also helps identify flows and bound within and between organizational activities.

An advantage of EA is derived from its dynamic nature. EA has proven its success in measuring regional sustainability within a specific geographical boundary. For instance, studies addressing green performance and sustainable practices have found some variations when using other techniques depending on the level of economic development. In reality, businesses operating in a developed region achieved better performance when adopting sustainable and green practices whereas in developing regions the situation is not always optimistic. With limited capabilities and less stringent regulations, developing regions tend to overuse their natural resources in unsustainable approaches to achieve rapid economic growth which will eventually aggravate serious environmental concerns (Khan et al., 2017b; Khan, 2019). It was found that although green practices have a positive impact on the environmental performance, economic performance did not positively improve (Khan and Qianli, 2017). Thus, using EA as a tool along with other performance measures can significantly widen the evaluation scope by accounting for the environmental contribution of any particular region to give a better assessment of the current situation.

Unlike other environmental assessment tools and performance measures, EA has the capability of quantifying the work of nature and assigning real values to enable a more objective performance assessment. In general, other performance measures accounts for the effect of some environmental practices (i.e. amount CO_2 emissions) and overlook the real ecological contribution to produce a product or a service.

An essential feature of EA that can differentiate it from other performance measures is its ability to account for different flows with different units and integrate them into one measurable unit (solar emjoules)(sej). It integrates natural resources, purchased resources, human contribution and information (Brown and Buranakarn, 2003). EA can be considered as one of the most comprehensive tools in measuring the TBL dimensions including social – labor – and economic concerns.

The use of EA complements the results obtained with other environmental performance systems. Some studies have integrated EA with LCA to measure systems. For instance, Ren et al. (2015) used emergy-based indices to measure the sustainability of biodiesel supply network by taking a life cycle approach to evaluate multiple designs of the biodiesel supply network. It can also be integrated with material flow analysis which is popular in the industrial ecology literature.

Like other performance measures, EA has limitations that need to be improved and revised. Deriving from thermodynamics and general systems theory, EA can be integrated more interactively with other fields to advance its applications. For instance, the biggest limitation is the underdeveloped literature connecting EA to other disciplines such as SSCM. Much of the data is at a very high level of granularity.

The applications of EA as a performance measure can be advanced by targeting different levels of analyses. To be able to disaggregate this data to the organizational, product, or supply chain level takes careful thought and examination. The sourcing of materials becomes a major issue. In this case it is not always clear what portions of a material or product come from a given region. Knowing the basic effort in value adding processes and the source location of materials is not always easy.

EA also requires a set of numeric calculations and specific parameters that might not be either available or up-to-date in some regions; with developing countries where significant basic resources are extracted is an instance of poor data availability. This limits the results obtained by EA and emergy-based indicators.

Given the complex nature of EA, large-scale production systems – the regional level – can be quite different. These broader levels are used to evaluate the environmental performance which proposes potential uncertainties of the ability of EA in evaluating small-scale production systems (Asamoah et al., 2017).

Another downside of using EA is the level of complexity associated with communicating and explaining the logic behind it. Since EA extends to resources formation level, far underneath the apparent typical production system, it is not an easy task to rationalize system boundaries and results obtained from using Emergy-based indicators which might also be subject to different interpretations (Raugei et al. 2014).

Practical business application for EA also has barriers. Current performance measurement systems are in place. Adjusting these systems for EA would require significant effort. For example, bills-of-material are used to manage many products through enterprise resource planning (ERP) systems, how to tie these systems and their data to EA is not a trivial exercise. Developing the linkages and databases is a major concern. New technologies, such as blockchain technology (Kouhizadeh and Sarkis, 2018) may be useful in this situation as emergy data becomes updated.

Also, it is not clear how the data would take into consideration evaluations of such categories as equipment. First, the calculation of the emergy values is not easily transparent, this data would need to be made more transparent with assumptions and sources. Secondly, given that components such as equipment is based on resources and energy used to calculate their emergy, how do the values get allocated? Equipment may manufacture millions of products over its lifetime. The unit of analysis would be necessary information. Also, a major portion of equipment may be resold or reused, how this end-of-life emergy is assigned also becomes an issue.

Decomposition of emergy information to the factory and product level over the life of an operation, and its after-life needs to be carefully planned. It will likely be based on future forecasts of the life of the product and how many times and ways the material is recycled or reused.

FUTURE RESEARCH

The limited literature integrating EA with other topics such as SSCM indicates considerable potential for future research. In a recent state-of-art-literature review completed by Ansari and Kant (2017), a gap is identified in using emergy as an analysis technique within the context of SSCM.

Application and analysis studies are required at the SSCM level. Potential applications include supplier selection (e.g. Trapp and Sarkis, 2016), supplier development (e.g. Bai and Sarkis, 2010), and supplier segmentation through performance evaluation (e.g. Bai et al., 2017).

Supplier selection may utilize emergy scores to identify which suppliers, their materials, locations, production methods, transportation methods, and systems would be most sustainable. That would mean being able to identify the emergy of each organization and its system. The same information, over time, can be used to determine how well suppliers are performing. Poorly performing suppliers may be identified for supplier development programs.

For future research, integrating the three pillars of sustainability (economic, social and environment) into the applications of EA would fill the gap of the limitations observed with the current one-dimensional and two-dimensional performance measures. Currently, the social pillar is still not fully developed as a measurable dimension with specific emergy-based indicators.

There are hundreds, if not thousands, of models for strategic and operational decisions related to green supply chain and sustainable supply chain management (for example see Brandenburg et al., 2014; Govindan et al., 2015). Integrating EA into these formal analytical green supply chain analysis planning, design, and selection models is a fertile area for research.

To some extent, the scope of EA applications imposes a certain scale for systems' under study, large-scale systems in this case, creating a gap in addressing issues related to systems with other scales (small scales in particular). Thus, assessing the sustainability of small-scale production system is still under presented in the literature (Asamoah et al., 2017).

Using emergy simulation tools is a promising area that can be further developed to measure and optimize certain practices and policies such as by-product activities and waste treatment strategies (Geng et al., 2010).

CONCLUSION

The field of SSCM is still very fruitful research area. It can still be expanded and integrated with other areas to advance both academic scholarship and industrial practice in general. This chapter provides emergy analysis as an emerging concept to investigate and evaluate the efficiency and effectiveness of the environmental performance of businesses and corporations.

Within the context of SSCM, a number of pressures have been identified as triggers for adopting and integrating sustainable practices within the supply chains (Seuring and Müller, 2008). More importantly, serious environmental issues associated with operations and practices of the SC is another critical pressure placed on both individual organizations and supply chains. Thereafter, literature has expanded to meet the need for developing techniques to measure sustainability.

SSCM focuses on the integration of eco-friendly practices with feasible financial planning in addition to maintaining socially responsible standards in dealing with materials, information and capital flows. SSCM literature shows some variations in the number of studies addressing the three pillars of sustainability -- economic, social and environment -- where the economic dimension is extensively addressed compared to environmental and social dimensions.

With the increase in stakeholder pressures, highly competitive environment, and new economic models – such as the circular economy -- the need has also grown for redesigning supply chains to implement sustainable practices. In line with these challenges, organizations seek to measure their performance as an attempt to benchmark themselves and survive against competition. From SSCM perspective, PMs are techniques developed to quantify the efficiency and effectiveness of business processes.

This chapter focuses on the environmental aspect of sustainability and potential ways to measure and quantify the work of nature. EA is presented as a performance measure for sustainable practices within the supply chains such as green supplier selection, development, process design, and circular activities, where environmental performance plays a key role.

Introduced by H.T. Odum in the 1980's, EA is a thermodynamics and general systems theory that is used to quantify the accumulative available energy consumed directly or indirectly to produce a product or a service (Odum, 1996). One of the most distinctive features of EA is its ability to aggregate different flows of energy into a single unit, sej, to make objective comparison between different processes, products or services.

Emergy based indicators are a set of metrics and ratios used to measure the environmental impact along the production process beginning from resource generation to finished product (Odum, 1988). These indicators are useful in supporting policy making processes as they are able to capture different aspects of the SC by addressing various environmental and/or economic indicators. Emergy based indicators can be further developed to address the social dimension of the SC. A brief review of the background of SSCM, EA, and PMs are introduced in this chapter together with its capabilities, limitations and future opportunities.

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KEY TERMS AND DEFINITIONS

Circular Economy: A business model that aims to keep materials and components within a closed loop. **Emergy Analysis:** An assessment tool that quantifies the accumulative available energy consumed directly or indirectly to produce a product or a service.

Performance Measures: A set of indicators used to quantify the efficiency and effectiveness of business processes and activities.

Solar Emjoules: The unit used to measure the total emergy of a particular system.

Sustainable Supply Chain Management: The integration of eco-friendly practices with feasible financial planning in addition to maintaining socially responsible standards in dealing with materials, information and capital flows.

Transformity: A measure of the intensity of the support provided by the natural system to the final product.

Trible Bottom Line: The economic, social and environment dimensions of a business.

Chapter 5
Blockchain Characteristics and Green Supply Chain Advancement

Mahtab Kouhizadeh
Worcester Polytechnic Institute, USA

Joseph Sarkis
Worcester Polytechnic Institute, USA

ABSTRACT

Blockchain is an emerging technology that has been widely hyped for addressing many business issues. Blockchain's disruptive technological capabilities have the potential to revolutionize global supply chain management processes, and impact green supply chain initiatives. Blockchain technology incorporates four major characteristics: transparency, reliability, smart execution, and tokenization. Blockchain characteristics have implications for green practices in the upstream supply chain, focal company, and downstream supply chain. This chapter provides insights, exemplary practices, and use cases on how blockchain features can enhance green supply chain activities. Research concerns and directions are proposed to advance the discussion and research on this emergent field.

INTRODUCTION

Rapid growth in technological advancement offers new potential and opportunities for supply chain management. Industry 4.0, as a business paradigm that supports digitalization, has substantial influence on supply chain models and practices. Industry

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4.0 refers to the use of digital technologies to automate manufacturing processes and building smart factories, also termed smart manufacturing. The evolution of these systems has been occurring for decades as now the information interconnectivity has created a new paradigm for modern manufacturing and supply chain practices (Khan et al., 2019).

Supply chain networks will need to transform. This transformation will include redesign of their governance, manufacturing processes, facility layouts, and location to support Industry 4.0 principles (Hofmann & Rüsch, 2017). Industry 4.0 connects multiple organizations along supply chains and enables flexible and smart process design by incorporating information, cyber-physical systems and Internet of things (IoT) devices that collaborate with each other without human intervention (Ivanov et al., 2018; Liao et al., 2017). Industry 4.0 can enhance environmentally and socially sustainability value in supply chains. Smart data acquired from digitalized processes can help companies build closed loop product life cycles, form industrial symbiosis relationships, and develop sustainable business models that minimize the negative environmental impacts (Bocken et al., 2014; Stock & Seliger, 2016).

Blockchain, also known as distributed ledgers, is an emergent technology that may be an integral development for the Industry 4.0 paradigm (Xu et al., 2018). Transactions generated by autonomous and cyber-physical devices can be recorded on blockchains. Blockchain technology is defined through distributed ledgers that collectively maintain data in a secure and verifiable manner (Swan, 2015). Blockchain ledgers can link all supply chain entities. It can digitalize various types of supply chain transactions, including the history of materials and products, transportation information, financial documents, and agreements (Kouhizadeh & Sarkis, 2018). Green initiatives embedded in transportation and distribution can positively affect the organizational performance (Khan et al., 2018b). Lower transaction costs and enhanced efficiency, security and transparency facilitated by blockchains motivate supply chains to move toward this new technology (Saberi et al., 2019a). These motivations can be substantial, but organizations and their supply chains will face significant barriers and will require enablers to overcome the barriers.

Blockchain technology, although a relatively contested definition with much variation, can generally be associated with four major capabilities: (1) transparency, (2) reliability, (3) smart execution, as well as (4) tokenization. Shared ledgers among authorized participants of the supply chain network enables transparency and traceability of information. Reliability of information is supported by cryptographic structure of blockchain that elevates the level of security; and with multiple organizations or actors validating the information. Smart execution comprises rules and conditions of contracts and triggers the underlying actions in a digital way. Tokenization refers to cryptocurrency application of blockchain that can promote blockchain adoption, incentivization, and further facilitate blockchain governance structure in supply chain networks. These blockchain features can support green supply chain management in many different ways.

This book covers green supply chain management from many perspectives. So the authors will only keep the definition very general. Green supply chain management incorporates material, finance, and information flow in supply chains while addressing environmental degradation issues. Companies may seek to adopt eco-friendly practices, especially green supply chain management to gain competitive advantage, better image, and attract environmentally cautious customers. There is a wide range of factors that may drive companies to adopt green practices. Governmental pressures and regulations, customer need for green products and sustainable activities, and competitor and supplier pressures, and even investor pressures, are some example pressures that can prod companies to adopt green practices (Diabat & Govindan, 2011; Hervani et al., 2005; Walker et al., 2008; Zhu et al., 2016).

Non-governmental organization (NGO) pressures on organization to meet societal expectations about sustainable practices is another motivator for green initiatives. The personal motivation of individuals to adopt eco-friendly practices and reduce waste and pollutions, organizational attitudes and values (culture), employee involvement and awareness about green processes, and leadership and internal integration are some internal drivers that promote integration of green paradigm (Graves & Sarkis, 2018; Graves et al., 2019). Green supply chain practices initiatives should be embedded in organizational strategy, culture and behavior, which were driven by a focus on cost reduction, waste and pollution elimination, and quality improvement (Sarkis et al., 2011). Companies can improve risk management in the supply chain and collaborate with other supply chain partners to minimize environmental impacts of materials and equipment.

There are a range of green supply chain practices that include upstream and downstream efforts, in addition to internal supply chain activities (Sarkis & Dou, 2017). There are also supply chain loop-closing activities such as reverse logistics that are important for green supply chain activities (Sarkis & Zhu, 2018). Activities may include supplier development, investment in technology, and managing of collaborations for greening (Bai et al., 2016). These and other examples will be presented later in this chapter.

This study seeks to provide some insights into the linkage of blockchain technology, as an enabler of digitalization and Industry 4.0, and to effectively support green supply chain initiatives. To achieve the goal of this chapter, an overview of blockchain technology and its underlying characteristics are presented in the next section. Then the discussion continues and elaborates how blockchain characteristics can contribute to green supply chain initiatives in the upstream supply chain, focal company, and downstream supply chain. Example practices and use cases are provided. The research implications section includes the potential for future research in this area. The final section specifies the summary of the discussions.

BLOCKCHAIN TECHNOLOGY AND ITS UNDERLYING CHARACTERISTICS

Blockchain technology was initially invented to support bitcoin, a digital cryptocurrency that facilitates transaction between unknown parties without intermediaries, such as central banks (Nakamoto, 2009). Blockchain is a digital technology platform that records transactions on decentralized and encrypted ledgers. Blockchain includes decentralized ledgers of transactions that are recorded and shared among the participants of a network. The transactions are recorded as forms of blocks. Each block includes timestamp data and a link to the previous block, creating a chain of digital blocks that describes the term "blockchain" (Nakamoto, 2009; Swan, 2015).

Blockchain ledgers can link all network members in a decentralized manner on a peer-to-peer network. This characteristic ensures the credibility of transactions that is determined by the network itself, rather than central authorities. The verification or consensus requirements can be defined by network participants (Crosby et al., 2016). Depending on the extent of visibility and information of ledgers, different types of blockchains may exist. The major categories, at each extreme include public versus private – permissioned -- blockchains (Ølnes et al., 2017; Pilkington, 2016).

Public blockchains incorporate anonymous users that exchange information on a public platform, where anyone can create a new transaction and track the information. Bitcoin and cryptocurrencies are examples of public blockchains. Alternatively, private blockchains contain known network participants, who need permission to see, update, or produce transactions. A hybrid combination of private and public blockchains can also be developed to incorporate the benefit of both types of blockchain governance.

Beyond cryptocurrencies and financial applications, blockchain technology provides a platform that shows promise to benefit and transform supply chain management. Blockchains can collect and integrate significant and multiple forms of information in supply chains (Saberi et al., 2018; Saberi et al., 2019b). In many cases, supply chain network members are known and trusted. Although, supply chain members might hesitate to share their critical information, such as capacity information or financial performance, even with known trusted parties. This characteristic and reality attests to the appropriateness of private blockchains for supply chains, where restricted access to known members should be given to allow them to track and validate information.

Nevertheless, blockchain is introduced as a technology that removes central authorities and intermediaries from transactions. The use of private blockchains in which central parties control accessibility to the ledgers may move the system concept toward centralization and limit the full advantages of blockchains. There might be other centralized system solutions, like cloud systems, that provide supply chain visibility without the technical difficulties that blockchains may offer. Therefore, the usability of blockchain as an emergent technology in supply chains and the underlying governance structures is still debatable and requires addressing nuances. The technology has limitations and alternative information and data sharing technologies should be carefully examined when blockchain is to be considered.

Blockchain technology inherently shares some characteristics. The integration of these characteristics make blockchains unique and motivate broader adoption of this technology. These corresponding features include transparency, reliability, smart execution, and tokenization.

Transparency involves the visibility of information to the related actors in a blockchain platform (Mougayar, 2016). Blockchain ledgers are available to everyone in a public network and authorized parties in a private system. Every network participant holds a synchronized copy of blockchain ledger, which is updated with the verified transactions in a real-time manner. This characteristic can provide transparency and traceability to transactions. These factors represent an urgent need for a variety of multi-national multi-layer supply chain networks, especially in green context. A transaction may reflect the quantity, quality, or features of products, and the resources products consumed and the related actors who handle the products through the supply chains (Kouhizadeh & Sarkis, 2018). This information can be instantly available on blockchains and traceable and verifiable by supply chain members. Improved transparency and traceability can add value to the supply chains which in most cases suffer from disparate data management systems, such as Enterprise Resource Planning (ERP). These disparate systems make it difficult to access, integrate and trace data from complex multi-echelon supply chain networks.

Reliability is maintained through high security levels and participant consensus in blockchains. Enhanced security stems from three principles: encryption, immutability, and decentralization. First, blockchain technology utilizes encrypted ledgers. Every user on a blockchain has a private key with a personal digital signature. Encryption and cryptography are integral elements of blockchains to enhance security and reliability of information. Second, blockchain ledgers are immutable and append-only, meaning that the verified information cannot be removed or changed without obtaining network consensus. This requirement further increases the level of security and prevents data manipulation, forged documentation, and counterfeit products in supply chains. Third, blockchain ledgers are decentralized and shared among the network. Decentralized structures further make blockchains tamper-resistant. The information is distributed and no central location or single point of failure exists; it would be extremely difficult to hack or attack multiple databases simultaneously. Reliability of information is the essence of green initiatives. Actors located in different levels in supply chains need to ensure about the authenticity of information; their provenance. For example, they need to ensure that a purportedly green product is actually green or ethically sourced.

Smart execution refers to automatic, digital execution of actions based on the predefined rules and conditions stored in smart contracts. In other words, blockchain technology contains smart contracts that incorporate rules, conditions, and agreements of a contract on a digital platform (Giancaspro, 2017). Users can define the terms, conditions, and the corresponding actions of a contract as smart contracts. When a term or condition is met, the underlying action to that condition would be triggered automatically by the system. This feature distinguishes blockchains from similar cloud-portals and further support Industry 4.0 principles that seek to implement full automation in a manufacturing industry.

For example, product return conditions can be defined as smart contracts. When a returned product is received by the manufacturer, an automatic payment would be executed based on the conditions of the product. Another application of smart contracts is in allowing permission to blockchain users and converting a public blockchain to a private one with restricted access. The Ethereum blockchain platform (Mougayar, 2016) is an exemplary application that can build a private blockchain with the use of smart contracts. In this case, a smart contract stores the permission rules and authorizations of users to ensure that all users do not have equal rights to interact with the system and their access would follow predefined rules.

Tokenization represents the actual value that is generated and managed by blockchains. Specific assets such as currencies, lands, materials and products can be stored as digital tokens on blockchains. Digital tokens can be in form of cryptocurrencies, which are the most popular applications of blockchains. Tokenization leverages blockchain adoptability and creates novel business models for blockchains implementation. In terms of consensus and encouraging participants to help manage blockchain information, users can verify transactions and be rewarded as forms of cryptocurrency tokens. Digital tokens can also be used to reward users for doing certain behavior. For example, green practices in the supply chain can be rewarded as forms of cryptocurrency tokens; which may be non-country specific and easily transferable. Cryptographic tokens can act as the main drivers that incentivize users to be involved with the system, be rewarded, and keep the integrity of transactions.

In the next section, the application of each blockchain characteristic in addressing some green supply chain concerns is delineated. These are only exemplary with many additional issues, some that exist some that will emerge in the future to be addressed.

BLOCKCHAIN TECHNOLOGY AND GREEN SUPPLY CHAIN

Blockchain technology has the potential to support green initiatives in the supply chain. This section exemplifies how blockchains characteristics and capabilities; specifically transparency, reliability, smart execution and tokenization, can improve and address environmental concerns in the whole supply chain. The three supply chain dimensions include the upstream supply chain, focal company, and downstream supply chain. Table 1 summarizes how blockchain's underlying dimensions – the columns -- enable green practices in different supply chain stages – the rows.

Blockchains and Greening the Upstream Supply Chain

Upstream supply chain activities typically include purchasing, sourcing materials and products, and supplier selection, vendor management, and supplier development. Blockchain technology can transform upstream activities in the supply chain. Materials that flow from suppliers to the buyer company can be better controlled and traced through the supply chain. The history of materials and products are transparent on blockchain ledgers. Thus, all of the authorized supply chain members can obtain accurate information regarding the sources that materials are extracted from and whether environmentally sound resources and materials were utilized. Whether the materials are renewable green resources or where they were located such as in environmentally sensitive areas would be exemplary information. Renewable energy and green resources have considerable contribution in minimized negative

Table 1. Blockchain technology supported green initiatives in supply chain

	Transparency	Reliability	Smart Execution	Tokenization
Upstream Supply Chain	● Green source of materials and products. ● Suppliers' green performance.	● Prevent data falsification in sourcing. ● Share tamper-resistant information.	● Supplier development programs.	● Rewards for adoption of renewable resources.
Focal Company	● Green process analysis and continuous improvement.	● Manage environmental certificates.	● Waste reduction programs.	● Carbon offset tokens.
Downstream Supply Chain	● Demand management. ● Product life-cycle analysis.	● Restore customer trust in product safety. ● Identify counterfeit green products.	● Automatic payments for returns.	● Second material/ product market ● Rewards for bringing back the recyclable wastes.

environmental effects and enhanced economic growth (Khan & Qianli, 2017; Khan et al., 2018a).

High levels of information transparency provided by blockchains can further help companies to trace green performance of suppliers. This information can also include processes and materials performance. Companies can use this information for supplier selection, partnering with suppliers who have better environmental performance. Example information may mean carbon footprint and renewable energy usage by suppliers. Renewable energy sources is a main factor in green supply chain performance (Yu et al., 2018). Also, the use of critical or hazardous material may be recorded; verified blockchain data for material safety data sheets (MSDS) may be an example.

Blockchain technology provides a reliable information sharing platform that helps companies prevent and detect fraud, pilferage or falsification in green initiatives (Benjaafar et al., 2018). Secure information on blockchain ledgers can ensure companies that provide products that are really environmental friendly and the chain of custody is genuine. The transparency allows user to see the information and trace it, reliability that it is true is an important provenance characteristic. This reliability helps reduce the possibility of 'greenwashing' and building environmental consumer confidence later in the supply chain.

Smart contracts that store codes of conduct further support automation and Industry 4.0 principles in green supply chains. Supplier development programs that concern supplier environmental knowledge and performance can be coded and executed through blockchains execution.

For example, green supplier development (Bai et al., 2016) can effectively use this information. Sometimes suppliers need to build their knowledge and expertise with the help of a focal company, or other partners. Educational programs can help this effort. The type of educational program that is based on current suppliers' performance and the necessary resources that are needed can automatically be triggered by smart contracts based on the predefined conditions. The type of knowledge, educational practices, and the performance of such programs can be traceable on blockchains (Kouhizadeh & Sarkis, 2018). This application can provide fundamentals to improve the effectiveness of supplier development programs.

Tokenization is another feature that can bolster green initiatives. As an example, in upstream supply chains, suppliers that utilize renewable resources can be rewarded as forms of cryptocurrency tokens. For example this may be an effort to help in carbon neutrality of supply chains. This incentivization of green sourcing behavior helps motivates companies to move toward green energy resources. Other practices to encourage environmentally sound organizational behavior can also be incentivized.

Blockchains and Greening the Focal Company

Focal company supply chain activities internally incorporate process and product design, production, and materials management activities. The industrial revolution provided by Industry 4.0 moves manufacturing companies toward full-automation. Autonomous robots, artificial intelligence, additive manufacturing, and IoT devices can each help manage real-time data to blockchain ledgers. Digitalized integrated information available on blockchain ledgers can prove essential for process design and continuous improvement; and to address natural environmental issues. A focal company can analyze the blockchain data and design green and smart closed-loop production processes. Green product design and green operations can further boost organizational performance (Khan et al., 2019). Companies can evaluate and manage environmental performance of their internal processes. With these tools and data they can reduce the negative environmental effects such as green-house gas emissions, water and energy use, and hazardous materials in their processes. In addition, the environmental effect of these activities and characteristics to the whole supply chain can be integrated and measurable on blockchain ledgers. The additional transparency can aid the focal company to diffuse green practices and expertise along the supply chain.

Environmental management systems (EMS) and certifications -- ISO 14001 as an example -- were developed to standardize corporate green activities and provide a framework that help them reduce their negative environmental effects and aspects (Jiang & Bansal, 2003). Blockchain technology can link all the geographically dispersed entities to facilitate certificate management. This is especially more important for global multi-national companies that are distributed in multiple regions where regular audits may be burdensome. Environmental certification documents and audits can be recorded and verified on a reliable and secure platform provided by blockchain technology. Secure data shared on blockchain ledgers prevent data manipulation and fabrications that may be done to acquire and maintain environmental certificates.

Smart contracts can be used for recording and evaluating whether waste reduction metrics, criteria and conditions are met. When the focal company reaches wastes limits, blockchain smart contracts can notify the company and smartly execute the corrective actions, whether suggesting to update the machines or optimize processes. This effort is more important when hazardous wastes and toxics are produced during the production processes.

The information gathered in the production processes can be utilized to design processes with minimum wastes and improve industrial symbiosis principles, where wastes and by-products can provide useful inputs to other companies. Waste trading programs can further be managed and automated through smart contracts; with payment through tokens.

Blockchain technology can record carbon footprint of products and companies. The accurate data regarding the amount of carbon emissions can be utilized to assess the amount of carbon tax that a company should be charged and allows companies to manage their processes to support low-carbon footprint. To minimize the accumulation of greenhouse gas emissions, carbon credit markets have been formed to trade for carbon credit offsets (Diabat et al., 2012). Blockchain technology provides a platform that supports the performance of carbon credit markets to exchange carbon credits. The amount of available carbon credits can be recorded as blockchain tokens and be traceable and verifiable on blockchain ledgers. Governments and policymakers can further take advantage of the collective carbon credit information available on blockchains to make policies and rules regarding the emission allowance, the optimized market price for carbon and the emission market performance. Acquiring and integrating such information in an effective way is difficult, because of the traditional detached markets. Organizations can be involved more effectively and efficiently by monitoring their processes for carbon emissions that may be validated by 'on-the-ground' agents who are third parties (individuals and NGOs) who can be paid for certification efforts through tokens.

Blockchains and Greening the Downstream Supply Chain

The downstream supply chain refers to various practices that are mainly customer-centric and address customers' needs and concerns. Exemplary downstream activities contain sales, marketing, distribution and logistics, and reverse logistics, such as reusing, recycling, revitalizing, and remanufacturing components and products.

Blockchain technology supports effective demand management (Ivanov et al., 2018). Information regarding customer demands, needs, and pre- and post-purchase behavior can be recorded on blockchain ledgers. The transparency and traceability of information facilitates accurate demand forecasting that can help companies save inventory costs, mitigate wastes, and reduce risks.

Transparency and accuracy of information can bolster product life-cycle analysis. Companies can track the products through their life-cycle and at the end of life when the product is back to the supply chain. This can further help supply chains to investigate the durability of products and design products with maximum circular values (Zhu & Kouhizadeh, 2019). Many times it is not clear where products are after sale, especially products that may require returns based on regulations – for example electronic wastes. These end-of-life products may be the responsibility of various actors in the supply chain. Knowing where they are, their condition, and their material characteristics, can all be included in blockchains that may be widely visible and traceable. This situation can make green and reverse logistics and various recovery operations more efficient and effective.

Reliable information available through blockchains can ensure customers about the source of green products, green transportation, and authenticity of information. A blockchain that is leveraged with IoT, sensors, or traceability devices, such as GPS, can generate automatic real-time information about the sources, locations, and condition of products. Customers can trace the journey of materials and products, involved entities, green certificates and quality control experiments on blockchain ledgers with extra layer of security and reliability through cryptographic mechanisms and consensus requirements. This reliability is critical for maintaining or restoring customer trust in product stewardship. This may be especially pertinent for high value goods or perishable items like food, where safety is an integral need. Reliability and verifiability of information provided by blockchains can further help customers to distinguish counterfeit and fake green products; further preventing the greenwashing of green products.

As mentioned in transparency and secure reliable information, blockchains can be utilized to track the location of materials and products at the end of their life-cycle. Smart contracts can capture the conditions and necessary actions needed to return products back to the supply chains. When a returned product is received, smart contracts can automatically notify the related parties in the supply chain and execute the payments and related processes. This can greatly enhance collection and sorting activities without the necessary intermediaries. It will require an infrastructure that can do this with unmanned collection centers. Payment, from the smart contract can be through tokenization. More incentive and tokenization mechanisms are now discussed.

Blockchain technology can form a market for circular economy activities. These example activities include sharing, servicizing, leasing, or trading second-hand materials and products (Kouhizadeh et al., 2019). Each product or asset can be defined and valued through tokens. They can be recorded and traded through blockchain-supported markets. Those companies that are more involved in circular economy activities and trading second-hand products can be rewarded in forms of cryptocurrency tokens. Moreover, customers who return products at the end of life cycle or bring wastes back to the system can be incentivized and rewarded cryptocurrency tokens. This financial incentivization can further encourage adoption of green behavior in customers.

RecycletoCoin (2019) is an example blockchain-based mobile application developed by Blockchain Development Company that rewards customers in forms of cryptocurrency tokens for returning the recyclable wastes to participating stores. To leverage and increase the operability of RecycletoCoin incentive system, Blockchain Development Company utilizes the Scannable Quick Response (QR) codes that maintain the token credits in their account and are redeemable for exchanging with gift cards or donating for non-profit environmental safety programs.

These are only some example practices. Given the potential for various elements of blockchain as a collaborative supply chain instrument can provide more direction for future ways to improve environmental performance of supply chains. There are also barriers and costs, even environmental costs, as blockchain energy requirements can be quite substantial. Which brings this discussion to a number of research questions and implications; some of which are now highlighted.

FUTURE RESEARCH DIRECTIONS

Blockchain technology as an enabler that can alleviate traditional supply chain problems and elevating provenance of materials and products has received great attention from business practitioners and researchers. However, this technology is still a 'contested concept' and clarifications are needed to address a better and clearer definition of what a blockchain entails. A comprehensive review is needed to describe the technology itself and the required technical advances and improvements. More research is also needed to address the potentials of blockchains in solving different business problems discussing if the problem is solvable without blockchains, as well as the caveats and disadvantages in apply blockchain to the many dimensions have been examined.

Although there is significant growth in blockchains supply chain use cases, the majority of use cases evaluate blockchains through pilot projects and experiments. The applicability of blockchain in real-world situations and the required business models and governance structures to support blockchain application in the supply chain can shed the light on the future research in this area.

Furthermore, the technical difficulties of blockchains requires further investigation. For example, blockchains are still immature and face scalability issues that prove difficult in managing big data. This is a common case for supply chain where big data is gathered from numerous multi-faceted multi-layers resources. How blockchains should be improved to fully support supply chains' issues and needs can be addressed in future research.

Supply chains have legacy systems and processes. An important concern in the blockchain adoption and application is how does the supply chain have to be reengineered? Greening issues are also concerns not only for members of the supply chain operations team, but a variety of stakeholders, both internal and external to the supply chain. How their roles evolve will require further investigation. Will certification agencies be involved in the future when information is readily available and transparent? Will global supply chains be more or less efficient as governments and policies tend to differ? How will blockchain and its smart contracts and data requirements vary? Can we learn from legacy information and process systems? Will tokenization be acceptable and follow fiduciary rules? These are only some of the many research questions that need to be investigated and evaluated. Blockchain may be a very disruptive technology that requires research; especially if the promise is to be fulfilled.

CONCLUSION

In this chapter, blockchain, as an emergent technology that can have various implications for supply chain management, has been introduced. Then blockchain technology characteristics and features are described and their implications in a supply chain context is examined.

This chapter mainly aimed to illustrate how each blockchain characteristic can support green initiatives in different supply chain stages: upstream, focal company, and downstream supply chain stages. Some exemplary use cases, potentials and examples were provided to elucidate the application of blockchain features in addressing environmental issues in the whole supply chains. The discussion is continued by adding research concerns and implications.

Given that blockchain is a relatively new technology and its implications and operability for supply chains is still controversial, further investigations and clarifications are needed to examine blockchains applications in addressing sustainability and supply chain issues. In this chapter, the main focus was on environmental concerns. Similar to green values, blockchains may address other sustainability dimensions in supply chains: economic and social issues. A similar study may evaluate the potentials of blockchains in addressing financial aspects and social dimension and extend what is reviewed in this chapter.

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KEY TERMS AND DEFINITIONS

Blockchain Technology: A digital technology that incorporates distributed ledgers of transactions that are shared among the participants of a given network.

Circular Economy: A principle that refers to manage the practices that seek to minimize wastes, reuse, revitalize, regenerate, and recycle materials and products.

Green Supply Chain Management: An integrated design of environmentally-friendly initiatives and supply chain management.

Industry 4.0: A business paradigm that focuses on the full digitalization and automation in the manufacturing industry.

Supply Chain: A network of companies involved in the supply chain activities that aim to create, sell, and deliver goods and services to the customers.

Supply Chain Management: The management of the flow of goods, finance, information and services from the original suppliers to the end customers.

Sustainability: A principle that incorporates environmental, social, and economic consideration into processes and activities.

Use Case: A practical situation that demonstrates the possible use of an innovation.

Section 2

Chapter 6
Green Product Innovation and Financial Resource Availability:
Multi-Actor Model Approach

Haroon ur Rashid Khan
Nanjing University of Information Sciences and Technology, China

Zubair Rashid Khan
COMSATS University, Pakistan

ABSTRACT

There is dire and critical need to deeply understand green consumers, given the implications for marketers to comprehend and communicate green buying patterns on the one hand, and to design and strategize both product range and motivation and financing available to develop them on the other hand. The chapter is built on theory Rational Choice and Revealed preferences Theory, while extending using experimental approaches involving multi actors' model. The multiple actors included consumer with their preferred order of choices, entrepreneurs with their preferences, and financiers with their preferred order, under the budget constraint. This chapter interacts with practical aspects of green product innovation behavior in general, and advances research with a focus on specific behaviors, highly desired in this field investigating the rise of green purchases. Globally, consumers are increasingly acquiring green products, and this study indicates to an improved understanding of the decision-making process of consumers' green product.

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INTRODUCTION

Meanwhile, the upsurge of green consumption has garnered inquisitiveness from academic circles over the years (Chang & Chen, 2013; Codini, Miniero, & Bonera, 2018; H. ur R. Khan, Ali, Olya, Zulqarnain, & Khan, 2018; Syed Abdul Rehman Khan, Golpîra, & Yu, 2018; Syed Abdul Rehman Khan & Qianli, 2017b; Miniero, Codini, Bonera, Corvi, & Bertoli, 2014; Zhang, Khan, Kumar, Golpîra, & Sharif, 2019). The prior researchers have attributed this drift in buying of green innovative products to the several reasons. It is believed to be either a consequence of improved environmental knowledge driven by consumers' environmental concerns, (Abeliotis, Koniari, & Sardianou, 2010; Diamantopoulos, Schlegelmilch, Sinkovics, & Bohlen, 2003; Syed Abdul Rehman Khan & Qianli, 2017a; Z. Khan & Nicholson, 2014, 2014; Reynolds, Simintiras, & Diamantopoulos, 2003; Walker, 2013), or the result of socially responsible decision-making processes imminent after personal ethical considerations or a set of sustainable and green personal principles and attitudes (Anderson Jr & Cunningham, 1972; Antil, 1984; S. Abdul Rehman Khan, Jian, Yu, Golpîra, & Kumar, 2019; Syed Abdul Rehman Khan, Dong, Zhang, & Khan, 2017; Syed Abdul Rehman Khan, Sharif, Golpîra, & Kumar, 2019; Syed Abdul Rehman Khan, Golpîra, et al., 2018; Webster Jr, 1975; Yu, Golpîra, & Khan, 2018), other motives that may describe the increase of green consumption, are the attributes and areas of green products innovation for instance.

Environmental consciousness and gearing attitudes on the way to "green consumption" are evident in world leading economies. Despite the popularity of green products, the market share of these products continues to be low in the entire market (Bray, Johns, & Kilburn, 2011; Syed Abdul Rehman Khan, 2019; Syed Abdul Rehman Khan, Golpîra, et al., 2018; Zhang et al., 2019). Several authors including (Babiak & Trendafilova, 2011; H. ur R. Khan et al., 2018) have explored young consumers' attitudes toward eco-friendly products. Since the environmental movement of the 1960s, green consumption has been identified as a pro-environmental behavior (Alwitt & Pitts, 1996; Syed Abdul Rehman Khan, Dong, & Yu, 2016; Syed Abdul Rehman Khan et al., 2017; Syed Abdul Rehman Khan, Zhang, Anees, et al., 2018; Mostafa, 2006; Shrum, McCarty, & Lowrey, 1995) . A green consumer cogitates physical environmental concerns in consumption decisions (Syed Abdul Rehman Khan & Qianli, 2017a, 2017b; Syed Abdul Rehman Khan, Zhang, Golpîra, & Dong, 2018; Ozusaglam, 2012; Shrum et al., 1995). Thus, a green purchase occurs when consumers procure green innovative products related to energy conservation, low carbon emission, solid waste reduction etc (Mostafa, 2006).

With few exceptions, European advanced economies have high consumptions. Thus, it is vital to understand these population segments in terms of numbers and purchasing behavior of eco-friendly products with green innovative practices. Although new generation is getting more actively involved in addressing environmental issues, demonstrating high levels of interest in learning about environmental problems and even hoping for careers in sustainable companies besides entrepreneurial intentions for developing such products. The issue of affordability in consumers choices and availability of financial resources from financiers for green innovation to tackle environmental and energy related issues is a major concern.

The objectives of this chapter are to identify the preferred areas of green innovation practices and advice the practitioners and financiers to align the varying set of preferences. The findings provide unique set of preferences to academics and practitioners underlying the peculiar nature of the research.

The authors have conducted this study a western European country of France, who has one of largest percentage of population with flair for green innovative products. France is best known for its stances on climate change, environmental hazards, sustainable goals, low carbon emissions, clean energy and its commitment both at public and private level is unparalleled in contemporary world. Similarly, the entrepreneurs are highly interested in solving the issues though innovation and elopement of green products. Regulators and funding agencies are most open to novel ideas and sponsoring green product innovations. This has offered France a unique place to conduct these experiments with ideal and green sensitive actors for their role plays.

In this study, through several interviews from academics and practitioners in the area, we have shortlisted the green innovative management practices related to the certain areas.

These identified areas are quintessential for identifying the purchase intentions from consumers' perspectives as well as entrepreneurs and financiers related to the green innovative products. These attributes determine the green innovation in products and the preferences as identified by the varying set of groups including consumers, entrepreneurs and Financiers.

Three experiments were performed, in the second phase to match and contrast the choices among consumers, entrepreneurs and financiers. In the first experiment, we asked about the purchase intentions of green innovative products related to above-mentioned areas. The pricing and affordability were also an essential actor in purchase intentions for the green innovative products.

In the second experiment, we explored the effect of financial resources availability to the entrepreneurs with intentions to develop such innovative products in the above-mentioned fields.

In the third experiment, we asked the fund managers of venture capital. They have been asked to identify the top four areas as per the preferences and within a given budget constraint.

The research paper has been structured in the following sections. Introduction is followed by the section, which describes the theoretical background. Then, the proposed experiment is explained. Subsequent section is dedicated to findings; while lastly, conclusions as well as theoretical and managerial implications are discussed.

THEORETICAL BACKGROUND

The pro-environmental behavior of consumers and entrepreneurs has remained a complex research topic of interest. The purchase intentions and green innovation relationship has been investigated through a range of frameworks describing relationships among several demographic, socioeconomic, psychographic and behavioral factors. Nevertheless, the economic intention and question of availability of financial resources in this comportment is yet to establish. Under the budget constraints, real behavior may diff from the intentions expressed in survey-based studies.

This research has extensively borrowed the concepts from the pervasive theories, like rational choice or consumer choice theory and the theory of revealed preferences, to identify and match the top preferences green innovation in products as ranked by consumers, entrepreneurs and fund managers.

Purchase Intentions

The intentions are consequent of prime specific desires for satisfaction and shaped by choices through which satisfaction can be accomplished (Boella, 2002). The green purchase behaviors of individuals are transformed and driven by their economic intentions. Existing theories that incorporate intentions unequivocally mainly focus on economic intentions (Groening, Sarkis, & Zhu, 2018; Kushwah, Dhir, & Sagar, 2019). These economic intentions can be best explained by the theory of rational choice and theory of revealed preferences.

The **theory of revealed preferences** (Samuelson, 1938) is an economics theory, which posits that consumers' preferences can be revealed, by what they purchase under different circumstances, predominantly under different income and price settings. The theory requires that if a consumer purchases a particular pack of goods, then that bundle be *"revealed preferred",* given constant income and prices, to any other bundle that the consumer could afford. By changing income or prices or both, researcher can infer a representative model of the consumer's preferences (Bakker, Groenewegen, & Hond, 2005; Dyer & Jia, 2013; Groening et al., 2018; Kushwah et al., 2019).

Elucidations and forecasts of individual choices are commonly in the light of notion of human rationality, by which an individual utilizes to enhance his advantages (Gilovich, Vallone, & Tversky, 1985; Tversky & Kahneman, 1989, 1991). The *Rational Choice Theory* (RCT) demonstrates that individual practices are because of individual cost inclinations and institutional requirements, for example, the standards and traditions of a given social setting (Friedman & Hechter, 1988). Cost preferences allude to the opportunity costs in picking one alternative over another. *Buyer choice theory* (BCT) is a subset of *Rational Choice Theory*, with an emphasis on purchaser purchase choices (Hands, 2009). Numerous sorts of choice factors can influence green consumption, and the planning of their calisthenics by respective green entrepreneurs. For example, choice factors - cognitive, ethical, social, geological and economic variables - were utilized to demonstrate the determinants of neighborhood woodland carbon-counterbalance valuation in Guadalajara, Mexico (Torres, MacMillan, Skutsch, & Lovett, 2013).

Different researchers have explored the certain where the choices of green products and the concept of utility maximization is consistent. For instance, this theory has been used to explain how the price of green products affects individual utility functions; green purchasing decreases as prices for green products increase (Abaidoo, 2010). Optimization of a consumer's utility was found to be positively related to the consumption behavior of her reference groups, past consumption behavior, green product variety, and negatively related to the quantity of green product consumption (Welsch & Kühling, 2011).

Theory can give extra understanding into green advertising and marketing. For example, research about has connected expansions of these conjectures to discrete decision and expressed reference models for green products and administrations (Chen, 2001). Nevertheless, while existing green product innovation studies are survey centered, research has not utilized experimentation technique with Consumer decision conjectures and rational choice and preferences theory. For example, the scarcity rule, where shortage exalts the worth or desirability of merchandise, could be inspected in a green purchases setting. Such an examination could give fascinating outcomes in light of the fact that the buy decision procedure for green products can be more intricate than for customary products, however scarcity modifies the basic decision-management process. That is, in what manner will these two contending basic management concepts will connect? (Groening et al., 2018). Therefore, the study has conjectured the ordered preferences to understand the peculiarities of the green purchases and green product innovation development alongside financing issues.

Green Product Innovation

An increasing number of companies are considering green and environmentally friendly products as part of their corporate strategies. The society, the government and other stakeholders (employees, customers. etc.) are aware of environmental concerns. Green product innovation includes actualizing new or changed procedures, strategies, and frameworks to lessen environmental damages and can be viewed as a specialized innovation process (Henriques & Sadorsky, 2007; H. ur R. Khan et al., 2018; Rothenberg & Zyglidopoulos, 2007). In addition, implicit and responsive strategies lead to constant gradual changes in tasks as well as products while environmental products involve fundamental and consistent changes. The technological characteristics must be considered while analyzing the product innovation. The explicit ecological management is linked to radical innovations, whose selection requires significant financial commitments at the development stage. However, when effectively structured, enables managers to more readily control the change procedure, reduce sunk costs and, in the end, improve an organization's productivity and profitability (Azzone & Noci, 1998b, 1998a). Also, an explicit management is essential when environmental concerns are being exploited are take achieve competitive advantage (Hutchinson, 1996; Shrivastava, 1995, 1995). In particular, countries where the market is described by a high ecological mindfulness and guidelines set tough environmental norms in the product introduction and process 'green' innovations may lead an organization to improve its market share or potentially lessen conservative endeavors related with environmental management. Also Studies investigate how activities, promoting, inbound and outbound logistics should change as indicated by an eco-proficient point of view (Engelen, Gupta, Strenger, & Brettel, 2015; H. U. R. Khan et al., 2019; Z. Khan & Nicholson, 2014; Quakernaat & Weenk, 1993). Most studies on green product innovation center around large corporations; however small business endeavors manage the environmental challenges through certain receptive activities due to their small size. Even though this adaptability encourages favorable circumstances when managing the multi-dimensional nature and expansive extent of environmental innovation. Studies feature that budgetary constraints and limited administrative control in small enterprises reduce their ability to enact new associations with nontraditional partners (e.g. public administration, competitors, companies providing logistics services, research laboratories) may represent an obstacle to the development of `green' technological innovations. Henriques and Sadorsky (2007) argued that environmental technical innovation involves adopting end-of-pipe technologies and clean production technologies

Also some studies on green technical innovation suggests that the nature of technology is a pertinent characteristic that is affecting the adoption of new technologies (Chau & Tam, 1997; Frambach & Schillewaert, 2002; Tornatzky, Fleischer, & Chakrabarti, 1990). Qualities of new technology, for example, similarity, compatibility, complexity multifaceted nature, and relative preferred position may influence its selection (Groening et al., 2018; Jeyaraj, Rottman, & Lacity, 2006; Rogers, 1995; Tornatzky et al., 1990). Frambach and Schillewaert (2002) place the apparent attributes of the innovation at the core of their hierarchical innovation selection. Another researcher (Boiral, 2002) contends that qualities of environmental learning are pertinent in environmental product management. Henriques and Sadorsky (2007) argued that environmental technical innovation involves adopting end-of-pipe technologies and clean production technologies. Previous studies suggest specific rules and methods for green product designs and methodologies which support in the design of new products according to an ecological perspective. However, these methodologies often do not account for the economical and managerial consequences of `green' design solutions (Charlton & Howell, 1992; Linnanen & Halme, 1996; Welford, 2016). This paper contributes to this debate, investigating whether `green' product innovation may occur and may have strategic implications also in establishing the key areas of green product innovation.

Availability of Financial Resources

Consequently, implicit management of environmental issues often results in several uncorrelated elementary actions that as a whole call for high sunk costs. Most of the green or environmental friendly products are tend to be more expensive as compared to their counterpart traditional products (Kardash, 1974; Puška, Beganović, & Šadić, 2018; Sriram & Forman, 1993; UNCTAD, 2015). So green consumers choices are often evolved in the light of their financial constraints. As applying environmental criteria into corporate activities requires investigating through new asset combinations and developing existing resources in new ways (Hart, 1995). Green products are costlier at the stage of market entry since they can't be delivered on a huge scale. Despite the fact, that some green products spare cash over the long run (e.g., an energy-saving), they are costlier at time of procurement (Drozdenko, Jensen, & Coelho, 2011; Enzler, Diekmann, & Meyer, 2014; Joshi & Rahman, 2015). However, growing the net advantage of green products is significant in adoring them further attractive to larger segments of consumers (Jackson, 2005b, 2005a, 2005a; Peattie, 2001a, 2001b, 2010).

Hypotheses

In the light of above theoretical discussion, the hypothesis framed are as follows

Hypothesis 1: Consumers are aware of Green innovative products

Hypothesis 2: Consumers are willing to buy green innovative provided they are affordable

Hypothesis 3: Entrepreneurs are willing to invest in green innovative products subject to their preferences and available resources

Hypothesis 4: There are limited financial resources available for financing green innovative products.

Hypothesis 5: Financial resources budgeting plays an important factor in the order of preferences for green innovative products.

RESEARCH DESIGN

The authors have structured this research in multiple phases. Firstly, areas of green innovation practices are identified. Then, in a second phase, authors have performed series of experiments and they solicited responses from the selected consumers, aspiring entrepreneurs and venture capital fund managers. This gives a unique opportunity to explore the green innovation areas with purchase intentions, financial resources availability and affordability. The order of preference also gives a unique insight into the relevance of areas in green and sustainable innovation management.

RESEARCH EXPERIMENT

In the first phase, we conducted several interviews from academics and practitioners in the area. These include professors at the business school with teaching and relevant research experience, while practitioners were business managers with corporate experience. After which we have shortlisted the green innovative management practices related to the following areas:

1. First, related to the energy conservation or efficiency.
2. Second, related to the reduction in carbon emission or environmental friendliness.
3. Third, related to reduction in solid waste.
4. Fourth, related to social issues entrepreneurship

These identified areas are quintessential for identifying the purchase intentions from consumers perspectives as well as entrepreneurs and financiers related to the green innovative products. These attributes determine the green innovation in products.

We conducted three experiments in the first experiment we asked about the purchase intentions of green innovative products related to above-mentioned areas.

The pricing and affordability were also an essential actor in purchase intentions for the green innovative products.

In the second experiment, we explored the effect of financial resources availability to the entrepreneurs with intentions to develop such innovative products in the above-mentioned fields.

In the third experiment, we asked the fund managers of venture capitalists. They have been asked to identify the top four areas as per the preferences and within a given budget constraint.

SAMPLING

There were two phases of the research, where in the first phase, semi structured interviews were conducted with academics and practitioners, while the second phase is comprised of three experiments with selected set of informed consumers, Entrepreneurs and VC fund managers.

The setting of the research is France. The reason France is selected is because in France the general awareness about the green innovation and sustainable practices is among the highest in the world.[1] France strongly supported the *United Nations'* adoption in September 2015 of the *2030 Agenda for Sustainable Development*, which sets 17 *Sustainable Development Goals* for the world to eradicate extreme poverty, combat inequalities and protect the planet. France has accomplished a high standard of living and quality of life determined by comprehensive social security systems (unemployment benefits, supplementary benefits and redistributive policy) and everyone access to healthcare along with access to the basic goods and services. The country has also developed state-of- the- art public and private infrastructures (innovation and research, transport, communications, and cultural heritage) [2].

In the first experiment, regarding the order of preferences, alumni of the university were approached. Potential participants were briefly informed about the nature of the study and given a definition of what comprised green product and green innovation. If an individual was interested in participating in the research and met screening criteria, they were directed to simple and self-administered questionnaire that was posted online. Individuals excluded from the study were any individual who Individuals excluded from the study were any individual who either not had purchased a green product in the past 12 months previous year or were under 18 or over 55 years of age.

In the second experiment, MBA students and alumni were contacted, who were registered with the agency for entrepreneurial activities. These respondents have been engaged in the entrepreneurial activities recently or aspiring to begin in the near future. In the third experiment regarding the financing of green innovative

Responses	Consumers	Entrepreneurs	VC Fund manager
Energy Conservation/Efficiency	**39**	27	19
Low carbon Emission	**33**	18	22
Social Entrepreneurship	**19**	22	7
Solid Waste Reduction	**17**	14	6
total	108	81	54

products, VC fund managers were contacted. Top 50 VC fund managers of France were contacted using the help of corporate office of business school and directory of VC funds.

FINDINGS

After discussion and semi-structured interviews with the academics and practitioner, there were four areas identified for the green innovation practices, these areas are quintessential to the identification of preferences of the consumers, and order of preference in the pool of finances being available.

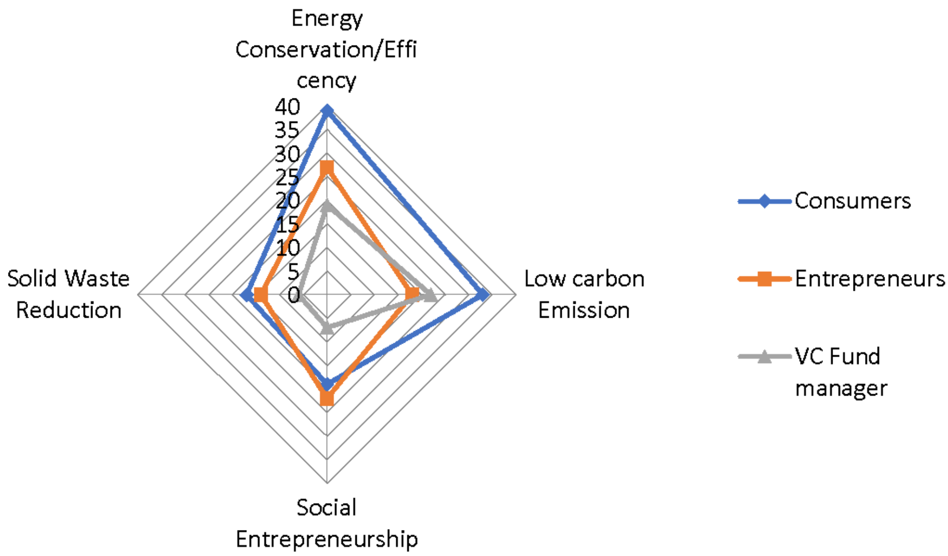
Within a budget constraint, the informed and interested consumers when asked to rank their preferences in order have ranked the presented choices, they ranked energy conservation/or efficiency as first choice, low carbon emission as second and social entrepreneurship as third and solid waste reduction as fourth choice. On the other hand, the responses of entrepreneurs were little dissimilar, in a sense that, although they also appraised energy conservation/efficiency as top choice, but social entrepreneurship as their second option, with low carbon emission as third and solid waste reduction as fourth option. On the other hand, financiers, when given choice regarding funding of these green innovative products under a budget constraint, preferred low carbon emission as first venue to invest in. The energy conservation was close second.

Figure no 2 shows the percentage wise the ordered preferences of different actors in the experiment.

SOLUTIONS AND RECOMMENDATIONS

Practitioners, managers, financiers and strategic decision makers also possibly will discover the work in our paper valuable in connecting gaps in the theory and practice;

Figure 1.



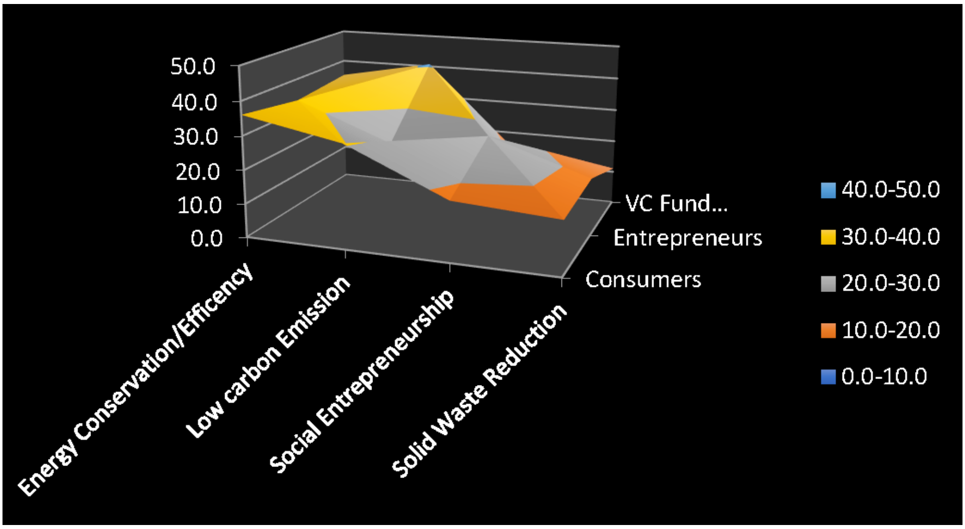
entrepreneurial decision makers correspondingly may perhaps build competitive advantages by mounting on these discernments and insights.

At the present time, there is dire and critical need to deeply understand green consumers, given its implications for marketers to comprehend and communicate green buying patterns on the one hand, and to design and strategize both product range and, motivation and financing available to develop them on the other hand.

This study enhances the idea and comprehension of green products and Green innovation rehearses. Moreover, it signifies that how sustainable and socially responsible products and green innovation practices will be valuable for the both the environment and consumers. This study will feature the key factors that affect the consumers green purchasing behavior and the effect on purchase choice. This experiment uncovers that how socio-statistic attributes sway the green consumers purchasing conduct and buy choice.

%age	Consumers	Entrepreneurs	VC Fund manager
Energy Conservation/Efficiency	36.1	33.33	35.19
Low carbon Emission	30.6	22.22	40.74
Social Entrepreneurship	17.6	27.16	12.96
Solid Waste Reduction	15.7	17.28	11.11

Figure 2.



FUTURE RESEARCH

The future research may enhance this exploratory study under different climes and cultures. Future research may include longitudinal data to recognize further the peculiarities attached with green products development, financing, innovation and purchases in the relevant areas. This research may include different theoretical paradigms for grasping the underlying concepts and practices in vogue.

Given the incredible apprehensions about environmental change and sustainability, we anticipate additional work in green products innovation and selling, particularly at the consumer, entrepreneurial and financier level.

CONCLUSION

Most consumers take environmental issues very seriously and show positive attitude towards purchasing of Green products. This finding is also supported by previous study which reveals that Green consumers are realizing that their buying behavior will ultimately impact the environment so they are feeling the sense of responsibility towards the ecosystem and thus indulging themselves in buying Green Products (Han & Kim, 2010; Kim & Han, 2010).

The government regulators, financiers and strategic decision makers likewise assume a significant job in different phases of our green consumer model scheme.

Regulators are at the helm of setting different standards and revealing provisions for suggestions and products (Marques & Simões, 2008).

At long last, the field of green product innovation would profit by looking at real comportment rather than purchase intentions and theoretical situations (MacDonald & She, 2015) for three reasons. To begin with, consumers' readiness to pay a premium for green products is extremely low (Groening et al., 2018; Laroche, Bergeron, & Barbaro-Forleo, 2001). Second, there is firm prospective for one-sided responses to green products surveys, since most customers show an inclination for green over non-green products but these responses or intentions are sustained by comparing actual comportment (Griskevicius, Tybur, & Van den Bergh, 2010; Kenrick, Neuberg, Griskevicius, Becker, & Schaller, 2010).

Third, there may be boundaries for consumers to accomplish green comportment, for example, the absence of a wide-ranging collection of accessible green products at utilitarian costs (Young, Hwang, McDonald, & Oates, 2010).

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ENDNOTES

1 ASEIC (2018) 2018 ASEM Eco-innovation Index (ASEI). http://www.aseic.org/pblctn/PblctnPageR.d

2 https://sustainabledevelopment.un.org/memberstates/france

Chapter 7
Nexus Between Money Laundering and Sustainable Development Goals:
A Threat to Developing Countries

Laeeq Razzak Janjua
Poznan University of Economics, Poland

Syed Abdul Rehman Khan
School of Economics and Management, Tsinghua University, China

ABSTRACT

Money laundering is a hot debate discussion among policymakers, as money laundering usually arises due to theft of money or other illegal activity. Such criminal activities damage every stakeholder of the economic cycle, whether it is trade, productivity, or contribution of the financial sector itself. Due to the fact money laundering makes the industrial growth process very slow and undercuts economic activities, which are essential for the development. This chapter explores the nexus between money laundering as a threat to a sustainable development goal from different angles. The discussion reveals that money laundering negatively impacts economic growth, and the fundamental pillar of sustainable development is economic growth. So can we achieve sustainable economic growth and development without controlling money laundering? The authors conclude it is not possible.

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INTRODUCTION

Crime is not fruitful for economic growth in any condition. Criminal activities lead to social inequalities and unbalanced economic growth. One of the most harmful phenomena which illegal activities for any society or country is bad reputation itself. The high rate of crimes usually presents a lack of law and punishments and low moral values of the people. Similarly, countries can achieve growth and overall success without justice. Education always plays a vital role in the success of society. Training and schooling provide a way to the people to distinguish between bad and good for them and others. Highly educate society able people to contribute their positive for the healthy atmosphere with in the community. Literature also reveals a consensus on the negative impact of crime on economic growth and development, thus crimes generate more inequality and poverty in society. The magnitude of money laundering varies in different countries. It is hard to enlist the negative effect of money laundering on an individual state, thus it based on various factor and different by which illicit money flow in the economy. However, such criminal activities damage every element of the economic cycle. Trade, productivity, service sector contribution of the financial sector itself, furthermore at the micro-level, money laundering effect can be observed at the primary, secondary and tertiary sectors as well.

The factor of globalization, new inventions and innovation dramatically change the overall world, thus from the last few years these dynamic and threats are collected under the head of sustainable development goals. Migration of people, changes in economic and social clusters, technological advancement, and more specifically, trends towards environmental deterioration are counted as these dynamics. In recent time, the demography of the world population changes dynamically, which lead movement of people from rural areas to urban areas for better living, especially in developing countries where majority of people living in rural areas because their lives attach with gaining benefits from natural resources like forest, rivers, lakes, and cultivation of land, but due to the factor of global warming these natural resources are destroying rapidly and people moving towards urban areas for better life. Although urbanization becomes a significant cause of structural change, as people are shifting from traditional farming to the employment sector, thus it provides jobs to those who don't want to engage with the conventional industry of agriculture. However, on the other hand, it increases the concentration of people in cities which directly affects on the demand for energy, water, sanitation, and public services like education and health care. The major problem while implementing strategies related to urbanization is corruption and also the rule of law which is a significant issue in middle income and low-income countries. Urbanization increases consumption. With limited supply, it induces inflation, lack of jobs in cities with increases in poverty in towns as well; however, these are a common threat in achieving sustainability.

On the other hand, due to a high level of corruption in developing countries, the implementation of strategies and flow of fund which are providing through AID along with clean distribution is one the most significant issue nowadays. Initially, with corrupt practice, these funds are misused and then these funds are converted in to black money as well. Furthermore, in the other step, these funds are converted from black money to white money and then laundered around the world. According to the estimate, around 3%-5% of world GDP is the estimated amount of money which is laundered around the world, however, in developing countries, it is assumed that the situation is worse which is due to the lack of financial money units, and weak Anti Money Laundering laws.

This chapter explains the nexus between money laundering and, its negative impact on the economy and sustainable development goals. The growing magnitudes Money laundering and new techniques are becoming challenges task for international regulatory bodies to stop its flow. Economic development and growth always a vital topic to discuss among the policymakers, but recently both phenomena are packed in a box of sustainability. Economic growth itself is a complex phenomenon, but understands ***"Sustainable growth and development***" is more complicated; however, its scope is more comprehensive. ***Section I,*** of this chapter, briefly highlights the concept of sustainable development goals and its pillars and its importance in current world dynamics. ***Section II*** illustrates the idea of money laundering and its different flows within the economy. ***Section III,*** explain nexus between money laundering sustainable development goals along with economic growth mechanism

SECTION I: ON-GOING DEBATE ABOUT SUSTAINABLE DEVELOPMENT

At the moment, the majority of the population of the world facing challenges of financial issues which, lead them toward different social imbalance such as income inequality. In simple words, bias or inequality refers to the condition of being unequal and generally expressed in numeric form. Still, on the other hand, evaluation of economic growth in a quantitative way such as GDP per capita restricts the inside distribution of income, which expressed in index form as the GINI coefficient. As Foley et al (2016), refer current economic growth path has resulted in wealth concentration, which trues as it is more comprehensive the gap between rich and poor people with in the society which reflects the phenomenon of income inequality. Similarly, Foley at al. (2016) also mentions in their work that in 2015, 2000 global companies from 60 countries disclosed total revenue of 39 trillion US$, with a profit of 3 trillion, however according to the UN estimation with the help of 30 billion US world hunger can be handled.

At the time of economic growth, keeping balance with the in the economy is always a challenging issue, any unstable and inappropriate economic activity within the commercial may create a long term or short term adverse economic and social effects. Every financial crisis generates an economic bubble, which affects every sector, such as the real sector, industrial sector, or the service sector as well. As these bubbles burst, it slows down the economic activities, and even sometimes, it creates pause on every commercial business. The consequences of these lockdown situations of economic activities may cause a real reduction in income, the welfare of people and increase inequality of income with in the society which induces poverty incidences. Therefore, it is essential not to disregard income inequality. Significant imbalances between rich and poor classes of people with in the society also lead to political instability and corruption. In order to achieve sustainable development, the measures of equal distribution of wealth should apply and not tolerate any practice, which increases income inequality.

Economic growth mostly represent in terms of quantity, GDP consider as most important macro-economic indicator, but GDP as sole indicator not enough to measure balance of activities, as it doesn't not take into account the factor of education, health and environment, as work done by (Boldea, 2012)state that, for achieving economic growth, countries should make polices which focus on social development such as increasing in life expectancy, promoting educational standard and poverty reduction by increasing employment opportunities for everyone within the society which is probably true phenomenon. He further argues that investment in human capital may create a balance between ever pillars of economic activity which lead to more sustainable development. Economic growth is a complex phenomenon, as its understanding depends on several attributes of macroeconomic such as productivity at the micro and macro level, price mechanism which indicate inflation, the supply of money and employment with in the country, and the most important the role of institutions and governance which keep a balance between the economic and social clusters. The major role of institutions is the formulation of strategies and polices concerning economic and social issues which directly affect the cycle of economic growth. Moreover, while discussing factor which affects economic growth, the essence of stable monetary policy and fiscal policy of countries cannot be ignored. Monetary policies are made by the central bank which represents the overall flow of money with in the economy and also for setting up the interest rate; moreover both factors affect sustainable development. On the other hand, the fiscal policy represents the overall expense and earnings of each country, thus how the country will spend on education, health, and environment. In terms of earning fiscal policy highlight taxes, which are imposed on consumer products and individual's income. The imbalance between government earning and spending may lead to political instability and ineffective governance.

Economic growth represents the quantitative aspect, whereas economic development explains the qualitative attribute; indeed, sustainable development explains both characteristics in more depth and in a broader way. The human race of the world is facing challenges in terms of economic, social and environmental problems; collectively, all these dimensions are discussed under the head of sustainable development. The current ongoing in the world cannot be complete without discussing sustainable development. As world resources are very limited in nature, but on the other hand, the world population is growing very fast. Utilization of resources making them more limited for our upcoming future generation, even while utilizing these resources and transforming them from raw to useable form, apparently it affecting the natural world which surrounds us in terms of air and water pollution which lead the entire world toward global warming.

According to the UN estimations, for human survival till now 1.6 planet resources we already used and while observing the acceleration by which we (humans) utilize natural resources two piles of the earth will be required by 2030 (Global Footprint Network, n.d.). As (Foley at al. 2016) mentions, in his ecological overshoot, he is concerned about the conversion of resources into waste faster and vice versa. The most noticeable effects of overshooting or overutilization of natural resources can be observed through diminishing forest covers, collapsing fisheries, rapid fall in water level under the earth crust, carbon dioxide emissions which all are creating global climate change. Global warming affects all species which are living on the earth. According to living planet report 2014, the population of living species has declined by 52% from 1970 (World Wildlife Fund, n.d.). The idea of Sustainable Development Goals, become more important among intellectual, economist, and scientist due to the growing urgency of sustainable development for the entire world, as climate change and medical issues are those common challenges. United nation conference on Sustainable development, 2012 define sustainable development in the following way (Sustainable Development Goals, n.d.a):

Sustainable development meets the needs of the present without compromising the ability of future generations to meet their own needs. Seem like the guiding principle for long-term global development; sustainable development consists of three pillars: economic development, social development, and environmental protection. (Sustainable Development Goals, n.d.a)

Economic growth is conditioned by existing potential resources, but also by how they are used and valued. As commercial production cannot deal without the combination of a factor of production, which is land, labour, and capital, apparently property is natural recourse. Still, another essential element of the production is labour, and in the new period quality of work cannot be ignored. As it depends on education, technical know-how, skills, and health. After land and labour, the capital considers as an essential factor of the production function, capital used for multiple purposes as for acquiring land, then for construction, and training for labour. Training directly affects production and management for production firms, and effective management involves in research and development as well. In terms of all these factors of production, each country has the specific characteristic of natural resources, labour, capital, management, and involvement of technology. Therefore, each state develops its particular strategies for economic growth by utilizing all these resources. Natural resources are considered as an essential factor of economic growth and recognized as a push factor for the economic cycle. Table 1, indicates a list of sustainable development goals by United Nations

Sustainability is a small word, but its explanation covers a different phenomenon. Sustainability also refers to equality. Equality can be in the sense of social and economical along with equal access to environmental resources with destroying them. The attributes of sustainable development are economic, social and ecological, explain in literature with several different terminologies. As (Moldan et al., 2012) mention in their work as pillar, similarly (Carter & Moir, 2012) named as dimensions, on the other hand (Zijp et al, 2015) stated as components, and aspects by (Lozano, 2008), furthermore (Arushanyan et al, 2017) indicated as perspective. All the terminologies are primarily used interchangeably in fact, preference for term pillar is

Table 1. List of sustainable development goals

Dimension	Goal
Inclusive Growth and Development	**Goal 1: No Poverty Goal 4: Quality Education Goal 5: Gender Equality Goal 8: Decent work and Economic Growth Goal 10: Reduce Inequalities**
Production, Industry and Innovation	**Goal 9: Industry, innovation and Infrastructure Goal 11: Sustainable cities and communities Goal 12: Responsible Consumption and Production**
Health and Wealth being	**Goal 2: Zero Hunger Goal 3: Good Health and Well-being Goal 4: Quality Education**
Environment and climate	**Goal 7: Affordable and Clean energy Goal 13: Climate Action Goal 14: Life below water Goal 15: Life on Land**
Institution, Cooperation and Regional Integration	**Goal 16: Peace, justice and strong institution Goal 17: Partnerships for the goal**

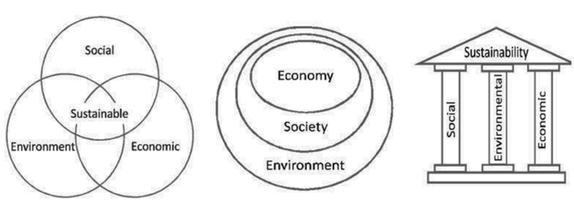
Source: (Sustainable Development Goals, n.d.a) mainly arbitrary (Purvis et al., 2018). However, graphically, sustainability presented in the literature with different approaches. More often in literature, graphically sustainability is presented in the shape of Venn diagram where its three pillars are in three circles, and interacting point is referred to as sustainability, alternatively it is also graphically presented as nested concentric and literal pillars in vast business literature, policy papers and online as well, as shown in Figure 1.

SECTION II: MONEY LAUNDERING

Historically, the phenomenon of money laundering can be traced in history as long as the pirate's criminal activities exist. Still, in a recent period, this phenomenon got more attention due to the criminal activities of famous gangster Al-Capone. By his mafia team, they usually convert their illegal or theft money through money laundering in such a way that it looks as legitimate income, furthermore often in all that process, they used innocent people (Duyne et al., 2003). A more in-depth look and analysis indicate that this phenomenon existed during the period of pirates when sea robberies were prevalent. Technically, the word launder means washing out; therefore, money laundering refers to an event in which dirty or illicit money is converted into the legitimate source.

But on the other hand, what precisely is being laundered (cash or non-cash item) and by which manner still need more discussion and debate. Furthermore, lawyers, economists, political activists, and international bodies highlight different views on money laundering. In the purest form, the money laundering can be defined as it is phenomenon used to attempt to disguise proceeding of illicit fund or money from the illegal activity so that they appear to generate from a legal source or business. There are more than 14 different definitions of money laundering exist in the literature, in some description, besides money property and other assets are mentioned as the subject of money laundering. In contrast, the source of the matter is criminal or illegal, and the last goal and motive are to hide the source and make it appear legal.

Figure 1. Three ways for graphical presentation of sustainability
Source: (Purvis et al, 2018)



Some of the origins of the subject the criminal activities are illicit arms trafficking, corruption, fraud, counterfeiting currency, human trafficking, environmental crimes, drug smuggling, robbery, extortion, theft extra. These crimes are usually common all around the world; therefore, the estimated volume of money is estimated at around 2.7 to 3.5 trillion dollars, which is nearly 3% to 5% of world GDP (Walker, 1999).

Technically, money laundering consists of three stages; Placement is an initial stage in which the fund or money derived from criminal activities or in a recent period by corruption are introduced into the financial system of any country. The second stage of money laundering is known as layering, in which illegal money is structured into small units or transitions so that it does not trigger any monitory or audit alert. The third and final stage is called integration, in which laundered money is disbursed back to the system so that it appears as legitimate money.

Here one question arises, to combat against money laundering, are any efforts taken by the International community to fight against it? For sure yes, as we have already discussed previously, money launderings are illegal activity and the money which is laundered usually derived from various serious crimes, international community work together, and formulate specific regulations and standards. These standards published as, the International Standards on Combating Money Laundering and the Financing of Terrorism & Proliferation. The body which recommends this standard is known as FATF (Financial Action Task Force), established in 1989-90. FATF consist of 40 recommendation or measures which are implemented by its member countries to combat terrorist financing and money laundering.1 Due to global dynamics and geo-political situations, in 1996, 2001, 2002, 2003 and 2012, its recommendation was revised. Technically here one questions arise, does financial action task force recommendations are based on one size fit for all phenomenon, its answer is No.

The working mechanism of FATF is the assessment and examination of different police adopt by various countries to stop money laundering and terrorist financing; similarly, FATF also provides their recommendation to make these police more effective. Before illustrating the negative effect of money laundering on economic and social development, it will be useful to highlight the different directions of illicit flow within the economy. These directions are divided into five sub-categories, as presented in Figure 2.

Domestic Money Laundering: Refers to a phenomenon in which illicit funds are laundered within the developing countries economic, usually spent or reinvestment in such a way that origin is hard to identify.

Returning: Refers to a situation in which a full or partial amount of illicit funds are laundered overseas and then return for integration.

Inbound: A situation in which proceed of crime occur overseas or in the third country, but at the end eventually, illegal funds integrated into developing the economy.

Outbound: Refers to a mechanism in which usually illegal or illicit funds are a departure from developing the economy, but not return for integration.

Flow-Through: A situation in which fund is coming within the economy from outside in the laundering process and then disappears for integration in another place, usually plays a negligible role in the economic circle itself.

These different directions of money laundering are always essential to study the impact of money laundering on economic growth; furthermore, these directions also provide a reference point to the financial and regulatory institutions to develop their compliance and monitory policies to combat money laundering and terrorist financing. As we can see in figure 2, domestic, returning, and outbound referred to as predicate crime. Thus, a criminal activity occurs within the developing country itself, whereas inbound and flow through are typically controlled by the criminal element which exists outside the boundaries of developing countries.

These different directions of money laundering are always essential to study the impact of money laundering on economic growth. Furthermore, these directions also provide a reference point to the financial and regulatory institutions to develop their compliance and monitory policies to combat money laundering and terrorist financing. As we can see in figure 2, domestic, returning, and outbound referred to as predicate crime. Thus a criminal activity occurs within the developing country itself, whereas inbound and flow through are typically controlled by the criminal element which exists outside the boundaries of developing countries.

It seems very hard to stop illicit financial flows around the world due to the deep saturation of white-collar criminal activities in the economic system. Still, with the help of combating strategies, financial regulatory analyses, and monitoring, the amount and frequency of illicit flow can be reducing. Financial monitory under financial regulations is still a challenging issue; therefore, most of the countries establish their FMU or FIU, which works under the financial regulatory framework. The critical role of FIU is reviewing and analyses financial information receiving after the filtering of financial transactions through different filters, then to transmit and disclose it to the competent authority as a suspicious transaction. As FATF, the framework also presents FIU's role under various recommendations, which increase effectiveness as well. The international convention has also recognized the effectiveness of FIU in the modern financial system to fight against illicit flows and terrorist financing, furthermore, these international conventions also provide plate form to under developing countries to discuss and take technical assistance from the well-developed financial regulatory country as well.

Furthermore, at the regional level, multilateral financial institutions also establish their FIU, which provide technical assistance and guideline to the local clients. The scope of work of all these organizations is extensive, as these conventions give support to every country for strength their anti-terrorist, AML, and anti-corruption jurisdiction and provide the flat form for debate to make these conventions more preventive and effective. Furthermore, these conventional bodies work side by side local national wide and international FIUs, which enhanced the effectiveness.

The full scope of FATF recommendation and international conventions provide a mingle effect, jointly with FIU, thus a practical outcome. In-depth analyses that help to discover criminal channels proceed of crime and suspicious transaction monitory, which induces money laundering, is a pragmatic attribute of FIU. However, in a recent period still, numerous challenges exist, which need further consideration of international conventions and regulatory authorities. One of the significant challenges is to stop illicit flows via cryptocurrencies, by which it's complicated to figure who is the actual owner.

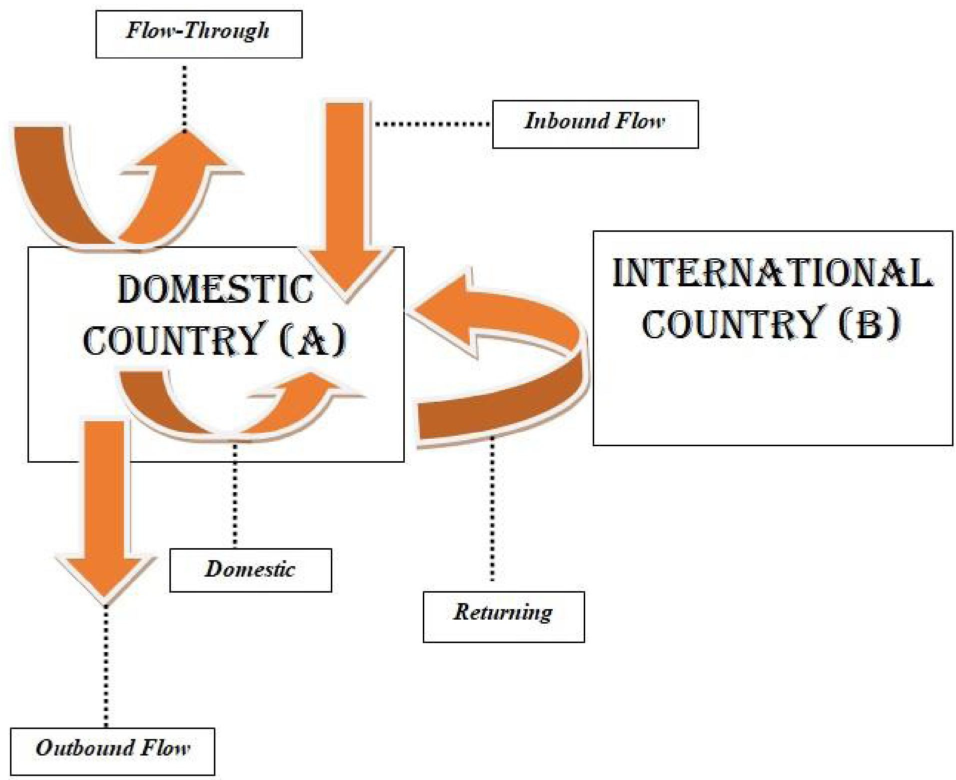
Furthermore, the political and administrative involvement of political parties in financial regulatory authorities in developing countries still needs proper care as it raises the question against the autonomy and accountability of FIUs in developing countries. Thus it reduces the overall effectiveness.

SECTION III: NEXUS BETWEEN MONEY LAUNDERING AND SUSTAINABLE DEVELOPMENT GOALS

Sustainability means equality in all the attributes which directly or indirectly impact on economic growth and development with social balancing without compromising on damaging the quality of the environment. Money laundering also directs or indirectly impact on the overall economic output; somehow it reduces production, which directly influences on employment by diverting resources. Money laundering shrinks down productive commercial sectors, such as clothing and footwear and so on to sterile industry which are real estate, jewellery, and art extra. As productivity sector requires more labour as input but shrink increases unemployment. This multiplier effect of unemployment and low productivity negatively impact on economic growth. Furthermore, it also lowers down the income of the entire stakeholder, which directly or indirectly associates with productivity sector. Similarly (Walker, 1995), mention in his work mentions the same seniors of the negative impact of money laundering on economic growth by shrinking productivity sector. Furthermore, he also points out that, by using input and output method in case of Australian economy he estimated that if 1 million dollars are laundered out from Australian economy, by average, it damages Australian economic by 1.126 million dollars and considerable unemployment as well.

In developed countries, the magnitude of loss is lower than in developing countries due to stable economic structure. Lower productivity directly effects on demand

Figure 2. Directions of money laundering
Source: Author's own based on discussion

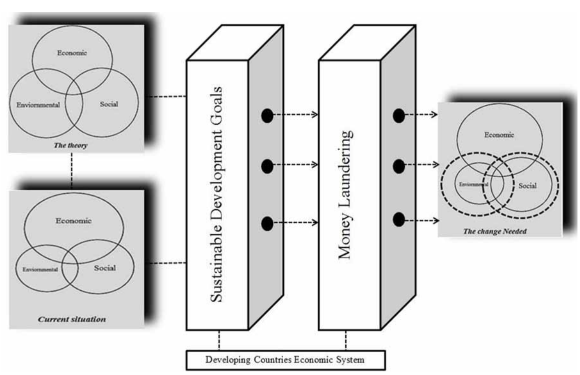


and supply of a good in the market such that creates more unstable market along with fluctuating prices. The primary aims of sustainable development goal are to stabilize economic growth by providing equal and quality employment opportunities to everyone, without compromising on social and environmental degradation. In a social context, one of the significant drawbacks of unemployment is the increase in crimes and poverty in society. Furthermore, approximately 800 million people still living below the poverty line earn only US 1.90$ per day (Sustainable Development Goals, n.d.b). One of the targets of Sustainable development goal is to achieve a higher level of economic productivity through diversification with the help of technology and innovation, furthermore with the focus of top value-added and labour-intensive sector. According to the estimation of United Nations, to meet the demand of job market it is necessary to create more than 500 million jobs in labor market during 2016 to 2030 (Sustainable Development Goals, n.d.c). Education-related job and working opportunities for everyone also covered under the head of sustainable development, without any gender biasedness. Financial sector strength also crucial for economic growth, therefore one the target of sustainable development is to strengthen the capacity and productivity of financial institution domestically for economic expansion. Similarly, on the other hand, it is also the responsibility of the regulator of the financial sector to exert strict compliance and financial monetary measure to control the flight of (Walker, 1995) money and capital from the economy due to money laundering. The Figure 3 explain how money laundering impacts sustainable development goal in developing countries.

In case of developing countries financial aid and along with trade play an essential role in economic growth and development, however, the high level of corruption and mismanagement of financial aid does not provide fruitful effect thus not accelerate economic growth. The grant usually spends on those projects which do not create enough employment opportunities. The stolen amount from the economic system is higher than official development assistance received, which is due to financial crimes and corruption in the economic order. Access to water and sanitation facilities to urban and rural areas, construction of road and bridges, and access to access to electricity are handle by grants. According to estimation of United Nations, 30% of the world population still living without access of the safe drinking water and 60% of the world population without sanitation as well (Sustainable Development Goals, n.d.b.).

The penetration of corruption roots in political dynamic, economic and social reforms cannot be ignored. Thus, it is considered as a significant obstacle in economic growth and development process. In developing countries, accountability laws are not strong enough; therefore, the roots of corruption in political institution spread so quickly, which effect on the development process. Dishonesty is considered as the use of public office for private gain, and usually political expose person involve in it when public officers take, solicits and extort a bribe. Corruption also

Figure 3. Impact of money laundering on sustainable development goals
Source: Author based on explanation



occurs when a person or any political party offer a bribe to a public office holder for their gains through patronage and nepotism and involve in the theft of state assets. Majority of the research mention in their work that corruption decreases economic growth, furthermore it creates inequality in the society, and it is terrible for development (Azariadis & Lahiri: 2002) and (Ehrlich:1999). Illicit then further laundered around the world intending to turn into white money. Weak financial accountability system and monitoring laws promote corruption, which becomes a significant cause of money laundering; therefore, it also negatively influences other sectors of the economy as well.

In current world dynamic, especially the socioeconomic and political changes deeply influence overall functions and strategies of national and international regulatory bodies, in fact, some time they need to reshape their policies very quickly to maintain their authenticity. In the recent era, data protection laws and political engagement of countries in different geographical blocks and associations are also problematic issues as well. Combating money laundering and terrorism is not an easy task, it always requires will along with effective strategies and authority to enhance the efficiency of a regulatory body to fight against that particular crime and furthermore require intelligence to break the channels which involve in all process. However, the gap between the developed country's financial institutions in contrast with developing country's financial institution effective is still very wide, which is due to numerous reasons. Infrastructure and budgetary issues are major concerns in developing countries along with technical skills of staff, and moreover, data sharing between developed and developing countries still need consideration and sometimes it takes long channels of authorization which reduces the effectiveness of financial institutions to fight against financial crimes. On the other hand, the filters which help to detect financial crimes have different attributes among the countries: such as, a financial transaction is considered as legitimate in one country, whereas it is not in another one.

One of the major issues raised by financial and white-collar crimes are the way of living which can be easily shown in society, as (Unger et al, 2006) mention in their way, with in the society they way of spending money by the criminals might be very high and different from those of the ordinary people. In the social school of thought, these unbalanced patterns of distribution within the society increase the inferior complex among the people, and somehow it also increases the rate of crimes within society especially among the young and unemployed people, after seeing the lavish lifestyle of criminals. On the other hand, most of the people who involve in money laundering and other financial crimes they hide they illicit money by investing in real estate business locally and abroad, furthermore they also purchase expensive jewelry and other artistic items which can also move from one place to another place easily. Generally, these spending pattern increases multiplier effect in two different ways, initially the victims reduce their money which decreases their spending and on the other hand it increases the pattern of spending of criminals which make society unbalance. As (walker: 1995) mention in his discussion, those industries supplying goods and services to the superannuates will suffer a reduction for the demand for their services, and this will ripple through their suppliers and their supplier and also vice versa. This unbalance consumption and spending pattern arises due to money laundering and financial crimes Table 2, briefly explain the relationship of different attributes of economic and money laundering, and its long-run and short-run impact as well.

As for achieving economic and sustainable development, it requires having a balance between consumption, production and as well as spending pattern. Furthermore, a large share of the world population is still consuming too little and even living in a tough circumstance, which is not enough to meet the basic needs. However, on the other hand, there is still a large group of people exist in every society which influences most of the resources within the community, however, equality is an essential ingredient for sustainability. Uneven spending and consumption pattern directly effect on a production level. Furthermore, financial crimes and money laundering also induce high prices of goods and services. Crime also influences the service sector. Providing law-related services and tax service to common man also become expensive and outreach from most of the people.

The artificial increase in prices is the aftershock effect of financial crimes within the society.

Furthermore, one of the primary reasons is that criminal who involved in financial crimes and money laundering they typically want to hide their illicit money as quick as they can.However ,they usually agree to pay more the market prices which cause price increase shock on real estate business as well as other expensive business.

Criminal People who are involved in money laundering are willing to pay for assets (expensive building, tourist private tourist spot, precious stones) more than their actual worth which divides society as mentioned by (Keh, 1996). Similarly, artificial increase in prices can also observe in capital markets as well, which creates a monopolistic environment due to the heave cash availability of money among the brokers, which are front of player of criminals. Furthermore, that monopolistic environment directly effects on production and consumption of good and services within the society. Monopolistic situations induce unfair competition, as Gresham's law state that, "bad money drives out good money". As due to availability of large cash which is obtained from financial and other crimes increases unfair competition which is due to the artificial prince increase effect, as one of the major concerns of the criminal is to hide their read cash as quickly as it is possible.

On the other hand, in case of other business activities such production and manufacturing, and also in case of business expansion when additional funds are

Table 2. Impact of money laundering on economic growth

<table>
<tr><th rowspan="3">Attribute</th><th colspan="2">Economic</th><th colspan="2">Real sector</th><th rowspan="3">Short & Long Run Effect</th></tr>
<tr><th colspan="2">Social</th><th colspan="2">Financial Sector</th></tr>
<tr><th colspan="2">Political</th><th colspan="2">Fiscal and Monetary dynamic</th></tr>
<tr><td>Consumption</td><td>Economic</td><td>Social</td><td colspan="2">Real sector</td><td>Short Run Effect</td></tr>
<tr><td>Investment and Saving</td><td colspan="2">Economic</td><td colspan="2">Real sector</td><td>Long Run Effect</td></tr>
<tr><td>Artificial Inflation</td><td>Economic</td><td>Social</td><td>Real sector</td><td>Fiscal and Monetary dynamic</td><td>Short and Long Run Effect</td></tr>
<tr><td>Trade Dynamic</td><td colspan="2">Economic</td><td colspan="2">Real sector</td><td>Short run</td></tr>
<tr><td>Private sector</td><td>Economic</td><td>Political</td><td>Real sector</td><td>Fiscal and Monetary dynamic</td><td>Short and Long Run</td></tr>
<tr><td>Money Supply, Interest rate and Exchange rate</td><td colspan="2">Economic</td><td>Real sector</td><td>Fiscal and Monetary dynamic</td><td>Short Run</td></tr>
<tr><td>Availability of Credit</td><td colspan="2">Economic</td><td colspan="2">Real sector</td><td>Short Run</td></tr>
<tr><td>FDI flows</td><td>Economic</td><td>Social</td><td>Real sector</td><td>Fiscal and Monetary dynamic</td><td>Long Run</td></tr>
<tr><td>Financial sector stability and liquidity</td><td>Economic</td><td>Social</td><td colspan="2">Financial Sector</td><td>Long Run</td></tr>
<tr><td>Public Sector</td><td colspan="2">Economic</td><td colspan="2">Fiscal and Monetary dynamic</td><td>Short and Long Run</td></tr>
<tr><td>Growth Rates</td><td>Economic</td><td>Social</td><td colspan="2">Real sector</td><td>Long Run</td></tr>
<tr><td>Profitability and Reputation of the Financial sector</td><td>Economic</td><td>Social</td><td>Real sector</td><td>Financial Sector</td><td>Long Run</td></tr>
<tr><td>Transformation of illegal business to leg business</td><td>Economic</td><td>Political</td><td>Real sector</td><td>Financial Sector</td><td>Short and Long Run</td></tr>
</table>

Source: (Unger et al, 2006)

required, ready cash among the money launders become a competitive advantage and most of the case market lost their honest businessman as they usually don't have too much-prepared stock. It creates a monopoly in the market (Keh,1996). This phenomenon also becomes a significant cause of monopolistic competition and the involvement of criminal people in the business environment as well.

One of the significant phenomena which can be observed in society and economic system is a dominance of money launders and financial criminals on foreign exchange markets, especially in developing countries where the fiscal, monetary policy is usually weak, and the exchange rate is based on market demand and supply. The devaluation of local currency compares of other foreign currencies and lack for foreign reserve, usually make foreign currencies expensive cash instrument. Money launders and other criminals try to control foreign exchange market by purchasing foreign currencies with illicit funds which create a monopoly and artificially increase exchange rate. That creates a significant problem for importer, which usually makes their international payments in foreign currencies. Furthermore, devaluation of local currency directly effects on prices of imported items. However, imported items are generally consumed by the upper class of society, which creates inequality. It has also been seen; the money launders and another financial criminal usually lavishly spend their lives by using the imported luxury item. In case of developing countries, money laundering also leads to volatility discount furthermore it also created an unexpected appreciation and depreciate of the exchange rate as well due to high inflow and outflow of money (Tanzi, 1996). Similarly, (Tanzi,1996) also highlight that inflow of money laundering usually appreciate countries exchange rates, but on the other hand, it has been observed that the country which experiences capital flight due to money laundering, results in depreciation in local currency.3 Increase in exchange rate usually causes a reduction in exports and made countries to heavy reliance on imports. Similarly, amortization in local current and unavailability of foreign currency often bring payment issue for developing countries which experience heavy money laundering outflow.

The criminals who involve in money laundering usually they always looking for those destination which is easily for placement of their illicit funds such that, they always interested to put their illicit money in those financial institution which not ask too many question of origin of their fund. This factor induces fund flow towards that destination where financial regularity and monitory police are weak enough to provide an opportunity for the launder to place their illicit fund in the economy. As the main aim of money launders is to hide their illicit money so usually they agree to place their funds in a financial institution with lower rates of return. To and from mechanism of capital flight is important to discuss, a country which receiving illicit flows usually their economic system become stronger, as they have more foreign reserve for their international payment and huge availability of funds for local investment, but on the other hand outflow of money from any country due to money laundering, adversely impact on economic and social growth. The outflow of money and corruption make public institution weaker, and due to lack of fund, they heavily depend on debts (local or foreign), and usually end up with debts trap and become a burden for the government. Public sector institution which runs under loss lead government towards more financial crises, which slower down overall economic growth as well. As countries start financing public institution by taking loans rather than to investment in more new institutions and departments for earning purposes. Overall corruption, bribes, weak financial controls and ineffective working of public institution usually decreases foreign direct investment. One of the most important reasons which lead to a lack of foreign direct investment is the presence of criminal elements in the economic system as well in public offices.[4]

The reputation of a financial sector always plays a vital role among the international investors, however, flow on money laundering from any financial institution heavily damage financial sector reputation, as (FATF: 2002) state that, Organized crime can infiltrate financial Institutions. Furthermore, if any financial institution involves in money laundering it loses reputation among the public, as (Bartlett, 2002) high that, once a financial institution involves in money laundering or provide any plate form to criminal to laundering their money it will lose credibility and customer confidence. The negative reputation of a financial institution among foreign investors deeply harms financial sector growth as well. This negative reputation also causes legitimate capital out flow from the economic circle as well - legitimate capital outflow slower down the economic growth and development process.

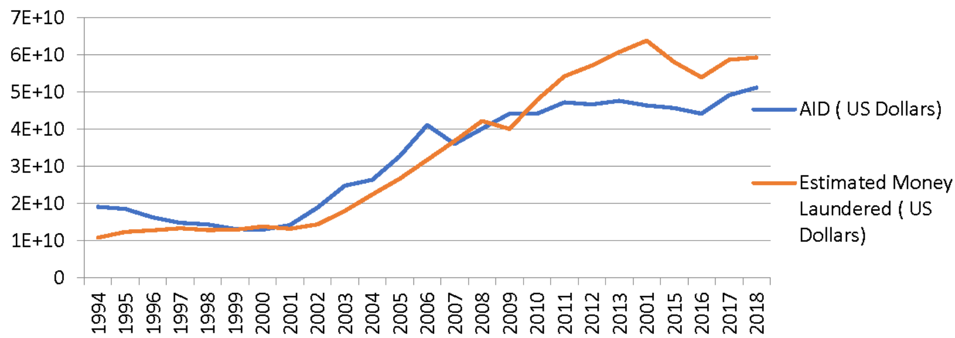
Sustainable development is a long-run process, which consists of three pillars economic, social and environmental. This process needs continuous monitory so set target regarding sustainable development goals, whether they are met in agreed time or not. If these targets are not met, usually, new policies are implemented. These targets are evaluated by gathering field data and then compared with the actual standard and targets. Similarly, a noticeable harmful effect of money laundering is the distortion of economic data and statistics, which can subsequently give rise to errors in policymaking (Tanzi, 1997). This distortion usually based on numerous factors, as motives of money launders to convert their illicit flow quickly into legitimate funds, therefor one sector show spikes in overall revenue where as other sector expand with normal speed, as primarily motive of financial criminals and money launders is to avoid detection and monitoring (Alldridge, 2002).

Corruption, bribes and then money laundering become threatened to the private sector. Corruption and bribe induce unfair competition in society. Due to the fact, mafia concentration at government level due to the illegal and theft money, it is hard to the honest purchaser to acquire partial or fully share of state-owned companies (McDowell, 2001)

Similarly, a serious consequence arises with political expose person, working in public office involved in bribe and corruption and then exert its official power to provide an advantage to a group of people and bodies who has a governmental contract for public development creates more harmful effects. Bribes and corrupted people expose people to induce the presence of criminal in the economy, therefor these criminal elements use public office for personal use thus social effect of public office does not transfer anything towards the public. One of the harmful effects of corruption can be observed in development countries. Poverty and social inequality arise usually due to mismanagement of public fund and corruption. Furthermore, bribes also create massive destruction in society. Public officers take bribes to provide unlawful benefits to contain group from the private sector. These benefits usually create a strong hold me a few people in the private sector, which make the economic system more unequal. Unfair competition in the private sector creates a more informal economy. Majority of developing countries are under the phase of structural change in their economic pattern, and the private sector always acts as the backbone of the economy. For expansion purpose, private sectors always need funds, but bribes and corruption usually create a problem for the private sector to meet with their credit needs. It usually happened due to unequal distribution of wealth in the society. It has been also observed in developing countries, a certain group of people from the private sector and the public sector creates informal mafia group and cartels which control the financial sector as well. Due to availability huge illicit fund, these cartels informally offering loans to the private sector, on their own terms and rate which are lower the official rates, and on the other hand due to the unfair competition it's hard to for private sector to pay back their loans, which create furthermore dominance of these criminal's cartels in the private sector.[5] As (Keh, 1996) also mention in hi work, criminals leaders usually had a great availability of fund which they earn by unfair mean, and also they are not burdened by high transaction, therefore they have a competitive advantage over domestic banks and offer loans with lower lending rates and also offer attractive deposit rates. This illegal mechanism creates more difficulties of legitimate lending institution thus usually they transfer their business to other countries and in more savior cases these institutions completely close their business operations. Private sector downfall creates more unemployment and slower down the investment cycle as well. As it has been discussed earlier unemployed increases poverty and other harmful social issues specially lack for medical facilities (Sustainable Development Goals, n.d.e.). According to the estimation of, World Health Organization approximately 5 million children die before reaching 5 years and furthermore 37 million people globally living with HIV (Sustainable Development Goals, n.d.e.). As we can see in figure 4, the AID which is provided to Sub-Sahara Region lower than the estimated money which is laundered from there, however it because of the high level of corruption in the sub-Saharan region.

Furthermore, due to corruption and the bribes-based environment in developing mainly in the least developed countries, where aids and other financial assistance are

Figure 4. AID received, and estimated money laundered from Sub-Sahara region
Source: WDI



theft and then usually laundered, the government official does not cooperate with field data collectors which provide numerical statistics for further policymaking. However, numerous fake schools and hospitals are documented in papers but do not exist. According to the estimation of the United Nations, approximately 60 million children are still out of primary school and 620 million youth world wired living with illiteracy (Sustainable Development Goals, n.d.f). The foraging in data and statistic creates numerous problems for policymakers of sustainable development goals in evaluation. Furthermore, (Quirk, 1997) indicates in his discussion, money laundering can skew economic data due to the difficulty to measure the exact scope and implications of this phenomenon.

CONCLUSION

In seeking to clarify the impact of money laundering on economic growth and further on sustainable development goals, this discussion reveals that for sustainable development goals it is mandatory to stop the flow of money laundering around the world and formulate strict policies and procedures regarding anti bribe and anti-corruption. It is also the responsibility of all the financial regulators, and the monitory unit provides proper guideline and support to implement all the anti-money laundering procedures and standard, which help the flow of illicit funds around the world. Furthermore, it is not only the responsibility of single an origination or country to comply with antimony laundering polices everyone needs to take part in it, as Sustainable development is for us, and our next generation as well.

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ENDNOTES

1 **Recommendation (1 and 2**), provide guidance regarding AML Policies and coordination, **Recommendation (3 and 4)** explain money laundering and its Confiscation, **Recommendation (5 to 8)** provide legislative measure to fight against terrorist financing and also financing of proliferation, **Recommendation (9 to 23)** provide in depth explanation of preventive measures, **Recommendation (24 and 25)** illustrate accountability, transparency and legal ownership arrangement of business and in the last **Recommendation (36- 40)**, provide mechanism of international cooperation

2 International Convention for the Suppression of the Financing of Terrorism or UN Convention against Transnational Organized Crime and the UN Convention against Corruption

3 In past, few year Pakistan's economy hit by massive capital outflow due to money laundering, therefor it brings quick depreciation of local currency and furthermore short of foreign reserves in terms of dollars along with heave repayments of foreign debts and import bills.

4 FATF and OECD, continuously publish list of countries for the guideline of other financial institutions and investors regarding investment, regularity and compliance standards.

5 Among 81 sugar mills in Pakistan, approximately 65 mills are fully or partially owned by political expose people, their relative and front man, which easily control prices and supply of sugar in the market.

Chapter 8
Current Situation and Solution of Express Packaging Under "Green Logistics"

Zhang Yu
School of Economics and Management, Chang'an University, China

ABSTRACT

With the continuous development of e-commerce in China, the business volume of the express delivery industry is also growing, which brings tens of millions of express package garbage, which not only causes serious waste of resources, but also serious environmental pollution. This chapter analyses the current situation of packaging in express delivery industry, in the "green logistics". The main measures for the green development of express packaging are given below.

INTRODUCTION

With the rapid development of "Internet +" in China, online shopping has become an indispensable part of most people's daily life. In November 11, 2017, sales of Tmall only amounted to 168 billion 200 million yuan, and all kinds of goods purchased online need to be delivered to customers by express delivery, according to the state postal service. According to the statistics of the bureau, 40.6 billion express deliveries were completed in 2017, an increase of 28% compared with 2016. In 2017, all express delivery industries in China consumed about 4.1 billion woven bags, 8.7 billion plastic bags, 4.7 billion packing boxes and 420 million packing belts. However, the overall recovery rate of express packages in China is less than 20%, and the recovery rate of packaging boxes is far less than 50%, while the recovery

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rate of plastic components such as fillers, sealing tapes and packing tapes in express packages is basically zero. These non-recycled packages are eventually incinerated in the form of garbage, resulting in harmful dioxins and toxic gases (Alvarez et al., 2011). It not only endangers people's health, but also has a certain impact on the environment. Therefore, with the increasing number of packages in express industry, how to make express packaging Green has become a critical issue for the current development of express industry.

MAIN PROBLEMS EXISTING IN PACKAGING OF EXPRESS INDUSTRY IN CHINA

Over Packing in Express Industry

With the rapid development of e-commerce in China, the express industry has sprung up rapidly, such as Shunfeng Express, Jingdong Express and "three links and one access". However, China's express delivery is still in the initial stage of logistics, only engaged in simple manual loading and unloading, handling, storage, warehousing, warehousing and distribution operations (Angell and Klassen, 1999). Usually, consumers place orders online and receive products. Commodities are often loaded, unloaded and transported more than five times before they reach consumers smoothly. In this process, express delivery often causes damage to the goods. Many sellers often use excessive packing boxes and cushioning materials in order to reduce the loss of goods during express delivery. This is far beyond the actual needs of express packaging function. On the one hand, it leads to the waste of packaging materials resources, on the other hand, it leads to the waste of express transport capacity. According to the statistics of China Federation of Logistics and Purchasing, the solid packaging waste produced by express industry in China is far more than 200 million tons per year, and the recovery rate of express packaging is less than 20%. In recent years, with the rapid growth of e-commerce business, in order to ensure that goods can be delivered to consumers in good condition, the over packaging of express industry is particularly obvious.

Good and Low Recovery Rate of Express Packaging

At present, when almost all the sellers of electric business send goods, express packaging is usually at present. When almost all the sellers of electric business send goods, express packaging usually includes: paper packing box, document bag, plastic bag, sealing belt, plastic woven bag, inflatable internal buffer, and these packaging only contain paper. Plastic woven bags of quality packaging boxes and document bags can be recycled. Because other packaging materials cannot be degraded, or are overused or discarded at will, it is difficult to recycle packaging (Aspan, 2000). The main reasons for the low recovery rate of express packages are as follows: First, as far as the buyers are concerned, after receiving the purchased goods, most people choose to throw all the packages away as garbage, and have not formed the consciousness of actively participating in the recycling of packages; Second, from the fast logistics. From the perspective of delivery companies, express companies are also reluctant to take the initiative to recycle packaging. Because of the low profit of the express delivery enterprise's recycling package business, the express delivery enterprise often needs to spend extra labor, expenses and the corresponding stacking place to recycle the package. Especially when the express waybill is firmly pasted in the package box, the recycling value of the express package is even more in this case. Low, which weakens the enthusiasm of logistics express delivery enterprises to recycle packaging; finally, because we are still in the developing countries, the whole society has not built a system for the recycling of express packaging waste, which is also an important reason for the low recovery rate of express packaging.

Significance of Developing Green Packaging in Express Industry

Green logistics refers to the planning and implementation of logistics activities such as loading and unloading, handling, transportation, storage, packaging, circulation and processing by making full use of advanced logistics technology, aiming at reducing pollution to the surrounding environment and resource consumption as much as possible. That is to say, while fully restraining the harm of logistics to the environment in the process of logistics, we should purify the logistics environment and make the best use of logistics resources. Green logistics includes the greening of all operation links of logistics and the greening of the whole process of logistics management.

Green packaging refers to the packaging that is harmless to the whole ecological environment and human health, can be reused and utilized, and conforms to the sustainable development. The core of green packaging is to protect the surrounding environment, while helping to save resources. These two aspects are complementary and inseparable. The 4R1D principle of green packaging (Reduce to reduce the use of packaging, Reuse to reuse packaging, Recycle to recycle packaging, Recover to recycle packaging, Degradable packaging can degrade decay) is to develop green packaging from the source of express packaging and thoroughly solve all kinds of non-environmental packaging used in logistics process. Material, and then can be a good solution to express packaging generated by a large number of garbage problems, can play a role in protecting the environment and reducing waste of resources.

At present, the annual use of express packaging in China is huge, and the generated express garbage is also huge. There are two main ways to dispose of express packaging wastes in China: one is to be transported to fixed garbage disposal sites for centralized burial; the other is to use incineration as energy source for energy generation, which is a harmless way of disposal and recovery, but the actual recovery rate of express packaging is less than 10%. So how to solve the current situation of unsustainable packaging in express delivery industry, reduce the excessive consumption of raw materials in the process of express packaging, and reduce all kinds of pollution problems caused by packaging materials (Bai and Hidefumi, 2001). The green packaging of express delivery industry is the main measure to achieve this goal. Nowadays, in developed countries such as Britain, Japan, the United States, and Germany and so on, express goods have already implemented green packaging of goods, and have achieved quite good results.

COUNTERMEASURE OF GREEN DEVELOPMENT OF EXPRESS PACKAGING

Reducing Over-Packaging and Adopting Environmentally Friendly Packaging Materials

E-commerce buyers over-packaging express goods, mainly for the following two reasons: First, sellers in the delivery process, in order to reduce the loss of goods in the express delivery process, often use excessive packaging boxes, buffer materials, which can reduce the operation of sellers. Second, excessive packaging is nothing more than to highlight the intention of the seller, in order to improve the buyer's shopping satisfaction, and cultivate these consumers to become their loyal customers (Bowen et al., 2011). However, packaging is only the shell of the product, and the quality of the product is the real key factor. Therefore, on the one hand, e-commerce sales can only improve their own level of service and enhance product quality, so as to lock in target customers and improve consumer stickiness. On the other hand, for e-commerce online sellers, express companies can communicate and cooperate with e-commerce platform sellers, so that online sellers can use green, recyclable and degradable express packaging materials as far as possible. Online sellers can do enough work on product packaging, such as: sellers can choose appropriate green packaging according to different products for packaging. For example, Dangdang took the lead in the express delivery industry for its own commodities, replacing the traditional plastic bags with green degradable packaging bags, which mainly consisted of corn and straw starch. This kind of packaging bags can degrade naturally in the soil over time, and can reduce oil consumption as well. Consumption, can also achieve green environmental protection. For such sellers as O2O, sellers can direct consumers to the store to pick up goods. This kind of self-withdrawal method can either conduct on-the-spot inspection, receipt or return service.

From the second half of 2016, Alibaba's rookie logistics united with 32 logistics express enterprises in China to explore the development of green logistics. At the end of 2016, Alibaba pioneered the "green warehouse" in the industry. All express packages in the green warehouse use all tape-free express box and completely degradable green environment protection. Express bags. During the "Shuang11" period in 2017, newbies launched 20 "green warehouses" nationwide. When buyers select goods online, green parcels will be marked on the webpage, which means that this kind of products will be delivered uniformly using green parcels.

In the huge supply chain of green packaging of logistics express, it includes not only tens of thousands of consumers, but also the suppliers of packaging materials, logistics enterprises, e-commerce platforms and platform sellers. During the period of "Shuang11", Alibaba New Bird Logistics started to recycle express cartons in the first and second-tier cities of China. In northern Guangshen and other places, as well as most of the university's rookie posts, consumers complete the receipt and inspection, cartons can be directly left in the rookie posts. Next, the newcomer logistics will combine with the relevant packaging enterprises to process the express cartons and make them into express cartons again.

Promoting Express Packaging Recycling by Various Incentives

E-commerce enterprises and sellers can cooperate in launching express package recycling activities. They can take the form of bonus points system and rebate vouchers to bring more convenience and welfare to the participating consumers, so that consumers can actively participate in this activity, and constantly promote the environmental awareness of recycling packaging (Carter, 2000). Make the awareness of green environmental protection deeply rooted in the hearts of the people. In this regard, online supermarket No. 1 took the lead in launching the "environmental protection and carton recycling" campaign. Shop No. 1 offers a 50-point bonus for each recycled package. Consumers can exchange vouchers, buy their own products directly, and regularly participate in the lottery activities of shop No. 1. Store No. 1 gives bonus points to customers (Carter and Carter, 1998). Consumers are encouraged to actively participate in the recycling of express packages. At present, No. 1 shop has covered the self-distribution areas of 20 cities such as North China, South China and East China.

Drawing on the Experience of Green Logistics Packaging of Express Goods in Developed Countries

Developed countries started early in express green packaging, and have achieved good results in express green packaging. Britain is the first country to promote "Zero Waste Action" in the world. In the past decade of the 21st century, the packaging of products in Britain has been reduced by 40%. At the legislative level, relevant laws have been promulgated for product packaging, requiring that no additional packaging should be added except that product packaging can ensure the hygiene and safety of the product. If the merchants violate the regulations, consumers can complain to the relevant regulatory authorities, which can deal with them accordingly. As early as 1990, Germany promulgated the Regulations on the Management of Packaging Waste and the Law on the Recycling and Recycling of Packaging, which clarified the responsibilities of both sides (Carter 1998). For example, it stipulated that product packaging must be recycled completely, 80% of product packaging waste must be recycled, and each of product packaging treatment must be recycled. All steps are subject to the relevant laws.

CONCLUSION

Express Green Packaging is a multi-party system engineering, which involves not only e-commerce platform enterprises, but also express logistics companies, consumers and product packaging recycling departments. It also needs the active advocacy of government regulatory departments. In order to promote the green development of express packaging smoothly, all parties should cooperate and make concerted efforts to promote, so as to promote the sustainable development of express green packaging.

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Chapter 9
Roles and Strategies of 20th and 21st Century Women Environmentalists

Mercia Selvia Malar Justin
Xavier Institute of Management and Entrepreneurship, India

Perfecto Gatbonton Aquino, Jr
Duy Tan University, Vietnam

Doan Hong Le
Duy Tan University, Vietnam

ABSTRACT

The chapter presents the roles and strategies of 25 women environmentalists from across the globe in the 20th and 21st centuries. They were chosen based on the various awards and recognitions they received in recent years. The role of the women environmentalists before becoming environmentalists was found to be diversified, from politicians to researchers to a high school student. Their roles after they committed to environmental protection and nurturing again varied from advocacy, activism, policy initiatives, research supporting environmental protection, etc.

INTRODUCTION

God created the earth and gave it to humankind to nurture and protect it. He gave woman as a helpmate to man. God in His wisdom since the beginning have given women the role and responsibility in nurturing and protecting the earth that he created. Men and women have their roles and responsibilities in protecting and

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Table 1. Risks that could influence the world

Risk	Rank
Weapons of mass destruction	1
Extreme weather events	2
Natural disasters	3
Failure of climate change mitigation and adaptation	4
Water crises	5

Source: Global Risks Perception Survey (2017-2018)

nurturing planet earth. Men and women need to exercise their role and responsibility of nurturing and protecting planet earth. Over the centuries, the role has changed to that of destroying planet earth for selfish motives. Today planet earth is in devastated condition. World Economic Forum fixed its global agenda for 2018 as the role of technology in solving world's biggest problems. The introductory remarks were as below:

As world leaders gather in Davos this week to discuss how to better shape our future through strengthened cooperation, it's imperative to also focus on how to prevent the health of our planet from failing. This is not "doom and gloom" – the risk is real.

The Global Risks Report, based on the Global Risks Perception Survey (2017-2018), World Economic Forum, lists the five risks that will have the biggest impact in the next ten years, as follows:

As we can see from the above table, four out of five risks are associated with environment. Extreme weather events, Natural disasters, Failure of climate change mitigation and adaptation, Water crises are all outcomes of poor environmental nurturing and protection initiatives of humankind. Marco Lambertini, Director, WWF International says, "No human technology can replace 'nature's technology' perfected over hundreds of millions of years to sustain life on earth". Our planet is on the brink of destruction, there is no doubt about it. The health of our planet has been failing rapidly. Over the past six years, planet earth has been experiencing the hottest climate. The Arctic is warmed faster than predicted. Climate related disasters have damaged worldwide approximately $1.4 trillion over the past ten years. Just over the past 40 years, the world has witnessed 60 percent decline in wildlife populations across land, sea and freshwater. By 2020, the shrinkage in wildlife is expected to be two thirds. Forests are dwindling and under further pressure. Deforestation of over 170 million hectares is expected to happen by 2030. Oceans have become dumping grounds for plastics and toxic chemicals. Unsustainable mechanisms of fishing has caused overfishing of 90 percent of oceans' fish stock. World's coral reefs are lost 50 percent over the past three decades. Our planet earth is under the threat of reaching extinction. The food and water scarcity, along with poor quality of air to breathe, speaks louder and clearer that the planet earth is under a huge threat and needs urgent attention.

Norgaard & York (2005) empirically assessed the association between the representation of women in national Parliament and environmental treaty ratification, using a large sample of nations. The findings indicated that nations with higher proportions of women in Parliament are more prone to ratify environmental treaties than are other nations. The result pointed to the importance of considering the role of gender in analyses of state behaviour and environmental politics. The results were consistent with the argument of some feminist theorists that the exploitation of nature and the exploitation of women are interconnected. Jackson (2008) examined the women and environment linkage, which characterized not only ecofeminist thought but also, increasingly, development discourse and practice -from NGOs to the World Bank. It suggested that gender analysis of environmental relations leads to very different conclusions, of potentially conflicting rather than complementary agendas, for gender struggles and environmental conservation. Goss & Heaney (2010) highlighted the role of feminine expression and concerns about the intersectional marginalization of women in resolving the historic tensions between maternalism and egalitarianism. They demonstrated hybridity as a useful analytical lens to understand gendered organizing and other forms of grassroots collective action. Alaimo (2008) suggested that it is crucial that we interrogate the grounds, purposes, and consequences of linking environmentalism and feminism, by analyzing specific articulations within particular places and contexts. The author also wondered whether it is beneficial to merge feminism and environmentalism remains an open question.

Agbogidi & Ofuoku (2007) established that the environment, which is a common heritage of humanity, needs to be sustainably managed to fight against poverty, food shortage as well as homelessness, which are some of the serious consequences of environmental degradation. Nugent and Shandra (2009) found strong support for the idea that increasing women's political status in particular through representation in national government has a positive effect on state environmental protection efforts. They found no evidence that connection to a world polity has a significant effect on nation-state designation of protected land area. Peeples and DeLuca (2013) explored the communicative practices that have enabled the women of Environmental Justice to achieve change in extraordinarily difficult contexts. The women used what appears to be a liability, their gender, especially their role as mothers, to challenge practices and policies that threaten their homes, families, and communities. Prindeville and Bretting (1998) examined the political identity, demographics, and experience of 16 Latina and Native American women activists in environmental justice organizations in New Mexico. The study concluded that there are important similarities between women active in grassroots community organizing. Further, it was found that differences in their ideologies and motivation for participating in politics, however, warranted the development of new conceptions of political activism, feminism, and environmentalism. Quigley, Che, Achieng and Liaram (2016) adopted Participatory Rural Appraisal to examine through participatory approach gender tensions. The findings were on the themes: Why are people doing what they are doing? Who is or is not acting? How do we move forward? The research documented gendered tensions such as the burdens of responsibility, the power imbalance disadvantaged women feel regarding solving environmental issues, and the blame that is directed at both men and women.

Barry (2008) examined the environmental justice efforts of the Coal River Mountain Watch (CRMW) in Boone County, West Virginia as a case study. The shortcomings in the ecofeminist scholarship was redressed by highlighting the role of women collectively in addressing environmental issues through environmental justice organizations. Larkins (2017) addressed how gender interlocks with other identities (such as femininity, motherhood, and citizenship subjectivities) to mediate environmental realities, experiences of injustice, and claims for recognition. It was found that the women, and organizations, who conform to hegemonic expectations, face less relational, community, or political censure. Logdson (2011) provided support for the necessity and utility of matricentric feminism in understanding historic and current activism. It was concluded that the evolution towards activist mothering began in the later half of the twentieth century.

The chapter is an attempt to examine how women environmentalists are playing a crucial role in nurturing and protecting planet earth. Women have equal responsibility as men towards the health and wellbeing of the planet earth. Women's contribution towards nurturing and protecting planet earth is found crucial during these days of threat to planet earth. Women have the inbuilt character of nurturing and protecting, as they are the life givers. As much as they nurture and bring up their children, they are capable of and willing to nurture and protect planet earth. While all women have their contributions towards nurturing and not everyone comes out to nurture and protect planet earth in a remarkable way. Women are less damaging and less destructive on planet earth. Women are not the ones who destroys forests; cause massive destruction to ocean-freshwater-land based species, or unmindfully pollute air-water-soil. Most of the decisions and actions in these directions come from men as men predominantly occupy the leadership positions of organizations and countries.

METHODOLOGY

Women in the 21st century are fighting their way back to leadership roles as in ancient times. Women are working to gain their power in society and countries to lead societies and countries. As a large chunk of women struggle to find their way to powerful positions to lead some women have already reached there. They have found the cause of environmental protection as an ideal to work for and therefore have empowered themselves to act in favor of nurturing and protecting planet earth. These women thus have made a mark in the world as environmentalists and have received the due recognition. The paper has identified 25 women environmentalists of 20th and 21st century and reviewed their role and strategies in protecting planet earth. These women environmentalists were selected based on reports published during 2018 & 2019, highlighting women environmentalists.

Roles of the 20th and 21st century women environmentalists have been very different and diverse. Some of them started as researchers and later turned into environmental activists. While others have been students, social workers, fashion designers, etc. who were touched and transformed to be environmentalists. Let us have a glimpse of each of these women environmentalists and their contribution to protect environment through their roles and strategies.

WOMEN ENVIRONMENTALISTS

Anne Hidalgo is serving as the Mayor of Paris since 2014. She is the first woman to hold such office. Her 'Paris Breathes' initiative since 2016 prohibits any motor vehicle to enter some parts of the city on the first Sunday of the month. On that day, the electric vehicles are free, along with bike rentals. She has promised public metro to work for 24*7. She has proposed a ban on diesel vehicles. She has introduced the Velib bike- hire system and expanded it to 43 cities from just 6 cities. She has advocated for pedestrian spaces and green spaces, thereby contributing to environmental protection.

Arundathi Roy a great Indian writer in English has contributed a great deal to environment protection. She is an activist on several social and political causes. She has expressed her concern for nature through her writings, especially in the Booker Prize winning God of small things. She has also actively participated in activities of Narmada Bachao Andolan and Saving Niamgiri Hills. Many researchers have highlighted her writings in strong favor of protection of environment. She has also voiced her opinions against globalization, which is a threat to environment.

Berta Cáceres grew up in violent torn Central America. She has seen her mother a midwife and a social activist who gave protection and care for refugees from El

Salvador. She learnt from her the value of standing up for disenfranchised people. She grew up to become a student activist. In 1993 along with others, she founded National Council of Popular and Indigenous organizations of Honduras (COPINH). The purpose of the organization was to address the threats posed to Lenca people by illegal logging, fight for their territorial rights and improve their livelihoods. She mounted pressure through campaign against the Agua Zarca Dam, based on the request of the local community. She brought the injustice involved in it to the attention of international community. Gunmen shot her dead in her home in 2016. She is the recipient of the Goldman Environmental Prize.

Bina Agarwal is a Professor of Development Economics and Environment at the Global Development Institute, University of Manchester, UK. She is an acclaimed writer covering themes like lands, livelihoods and property rights, environment and development, the political economy of gender, poverty and inequality, agriculture and technological transformation, legal change, etc. Her most popular and powerful book is, A Field of One’s Own: Gender and Land Rights in South Asia. The book won many prizes and influenced governments to change policies on women and their property rights. Indian Government passed the Hindu Succession (Amendment) Act in 2005 spurred by her book and the succession movement she led. Both married and unmarried women hold equal rights along with men in the inheritance of the property, specifically agricultural land.

Carol Martha Browner was informally referred to as the ‘Climate Czar’, while serving as the Director of the White House Office of Energy and Climate Change Policy in the Obama administration. As Administrator of the EPA under President Clinton she started a successful program to deal with contaminated lands in urban areas. She was the driving force behind a stringent tightening of air quality standards. She was guided by the philosophy, ‘the environment and the economy go hand in hand. We can set tough standards to protect the environment and public health - but do so in ways that promote innovation, flexibility, and American competitiveness.’

Christiana Figueres began her public service as a Minister Counselor at the Embassy of Costa Rica in Bonn, Germany in 1982. Later she moved to USA as Director of Renewable Energy in the Americas (REIA). In 1995 she founded the non-profit Center for Sustainable Development of the Americas (CSDA) which she directed for eight years. She is internationally recognized and acclaimed as a leader on global climate change. She served as Executive Secretary of the United Nations Framework Convention on Climate Change (UNFCCC) 2010-2016. In view of the failed Copenhagen 2009 conference, she was determined to lead the process to a universally agreed regulatory framework. Working towards the goal, she organized successful conferences of all concerned parties over the period of her tenure at Cancun 2010, Durban 2011, Doha 2012, Warsaw 2013, and Lima 2014, and culminated her efforts in the historical Paris Agreement of 2015.Throughout her tenure with UNFCCC, she brought together national and sub national governments, corporations and activists, financial institutions and communities of faith, think tanks and technology providers, NGOs and parliamentarians, to jointly deliver the unprecedented climate change agreement. She has been credited with forging a new brand of collaborative diplomacy in order to bring about such an achievement.

Erin Brockovich is remembered as a consumer advocate and environmental activist. She turned her normal life of a file clerk working for a law firm in Los Angeles into one that fought against a powerful corporate that caused serious health threat to people of Hinkley, California. She uncovered documents that helped 600 residents file a lawsuit against PG & E and received a settlement of USD 333 million for the residents.For her part in bringing the case to the firm, Brockovich received a fee of $2.5 million. Jersey Films bought the rights to Brockovich story in 1995 and the film was released in 2000 as Erin Brockovich.

Greta Thunberga schoolgirl with sheer determination has turned from a lone activist in August 2018 to a great leader for the School Strike for Climate across 700 places in 71 countries. For eight months in sun, rain, snow and ice, she did not fail to go every Friday to sit at the cobblestones outside the Swedish parliament with a hand painted banner. She has felt the shock of climate change in her 8^{th} year and has convinced her parents to contribute to climate change positively – her mother has given up flying and have serious impacts on her career and her father has turned a vegetarian. After influencing her home for good, she has turned to influence the public for the good. She spoke at the World Economic Forum criticizing the leaders and corporates that they are not doing anything. Though she accepts that governments and corporates need to do much she also believes that individuals must do their part. She lives her values – as a vegetarian and travels abroad only by train. The world is seeing her as a hope for climate change issues.

Dr. Gro Harlem Brundtland is a Norwegian politician who served her nation three terms as Prime Minister. She was Norway's first woman Prime Minister. She stepped down from Prime Ministerial role to take up the call from World Health Organization to serve as its Director General. She served the World Health Organization as Director General from 1998 to 2003.Dr. Brundtland has developed a growing concern for issues of global significance from her childhood through her father. In 1983 the then United Nations Secretary-General invited her to establish and chair the World Commission on Environment and Development. The Commission, which is best known for developing the broad political concept of sustainable development, published its report Our Common Future in April 1987. The Commission's recommendations led to the Earth Summit - the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro in 1992. Brundtland report is the forerunner of UN's MDGs (2000-2015) and the UN SDGs, which we are currently working on.

Dr. Heather Leslie is an international leader in marine conservation science. She conducts research on the ecology, policy, and management of coastal marine ecosystems. Her contribution as an environmentalist is the outcome of her service as Director of the University of Maine's marine laboratory, Darling Marine Center, and Libra Associate Professor of Marine Sciences in UMaine's School of Marine Sciences. Her research has a great impact on the protection of marine flora and fauna. As a marine conservation scientist, Heather Leslie investigates the connections between people and coastal marine environments in order to advance knowledge of how marine ecosystems work and to contribute to conservation that is more effective. Her specific areas of expertise include marine ecosystem-based management, coupled human-environment systems, and coastal ecology.

Isatou Ceesay is popularly known as the Queen of Plastic Recycling in Gambia. She educates the women in the Gambia to recycle plastic one of the worst pollutants and to generate revenue for themselves. She has been working for the past twenty-one years empowering women and thus the families in The Gambia. She along with four women started the Recycling Centre of N'Jau in 1997. On Sundays along with women volunteers, they educate people in the local markets as to how to handle waste. After seventeen years of hard work, she could convince the government to declare a ban on plastics in The Gambia. She loves women and believes in their power to make the planet a better place. She says that women have a key role to play across the world and have a key responsibility in protecting and nurturing the earth. She says women by nature are the engines of human development.

Julia 'Judy' Bonds also called as 'the godmother of the anti-mountain removal movement' is an activist and organizer from Appalachian Mountains. She led the fight against mountain top mining in Appalachian Mountain range. She was inspired by the writings of Marin Luther King, Gandhi and the teachings of her mother, the religious convictions of her Southern Baptist and Cherokee backgrounds. She said convincingly, "I don't mind being poor. I mind being blasted and poisoned. There ARE no jobs on a dead planet." She was awarded the Goldman Environmental Prize in 2003.

Kristin Marhaver is a coral reef biologist who works with CARMABI foundation. Her research interests are coral reproduction and larval behavior, microbial ecology of coral settlement, endangered species breeding, coral speciation (or the lack thereof), coral reef ecology, reef restoration science, conservation biology. She has done her post-doctoral in Ocean Sciences. She is guiding more than 19 research scholars in Ocean Sciences and Coral Ecosystem. She is also invited speaker in great forums like World Economic Forum, TED Global, etc. and universities like Harvard, San Diego Zoo Institute, etc. By doing research in the areas of coral reef ecology, reef restoration science and conservation biology she is doing a great service to the environment in protecting and nurturing planet earth.

Laurie David is an author and producer. Her movie The Inconvenient Truth based on the former Vice President of US Al Gore's research findings presented as slides shook the world to realize the seriousness of climate change and global warming. Her documentaries and her writings have brought a tremendous impact on people to work towards a better world reducing the possibilities of global warming and climate change. She authored the best-selling Stop Global Warming: The Solution is you! She co-authored the children's book The Down-to-Earth Guide to Global Warming, which received the Green Earth book award. She also produced documentaries like Earth to America, Too hot to handle, Fed up, etc. which have had huge influence on people. The Inconvenient Truth is necessary watch for all to understand and work for the protection and care of planet earth and stop global warming and climate change. What she started as an advocacy project turned out to be a global phenomenon that opened the world's eyes to human-triggered environmental catastrophe called climate change.

Marina Silva is a Brazilian politician and environmentalist. The Brazilian environmentalist Chico Mendes inspired her and she participated in "draw" protests joining rubber workers in forming a human chain to protest deforestation. Silva began her political career in the '90's running on protecting environmental resources and promoting sustainable development in the Amazon. Her hard work was noticed and appreciated. Silva won the Goldman Environmental Prize for South & Central America. She was appointed Brazil's Environmental Minister. As a highest standing public servant committed to sustainability she fiercely fought against large agribusinesses. She delayed permits to project she thought were environmentally detrimental. She was forced out of her position because of her strong environmentalist actions and beliefs. Marina Silva helped establish a 2-million-hectare reserve managed by traditional communities.

Margaret Atwood is a Booker prize-winning author. She predicted that climate change will not be far from her fiction depictions and that it would be harder on women. She practices environment friendly initiatives as much as she preaches them. In her Booker famous book The Handmaid's Tale she explains pollution as a cause for infertility. She gave up her home in France in 1995 as France resumed nuclear testing. She donated significant portion of her Booker prize to environmental groups. She uses her book tours to promote environmental awareness, environmental activism and ensures that her tours are Carbon neutral. Particularly she uses shade grown coffee which had not cause any deforestation to protect the songbirds of the forest canopy.

Pashon Murray is a woman who is not afraid of dirt and found her own company Detroit Dirt. Her father's waste management company has always made her wonder why people would waste-buy-waste. Her company was started immediately after her graduation. She buys all organic waste like –food waste, garden waste, wood waste, etc. and heaps them for the earthworm to work on it. The resulting compost is sold to urban farmers. She believes in circular economy.

Rev. Sally Bingham brought widespread attention to the link between religious faith (Christian) and the environment through her work on the Regeneration Project and the Interfaith Power & Light campaign. She is driven by the love of nature and the fact that environmental issues were being ignored and neglected by religious denominations. She as a faith leader considers global warming as a core moral issue and mobilized thousands of religious people to put their faith into action through energy stewardship. She served in President Obama's Advisory Council on Faith-Based and Neighborhood Partnerships.

Sheila Watt-Cloutier is one of the outstanding advocates of economic, social and cultural rights of the Inuit of the Arctic. As an elected representative of her people making an overhaul of the education system in Northern Quebec meeting the needs of the Inuit communities. She was influential in the adoption of the Stockholm Convention to ban persistent organic pollutants present in the Arctic food chain. She advocated and shifted the discourse on climate change by establishing how unchecked greenhouse gas emission violate the collective human rights of the Inuit. She has been recognized with several awards including the UN Environment Programme's Champion of the Earth Award in 2004, the Governor General's Northern Medal in 2005 and the Officer of the Order of Canada in 2006. She was also recommended for the Nobel Peace Prize in 2007.

Simona Getova is a Macedonian environmental activist and friend of Young Friends of Earth Europe. She started SOS Valandovo. She worked tirelessly for years to raise awareness of the potential environmental and community damage that could be caused by the Kazandol copper mine in the clean and green agricultural region. She gave up her job and returned to her native only to fight against Kazandol mine. She fought against the fracking process engaged by the mine saying that she and her children needed clean air and water.

Sunita Narain is a political activist and environmentalist who works for green sustainable environment. She started her career with Center for Science and Environment and is now its Director General. She serves as the treasurer of Society for Environmental Communications and editor of the fortnightly magazine, Down To Earth.

Suzy Amis Cameron began her career as a Ford model and then entered Hollywood. She retired from acting after the film Judgement Day. She and her husband practice plant-based diet. She along with her sister founded a school, which practices plant-based diet, zero waste and 100 percent solar powered. She also founded the Red Carpet Green Dress a global initiative to showcase sustainable fashion at the red carpet at Oscars. She partners with powerful brands to showcase recycled, repurposed, vintage and eco-designs. She involves some powerful brand ambassadors for the event.

Sylvia Earle is an Oceanographer, explorer, author, lecturer and the founder of Mission Blue an organization that inspires action to explore and protect the ocean. Mission Blue is uniting a global coalition to inspire an upwelling of public awareness, access and support for a worldwide network of marine protected areas. The New Yorker calls her "Her Deepness", the Library of Congress "Living Legend and The Times call her "Hero for the Planet". She had led more than 50 expeditions and clocked 7000 hours underwater. She started the companies Deep Ocean Engineering and Deep Ocean Technologies with engineer Graham Hawkes to design undersea vehicles that allow scientists to work at previously inaccessible depths. According to the New York Times, "she has done pioneering research on algae, probed the ecology of coral reefs, set records for deep diving, tracked marine mammals and lobbied for the creation of marine sanctuaries".

Vandana Shiva is an Indian Physicist and Social Activist. She founded the Research Foundation for Science, Technology and Natural Resource Policy. The foundation is devoted to sustainable agriculture since 1982. She worked with Indian Institute of Science and Indian Institute of Management. She proceeded to work among the grassroots. Wikipedia describes her as an Indian scholar, environmental activist, food sovereignty advocate, and alter-globalization author. She is a Gandhian who promotes Gandhian philosophy. She has authored more than 20 books. She runs 'Navadanya' an organization for protecting indigenous seeds and the organization works among farmers encouraging them to use organic method of farming and to use local expertise. She defends and celebrates biodiversity and indigenous knowledge.

Wangari Maathai was awarded Nobel Peace prize in 2004 for her contributions towards sustainable development, democracy and peace. She founded the movement called Green Belt Movement. She has written four books, The Green Belt Movement; Unbowed: A Memoir; The Challenge for Africa; and Replenishing the Earth. The documentary film titled, Taking Root: the Vision of Wangari Maathai (Marlboro Productions, 2008) was focused on her and her Green Belt Movement. The Wangari Maathai Institute for Peace & Environmental Studies is dedicated to excellence in experiential learning, transformational community outreach, and research for sustainable environments and cultures of peace. The Wangari Mathai Foundation has been established with a vision to enable individuals acknowledge their capacity to be a force for positive change.

ROLES AND STRATEGIES

Women represented in this chapter as environmentalists have been emerging from various occupations. They have emerged as environmentalists after they have had an awareness and awakening about the environmental issues. Once they have received the awareness they have leveraged their roles, their positions and their resources to serve as environmentalists. Most of the women environmentalists though they began their work in their own nations have made an impact globally. These women environmentalists have adopted a wider spectrum of strategies as could be seen from each one's life. There are powerful activists and advocates who work through their activism and advocacy. There are scientists and researchers who through their scientific research create a positive impact on the environment. There are politicians and policy influencers who have contributed to positive policy initiatives. There are multilateral agency leaders who have guided the international community to take positive steps towards environmental protection and preservation. The roles and strategies of each individual women environmentalist have been unique and special. The summary of the roles and responsibilities of women environmentalists is presented in Table 2. As can be seen from the Table 2, some of them paly multiple roles and adopt multipronged strategies. Each one of them is unique in their roles and strategies.

CONCLUSION

Women projected as protectors and preservers of environment is part of the concept of ecofeminism. Ecofeminism has recognized the power of women as individuals and as a collective group to protect and conserve environment. It also recognizes the fact that women as ordinary citizens and as political, economic and social leaders can contribute to environmental protection. The literature has ample examples of women rising to the occasion and fighting it out to protect their own environment. Women of all age groups – from being a school student to being a seasoned mother, experienced politician with several years of experience and expertise have all contributed to environmental protection. The literature also supports the view that women came to play powerful roles in environmental protection only from the latter half of the twentieth century and the efforts are continuing through the twenty first century.

From the discussion on women environmentalists of 20^{th} and 21^{st} century there is a clear learning that women can be great forces in protecting and preserving planet earth. Women have the innate ability and strength to protect what they are entrusted with. Women can bring about the positive impact the world needs regarding global warming or climate change. Women can stop environmental degradation and they

Table 2. Roles and strategies of women environmentalists

Sl. No.	Women Environmentalists	Roles	Strategies
1.	Anne Hidalgo	Mayor	a. Paris Breathes -2016 b. Velib bike- hire system expanded to 43 cities
2.	Arundathi Roy	Writer	a. Activism b. Writing powerfully
3.	Berta Cáceres	Founder - COPINH	a. Mounted pressure through campaign
4.	Bina Agarwal	Professor Development Economics and Environment	a. Writing on lands, livelihoods and property rights, environment and development, the political economy of gender, poverty and inequality, agriculture and technological transformation, legal change, etc.
5.	Carol Martha Browner	Administrator EPA	a. Program to deal with contaminated lands
6.	Christiana Figueres	a. Director, Renewable Energy in the Americas b. Founder, Center for Sustainable Development of the Americas	a. Collaborative diplomacy b. Paris Agreement 2015
7.	Erin Brockovich	a. Consumer activist b. Environmental advocate	a. Uncovered documents and helped 600 residents receive a settlement of USD 333 million from PG & E
8.	Greta Thunberga	School girl	a. For 8 months every Friday, sat before Swedish Parliament. Now leading school strikes in 700 places in 71 countries.
9.	Dr. Gro Harlem Brundtland	a. Norway's Prime Minister b. WHO's Director Genera;	Chaired the World Commission on Environment and Development, giving the Brundtland report, forerunner of the MDGs and SDGs
10.	Dr. Heather Leslie	a. Marine Conservationist b. Director of the University of Maine's marine laboratory,	Works for the conservation of marine environment
11.	Isatou Ceesay	Environment Educationist	Empowers women and families through environmental education
12.	Julia 'Judy' Bonds	a. Activist b. Organizer	Led the fight against mountain top mining at Appalachian Mountains
13.	Kristin Marhaver	Coral Reef Biologist	Research on coral reef ecology, reef restoration science and conservation biology.
14.	Laurie David	a. Author b. Producer	a. Authoring powerful books b. Producing serious documentaries
15.	Marina Silva	a. Politician b. Environmentalist	a. Fiercely fought against large agribusinesses b. Helped establish a 2-million-hectare reserve managed by traditional communities.
16.	Margaret Atwood	Author	Preaches and Practices environmental protection
17.	Pashon Murray	Founder and owner of Detroit Dirt, a waste management company	Practices circular economy: Collects waste and converts it into manure
18.	Rev. Sally Bingham	Christian Priest	a. Leading practice of energy stewardship b. Serves in advisory council of Faith based and neighborhood partnership
19.	Sheila Watt-Cloutier	Advocate of economic, social and cultural justice for the Inuit of Arctic	Influential in the adoption of Stockholm convention
20.	Simona Getova	a. Environmental activist b. Founder of SOS Valandovo.	Raised awareness on the damages caused by copper mining

continued on following page

Table 2. Continued

Sl. No.	Women Environmentalists	Roles	Strategies
21.	Sunita Narain	a. Political activist b. Environmentalist c. Director General, Center for Science and Environment d. Editor, Down to Earth	a. Suggesting policy decisions b. Writing regularly on protection of environment
22.	Suzy Amis Cameron	a. Model turned Hollywood actress	a. Practices plant based diet b. Runs a school that practices plant based diet, zero waste and 100 percent renewable energy
23.	Sylvia Earle	a. Oceanographer b. Author c. Explorer d. Lecturer e. Founder: Mission Blue	a. She unites a global coalition to inspire an upwelling of public awareness, access and support for a worldwide network of marine protected areas b. She has led more than 50 expeditions and clocked 7000 hours underwater c. She researches on algae, probed the ecology of coral reefs d. She tracked marine mammals and lobbied for the creation of marine sanctuaries
24.	Vandana Shiva	a. Physicist b. Social Activist c. Founder: Navadanya d. Author	a. Promotes Gandhian thoughts and philosophy b. Protects indigenous seeds c. Encourages farmers to use organic method of farming and to use local expertise d. Defends and celebrates biodiversity and indigenous knowledge
25.	Wangari Maathai	a. Founder: Green Belt Movement b. Founder: Institute for Peace & Environmental Studies c. Author	Provides excellence in experiential learning, transformational community outreach, and research for sustainable environments and cultures of peace

Source: Compiled by the authors

can promote a healthy planet earth. Women can be the saviors of planet earth from the harmful greenhouse gases. Women power is awesome and amazing. If every woman rises up to stand firm and protect planet earth, there is no doubt that earth will have a pleasant and splendid future for our future generations. “The greatest threat to our planet is the belief that someone else will save it.” said Robert Swan. It is the responsibility of every woman to do whatever they can in their own roles with suitable strategies to protect and nurture planet earth. If women fail to play their role as individuals and as a group planet earth would be missing the protection and preservation from the most powerful part of the dwellers of the planet.

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APPENDIX

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Section 3

Chapter 10
Research on Dynamic Mechanism of Developing Green Logistics in Agricultural Products Logistics Enterprises

Zhang Yu
School of Economics and Management, Chang'an University, China

ABSTRACT

With the improvements of people's living standards, the demand for low-carbon, fresh-quality, and safe agricultural products is rising. Consumers are not only concerned about green production and processing of agricultural products, but also the logistics. The chapter relies on logistics enterprises of agricultural products, takes the enterprise green logistics as the research object, and uses game theory as a tool to study the dynamic mechanism of agricultural logistics enterprises to promote green logistics.

INTRODUCTION

Society has entered a new era. With the general improvement of people's living standards, the demand for agricultural products is changing from quantity to quality. Consumers are increasingly demanding green, low-carbon, fresh and reliable agricultural products. Logistics connects the production and consumption of agricultural products. People not only pay attention to the green production and consumption of agricultural products, but also pay attention to the green logistics of agricultural products. Green logistics of agricultural products can not only provide

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important guarantee for consumers to provide high quality and high added value agricultural products, but also reduce the environmental and ecological impact of agricultural products logistics operation. Destroying the unity of realizing high-quality development of agricultural products and sustainable development of logistics is the main body of implementing agricultural products logistics. But in fact, enterprises often make decisions based on their own economic interests, ignoring the importance of environment and ecology, and will not actively promote green logistics for agricultural products. It is of great significance to study the dynamic mechanism of developing green logistics for logistics enterprises (Figure 1).

Foreign research on green logistics of agricultural products mainly focuses on green logistics and foreign research on green logistics of agricultural products mainly in the application practice of green logistics and green supply chain. Chan et al. (2001) points out that agricultural logistics based on green supply chain is more sustainable than Christmann and Taylor (2001) innovatively puts forward the food supply chain, emphasizing the importance of enterprise cooperation in the chain, Dodgson, (2000) is a supply chain of agricultural products from developed countries, mainly involving fresh supply chain and food supply chain. In the fields of chain cold chain system and agricultural product logistics, the macro and micro aspects of green logistics development of agricultural products have been extensively studied in China. Dyer and Singh, (1998) summarized the research progress of green logistics of agricultural products, and pointed out that green logistics of agricultural products is an important

Figure 1. Green logistics

aspect of research. Marion gnawed out the green logistics of agricultural products based on the establishment of green logistics system of agricultural products. From the financial point of view, this paper discusses how to develop green finance to support green logistics of agricultural products. Faruk, (2002) points out the main restrictive factors affecting the supply chain management level of agricultural products logistics enterprises, and puts forward specific countermeasures. Florida, (1996) takes the fresh-selling agricultural products logistics enterprises in Hainan Province as the research object, points out the current situation of development problems, and evaluates their performance. Florida and Davison, (2001) studied the necessity of cooperation and cooperation among domestic agricultural logistics enterprises, and put forward some measures such as developing third party logistics of agricultural products and supply chain logistics of agricultural products. Frauk, (2002) put forward the connotation and constituent elements of the core competitiveness of agricultural products logistics enterprises, and established the evaluation model of the core competitiveness of agricultural products logistics enterprises.

In summary, although the research on green logistics of agricultural products has made rich achievements at home and abroad, there are few studies on the main body of agricultural products logistics: agricultural products logistics enterprises, and few studies on the dynamic mechanism of green logistics of agricultural products logistics enterprises. From the point of view of agricultural logistics enterprises, this paper constructs a dynamic mechanism model for enterprises to promote green development, elaborates the operation mechanism, clarifies the obstacles, and puts forward countermeasures, with a view to providing important reference value for enterprises to make decisions on green logistics development.

DYNAMIC MECHANISM OF GREEN LOGISTICS IN AGRICULTURAL PRODUCTS LOGISTICS ENTERPRISES

The Connotation of Green Logistics Dynamic Mechanism of Agricultural Products Logistics Enterprises

The dynamic mechanism of green logistics in agricultural products logistics enterprises refers to various internal and external factors that promote the formation and development of the green logistics system of agricultural products, and the ways in which these factors affect it.

The research object of the dynamic mechanism of green logistics in agricultural logistics enterprises is the sum of the dynamic factors and the mechanism of the interaction between them in the process of promoting green logistics in agricultural logistics enterprises, as well as the system of the game among the interest groups that affect these mechanisms. Its essence is to reveal the intrinsic relationship between the different motivations of stakeholders and the external environment and the promotion of green logistics process by agricultural logistics enterprises.

Dynamic Mechanism Model of Green Logistics

The green logistics behavior of agricultural products logistics enterprises is essentially an optimization and improvement of production and operation of enterprises, aiming to help enterprises optimize the allocation of resources, reduce logistics operating costs, improve operational efficiency and comprehensive competitiveness.

In the process of promoting green logistics in agricultural logistics enterprises, the dynamic mechanism consists of endogenous dynamic mechanism and exogenous dynamic mechanism. Endogenous dynamic mechanism refers to the forces that are generated within enterprises and promote change and development. It is manifested in economic interests, differential competition, enterprise ethics and exogenous dynamic mechanism originating from external factors of enterprises, and in government regulation, consumer demand and competitor motive force.

Endogenous Dynamic Mechanism

Agricultural products logistics enterprises are the key subjects to promote the development of green logistics of agricultural products. The endogenous dynamic mechanism of promoting green logistics is generated within enterprises, which promotes the power of change and development. It is embodied in economic interests, corporate ethics and differential competitive advantages.

1. Economic interests. The ultimate goal of green logistics for agricultural products logistics enterprises is to maximize long-term profits, and economic benefits are the core elements to be considered first in enterprise decision-making. Faced with the new era of green revolution, enterprises can achieve through management innovation and technological innovation. On the one hand, strengthening the strategic docking with upstream suppliers and cooperating with them can guarantee the quality of agricultural products, prolong the life cycle and increase the added value of agricultural products, which can not only achieve considerable economic benefits, but also achieve good social benefits. On the other hand, through the scientific planning and rational layout of the whole agricultural product logistics network and sites, energy saving and emission reduction of the means of transport, green logistics of agricultural products logistics enterprises will greatly reduce the cost of logistics operation, save

logistics costs, reduce operating costs, and also reduce the cost. Environmental and ecological cost risk in logistics operation.

2. Differential competition. At present, most of the enterprises of agricultural products logistics are small and medium-sized logistics enterprises. Facing the huge demand of agricultural products logistics, the competition among enterprises is fierce. Enterprises can gain comparative competitive advantage by establishing a perfect green logistics system for agricultural products. On the one hand, it can help enterprises to establish a good social image, gain more brand reputation and recognition, and win customers. On the other hand, it can also get bad quality according to the perishability, vulnerability and poor quality of agricultural products. In order to ensure the quality and freshness of agricultural products, we should provide differentiated and individualized agricultural products logistics services through innovating product forms, logistics modes and sales channels, so as to increase market share and establish unique differentiated competitive advantages of enterprises.
3. Business ethics. Enterprise ethics surpasses the requirements of government laws, regulations and regulations, and can cope with the relationship between enterprise development and environment and ecology at a higher level. An ethical enterprise must be a practitioner of green activities. The implementation of green logistics for agricultural products by agricultural logistics enterprises can not only extend the industrial chain, value chain and value-added chain of agricultural products, create enormous economic benefits, but also bear social and environmental responsibilities. It can influence and change the behavior of enterprise organizations and members, produce green enterprise culture, and root in the blood of enterprises. This is the cornerstone of sustainable and connotative growth of enterprises.

Exogenous Dynamics

The exogenous dynamic mechanism of green logistics in agricultural products logistics enterprises comes from the external environment of enterprises, which is manifested by government regulation, consumption demand and competitor power.

1. Government regulation. Green logistics has positive externalities. Agricultural products logistics enterprises can not only rely on the role of market mechanism to promote green logistics. In order to remedy the shortcomings of market self-regulation, the government needs to develop green logistics for agricultural products logistics enterprises by formulating corresponding regulations and regulations, such as funds, credit, taxation, etc. In the aspect of support, help enterprises internalize positive externalities, supervise and encourage

enterprises' green logistics behavior, create a good market environment, and promote the orderly development of green logistics of agricultural products logistics enterprises.

2. Consumption demand. The demand of consumers determines the production of enterprises. Agricultural products are the necessities of the people's life. With the improvement of the quality of life, the requirements for the quality of agricultural products are getting higher and higher. People generally pursue green, fresh and pollution-free agricultural products. In addition, with the emergence of a series of problems, such as environment, energy and ecology, it brings great challenges to human living space. Consumers are more and more recognized for green behavior, and there is a huge demand for green products. Therefore, for the green logistics enterprises of agricultural products, the implementation of green logistics of agricultural products can occupy a favorable position of green demand. At the same time, it is also conducive to breaking green barriers to agricultural products and gaining comparative advantages in international trade.
3. Competitor power. The green behavior of agricultural logistics enterprises is influenced by competitor's competitive strategy. From the individual point of view, enterprises need special refrigeration and refrigeration facilities and equipment to promote green logistics of agricultural products. They need the introduction of green logistics technology to increase the cost pressure of enterprises. In the short run, there may be internal uneconomical phenomena within enterprises. But in the long run, agricultural logistics enterprises that first carry out green logistics can become successful. Overtaking competitors in cost savings, resource acquisition and market share. From the perspective of supply chain, in the new era, the competition between enterprises is more and more manifested in the competition between supply chains where enterprises are located. If the logistics enterprises of agricultural products in the supply chain can integrate the upstream and downstream enterprises and actively promote the green supply chain of agricultural products, the competitiveness of themselves and enterprises in the supply chain will be remarkable. Enhancement is a powerful tool to gain competitive advantage.

Operating Mechanism of Power Mechanism

The endogenous power and exogenous power of agricultural products logistics enterprises act together on the green logistics practice of agricultural products logistics enterprises. Endogenous power is the basis for enterprises to develop green logistics of agricultural products, while exogenous power is the condition for enterprises to promote green logistics of agricultural products. Exogenous power can only play a role through the optimization of external environment to promote endogenous power mechanism. The core motivation of endogenous power is the contradiction between supply and demand in the market, which is the core force to promote green logistics of agricultural products logistics enterprises.

The contradiction between the supply of green logistics services and market demand in agricultural logistics enterprises causes the endogenous dynamic mechanism of enterprises to play a role, namely, economic benefits, differential competition and enterprise ethics, to promote enterprises to optimize the allocation of resources, making agricultural logistics enterprises evolve towards the direction of green logistics development to meet market demand; and exogenous driving force Agricultural products logistics enterprises are the conditions to promote the development of green logistics. When government regulation, consumer demand and competitor power are consistent with the direction of green logistics, enterprises can accelerate green development. On the contrary, it is possible to become a resistance to the driving force of progress.

Game Analysis of Green Logistics Subject of Agricultural Crystal Enterprises in Fujian Province

According to the above analysis, the main body of green logistics of agricultural products logistics enterprises includes government, consumers and competitive enterprises. On the basis of rational thinking, participants play games with each other and choose strategies to maximize their own interests.

Game Between Enterprises and Consumers

The green logistics behavior of agricultural products logistics enterprises has obvious positive externalities. In the absence of effective government supervision and incentives for green behavior of enterprises, enterprises implementing green logistics of agricultural products can only internalize their externalities by raising service prices, which will inevitably increase the price of agricultural products. In fact, it is difficult for consumers to identify whether the majority of agricultural products provided by enterprises are obtained through non-green logistics or green logistics through appearance, and the price difference is often the only criterion to judge. This leads to the fact that agricultural products logistics enterprises without green logistics will also free-ride by raising service prices to obtain additional profit.

The strategies of agricultural logistics enterprises are to implement green logistics and not to implement green logistics; the strategies of consumers are to pay high prices and not to pay high prices. If the price paid by consumers is P, the cost of enterprises is C, the income of consumers is U, the cost of enterprises not implementing green logistics is C (C > c), and the consumer income u (U > u) fee does not think that the price paid by enterprises implementing green logistics is p (P > p).

Dynamical Obstacles of Green Logistics in Agricultural Crystal Logistics Enterprises

The endogenous motive mechanism for agricultural products enterprises to develop green logistics includes economic benefits, differentiated competition and enterprise ethics. However, most of our agricultural products logistics enterprises are small and medium-sized enterprises. Faced with the fierce competition in the market environment, the first consideration at this stage is survival. The core consideration is economic interests. Enterprises that do not implement green logistics will take advantage of the information advantages they have mastered on agricultural products, conduct false propaganda, and make adverse selection. High service price and increasing economic benefits are unfair to enterprises that implement green agricultural products logistics, which may force enterprises that implement green logistics to abandon the implementation of green logistics behavior. That is to say, the extra cost of developing green logistics for agricultural products logistics enterprises can not be obtained by increasing service price only through market allocation, which is the main reason. The reason is the externality and information asymmetry, which is the fundamental reason for the lack of endogenous economic power for enterprises to develop logistics green.

The exogenous motive force mechanism for agricultural products enterprises to develop green logistics includes government regulation, consumer demand and competitor motive force. However, the diversity of consumers' demand for agricultural products and information asymmetry lead to the shaking and unsustainable supervision of enterprises' green logistics and insufficient pressure on enterprises. In the game with similar competitors, in the absence of effective government supervision and incentives, it is easy to fall into the prisoner's dilemma, resulting in the loss of consumer and public interests. In contrast, government regulation is the most effective means of exogenous motivation. However, the green supervision mechanism of agricultural logistics enterprises has not been fully established, which leads to the lack of external pressure for enterprises to develop green logistics.

Motive Strategies for Agricultural Crystal Logistics Enterprises to Develop Green Logistics

Enterprise Level

Agricultural products logistics enterprises are the main body of practice of green logistics of agricultural products. Green logistics of agricultural products enterprises can not only obtain economic benefits, differential competitive advantages and improve enterprise ethics, but also meet the needs of consumers and enhance the competitiveness of supply chain. Firstly, green facilities and equipment should be selected to ensure the green operation of agricultural products logistics, such as agricultural products transportation, which requires special refrigeration and energy-saving and environmental protection transport vehicles, to ensure the quality of agricultural products and reduce the damage to the environment and atmosphere, and to ensure that the selection of packaging materials in the links should be reduced and reused. Secondly, we should strengthen the construction of enterprise informatization and improve the efficiency of agricultural products operation. Agricultural products have the characteristics of perishability and vulnerability, which put forward high requirements and high quality for logistics efficiency. Enterprises carry out joint distribution, multimodal transport and strengthen the coordination of supply chain members through information construction to improve the efficiency of green logistics circulation of agricultural products.

Government Level

The development of green logistics in agricultural products logistics enterprises can not only rely on market regulation, but also need government intervention to make up for the defects of market self-control. On the one hand, we should strengthen the institutional guarantee of green logistics for agricultural products logistics enterprises. We should formulate policies and measures to favor enterprises that develop green logistics of agricultural products in terms of finance, taxation and credit, and increase the construction of incentive mechanism. For enterprises that do not implement green logistics, we should improve the level of supervision and punishment, and reasonably guide enterprises' green behavior. On the other hand, we should strengthen the construction of public information platform for agricultural products market and standardization of green logistics. The above game analysis shows that the asymmetry of information is the main cause of adverse selection, and it also increases the number and cost of game among enterprises, governments and enterprises. In order to solve the problem, we should first formulate and improve the index system of green logistics of agricultural products.

CONCLUDING REMARKS

The feasible and effective way to solve the environmental and ecological problems and the plight of agricultural products development is to promote green logistics of agricultural products. Agricultural products logistics enterprises are the main body of practice in the operation of green logistics of agricultural products. Based on the agricultural products logistics enterprises, this paper takes the green logistics of agricultural products logistics enterprises as the research object, and uses game theory as the analysis tool. Research conclusion: Agricultural products logistics enterprises promote green logistics by endogenous and exogenous dynamic mechanism, the fundamental driving force is endogenous power. Participants of dynamic mechanism: game of mutual interests among agricultural logistics enterprises, government and consumers, elaborate barrier mechanism, put forward strategies from their respective levels, and jointly promote the healthy and sustainable development of green logistics in agricultural logistics enterprises.

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Chapter 11
Research on Problems and Countermeasures of Green Logistics Development in China

Zhang Yu
School of Economics and Management, Chang'an University, China

ABSTRACT

China's logistics industry is in an important strategic opportunity period of transition from extensive traditional logistics to green logistics. In this context, from the perspective of green supply chain analysis of China's green logistics development problems, the government should put forward corresponding solutions. The research shows that the government should build a green logistics evaluation system, speed up the improvement of green logistics-related policies and regulations, and strengthen the construction of green logistics-related infrastructure. The conclusion can provide some strategic inspiration for the government to promote the development of green logistics.

INTRODUCTION

Logistics industry plays an irreplaceable important role in the national economy and is the bridge to realize commodity circulation. China has the largest logistics market in the world, with the total volume of logistics transactions reaching 283.1 trillion yuan in 2018. But at the same time, the traditional logistics industry is also a typical energy consumption and environmental pollution industry. We should

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accelerate the pace of transformation and upgrading, and promote the transformation of traditional logistics industry to sustainable development of green logistics industry. At present, the general factors affecting the development of green logistics are enterprises, governments, society and customers. However, the existing research on the development of green logistics mostly focuses on enterprises to explore the development strategy of green logistics from the perspective of enterprises. Frosch, (1994) elaborated the relationship between circular economy and green logistics, drew lessons from the concept of foreign circular economy development, and put forward concrete suggestions for the green logistics practice of Chinese enterprises. Geffen and Rothenberg, (2000) put forward the decisive factors affecting the development of enterprise green logistics through combing the relevant literature, and regarded it as the key factor of enterprise sustainable development. Gent and Cote, (2002) analyzed the problems existing in the development of green logistics in China's logistics enterprises, and put forward improvement strategies from three aspects: strategy, information construction and mode. Geyer and Jackson, (2004) studied how manufacturing enterprises should design supply chain structure from the environmental point of view, identify the cooperative relationship between manufacturers and suppliers, and construct supplier evaluation and selection index system to make the two collaborative management and ultimately achieve green sustainable development under the environment of green supply chain management. Exhibition. By reviewing the literature on the relationship between global supply chain management, environmental cooperation and sustainable performance, Green, (1996) clarified the relationship between these three variables in the context of Malaysian manufacturing enterprises and proposed a reasonable conceptual model to promote the environment between manufacturing enterprises and suppliers. Cooperation. Gupta, (1995) put forward the research framework of green cooperation through collating 40 opinions of special journals, and solved the problem of how logistics enterprises cooperate to achieve green environmental protection. Hall, (2001) constructed an internal control framework of corporate social responsibility based on green supply chain management on the basis of combing relevant literature and analyzing the current situation of development, which provided a new perspective and method for theoretical innovation and practical application of corporate internal control. Hamel and Prahalad, (1989) and Handfield et al. (2002) took Baosteel as an example to analyze and evaluate the level of collaborative management of enterprise green supply chain and the synergistic effect of internal and external green performance development. Hanna and Newman, (1996) reviewed the research of reverse logistics system in green supply chain management, analyzed two strategies for domestic enterprises to participate in the construction of recycling system, namely, the problems and challenges faced by high-value recycling and low-value recycling, and accordingly put forward suggestions for the current development of EPR system in

China. Hanna et al. (2000) tries to analyze the trend of modern logistics management of domestic logistics enterprises and the means of management optimization under the requirements of green logistics development under the background of enterprise modernization transformation.

However, there is not much literature on the development strategy of green logistics from the perspective of the government. Gent and Cote, (2002) put forward corresponding solutions from the government's point of view based on policies, regulations, infrastructure, industrial structure and other issues. In view of this, this paper tries to analyze the problems existing in the development of green logistics in China from the perspective of green supply chain, and puts forward some suggestions aiming at the problems, in order to provide some strategic enlightenment for the government to promote green logistics.

CURRENT SITUATION AND PROBLEM ANALYSIS OF GREEN LOGISTICS DEVELOPMENT IN CHINA

In recent years, facing the complex and changeable market situation, China's logistics industry actively carries out reforms and actively adapts to the new requirements of economic restructuring and industrial upgrading. Green logistics has gradually become a new trend in the development of logistics industry. Both logistics enterprises and enterprise logistics are trying to integrate green elements into all aspects of logistics, on the one hand, to seize the opportunity of industry transformation; on the other hand, to guide more small and medium-sized logistics enterprises to carry out green reform, which gradually become an important force of industry reform and promote the green transformation and upgrading of the industry.

Current Measures for the Industry of Type Companies logistics enterprise Jingdong E-commerce:

Jingdong E-Commerce

1. **Green Storage**: The newly built 1.5 million square meters storage roof will construct distributed photovoltaic power generation system, which will reduce carbon emissions by 22.5 million tons per year;
2. **Green Transport**: More than 1000 new energy vehicles are planned to be put into more than 10 cities in China.
3. **Green Packaging**: the "Qingliu Plan" was launched jointly with brand manufacturers, logistics enterprises, packaging enterprises and trade associations; the "thin tape" was introduced, the width of the tape was reduced

by 15%, and the use of the tape could be reduced by 5 million square meters per year.

Shunfeng Express

1. **Green Packaging**: new technologies that subvert existing structures and processes are applied to woven bags, inner packaging and stickers to reduce carbon emissions by 9,500 tons, and hundreds of thousands of BOX recycling boxes are invested, resulting in a cumulative reduction of carbon emissions by about 1,600 tons;
2. **Green Transportation**: 7 734 new energy vehicles were put into operation in 41 districts of 22 provinces and municipalities;
3. **Industry Standards**: Participate in the formulation of industry technical standards from manufacturing, supply and other dimensions, and promote the construction of charging network supporting.

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Chapter 12
Construction of Cooperative Environment and Institution for Green Building Supply Chain Subjects:
Construction of Cooperative Environment

Syed Shahid Khan
Department of Management Sciences, Mohammad Ali Jinnah University, Pakistan

ABSTRACT

This chapter introduces the concept and connotation of the green building supply chain and summarizes its particularity. The author analyses the cooperation of stakeholders in the green building supply chain and discusses how to promote the cooperation of stakeholders in green building supply chain from two perspectives of environment construction and system construction, to further promote the stable development of green building supply chain. The chapter introduces the concept and connotation of the green building supply chain and summarizes its particularity. This chapter analyses the cooperation of stakeholders in the green building supply chain and discusses how to promote the cooperation of stakeholders in green building supply chain from two perspectives of environment construction and system construction, to further promote the stable development of green building supply chain.

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INTRODUCTION

Green building is a building that considers building energy, building land, building water, building materials and so on in the whole life cycle of the building, pays attention to protecting the environment and reducing pollution, and coexists harmoniously with nature, which conforms to the concept of low-carbon environmental protection of urban development. Aghazadeh, S. M. (2008) studied the distribution of interests among suppliers, third-party logistics providers and field contractors in the construction supply chain. Aghion et al. (2015) proposed a green partner selection and supply chain model based on the analysis of the network process and multi-objective programming. Anderson, (2009) Borrowing from the construction industry case to compare linear and cyclic supply chains. Domestic scholars mostly focus on the research of inter-agent relationship in the supply chain. Among them, Autry et al. (2001) analyzed the cooperative relationship between government and core enterprises in the green supply chain. Barclay et al. (1995) studied the game between government and enterprise in the green supply chain. Blanchard, (2007) focus on the operation mechanism of a green building supply chain management system. Cairncross, (1992) carried out the game analysis in the process of building the green supply chain of the construction industry and obtained the construction approach of construction industry supply chain which accords with the interests of the main players of the game. Cameron, (1978) use the fuzzy VIKOR method to select green building suppliers. In summary, in the process of supply chain construction in construction industry, the research on the selection of supply chain and the relationship between the main body of supply chain is mostly, while the research on environment construction and system construction to promote cooperation among the main bodies of the construction supply chain is still insufficient, while the research on supply chain for green buildings is less. This paper tries to analyze the cooperation among multi-agents of green building supply chain from two aspects of environment construction and system construction, in order to provide some reference for the development of green building industrialization.

DEFINITION OF GREEN BUILDING SUPPLY CHAIN

Most researchers generally believe that the green supply chain research (Campbell, & Fiske, 1959) is to integrate environmental factors in all links of the supply chain, reduce environmental pollution caused by various activities, and effectively optimize resource utilization. For the study of construction supply chain (Casadesus-Masanell et al. 2009), most scholars and experts believe that the supply chain of construction industry is aimed at satisfying the effective demand of consumers or owners for construction, with the general contractor as the core, involving the whole life cycle of construction, including project planning and financing, architectural design, construction, completion and acceptance, operation and maintenance and using process. Through the management of logistics, capital flow, knowledge flow, and information flow, the functional network structure model can reduce the total cost of the whole chain and enhance its competitiveness.

Although the concept of green building supply chain has not been uniformly defined, most experts and scholars agree that it should be based on the concept of sustainable development or life cycle perspective, starting from the affective needs of investment construction units or end-users (Cavana, 2001), taking the general contractor as the core enterprise to define (Aghion et al. 2015), integrating all kinds of internal and external resources, and considering environmental impact factors and energy resource consumption, to achieve the maximum comprehensive benefits.

THE PARTICULARITY OF GREEN BUILDING SUPPLY CHAIN

The formation of the green building requires the integration of "four sections and one environmental protection" technology and the collaboration between multi-agents (Khan, 2019; Khan and Dong, 2017a). The green building supply chain is the specific application of green building supply chain in the construction industry. Its effective operation cannot be separated from the collaboration among multi-agents in the supply chain and the integrated application of technology. On the basis of ordinary buildings, green buildings pay more attention to the whole life cycle of building formation and pay more attention to the harmonious relationship between people and the environment (Khan and Dong, 2017b). The related development of green building supply chain is very important to the healthy development of green buildings and the industrialization development of green buildings. Compared with the connotation of the traditional building supply chain, a green building supply chain has its particularity.

ANALYSIS OF THE COOPERATION OF RELEVANT STAKEHOLDERS IN THE SUPPLY CHAIN OF GREEN BUILDING

The supply chain of green building involves cooperation among multiple stakeholders. In the green supply chain, each stakeholder and its upstream and downstream are supply and demand relations (Khan et al. 2019). They cooperate with the upstream main enterprises, accept the products formed by the upstream enterprises, and supply the new products to the corresponding downstream enterprises through a series of management measures and technical means. In the process of multi-agent cooperation, a series of logistics, capital flow, information flow, and knowledge flow will be involved. This multi-agent cooperation in the green building supply chain can operate more quickly and effectively, and bring more comprehensive benefits. In view of the various forms of project contracting, in order to better discuss the problem, this paper chooses the real estate development project and the contracting mode of the general contractor (B) as the main research.

Design Department

Based on the perspective of sustainable development, in the whole life cycle of green buildings and in the stage of building design, design units actively introduce the recovery and utilization of resources in order to effectively protect the environment and take preventive measures. In the planning stage, the natural conditions of the site should be fully taken into account and the planning layout should be reasonable. During the whole design process, keep a close dialogue with the owner and appropriately solicit opinions and suggestions from other relevant parties in the supply chain of the construction industry to ensure high-efficiency product quality, reasonable cost and reliability of environmental objectives.

In the early stage of preliminary design and construction drawing design, the design department should proceed from the whole life cycle of the building, take environment and resources as the core, take the coordinated development of environment and economy as the design basis point of the building, optimize the design of building indicators, and ensure that its investment cost, building function, quality, and development cycle meet the corresponding objectives and requirements. On the premise of maximizing the utilization rate of energy resources, minimizing the pollution to the environment and the adverse social impact, maximizing the interests of the participants as far as possible.

Design department plays a decisive role in the green building supply chain. Although it does not produce specific materials or buildings in the overall chain, it determines the function, quality and operation mechanism of the building from the source. The impact of the overall comfort of the building on human health, water-saving, energy-saving, material saving, and other performance indicators are clear here.

Investment and Construction Sector

The investment and construction unit is the initiator of the whole project, which manages and coordinates other subjects in the supply chain. Its operation in the whole supply chain is mainly described in three aspects.

1. When choosing a site, the environmental, ecological and geographical characteristics of the selected site should be taken into account. In the early positioning, in order to obtain the real needs of consumers in the market, investment and construction units should conduct careful and thorough research, so that products and services in the later stage can be recognized by consumers.
2. In the selection process of the general contractor and some subcontractors (pre-qualification and bid evaluation stage), the first step is to examine the professional and technical level of the enterprise, the level of management and management, and the qualification and reputation of the industry. And according to its corresponding green management qualification, green construction patents and special technology and past experience and performance of similar projects, preliminary screening of qualified enterprises. When choosing a cooperative enterprise, there should be relevant environmental protection regulations, involving the use of green building materials, the level of environmental management and so on. Secondly, in the process of bidding evaluation, the investment and construction units focus on evaluating the bidding materials submitted by the general contractor, such as construction organization design, construction scheme, and so on, and comprehensively select the best green contractor from the aspects of technology, progress and "four sections and one environmental protection". Finally, in the process of construction, investment and construction units need to maintain close communication with the design department, construction department, and supervision department and coordinate and manage the cooperative relationship among the relevant subjects to ensure that the final building meets the needs of green positioning (Khan et al. 2018).
3. The necessary process during supervising construction. Investment and construction units have their green performance requirements in the construction process, which is conducive to guiding and motivating the general contractor, improving the quality and efficiency of green construction, further promoting the general contractor to strengthen the management of green construction, and improving the level of green construction technology. In addition, the supervision and evaluation of the construction process by investment and construction units is the necessary guarantee for the smooth implementation of green construction.

In the supply chain of green building, the formation of green building products is initiated and organized by a series of indirect activities of investment and construction units through organizing and integrating resources and does not involve on-site installation and construction activities. The investment construction unit receives the green building products from the construction party and transfers them to the users at last.

Supervision Unit

As a third party, the supervision unit is entrusted by the investment and construction unit and has the responsibility of supervising, inspecting and managing the general contractor in coordinating and managing the cooperation among the main bodies.

In the link of the green building supply chain, it proposes to adopt green materials to the investment and construction units (at the design stage). In the stage of bidding and procurement, the supervising unit puts forward professional suggestions for the investment and construction units to select green building materials, equipment, and general contractors. During the construction stage, it examines the general contractor's green construction organization design and green construction plan, witnesses sampling, inspections (such as whether building materials meet the design green performance standards), acceptance of green materials and green equipment that have entered the site, and supervises and inspects the construction activities on the site. If problems are found, they should promptly put forward and request rectification.

Material (Equipment) Suppliers

The formation of the green building requires not only the cooperation among many related subjects but also the green materials that meet the quality requirements. The production and supply of green materials put forward higher requirements for material suppliers. Material suppliers include raw material suppliers and material production suppliers.

1. Raw Material Suppliers

   In order to ensure the anticipated goal of green building, construction raw materials should be provided according to quality and quantity. Raw materials suppliers should provide raw materials with little impact on the environment when supplying materials, so as to effectively reduce SO2, CO2, and other harmful and toxic gas emissions and control radioactive hazards. At the same time, as far as possible to provide industrial by-products and recyclable building materials, reduce the development of natural raw materials.
2. Material Manufacturing Suppliers

   The raw materials are produced as green building materials through processing and production processes. In the process of selecting raw materials, we should try our best to have certain requirements in terms of quantity and type to reduce the impact on the environment. We should try our best to develop and select green building materials which have little or no impact on the natural environment.

The above two types of enterprises are involved in the green procurement phase. Material suppliers provide green materials and equipment that meet the quality requirements to the general contractor. They are at the source of the green building supply chain and provide materials that meet the quality and specifications (including raw materials and materials). The selection of green building materials should take into account environmental protection factors and the practicability and reliability of materials so as to achieve the expected functions of products. It should be noted here that the equipment lease is also a supplier, supplying the general contractor with construction equipment that meets the energy-saving requirements. In addition, equipment suppliers need to be considered, which provide building equipment, such as elevators, strength and weakness systems, heating and ventilation systems, water supply and drainage equipment, to a certain extent, can effectively save energy.

General Contractor

The general contractor is the most directly related enterprise to form green construction, and also the core enterprise in the supply chain of green construction (the author takes the general contractor as the core enterprise). As the main implementer of green building, the general contractor has a great responsibility. Because it plays an important role in the supply chain, it will have a contractual relationship with many related subjects. In the process of effective operation of green building supply chain, the general contractor mainly explains its own operation mode from three aspects: supplier selection stage, procurement stage, and construction stage.

1. In the stage of supplier selection, the supplier selected by the general contractor should have a certain ability to produce green materials and good equipment supply capacity and try to save energy and protect the environment in material processing, production, transportation, and use. Suppliers should have a corresponding green management structure systems, such as ISO certification, recycling and reuse of waste pollutants, resource utilization, etc. They also should have green cooperation consciousness and actively carry out periodic training on the green concept and environmental protection consciousness.
2. Procurement phase. In choosing green materials, attention should be paid to the use of low-pollution or even non-pollution building materials and accessories as far as possible; natural raw materials should be minimized; by-products,

recyclable materials, and materials with low energy consumption should be given priority to replace raw materials; and green packaging materials should be rationally utilized.

3. 3) Construction phase. Before construction, relevant personnel should be trained on the concept of green environmental protection, and the corresponding management system of green construction should be formulated. By optimizing the construction scheme, the environmental load caused by relevant measures in the construction process is reduced. In order to effectively reduce the cost of the construction process, prefabricated components and prefabricated components are preferred in construction; energy-saving, water-saving and material-saving are attached enough importance, and solid waste treatment and safety and noise control are strengthened; scarce resources are minimized, recyclable and low-energy-consuming materials are preferred; quality and energy-saving equipment is selected. To ensure the conservation and effective use of resources, it is also necessary to monitor and collect environmental data through scientific tools and methods, so as to evaluate the environmental impact and the degree of change.

In a word, in order to ensure the quality and quality of green buildings, the general contractor should establish cooperative relations with material suppliers and equipment leasers from the source of supply chain, and inspect the green materials on the construction site (with the supervision units); actively cooperate with the supervision units and accept the review of relevant government departments; when it comes to construction specifications, design consultants should be contacted, to discuss with them in time for problems solving.

Recycling Enterprises

Recycling enterprises are mainly responsible for recycling, treatment, and reuse of construction waste. Construction waste disposal is an indispensable link in the supply chain (Khan et al. 2016). Recycling units collect and classify all kinds of waste construction materials, then provide reusable materials to raw material suppliers, and then re-process them by raw material suppliers to produce qualified raw materials.

Households

In the green supply chain of the construction industry, the upstream related main bodies and units should fully consider the actual green needs of the end-users to ensure the high quality and high quality of green buildings; the recycling of waste materials generated in the process of user decoration is another link of green recycling. At the same time, because the end-user is the ultimate owner, enjoyer, and participant of green building, it hopes that the comfort of living and the cost of buying a house can meet its own capacity. Its satisfaction has a direct impact on the decision-making of investment and construction units, as well as on the market supply and demand for green materials and the energy consumption of buildings in the operation process. Users should set up the concept of green consumption, and actively run the concept of green consumption through the use of buildings to minimize the impact on the environment.

Government

The environmental and social benefits of green building supply chain are closely related to the government. The government's vigorous development of green buildings can effectively improve the community and even regional environment, reduce noise, improve people's comfort, but also improve government performance and establish a good image.

The supervision and management of the government can effectively promote the development of the construction market, and also promote the formation and effective operation of the green building supply chain. On the one hand, the relevant government departments supervise the general contractor, restrict the use of certain construction technologies and green building materials for specific buildings through relevant laws, regulations and mandatory norms, and manage the whole process of accidents to ensure their specific implementation. On the other hand, the relevant government departments should establish the enterprise green construction qualification audit mechanism and incentive mechanism. The eligible green construction enterprises should be encouraged by preferential policies such as tax return and tax exemption, so as to stimulate the enthusiasm of relevant subjects for returning logistics.

The government provides a limited amount of financial support for the three-level treatment within the general contractor, and provides reasonable subsidies for the waste recycling parties in reverse logistics according to their annual disposal capacity and types of waste, so as to compensate for the possible losses in the recycling process. In addition, while supervising the investment and construction units, design units and supervision units, the relevant government departments can help to manage the supply chain of green building by investigating and grasping the feedback information of users' multi-building products.

PROMOTING ENVIRONMENTAL CONSTRUCTION AND INSTITUTIONAL CONSTRUCTION OF SUPPLY CHAIN SUBJECT COOPERATION OF GREEN BUILDING

Promoting the implementation of the green building supply chain cannot be separated from a good environment and corresponding systems. Improving the implementation environment of the green building supply chain can form the soil for the healthy growth of green building supply chain, and formulating a reasonable system of the green building supply chain can promote the standardized development of green building supply chain.

ENVIRONMENTAL CONSTRUCTION

Core Enterprise Environment Construction

1. Actively build a procurement platform for green building materials and energy-saving equipment. Through the platform, the database of green building materials and equipment is established, which makes the relevant information of green building materials and energy-saving equipment transparent, and makes it easy to purchase on time, in quantity and in quality. At the same time, establishing strategic partners of green building materials suppliers and actively creating a good atmosphere of strategic cooperation will contribute to the long-term development of stable cooperation among enterprises.
2. Optimize the supply chain management of the green building. On the one hand, it optimizes its own management process and structural adjustment to improve the efficiency and response of enterprises; on the other hand, it strengthens the knowledge learning of green building supply chain for enterprise personnel and improves their awareness of green building supply chain.

Market Environment Construction

1. Develop regional green building demonstration projects. This paper tries to explore the supply chain management model of green building, and to carry out the closed management of the whole life cycle of design, construction, and operation, so as to improve the management level of green building and provide experience for the large-scale development of green building supply chain.
2. Construction of green building supply chain experience trading center. Build a direct platform for green building materials, energy-saving equipment, and

building applications. Based on the data collection of big data, a green building supply chain experience trading center based on Internet+ is established. For green building materials and equipment, green building construction integration scheme, overall solution of building industrialization, new technology in the construction field and other products and services, the "online and offline" one-stop service mode is implemented. Provide services for green building procurement and application, and guide green industry agglomeration.

Demonstration Construction of Green Infrastructure

We will actively incorporate the requirements of sponge city, comprehensive pipeline gallery and prefabricated bridges into the demonstration projects by carrying out demonstration projects of green infrastructure and formulate standards for green infrastructure construction by summing up the relevant experience.

Institutional Construction

The government should strengthen the system construction related to green building supply chain, give full play to the overall effectiveness of the system, and strive to build a scientific system, so as to make the cooperation among the relevant subjects of green building supply chain reliable.

1. Establishment of evaluation standard system and evaluation mechanism for green building materials and energy-saving equipment. In order to ensure the quality of green building materials, it is necessary to establish the corresponding evaluation standard system of green building materials and energy-saving equipment and the corresponding evaluation mechanism. In addition, we should improve the technical standards of green building and industry, compile assembly building atlas, and form the standard system of the green supply chain in the field of construction.
2. Developing a Green Credit Rating in Construction Field. Through the formulation of the relevant green credit rating system and the use of financial means to ensure implementation, the government has given financial and policy support to green credit rating units in some aspects. At the same time, we should strengthen the cooperation and incentive to the main body, formulate the overall solution of credit for green building construction, and carry out the development and innovation of green building financial products through the relevant policies such as enterprise tax preferences, consumption deed tax relief, discounts, and financial subsidies.

3. Promoting International Mutual Recognition of Supply Chain Standards for Green Buildings. The government should actively promote the international mutual recognition of green supply chain standards in the field of construction in the APEC economies and the "along with the way" countries, and enhance the ability of relevant entities to participate in international trade and "going out". Promote the industrialization of green building, establish the entry threshold, list of negative industries and list of investment invitation for overseas enterprises such as green consultation service, construction engineering design consultation service and construction, and actively and effectively attract foreign investment.
4. Promoting the Construction Industry Modernization System Construction. Firstly, we should innovate the integrated mode of engineering construction design and construction, cultivate the integrated enterprise of design and construction, and establish the relevant supporting system for the integration of design and construction adapted to international docking. Secondly, the construction industry modernization base should be established, the green supply chain rating of the construction industry modernization enterprise should be implemented, the whole procurement and bidding of the industrialization project should be implemented, the green supply chain management ability of the enterprise should be cultivated, the green supply chain management system of the enterprise should be constructed, and the strategic alliance of scientific and technological innovation of the construction industry modernization should be established.

CONCLUDING REMARKS

Green building is the result of cooperation among multi-subjects and integration of "4R+1D" technology. For a long time, in the process of building formation, the main body only considers its own interests but neglects the impact on the interests and environment of other main bodies. The implementation of the green building puts forward higher requirements for the relevant subjects. Each subject must have the overall consciousness of green supply chain. Only through effective coordination and cooperation can we achieve a win-win situation.

To solve the problem of cooperation among participants is the key to promote green building supply chain. By elaborating the concept and connotation of the green building supply chain, we refine and summarize the particularity of green building supply chain.

We analyze the cooperation among the stakeholders in the supply chain of green building, and puts forward some countermeasures and suggestions to promote the environment construction and system construction of the cooperation among the stakeholders in the supply chain of green building, so as to provide some reference for the construction and development of the supply chain of green building in China.

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Chapter 13
Research on Green Supply Chain Finance Model With Multi-Party Participation

Syed Shahid Khan
Department of Management Sciences, Mohammad Ali Jinnah University, Pakistan

ABSTRACT

Green supply chain and green finance, like effective market means, have played an important role in environmental governance since the reform and opening up in China for 40 years, and have accumulated rich practical experience in many regions and fields. In the new stage of social development and environmental management system construction in the new era, the organic combination of green supply chain and green finance will be very important for speeding up the construction of ecological civilization and achieving the sustainable development of the Chinese nation. This chapter summarizes the current situation and existing problems of green supply chain and green finance, and analyses the reasons why green supply chain finance can be used as a means to break through the bottleneck of environmental management, and creatively puts forward a new model of green supply chain finance with multi-participation, which provides reference for the government, financial institutions, and enterprises to make environmental management decisions.

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INTRODUCTION

Since the concept of green supply chain and green finance was put forward in 1990s, they have been widely used in China as market means of environmental governance. After years of practice and development, at the APEC Annual Conference in Beijing in 2014 and the G20 Summit in Hangzhou in 2016, China proposed to the international community the initiative of jointly promoting green supply chain and green finance, contributing to the wisdom of developing countries in solving environmental and development problems. Under the background of the new era, in order to better play the role of the market and promote the green transformation and sustainable development of private economy and small and medium-sized enterprises, the concept of green supply chain finance emerged as the times require. At the same time, "Guidelines on Actively Promoting Supply Chain Innovation and Application" and "Notice on Developing Pilot Supply Chain Innovation and Application" were released in late 2017 and early 2018 respectively, further promoting the application of green finance in the green supply chain. As a contributor of green finance and green supply chain concept and practice experience, China provides a favorable environment for the innovation of green supply chain finance. The development of green supply chain finance will enhance the efficiency of environmental governance through market and financial means, encourage the development of green industry, and drive small and medium-sized enterprises to achieve green transformation and upgrading, so as to promote the overall improvement of the environment, reduce greenhouse gas emissions and achieve the "five links", which further promote the green, low-carbon and sustainable development of the region.

DEVELOPMENT STATUS AND MAIN CHALLENGES OF GREEN SUPPLY CHAIN AND GREEN FINANCE

Current Situation of Green Supply Chain Management in China

The concept of "green supply chain" was first put forward by Michigan State University in 1996. It refers to the upstream and downstream supply relationship that coordinates business activities with environmental protection by integrating the concept of "green" into the whole process of product design, production, sale, use, and abandonment. After integrating producers, suppliers, and consumers, the green supply chain aims at maximizing resource utilization and minimizing environmental impact throughout the product life cycle. As an effective means of market-oriented environmental governance, green supply chain management has been practiced and verified in many regions of China. In 2010, with the support of the American Environmental Protection Association, the China International Cooperation Committee on Environment and Development launched a special policy research project on the green supply chain. At the end of 2012, Shanghai and Tianjin were selected as green supply chain pilot cities. In 2015, Dongguan became the first pilot city of green supply chain management approved by the former Ministry of Environmental Protection and has done a lot of work in promoting green supply chain management. As a participant, the American Environmental Protection Association cooperates with Dongguan Municipal Government, China-ASEAN Environmental Protection Cooperation Center and Central Joint Certification Center. Through two rounds of Dongguan Index Tests, it helps enterprises to establish a green supply chain management system and explore a green development path for small and medium-sized enterprises. In the pilot process, Dongguan City promoted and participated in the development and formulation of the "Green Supply Chain Dongguan Index". During the two rounds of index testing, a scientific and feasible index system of green supply chain management has been formed, and the performance of 66 enterprises in furniture, shoemaking, machinery, electronics and retail industries in three aspects: environmental protection, energy-saving and low carbon are evaluated, which helps enterprises identify the existing problems and potential, and points out the direction for the green development of enterprises (Khan, 2019; Khan et al. 2019).

In the promotion process of more than ten years, the practice of green supply chain of private SMEs in China is still facing great obstacles. Firstly, the top-level system design of green supply chain still needs to be improved. Although the State Council and the relevant departments attach great importance to the development of green supply chain management system, the focus of their work is different, which leads to the lack of a unified guiding ideology for the green supply chain management. Secondly, the standard system of green supply chain management is not perfect. Although some green supply chain standards have been issued in some advanced environmental management industries such as electronics and automobiles, and in Tianjin and Guangdong, there is still no clear and unified standard and evaluation and certification system. In addition, the more important point is that although private SMEs are gradually aware of the importance of environmental protection under the influence of downstream buyers, they lack financing advantages in green production and green project investment, and need the intervention of financial institutions urgently. Because of the inherent requirements of financial market risk management, green financing is difficult to cover SMEs directly. At present, green direct financing tools have higher requirements for the issuer's main qualification. Most small and medium-sized enterprises are difficult to reach the threshold of issuing green bonds and enjoy the convenience and benefits brought by green credit (Khan and Dong, 2017a). This contradiction greatly weakens the effect of green finance in promoting green development.

Development Status of Green Finance

Green finance refers to the financial services provided for economic activities to support environmental improvement, cope with climate change and economize and efficiently utilize resources. It is regarded as an effective means to utilize market forces to promote green economic transformation and promote sustainable economic, social and environmental development. It has been widely practiced worldwide (Falk, 2005; Khan and Dong, 2017b). According to CBI, the global green bond issuance in 2018 was 167.3 billion US dollars (Fassoula, 2005). Although China's green finance started late and is still in its infancy as a whole, in recent years, under the background of the construction of green ecological civilization, green credit and green bonds have achieved rapid development. In particular, the Chinese government has given strong policy support to the development of green finance. On August 31, 2016, the People's Bank of China and other seven ministries and commissions issued the Guiding Opinions on Building a Green Financial System, which laid a strategic foundation for the development of green finance in China. According to statistics, by the end of 2017, the total amount of green financing in China was nearly 9 trillion yuan (Fornell & Larcker, (1981).

At the same time, due to the single limitation of the profit model of green finance, compared with the traditional financial business, the enthusiasm of commercial banks to develop green finance is still limited. At present, the main business of green finance is still green credit. There is no essential difference between this business and traditional mortgage loan, but environmental factors are taken into account in credit rating. But in general, credit business occupies a large amount of cash (Khan et al. 2018). When banks carry out green credit business, it will inevitably lead to the abandonment of other loan business, which will affect the profits of commercial banks. Therefore, the development of green credit mainly depends on the policies of regulatory agencies and competent departments. In addition, in addition to green credit, the development of other green financial models is also facing various obstacles.

Major Obstacles to the Development of Green Finance

Green finance guides social resources into environmentally friendly and green development projects through financial instrument innovation, and resource allocation guided by the market itself is an important means to ensure the sustainable development of green finance. But at present, the development of green finance in China is mainly driven by the administrative means of the government, which relies too much on fiscal and taxation intervention and lacks certain sustainability. In addition, "unified green standard" and "effective information disclosure" as the premise of green finance, have important significance for the development of China's green financial market

1. Lack of uniform green standards. One of the main ways of green finance is to direct funds to green subjects. Only when enterprises truly form environmental benefits and disclose clear, measurable and verifiable information about environmental benefits, can they meet the requirements of green financing. Therefore, first of all, a set of evaluation criteria is needed to evaluate the environmental benefits of enterprises. However, for a long time, the identification criteria for "green enterprises" and "green projects" have not been clearly unified in China, and there is a lack of a standardized green subject evaluation and identification system. In addition, financial institutions lack professional knowledge of energy conservation and environmental protection, and cannot identify environmental risks and evaluate the environmental performance of enterprises, which affects the development of green finance (Khan et al. 2016).
2. It is difficult to guarantee the fairness of evaluation and the authenticity of data. The validity and authenticity of green information provided by enterprises are the basic requirements for the good operation of green finance. Because of the imperfection of environmental information disclosure system in China, some enterprises are financing in the name of green and actually, invest in other non-green projects. This kind of "drifting green" behavior has caused great obstacles to bank personnel in identifying green enterprises and green projects, increased the risk of financial institutions, and in the long run, will have a greater negative impact on the development of green finance. Therefore, it is one of the most important tasks to solve the problem of environmental information asymmetry and authenticity.

SOLUTIONS: GREEN SUPPLY CHAIN FINANCE

Research Progress of Green Supply Chain Finance

In view of the above problems in the current development of green finance, green supply chain provides an effective solution. The ultimate goal of a green supply chain is to reduce the environmental impact of products throughout their life cycle. Promoting the development of a green supply chain with green finance can reduce the cost expenditure of green production and alleviate the financial pressure of environmental investment (Gentry, 1999). At the same time, the penalties of "rectification" and "shutdown" brought by the environmental problems of small and medium-sized enterprises may impact the smooth operation of the entire industrial chain, affect the economic activities of the core enterprises in the supply chain, and thus lead to financial risks. Therefore, the combination of a green supply chain and green finance will play a mutually reinforcing role. Green finance can be carried out in the whole upstream and downstream supply chain formed by green supply chain condensation. It integrates the risk of uncontrollable individual enterprises into the overall environmental and economic risk of the controllable supply chain. At the same time, it can share the overall economic and environmental benefits of the supply chain. Therefore, if the environmental risk of the supply chain is included in risk management and control, and differentiated credit policies for the green supply chain are set accordingly, it will have positive economic benefits for the whole financial system (Grenadier, 2002). At the same time, the green supply chain considers the environmental impact from all aspects of the product life cycle, ensures the green of the whole industrial chain, and provides a basis for solving the problem of "what is green".

In addition, a green supply chain also provides a good solution to reduce the "credit risk" in green finance and helps financial institutions to solve the problem of asymmetric environmental information. Win-Win-Win: The Sustainable Supply Chain Finance Opportunity Report published in 2018 shows that sustainable supply chain financing is a win-win model for core enterprises, suppliers and financial institutions (Hokey & William, 2001). From the enterprise's point of view, enhancing the credit of SMEs with good environmental performance through the core enterprises, SMEs will have more chances to get green project financing in supply chain financing, so as to upgrade their environmental operation and management level, and ultimately enhance their economic performance in the supply chain, at the same time, bringing positive benefits to the core enterprises and the whole supply chain, and form a positive cycle of green supply chain and green finance. For financial institutions, after the implementation of green supply chain management, the stability of the industrial chain has been improved. The key to the business management of relevant financial institutions has also shifted to the assessment of the authenticity and stability of supply and marketing relations, which has increased operability, which can ensure the identification of green projects and green enterprises, effectively reduce environmental risks, but also greatly reduce financial risks. In some developed countries, there are already some cases of green supply chain finance (Hulland, 1999). For example, Puma, BNP Paribas, and IFC jointly launched the green supply chain financing plan in 2016, which provided short-term financing of over US$100 million for suppliers with different credit grades (Gentry, 1999).

The joint research of American Environmental Protection Association and Society General Economic Research Consulting Co., Ltd. shows that green supply chain finance includes three integration modes: Supply Chain Finance + green finance; Green Supply Chain + supply chain finance; and green supply chain +

green finance. This paper will focus on the analysis of "Green Supply Chain + Supply Chain Finance" mode, that is, through the evaluation of order information, environmental performance and credit enhancement measures of SMEs suppliers, the financial institutions will give priority to loans to enterprises with green production mode under the collateral of order receivables, thus realizing resource conservation and environmental protection (Grenadier, 2002). In the study, we can see that the narrow concept of green supply chain finance is smaller than that of green finance. It only uses supply chain finance as a product of many financial models to support the development of the green industry. The broad sense of green supply chain finance also includes the development of green financial services for enterprises with excellent green supply chain management. As the research and practice of green supply chain finance in China is still in its infancy, the organic combination of green supply chain finance, supply chain finance, and green finance needs to be explored step by step. According to the analysis of the report of Xingye Research, the main problems in the implementation of green supply chain finance are the imperfection and mismatch of the standard system, the imperfection of third-party evaluation, certification and supervision.

Innovation of Green Supply Chain Finance Model With Multi-Party Participation

In view of the above problems in the development of green supply chain finance, this paper puts forward a set of green supply chain financial innovation modes with multi-participation after detailed analysis and research of the existing green supply chain and supply chain finance, in which the original supply chain financial system composed of financial institutions, core enterprises, and suppliers will be joined by the participation of the government, third parties, NGOs and the public to form a joint force of multi-party governance. Before applying for supply chain financing, financing enterprises first entrust professional third-party organizations to carry out a green evaluation based on the unified green supply chain financial evaluation index formulated by various parties. According to the evaluation results, core enterprises can encourage suppliers with an excellent green evaluation to order. At the same time, financial institutions can provide different levels of financial services according to the evaluation results. Governments, NGOs and the public are fully involved in the formulation of green evaluation indicators and supervise the whole process to ensure the authenticity and reliability of environmental data information and professional fairness in the certification process.

CONCLUSION AND DISCUSSION

Green supply chain finance is an organic combination of the green supply chain, supply chain finance and green finance. Green supply chain provides a very good application financing scenario for supply chain finance and green finance. The combination of green supply chain and supply chain finance and credit will give more preferential measures to supplier enterprises with good environmental performance. Banks can develop different levels of interest rate preferences and corresponding products and services for suppliers with different environmental performance, promote green financial reform and innovation and pilot green supply chain finance, develop more green supply chain finance and credit products suitable for different buyers and banks, and serve more green enterprises. At the same time, more investment institutions should pay attention to the environmental risks of investment projects, standardize and encourage green investment behavior, so as to achieve a win-win situation of environmental and economic benefits.

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Chapter 14
Construction of New Circulation Model for Green Supply Chain of Agricultural Products in China

Syed Shahid Khan
Department of Management Sciences, Mohammad Ali Jinnah University, Pakistan

Syed Abdul Rehman Khan
School of Economics and Management, Tsinghua University, China

ABSTRACT

With the continuous development of China's agricultural economy, the concept of green production has begun to penetrate into the hearts of the people. Exploring a new circulation mode adapted to China's green supply chain of agricultural products is an important way to promote green production in China, and also an important condition to promote the successful transformation and development of China's rural economy. But in the process of building a green supply chain of agricultural products and exploring circulation mode, there are many problems that hinder the development of green industry economy. Therefore, it is necessary for the government to play a guiding role and actively guide farmers to explore green development ways and new circulation mode to meet their own development needs, which provides reference for better optimizing the new circulation mode of agricultural products supply chain in China.

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A BRIEF INTRODUCTION TO GREEN SUPPLY CHAIN OF AGRICULTURAL PRODUCTS

Green supply chain was first proposed by the Manufacturing Research Association of Michigan State University in the United States. It is also called environment-conscious supply chain. It is a modern management mode that takes environmental impact and resource efficiency into account in the whole supply chain (Khan and Dong, (2017a).

Its theoretical basis is green manufacturing theory and supply chain management technology, but it involves many stakeholders such as suppliers, producers, distributors and users. It will help to minimize the negative effects of the environment and maximize the utilization efficiency of resources of the whole process of the products from production to scrap disposal strives. From the point of view of the development of green supply chain of agricultural products in China, because the research started late and the research work is not enough, the research on the connotation and extension of green supply chain and the circulation mode of supply chain of agricultural products are not deep enough (Khan, 2019). In order to effectively promote the continuous improvement and development of the circulation mode of green supply chain of agricultural products in China, we need to further strengthen the research on its theory and application.

CONNOTATION ANALYSIS OF CIRCULATION MODEL OF GREEN SUPPLY CHAIN FOR AGRICULTURAL PRODUCTS

The circulation mode of green supply chain of agricultural products refers to a series of economic activities which are based on the theory of green supply chain management and guided by the concept of sustainable development in order to realize the healthy and stable development of food safety production and industry. The basic production processes are production, procurement, classification, primary processing, packaging, distribution, transportation, warehousing, consumption and final resource recovery. The operation organization of this mode has a large number of members, including suppliers of agricultural products, primary processors, logistics managers, individual distributors, consumer groups and so on. The green supply chain model has four objectives: first, to reduce the possible security risks of agricultural products in the circulation process, and to solve the security problems of agricultural products will help to maximize the willingness of consumers to buy agricultural products. Second, it can achieve the compatibility with the environment in the production process, because it takes green production as a means to minimize the adverse impact on production activities and circulation activities on the environment. Third, in the process of circulation of agricultural products, great attention should be paid to the optimal allocation of various resources in order to save circulation capital to the greatest extent. Fourth, we attach great importance to the construction of circulation industry of agricultural products, so as to promote the rapid development of economy through the improvement of circulation industry.

The operation of green supply chain circulation mode of agricultural products is based on developed logistics, vast information flow, fast capital flow and reliable security flow. Its connotation of information flow is more abundant, including production information, quality information, sales information and inventory information of products, and emphasizes environmental information. Information and product safety awareness in circulation mode. Generally speaking, the fundamental purpose of this model is to achieve sustainable and efficient development of agricultural products circulation industry.

CONSTRUCTION AND OPERATION PROCESS OF NEW CIRCULATION MODEL FOR GREEN SUPPLY CHAIN OF AGRICULTURAL PRODUCTS

Construction of a New Circulation Model for Green Supply Chain of Agricultural Products

The new circulation mode of green supply chain for agricultural products includes many aspects, such as the main components of the system mentioned above, from the production of products to the recycling of scrap, among which the main members are suppliers of materials, producers, processors, marketers and consumers of products, etc. As far as the supporting technology of the system is concerned, it mainly includes the design technology of green products, green purchasing mode, green production and processing mode, green marketing mode and logistics management mode and technology. Green supply chain of agricultural products is to achieve the overall development goals through these participants and technical elements (Khan and Dong, 2017b).

New Circulation Mode Operation Process of Green Supply Chain of Agricultural Products

Generally speaking, the operation process of the new circulation mode of green supply chain of agricultural products mainly includes the following aspects: green design process, green procurement process, green production process, green marketing process and green logistics circulation management process (Khan et al., 2016).

1. Green design process. Green design is also called ecological design or environmental design. Its main contents include green product design and green packaging design. In green product design, the principle of recycling and recycling should be followed. Therefore, the difference between green agricultural product design and traditional agricultural product design is that the whole design process of green agricultural products should take full account of the impact of agricultural products on resources and the environment, and reduce environmental pollution. The packaging design is mainly related to packaging materials and energy-saving design. The use of green environmental protection materials as packaging materials is conducive to prolonging the life cycle and service life of its products.
2. Green purchasing process. This process is the first step in the new circulation mode of green supply chain of agricultural products. Its main content is the procurement process of seedlings, feed, pesticides, fertilizers and other materials needed for crop growth. Enterprises or individuals responsible for purchasing materials needed for producing agricultural products should first establish awareness of environmental protection and safe use of materials, and improve and optimize the procurement process from the perspective of safety and environment. Secondly, before considering establishing long-term cooperation with suppliers, material suppliers should be required according to the standards of safety and environmental protection to ensure product quality, safety and environmental protection functions of agricultural producers. Thirdly, we need to check whether the supplier has passed QS certification, HACCP certification and ISO9000 quality management system certification. At least two or more certification bodies need to give the certification pass marks to consider it as a material supplier. Only in this way can we truly guarantee the quality and safety of agricultural products in the new circulation mode of green supply chain, and win the favor of market consumers with high quality and high environmental protection function.
3. Green production links. In the process of agricultural production, it is impossible to achieve real zero emission. It is inevitable that some undesirable substances will be discharged into the ecological environment. For example, in the process of fertilization or pesticide application, some fertilizers and pesticides inevitably enter the soil and atmosphere, which has a certain impact on the environment. Therefore, in order to maximize the realization of green production, in the production process of green products, agricultural products are required to increase the use of green raw materials in the process of planting, feeding and initial processing of products, which ensures that these adverse effects are kept to a minimum level. Waste caused by production and life can also be avoided as far as possible, and production costs can be effectively saved.

In addition, it is necessary to coordinate the ecosystem relationship among producers, eco-environment and residents in the environment by constructing eco-industrial parks, that is to say, coordinating the effective input and output of material and energy among the elements of ecosystem, ensuring that the system is in an efficient state of operation, and the resources and energy within the environment can be efficiently utilized, the waste outside the output system can be minimized, and the environmental pollution can be minimized, finally achieving good ecological and environmental benefits.

4. Green marketing. In theory, green marketing is a process that can identify, anticipate and meet the social needs of consumption, and this process is a continuous management process, which can bring certain profits. The connotation of green marketing of agricultural products includes three levels: one is the concept of saving. In the process of production and marketing of green agricultural products, all kinds of resources should be based on the concept of saving and make the best use of all kinds of resources. The second is to ensure the safety, nutrition and convenience of agricultural products. Safety refers not only to production safety, but also to marketing safety and consumption safety. Nutrition and convenience are to meet consumers' multi-level and high-level consumption needs. The third is to guide green consumption. At present, the concept of green consumption in the market is not strong enough, so we need to gradually guide and cultivate people's green consumption consciousness. Fourthly, we should pay attention to safety marketing and optimal allocation of resources from the perspective of safety and environment when carrying out marketing practice. In the actual marketing process, green marketing means effectively linking the interests of marketers, consumers and society under the premise of sustainable development concept, considering agricultural products in terms of planting, feeding and primary processing, and fully inspecting the green factors, improve the green connotation of products, in order to improve the green competitiveness of agricultural products.
5. Green logistics. Green logistics is a new concept in current logistics transportation. Specifically, green logistics refers to the construction of a logistics system in harmony with the environment. The whole process of the construction includes the acquisition of raw materials, the production, packaging, transportation, storage and final consumption of products, as well as the recycling and utilization of products. And the main feature is that while restraining the various hazards of agricultural products logistics to the environment, it can minimize the degree of such hazards, achieving the purification of the entire ecological environment, and minimizing the consumption of resources, so that the logistics resources can be fully utilized in the process of product circulation.

OPERATING CONDITIONS OF NEW CIRCULATION MODEL OF GREEN SUPPLY CHAIN FOR AGRICULTURAL PRODUCTS

Improving the Information System of Agricultural Products Circulation

Perfecting the circulation information system of agricultural products means using modern highly developed information network technology to improve the overall efficiency of the logistics circulation mode, so as to promote the circulation mode to better adapt to the changes and adjustments of market relations. As far as the current development of logistics industry is concerned, how to make full use of information network technology to develop logistics is also a problem that needs to be faced directly in the current development of agricultural products circulation industry. If we can use information technology to control business flow, logistics and capital flow and information flow reasonably, and integrate these elements effectively, it will be very helpful to promote the construction and development of new circulation mode of green supply chain of agricultural products. In the current process of rural development, farmers cannot obtain market-related information in time and quickly without electronic information technology, which hinders the smooth development of circulation links. Therefore, it requires rural areas to construct a relatively perfect agricultural product logistics information system, including nearby material suppliers, product processors, logistics providers, retail departments and so on, promoting the sharing of resources and information in order to help farmers get effective market information in time, and build a smooth information logistics system for agricultural products.

Improving the Logistics System of Agricultural Products

In the process of perfecting the information system of agricultural products circulation, attention should be paid to improving the logistics system of agricultural products, which requires the local government to continuously build and improve the infrastructure construction of agricultural products logistics. Firstly, a relatively large agricultural product logistics center can be established in the village center, and the corresponding information platform can be constructed by using information network technology to achieve effective monitoring of supply and demand information, so as to build a large-scale, centralized and standardized green agricultural product logistics system. Secondly, we need to integrate the circulation links, increase the support to the wholesale market, sales market, logistics and distribution of agricultural products, and increase the construction of market construction, storage facilities for agricultural products, transportation conditions and other infrastructure, and on this basis, form commodity standards for agricultural products. In the aspect of electronic information construction, as in the way of building agricultural product circulation information system, we should constantly improve the construction of supply and demand information platform and electronic trading platform in order to reduce the cost of logistics circulation and improve logistics efficiency. Thirdly, we should gradually unify logistics standards to ensure international docking. This requires the following points: First, the whole process of agricultural logistics should be brought into the track of standardization and standardization (Khan et al., 2019). The second is to continuously improve and improve the agricultural standard system, quality supervision system and product certification system. Thirdly, we should adopt international standards or general national standards in all aspects of construction, such as metrology standards, technical standards, logistics standards and so on, to form a unified industry standard as far as possible.

Standardization of Agricultural Products

Agricultural product standardization means that the society plans the development of agricultural product industry with the idea of industrialization, promotes the further rationalization of the division of labor within the agricultural product industry, and realizes the specialized production and intensive management of agricultural products. The significance of implementing the standardization construction of agricultural products is to help realize the coordinated development of various links in the agricultural products industry, at the same time to promote the optimal allocation of resources in all aspects, but also to achieve the effective docking of production and market, which is an important way to further promote the circulation of agricultural products. At present, people's living standard and consumption level in China are showing an increasing trend, and the demand for high-yield, high-quality, safe and harmless green products is also increasing year by year. There is an urgent need to break through technical barriers to trade in terms of trade and export, which puts forward new requirements for the standardization development of agricultural products in China, and it is necessary to realize the conformity with the international standardization level as soon as possible.

ANALYSIS OF MEASURES FOR IMPLEMENTING GREEN SUPPLY CHAIN MANAGEMENT OF NEW AGRICULTURAL PRODUCTS

Increasing the Utilization Rate of Green Information Technology and Promoting Regional Exchanges

The advantage of information technology is that it can collect all kinds of market-related information and information in a timely manner. Farmer chain can realize the regulation of green supply chain by grasping this advantage. Firstly, it is necessary to establish a database supported by information technology and its data transmission format. Through this database, information and data are integrated and exchanged among farmers and among agricultural enterprises, and effective and close links are established among various systems through these information flows, promoting the spatial exchange between rural areas, and strengthen the sharing of information and resources among time regions and users (Khan et al. 2018; Minahan, 1998). Secondly, each supplier needs to establish its own management information system to strengthen the links among supply chains, distributors, retailers and logistics providers in different regions, so that farmers can make decisions according to the specific situation, so as to improve the production efficiency of farmers. Thirdly, as an external support force, the government also needs to provide relevant assistance. For example, it can build a public information sharing platform supported by network system, dynamically track all links of agricultural products, keep abreast of the status of agricultural products in the production and circulation fields, and timely find market trends. Excavate business opportunities and seize market space.

Optimizing the Structure of Green Supply Chain and Coordinating Internal and External Organizational Capabilities

Only by realizing internal and external coordination of industrial institutions can we promote the transformation of green supply chain structure to standardization. In the internal aspect, the key is to implement scientific and effective management ideas and concepts, and then to establish a suitable quality management system, strengthen the quality supervision and management of agricultural production, and optimize the business flow, internal information flow and organizational structure within the scope of the supply chain. At the same time, we should strengthen the internal personnel management and training, especially the training of their green awareness and green management, so that green products become the culture of supply chain construction. Externally, we should actively use modern science and technology and the latest research results to strengthen the construction of our own information exchange platform, which is described in detail above. At the same time, we need to standardize the logistics process of supply chain, improve the technical content of logistics packaging and transportation, meet the technical requirements, and pay attention to the adoption of national standards and unified logistics industry standards within the industry, so as to realize the adjustment and optimization of the organizational structure of green supply chain management in our enterprise.

Rectifying the Green Supply Chain Market and Implementing Green Consumption and Green Recycling

In order to rectify the green supply chain market and implement green consumption and recycling, we need to do the following: First, we need to establish the concept of green management, adhere to the way of implementing green management, and improve the market attractiveness of products by taking agricultural products with high green connotation, so as to obtain a broader market space and enhance market competitiveness. Second, the selection and use of raw materials should follow the principle of strict selection, adhere to green procurement, and establish green procurement awareness. For example, in the selection of organic fertilizers and chemical pesticides, green organic fertilizers and low-pollution pesticides should be used to reduce the pollution of these raw materials to the environment and the content of chemical elements in agricultural products. Thirdly, the key point lies in the process of processors. Processors should adopt ecological environmental design and management methods to recycle processed materials, which can not only improve the efficiency of material utilization, but also help to reduce the negative impact of these materials on the environment (Rogers & Tibben-Lembke, 1998). Fourthly, the majority of farmers responsible for production should establish the concept of green and scientific production and management, urge them to strengthen their awareness of green environmental protection, produce green and safe agricultural products, refuse to produce counterfeit or inferior green products, and establish their own green brand image (Rogers & Tibben-Lembke, 2001).

Implementing the Strategy of Green Space Alliance and Establishing a New Win-Win Concept

At present, the concept of win-win cooperation has become a consensus to promote the common development of all enterprises. Therefore, the implementation of alliance strategy among green enterprises, strong alliance, and the establishment of a new concept of win-win will be able to achieve more benefits for the whole enterprise and achieve long-term development (Scott, 2008). Firstly, to achieve strategic alliance among enterprises, fair and reasonable cooperation concept and purpose should be taken as the basis for the sharing of information resources and the rational distribution of interests. Secondly, core enterprises possess technological advantages and can provide technical and empirical support for suppliers, distributors and logistics providers to improve the technological level of the whole supply chain and the ability to manage the environment (Shaharudin, 2009; Zhang, 2018). Thirdly, we must resolutely maintain the strategic partnership among the members of the strategic alliance, coordinate the interests disputes among the various business partners, give full play to the advantages of various businesses, jointly provide the market with high-quality, safe and green agricultural products, and earnestly guarantee the quality of products, so as to maximize collective interests. Fourthly, the incentive system should be implemented to encourage the members of the alliance to optimize their products in an appropriate and reasonable way, so as to form a kind of development situation and atmosphere of inspirational innovation and green supremacy within the alliance, and to strengthen the cooperative benefits of the alliance.

To sum up, the implementation of green supply chain management mode for agricultural products needs to take into account all aspects of affairs, and use modern management concepts and information technology to create appropriate operating conditions. And constantly explore and innovate its specific and appropriate measures to improve the utilization of green information technology, optimize the structure of green supply chain, rectify the green supply chain market and implement the green alliance strategy. Only in this way can the application and further optimization of green supply chain management be realized.

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Chapter 15
Study on Evaluation Index System of Green Supply Chain for Automobile Products

Rafia Khan
IQRA University, Pakistan

ABSTRACT

It is the focus of the automobile industry to guarantee the quality of automobiles and meet the requirements of green development. Based on the principle of sustainable development, according to the characteristics of green supply chain and the concept of the whole life cycle of the automobile, the evaluation index system of the green supply chain of the automobile is constructed from five links of design, purchase, production, sale, and recycling. The "green" runs through the whole life cycle of automobile products and evaluates the green supply of automobile products scientifically and accurately. Reference should be provided for the situation.

INTRODUCTION

The automobile industry plays an important role in promoting China's economic growth. In recent years, the automobile industry has always maintained a stable development trend. At present, in the global automotive industry, the rapid growth of automotive production and sales brings convenience to our life, while the contradiction between automotive industry and environment, resources and so on is becoming increasingly prominent. The "life cycle" green supply chain is the only way for the development of the automotive industry Lertwongsatien, 2000). It considers environmental factors on the basis of the traditional supply chain, so as

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to reduce environmental pollution and waste of resources throughout the life cycle of automotive products. Therefore, based on the principle of "green development, sustainable development, and life cycle", the author establishes a feasible, scientific and reasonable evaluation index system for the green supply chain of automobile products, which is the prerequisite for achieving social and economic benefits and the inevitable requirement of sustainable development (Luken et al. 2008).

In the early days, the concept of "supply chain" has become the focus of scholars from all walks of life. With the advent of the "green era", the green supply chain has increasingly become the focus of attention, and the former "supply chain" is naturally defined as "traditional supply chain". There are many studies on the evaluation system of the traditional supply chain at home and abroad. The classical models include the SCOR model abroad and the SCOR model at home. In 1996, the International Supply Chain Association (ISA) put forward the SCOR model, which provides a model basis for the evaluation of the supply chain in the automotive industry. This model mainly constructs the index system of the supply chain from four aspects: turnover period, cost, service, and assets. In 2013, China put forward the SCPR model. SCPR model combines the advantages of various performance models and is suitable for Chinese enterprises. This mode Type I is mainly embodied in order completion, customer satisfaction, team collaboration, node network efficiency, and business adaptability. In order to promote green development, green management and green performance evaluation of automobile supply chain have become a hot spot. In recent years, the research on the green supply chain of automobiles has been common. Domestic and foreign scholars' research on the green supply chain of automobiles is scattered. Most of them choose to add environmental or green factors from one of the links of green design, green procurement, green production, green sales, and green recycling. Zhu Xuhui (2014) explored the inevitability of green design in the automobile industry from the theoretical source, based on the strategy and benefits of green design, and Ma Huanhuan (2016) took green procurement as the starting point to study the selection of suppliers in automobile manufacturing enterprises. Based on the construction of supplier evaluation index system, taking L Company as an example, the TOPSIS comprehensive evaluation model is used to make an empirical analysis on the selection of suppliers of automotive engines. Li Weiming (2016) based on the green recycling and remanufacturing system, analyzed the influencing factors of recycling behavior, took the waste automobile as an example, constructed the green system dynamics model, from the essence of the model, based on population, resources, environment, and other factors, excavated the green factors of the whole recycling system.

Generally speaking, there are many studies on the evaluation index system of automobiles worldwide. The contents of the research are constantly enriched and the research methods are becoming more and more mature. However, domestic and foreign scholars in the green supply chain evaluation, the research angle is relatively single, the index system is not complete. Most scholars only analyze the process of purchasing, producing and recycling automotive products. It is difficult for "green index" to reflect the environmental performance in an all-round way. Even though green consumption has become the public's consumption concept and green development has risen to the national level, green supply chain management has not really been implemented. Therefore, drawing lessons from the existing research results, starting from the "life cycle" of products, the author aims to build a set of "life cycle" green index system, as a value evaluation system for enterprises to achieve green development, and to seek the optimal path to achieve sustainable development of the automotive industry, with a view to making the whole of automotive products. The life cycle is "green" to achieve a win-win situation between economy and environment.

ESTABLISHMENT OF EVALUATION INDEX SYSTEM FOR GREEN SUPPLY CHAIN OF AUTOMOBILE PRODUCTS

Thoughts on the Construction of Indicator System

1. Target layer. The green supply chain is based on the supply chain with the concept of "green", which pays attention to the impact of the whole process from production to recycling on the environment. It emphasizes green management and pays attention to the win-win situation of economy and environment. In the whole life cycle of automotive products, including raw material procurement, product production, sales, and recycling processes, reduce waste of resources, reduce environmental pollution, in order to achieve real scientific development. The evaluation index system of the green supply chain can provide quantifiable criteria for the development of "green ecology" automobiles, and continuously improve the environmental performance of automobile products.
2. Criteria layer. In order to improve the environmental performance of automobile products, we must take the green road of "whole life cycle". Product life cycle refers to the repeated cycle process of product production-recovery-reproduction. In the process of automobile production, there are many links, such as product design, material procurement, automobile production, marketing, recycling, logistics and so on. The evaluation index system of the green supply chain is to add "green" evaluation index on the basis of traditional index system such as design, procurement, production, sales and recycling, so as to make automobile products "green" in the whole life cycle. Therefore, the author comprehensively reflects the "green" value of automobile products from five

aspects: green design, green procurement, green production, green sales, and green recycling. While guaranteeing the quality of automobile products, the author carries out the responsibility of environmental protection and achieves a win-win situation between economy and environment.

3. Index layer. Referring to the evaluation index system of the traditional supply chain and green supply chain, the paper comprehensively evaluates the indexes used. According to the evaluation criteria of "green" development, it screens the indicators that can represent the essential characteristics of the evaluation objects based on the five aspects set by the criteria layer. In particular, the selected indicators must follow the principle of selecting indicators and comprehensively summarize all aspects of green design, green procurement and so on.

Principles for the Construction of Indicator System

The application of green supply chain should be based on the whole life cycle of the automobile, so that automobile products are "green" in the whole life cycle. Therefore, the selection of indicators must cover the green procurement, green production, (Mallinckrodt, 2006) automobile recycling, and other links. In the process of building the evaluation index system, we should follow the principles of the life cycle, sustainable development, a combination of quantitative and qualitative, independence and operability.

1. The whole life cycle principle. The indicators selected in the "life cycle" green supply chain evaluation index system should accurately and objectively reflect the actual situation of the product life cycle. The whole life cycle is a complete and comprehensive system, which involves the design, purchase, production, sale, recycling, and logistics of automobiles, so the indicators should cover the whole life cycle comprehensively and systematically.
2. Principles of sustainable development. The development of the social economy should meet the requirements of green and sustainable development, and the development of the automobile industry is no exception. When designing the index system of the green supply chain for automobile products, we should take the green development of the "whole life cycle" as the design idea. The purpose is to embody the scientific development concept of sustainable development, so as to evaluate the status of a green supply chain for automobile products scientifically and accurately. For example, in the selection of index "design" link, we should consider the content of product demolition, product recyclability, and fuel cleanliness, so as to achieve green ecological design at the source; in the "procurement" link, we should take supplier's ISO14001 certification and

environmental performance as the criteria to inspect suppliers, and raw materials can be purchased from Assessment of packaging, cost, and recyclability; strict control of waste production to meet national emission standards in the "production" link; greening of storage, handling, transportation, marketing and promotion in the "sales" link as far as possible; and recycling link, waste recovery rate and reporting Based on the reuse rate of waste products and other indicators, the higher the ratio, the more obvious the green performance. Considering the "green" evaluation index in every link of the automobile life cycle can more scientifically assess the environmental benefits and realize the sustainable development of automobile products (Minahan, 1998).

3. The principle of combining quantitative with qualitative analysis. When designing the index system of the green supply chain for automobile products, there are both quantifiable and non-quantifiable indexes. Firstly, for quantifiable indicators, such as raw material utilization, procurement cost, wastewater production, waste gas production, recovery cost ratio, green tool utilization, green storage, waste gas treatment cost, parts return rate, recovery rate, harmless treatment rate of waste gas are all quantifiable indicators. Quantitative analysis of relevant data is obtained directly through enterprise departments. For indicators that are difficult to quantify or quantify, such as product safety, product demolition, ISO14001 certification, supplier green acceptance, green demand satisfaction, green awareness, advertising green degree, promotion green degree, etc., can be used as the criteria for green evaluation. However, in the specific analysis process, we should combine qualitative and quantitative analysis to scientifically evaluate the green supply chain of automobile products according to the nature of things and the characteristics of indicators.
4. Principles of independence and operability. The "life cycle" green supply chain of automotive products is a large system, which involves many complex indicators. There are many cross-cutting contents in the design, purchase, production, sales, and recycling of automotive products. In order to ensure the independence of the indicators, according to the principle of operability, it is necessary to classify and summarize the indicators reasonably.

Specific Contents and Basic Framework of Indicator System

1. Specific content of the index system. According to the idea and principle of constructing green supply chain evaluation system and the connotation and essential requirements of green supply chain evaluation, the author divides the evaluation index system of green supply chain into five subsystems, namely, green design, green procurement, green production, green sales and green

recycling, in order to embody the whole life of automobile products. Cycle (Skinner, 2008).

2. Green design. Green design is a completely new design idea from ecology and economics. This index requires that the benefits of environment and resources should be considered comprehensively in the design stage of products, the concept of life cycle should be followed, the principle of sustainable development should be followed, and the latest concept of environmental protection should be upheld (Khan et al. 2018a; Khan et al. 2017a). In order to better realize a new design concept, starting from raw materials, automotive structure and energy use, products are guaranteed to have low pollution, high recovery and other characteristics. This requires comprehensive consideration of the recyclability, demolition, maintainability and recyclability of raw materials and products from the source (Khan and Dong, 2017a; Khan et al. 2018b).
3. Green procurement. In order to achieve green development and win-win between economy and environment, it is necessary to select "green" materials or suppliers as far as possible in the procurement stage to reduce waste of resources. It is necessary to protect the environment as much as possible, and also to consider the level of environmental performance. For general consumers, the green purchase means healthy, low-carbon and sustainable consumption activities, which can be divided into two perspectives: product consumption management and supplier consumption management. In these two levels, product management is very important. For the selected commodities, the quality of materials must comply with the relevant provisions of the national standards but also need to take into account the energy-saving, environmental protection, safety and durability of materials, especially the regeneration and recyclability. In terms of suppliers, we should not only consider "green environmental protection", but also realize the social effect of environmental friendliness.
4. Green production. Green production refers to incorporating the concept of "green" into the production stage of products to minimize the production and emission of pollutants. Enterprises should take industrial management and production technology as a means to achieve the goal of energy saving, consumption reduction, and pollution reduction, carry out comprehensive pollution control and carry out cleaner production in the production stage (Khan et al. 2016; Khan et al. 2017b; Khan et al. 2019a). First, to ensure that wastewater, waste gas, noise and other pollution generated by production meet the national discharge requirements. Secondly, real-time monitoring and detection of pollutant emission concentration should be carried out to achieve timely and effective control and management. "Green" production is to reduce or avoid environmental pollution. High environmental benefits. In the production process, we must pay attention to the utilization rate of equipment

and the discharge of three wastes in order to maximize the greenness of the production line.

5. Green sales. Green sales refer to the fact that while making profits, enterprises should also consider environmental performance in order to achieve long-term and sustainable development of enterprises. The sales process is mainly embodied in three stages: pre-sale, in-sale and after-sale. “Green” on the one hand requires enterprises to meet the green needs of consumers, on the other hand, requires enterprises to implement green storage and transportation. This not only helps enterprises to save resources but also helps to protect the safety of consumers. In the whole sales chain, a series of marketing links, such as customer demand, product promotion, storage, loading and unloading, transportation and so on, must take environmental performance into account so as to make the sales phase truly green.
6. Green recycling. This is a new concept put forward in the era of “green development”, and it is an indispensable link in the whole life cycle process of automobiles. Return and waste recycling are two specific manifestations of the recycling process. Firstly, in the process of returns circulation, the buyers and sellers include consumers, distributors, manufacturers and suppliers. Goods mainly refer to industrial supplies, defective products and surplus products of non-productive raw materials nature (Khan et al. 2019b). Secondly, waste recycling is to recycle and dispose the waste (waste, waste water, waste residue) produced in every link of the whole life cycle, so as to maximize recycling. In the whole recovery stage, we should not only adhere to the concept of green recovery, but also pay attention to green recovery methods, reduce secondary pollution as far as possible, and form a high recovery, high recycling, and high utilization recovery mode.
7. The framework of the index system. Based on the above ideas and principles, the author establishes a set of green supply chain evaluation index system, which is based on green design, green procurement, green production, green sales, green recycling five links, including 40 green indicators.

CONCLUSION

The Director of Energy Conservation and Comprehensive Utilization Department of the Ministry of Industry and Information Technology, put forward in his report that green manufacturing must be implemented in an all-round way and a green manufacturing system should be constructed. While doing a good job in energy saving and emission reduction, cost reduction and consumption reduction, new momentum for green development should be actively fostered and improved. Addition of quality and efficiency. The author makes a preliminary exploration on the construction of the evaluation index system of the green supply chain for automobile products and establishes a supplementary framework including five aspects: design, purchase, production, sale, and recycling. The purpose of this paper is to provide a reference for relevant researchers to carry out empirical evaluation and analysis of the performance of a green supply chain for automobile products, and to provide real evidence for manufacturers. Now the whole life cycle of automobiles "green up" to provide corresponding countermeasures and suggestions.

Promoting Green Design of Automobile Products

Design green manufacturing system to lead the sustainable development of the manufacturing industry. According to the concept of green development, based on green design, through strict parts purchasing, we can produce the automobile products needed by society under specific technical standards. Among them, the new energy vehicle is a new product emerged from the perspective of green development. Through the product design stage, suppliers should be selected according to the demand for "green" parts, and parts needed for automotive products should be purchased according to national standards. In the procurement stage, through quantitative analysis, we measure the "green" level of IS014001 certification, green acceptance and environmental performance among different suppliers, and then select parts with recyclable and renewable performance. However, there are many risks in the procurement stage, such as information asymmetry. Therefore, under the condition of the supply chain, the procurement of automobile parts and components should be managed in different directions, and the design and optimization of the management plan should be carried out according to the actual needs, so as to ensure win-win cooperation between the two sides. Then, the manufacturing process is quantified and the automobile parts and products are analyzed. The green development level of the automobile industry will be improved through the evaluation criteria for the energy consumption (equipment utilization ratio, cost recovery ratio) and the impact on the surrounding environment (wastewater, exhaust gas, noise, and another production capacity) of products in the whole production process.

Pay Attention to the Recovery of Automobile Products

The green recycling of scrap automobiles conforms to the requirements of circular economy development and the current concept of green development. It can not only improve the competitiveness of enterprises, but also an effective way to create profits. According to the design of the index system in this paper, the return rate, recovery rate and reuse rate of spare parts or whole vehicles are fully considered, and the product performance is continuously improved. According to the Management Requirements of Automobile Hazardous Substances and Recoverable Utilization Rate, the verification and evaluation of the harmful substances and recyclable utilization rate of automobile products are continuously carried out, and regular issuance of the corresponding documents is made. Conformity List. In this way, under strict supervision and management, it will not be a dream to achieve 95% recyclability of automobile products by 2020. For example, when spare parts can not be used in the original vehicle, they can be used in vehicles with lower requirements or converted to other uses, and their use-value can be brought into full play. The technology and equipment of spare parts manufacturers and automobile manufacturers can also be used in combination with cascade utilization to make full use of recycled materials and reduce the production cost of new cars. Green recycling technology is still a new subject in China. With the increase in car ownership and scrap in China, this problem will become more prominent. Therefore, we must establish a perfect recycling network for scrap vehicles, standardize the industry system, form a more perfect recycling industry chain model, and form the scale of the automobile recycling industry.

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Chapter 16
Compromise Optimal System Design for Solving Multi-Objective Green Supplier Selection Problems

Nurullah Umarusman
Aksaray University, Turkey

Turgut Hacıvelioğulları
Aksaray University, Turkey

ABSTRACT

Most instances like developing technology, scarce sources, and global warming have brought about an ongoing perspective with Sustainable SCM and Green SCM starting from Traditional SCM. Supplier selection in all these processes is a decision-making process playing a significant role in the success of enterprises. The most critical point in this decision-making process is the criteria used in the supplier selection process because they directly affect the selection of supplier that is appropriate for the strategy of the enterprise. In this chapter, the optimal quantity of products to be purchased from suppliers were determined through a solution offer that authors named as compromise optimal system design. For the recommended solution, first, a new model was introduced by arranging Multiobjective Supplier Selection problem based on the De Novo assumption, and then Compromise Programming was used for the solution of this model. The developed solution procedure was used to determine the amount of blending machine to be purchased from the green supplier of a milling machine manufacturer.

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INTRODUCTION

Supply chain management involves the management of the process from the beginning of the order, from the supply, production, storage, distribution of the components that make up the product to the end-user, to the completion of the product's life span. This process was handled by Elkington (1998) in 3 dimensions within the framework of TBL, resulting in Sustainable Supply Chain Management. Green Supply Chain Management, on the other hand, has been considered as an extension of Sustainable SCM due to environmental concerns. From this point of view, Sustainable Supply Chain Management and Green Supply Chain Management can be regarded as extensions of SCM due to developing technology, human needs, and scarce resources.

Collaboration in the supply chain enables firms to achieve cost optimization, high quality of product and innovation, risk minimization, and higher market status. It also studies environmental and social issues arising from pressures such as governments, clients, and stakeholders (İnce and özkan, 2013). Green Supply Chain Management's idea is to incorporate environmental thought into Supply Chain Management. As such, Green Supply Chain Management is crucial in affecting all organizations engaged in supply chain activities ' overall environmental effect. More significantly, Green Supply Chain Management can help to improve the performance of sustainability (Chin et al., 2015). Green and sustainable supply chain definitions vary according to economic, social, environmental, coordination, relationship, efficiency, and such performance criterias which belong to bussiness sustainability and SCM characteristics (Ahi and Searcy,2013). Green supply chain management is based on the traditional supply chain management structure. The principle is a supply chain with the cooperation firms coordinating their standard procedures. There is interdependence between current supply chain management and eco-programs in the context of green supply chain management (Sarkis,2001). Although in Supply Chain Management literature, Green Supply Chain Management and Sustainable Supply Chain Management are generally used interchangeably; it should be noted that these two ideas are slightly distinct. Sustainable Supply Chain Management involves economic and social sustainability issues and also environmental sustainability issues. Sustainable Supply Chain Management is thus a wider field that contains Green Supply Chain Management as part of it (Nikbakhsh, 2009).

The green supply chain consists of processes that involve the use of resources and waste minimization (Thun ve Müler, 2010). In the latest years, traditional supply chains have been held responsible for producing enormous amounts of emissions and waste and resource usage, contributing to environmental degradation and environmental deterioration. Besides, supply chains are often responsible for global environmental issues such as global warming. The outcome is an intensive integration of environmental sustainability into the imperious business experiences. To this end, the growing interest of the supply chains stakeholders in environmental issues has led to the development of green supply chains (Achillas et al., 2019).

PHILOSOPHICAL ASPECTS OF SUSTAINABLE SCM AND GREEN SCM

A company no matter in which sector or how huge, what it does, has an impact negatively or positively on around itself socially, environmentally and economically because of its operations. These are employment generation, innovation, starting to new products or services contributing to improving society, economic and social development by procurement of product but also it can happen unwelcome effects as devastation of natural environment, bad working conditions and negative economic and social standards. Essential issue that needs to be paid attention is being aware of negative effects and avoiding or minimising these negatives (Berzau, 2017). Discipline of customers, shareholders, civil society organizations and governments forced companies to establish a sustainable supply chain because of damages to environment and social anxiety with spreading globalization all over the world as a result of this sustainability gained popularity for companies (Liu, et al., 2012). While dealing with the sources for production supply chain management has an importance role of changing effects on procurement methods and natural environment with providing sustainability (Glover et al., 2014).

Sustainable Supply Chain Management is a management of material, information and capital regarding environmental, social and economic targets by cooperating with companies in supply chain in the scope of customer and shareholders necessities (Seuring and Müller, 2008). Economic, environmental and social factors must be remained on the agenda of companies while preferring supplier when sustainability is the issue. Integration of environmental and social criteria to economic aspect in performance targets of companies is a must along all supply chain (Bai and Sarkis, 2010). These criteria can vary according to targets of companies (Dahlsrud, 2008). Regarding environmental, social, economic, and ethical issues in process of sustainability provides not only for company to supply all materials, service, information and abilities leading fundamental and subsidiary activities but also adding value to society and economy (Miemczyk et al., 2012). In sustainable supply chains it is expected to fulfill the social and environmental criteria to remain the supplier in supply chain while fulfilling customer expectations according to economic criteria so as to sustain ability of rivalry. This definition is rather wide and combines those given for sustainability and supply chain management. It is also able to integrate green/environmental supply chain management as one part of the wider field (Seuring et al., 2008).

Green Supply Chain Management, resulting from intersection of sustainability, environmental management and supply chain, has been an instrument for ensuring balance of companies' economic and environment performance in terms of cost, speed and planning recently (Ergülen and Büyükkeklik, 2008). In process of supply chain, Green Supply Chain comprises decreasing or avoiding whole possible damageable activities to environment and activities with companies in chain as well (Azevedo et al., 2011). Green Supplier Selection is a critical practice for supply chain management due to the environmental performance of the supply chain being considerably impacted by supplier performance. Working with suitable suppliers impacts not only the economic dimensions but also the environmental dimensions directly (Çalık,2018).

Green Supply Chain Management

Green Supply Chain Management is integrating environmental activities with activities as supplying source, R&D, designation and innovation, production, logistics, packing, storing, returning, disposure, after sales service, management after lifetime of product (Min and Kim, 2012). Environmental conscience has become a must for companies in view of legal regulations, legislations and economic anxiety (Andiç et al., 2012). This awareness may result from both having environmental conscience culture and rivalry conditions (Hervani et al., 2005). Environmental performance of a company must be evaluated not only its activities but also activities of companies in its supply chain. Doing business with companies who has environmental anxiety and caring the matters and applying these will help companies to ameliorate environmental performances and applications (Lee, 2008).

Green supply chain management has its origins in both the literature on environmental management and supply chain management. Adding the ' green ' component to supply-chain management includes addressing the impact and relationships between supply-chain management and the natural environment. Similar to the supply-chain management idea, Green Supply Chain Management boundary depends on the investigator's aim (Srivastava, 2007). The Green Supplier Selection Problem can be defined as a classical Supplier Selection Problem in which, among the others, also environmental criteria are taken into account in order to select and evaluate suppliers' performance. (Genovese et al.,2010). The green idea differs from the concept of sustainability. Sustainability includes economic, social and environmental criteria, whereas green features are restricted to environmental criteria. As a result, the green idea is a part of sustainability concept (Igarashi et al. 2013).

Managers experience a range of decision-making issues in the supply chain management process, as in all company organizational procedures. Many decision problems such as suppliers, distributors, service providers, the determination of the product to be bought from suppliers, the quantity and frequency of products to be purchased from suppliers are researched by the enterprises (Yıldırım and Timor, 2019). Green supply chain ensures that organizational innovations and policies in supply chain management are evaluated in terms of a sustainable environment. If an industry is perceived as a complicated process of purchasing, producing, selling and delivering, the opportunities for environmental considerations when called into play in supply chain management could not only provide sustainable environmental measures but also benefit organizations and individual consumers alike (Bau and Wright, 2008).

The inter-organizational sharing of responsibility for numerous aspects of environmental performance is a key component within Green Supply Chain Management. Green Supply Chain Management should stimulate the sharing of environmental responsibility and devote itself to gaining environmental burden caused by industry (Hervani et al.2005). Green supply chain management has turned into a strategic and operational concern for the vast majority of companies. Organizations cannot just look inward anymore but necessitate partnering and looking outward to have the biggest effect on improving environmental performance (Sarkis and Dou, 2018). Green Supply Chain contains policies, practices and tools that can be applied by an organization in a sustainable environment context. Even though the incorporation of environmental concerns into supply chain management has developed into a distinct field of studies and enterprise, Green Supply Chain can be regarded as an interdisciplinary subject incorporating various and multiple businesses, social, financial, technological and environmental sustainability problems (Achillas et al., 2019). Green supply chain recognizes an organization's disproportionate environmental impact of supply chain processes and balances issues arising from both sides to satisfy stakeholders. The stakeholders in the green supply chain are not only buyers and suppliers, but also regulators, legislative bodies, non-profit organizations and, above all, customers. (Bau and Wright, 2008).

Enterprises have used their Green Supply Chain Management to enhance their core competitive advantage in terms of increasing global awareness of environmental protection. Green Supply Chain Management is a widespread practice among enterprises trying to enhance their performance in the environment. Green Supply Chain Management practices, seen as cross-organizational and closed loops, decrease the ecological impact of manufacturing operation without sacrificing effectiveness in terms of quality, cost, reliability, performance or energy utilize (Ghobakhloo et al., 2013). The concept of Green Supply Chain Management is to integrate environmental thinking into supply chain management. As such, Green Supply Chain Management is important in influencing the total environment impact of any organizations involved in supply chain activities. More importantly, Green Supply Chain Management can contribute to sustainability performance enhancement (China et al, 2015).

One of important issues is that process of selecting supplier in Green Supply Chain Management. Supplier selection criteria consist of basis of process of selecting supplier, because company needs to define the supplier whether it is convenient to company's structure or not so as to provide company's sustainability and achieving the goals in scope of these criteria. The criteria for selecting supplier may vary according to sector, company culture, purpose, geographical location and legal liabilities.

Green Supplier Selection Criteria

Dangerous materials in raw materials supplied from suppliers can cause serious environmental impacts. So selecting convenient supplier has become an important issue (Kuo et al., 2010). Defining criteria for selecting green supplier is an important issue for solution for problems. Even there are defined criteria for selecting supplier because of difference of sectors process of defining criteria may have been complex issue. Because of this reason defining criteria convenient to sector will be useful instead of overall tendency. By inspecting Green Supplier Selection criteria applicable criteria can be defined. So 12 scientific studies have been analysed. These are;

Lee et al., (2009) established a model for supplier selection in the high-tech industry using the *quality, technology capability, pollution control, environment management, green product, and green competencie* criterion. Awasthi et al., (2010) used the criteria which are *use of environment friendly technology, use of environment friendly materials, green market share, partnership with green organizations, management commitment, adherence to environmental policies, green R & D projects, staff Training, lean process planning, design for environment, environmental certification, and pollution control initiatives* to evaluate environmental performance of suppliers. Yeh and Chuang (2011) used the criteria of g*reen image, product recycling, green design, green supply chain management, pollution treatment cost, and environment performance assessment* for partner selection in green supply chain problems. Tseng and Chiu (2013) examined the businesses utilizing Green Supply Chain Management in Taiwan by using the criteria of "*degree of innovativeness of R&D green products, number of patents, green R&D, environmental management system, environmental criteria, flexibility of supplier, life cycle, green purchasing, service quality, environment-related certificates such as ISO 14000, Green design, product quality, delivery*.

Govindan et al., (2013) evaluated the supplier performance based on *pollution production, resources consumption eco-design, and environmental management* criteria and within the TBL framework. Samadhan et al., (2013) used *quality, environment performance assessment, green manufacturing, customer co-operation, green costs, green design, and green logistics design* criteria for green supplier selection and determined the importance of these criteria in Indian industries. Nielsen et al. (2014) detected general supplier selection criteria and green supplier selection criteria used in different sectors. Kannan et al. (2015) used 11 main criteria and 115 sub-criteria in the study for green supplier selection problem. Seven of the main criteria are *environment protection, corporate social responsibility, pollution control, green product, green image, green innovation, and hazardous substance management.* Banaeian et al. (2015) worked with *qualitative and environmental management system* criteria for detecting green supplier in the food industry. Hashemi et al. (2015) realized green supplier selection in integrated model through using *cost, quality, technology, resource consumption, pollution production management commitment* criteria. Guo et al. (2017) selected the green supplier of a textile company with *quality, cost, delivery, technology, service, and environmental competency* criteria. Yücesan (2019) evaluated three suppliers in the plastic industry using the criteria containing environmental and economic base to create a green supplier selection model. Major criteria in the study are environmental, *social, quality, service, risk cost/price, capability and business structure.*

As a result of this literature review, the criteria of quality, technology or technology capability, pollution control, green product, and green cost or cost are frequently used. Also, considering the criteria of customer co-operation, corporate social responsibility, staff training, green image, adherence to environmental policies, an assessment based on the social dimension emerges. According to these assessments, the Green Supplier Selection criteria are compatible with the TBL criteria, and this shows that Sustainable Supply Chain Management includes Green SCM.

Green Supplier Selection Literature Survey

Various methods have been applied in process of selection and evaluation. There are many scientific studies about classifying these methods. So the results from 12 different studies has been submitted instead of inspecting a new literature.

De Boer et al (2001), Ding et al (2003), Ware (2012), Chai et al., (2013), Nielsen et al., (2014), Govindan et al., (2015), Dung et al., (2016), Ghorabaee et al., (2017), Mukherjee (2017), Ozyoruk (2018), Basik (2018), Jafarzadeh-Ghoushchi et. Al, (2018), Umarusman (2019) analyzed a literature review for traditional supplier selection problems, sustainable supplier selection problems, and green supplier selection problems from different perspectives. This literature survey has shown that there are very few scientific articles on green supplier selection problems based on Multi-Objective Objective decision-making methods. Therefore a detailed literature review including MODM methods used in Green Supplier Selection could not be performed. The literature search in this study was obtained from Elsevier's Science Direct, Emerald Publishers, Springer, IEEE, Taylor & Francis, and Google Scholar and TR Dizin electronic database. The scientific studies identified are given below:

Tsai and Hung (2009) suggested a fuzzy goal programming approach that integrates activity-based costing and performance evaluation in a value-chain structure for optimal Green Supply Chain supplier selection and flow allocation. Kannan et al., (2013) showed an integrated approach, of fuzzy-multi attribute utility theory and multiobjective programming. Ashlaghi (2014) proposed a hybrid approach for selecting the best supplier by using Fuzzy DEMATEL, Fuzzy ANP and Linear Physical Programming. Liao (2016) developed new integrated fuzzy techniques for fuzzy-AHP(FAHP), fuzzy- ARASF and multi segment GP approach to solve the green supplier selection problems. Tuzkaya et al., (2016) developed a multi-objective model for the supplier selection and order allocation processes . This model is an integrated solution methodology that involves AHP and two phase fuzzy goal programming. Hamdan and Cheaitou (2017) developed an integrated MCDM approach based on fuzzy AHP, fuzzy TOPSIS and multi-objective mathematical modeling for supplier evaluation and order allocation problem. Bakeshlou (2017) developed a Fuzzy multi-objective linear programming model for a Green Supplier Selection problem. Çalık (2018) presented a new Multi-Objective Linear Programming model for green supplier selection and solved this model based on three different fuzzy approaches. Lo (2018) suggested a new model that integrates the best–worst method, modified fuzzy TOPSIS, and fuzzy MOLP to solve problems in green supplier selection and order allocation. Ghoushchi (2019) developed a fuzzy multiobjective linear programming to solve the green supplier selection problem. Torğul and Paksoy (2019) showed an integrated approach for the best supplier selection in a supply chain, targeting the maximize lean and green value in a supply chain network, using fuzzy AHP-TOPSIS and fuzzy multi-objective linear programming.

Additionaly, six scientific studies, including Compromise Programming or De Novo Programming methods, were identified in the literature research. These scientific studies are as follows:

Wang and Yang (2009) suggested a fuzzy model to select the suppliers in a quantity discount environment with AHP method and fuzzy compromise programming. Elahi et al. (2011) suggested a Fuzzy Compromise Program Solution in the Quantity Discount Situation for Supplier Selection. Huang and Hu (2013) suggested a two-stage solution approach for supplier selection using Fuzzy Analytic Network Process-Goal Programming (FANP-GP) and De Novo Programming for automotive industry supplier selection. The selected suppliers are evaluated based on the DNP method by rearranging the resource amounts of the constraints and increasing their capacity to reach the minimum total supply budget. Saeedi et al. (2015) proposed a De Novo-based closed-loop supply chain model that regards the effects of building a queueing system in recovery centers. Ekhtiari et al. (2018) established a nadir compromise programming model for decision-making under uncertainty regarding supplier selection in binary programming. Umarusman (2019) solved the multiobjective supplier selection problem using Compromise Programming.

FORMULATION OF MULTIOBJECTIVE SUPPLIER SELECTION PROBLEM

Supplier selectin problems can be modelled as Multiobjective Linear programming by taking into consideration process of procurement from more than one supplier problem. In this decision-making process also as named Multiobjective Supplier Selection problems every supplier has come out as decision variable and in evaluating process selecting criteria coming out as purpose function. Also maximum and minimum amounts to be procured from each supplier can be considered as constraint of company's capacity. So mathematical models of Multiobjective Supplier Selection problems can be improved according to different viewpoints. In this topic, it can only be possible a solution named as "compromise optimal system design" mathematical formulation has been reformed. Then a solution has been submitted by using Multiobjective De Novo programming problems and Compromise Programming approaches.

Gaballa (1974) developed the mathematical formulation of the supplier selection problem using mixed-integer programming. Multiobjective Supplier Selection Problem was rearranged by Weber and Ellram (1992), Weber and Current (1993), Ghodsypour and O'Brien (1998), Amid et al., (2011), and Umarusman (2019) from different perspectives. In this study, Multiobjective Supplier Selection Problem with regards to three objective functions of maximization type, maximum and minimum amount to be purchased from suppliers and the enterprise's maximum and minimum capacity is given below:

$MaxTC(x)=\sum_{i=1}^{n}T_i(x)$. $MaxQ(x)=\sum_{i=1}^{n}Q_i(x)$. $MaxS(x)=\sum_{i=1}^{n}S_i(x)$ .Subject to (3.1)

$\sum_{i=1}^{n}x_i \geq D_1$. $\sum_{i=1}^{n}x_i \leq D_2$. $x_i \leq C_{i1}$. $x_i \geq C_{i2}$. $i = 1, 2, \ldots, n$, $x \geq 0 and integer.$ .Where;

x_i . The product amount to be received from ith supplier,

n :.The number of suppliers,

D_1 . Aggregate Minimum quantity demanded,

D_2 . Aggregate Maximum quantity demanded,

C_{i1} :.Minimum quantity to be purchased from ith supplier,

C_{i2} :.Maximum quantity to be purchased from ith supplier,

TC_i :.Technological capability of ith supplier,

Q_i :.percentage of quality level of ith supplier,

S_i :.After-sale Services percentage.

Model (3.1) also known as Multiobjective Linear programming is solved by positive and negative ideal solution. The number of sets of nondominated solutions in Multi-objective Linear Programming problems is quite high. Therefore, the core process in examining Nondominated solutions is how to calculate the proximity to ideal solution points (Cohon, 1978). Many methods could be used for researching the proximity to ideal solution points, Zimmerman (1978), Tabocanon (1988), and Mollagselammi and Pet-Edwards (1997) can be referred as the fundamental sources about these methods.

Multiobjective De Novo Programming: Optimal System Design

In the De Novo Programming approach proposed by Zeleny (1976), he introduced how to design an optimal system. Later, Zeleny (1981) applied the de novo assumption to a classical Linear programming problem. These two scientific studies form the basis of Single Objective and Multiobjective De Novo Programming problems. In De Novo programming, the amount of resource constraints is restricted because the maximum amounts are managed by the budget. The most important feature of the De Novo approach is that the amount of resources used can be rearranged. According to Zeleny (1984), a system design, redesign, and optimization should contain the reformation of system limits and constrains based on goals. System design is not a selection of alternatives, but a process of creating alternatives. Multiple Objective De Novo Programming is mathematically formulated as follows (Zeleny, 1990):

$$MaxZ_k\left(x\right):\sum_{j=1}^{n}C_{kj}x_j \,.\, MinW_s\left(x\right):\sum_{j=1}^{n}C_{sj}x_j \text{ .Subject to} \tag{3.2}$$

$$\sum_{j=1}^{m}A_jX_j \otimes B \,.\, x_j \geq 0, k=1,2,\ldots,l, s=1,2,\ldots,r and j=1,2,\ldots,n \,.$$

Where;

$\otimes$ .denotes operator "$\leq$" or "$=$", Let $\mathrm{A_j} = \sum_{\mathrm{i=1}}^{\mathrm{m}}\mathrm{p_i a_{ij}}$. represents the unit cost of product j. Multiobjective De Novo programming problems can also be considered Multiobjective Linear programming. As there is no specific method for solving De Novo programming problems, it can be solved with the methods listed above. Ideal solutions used in Multiobjective Linear programming solution are classified into two groups as positive and negative ideal solutions (Lai and Hwang, 1994). Positive ideal solutions are also named as the best performance of each objective function in (3.1) or (3.2). The set of positive ideal solution is $I^* = \left\{Z_1^*, Z_2^*, \ldots, Z_l^*; W_1^*, W_2^*, \ldots, W_s^*\right\}$. Negative ideal solutions are named as the worst performance of each objective function in (3.1) or (3.2). The set of negative ideal solution is $I^- = \left\{Z_1^-, Z_2^-, \ldots, Z_l^-; W_1^-, W_2^-, \ldots, W_s^-\right\}$.

Compromise Programming

The main goal of Compromise Programming, developed by Yu (1973) and Zeleny (1973), is to minimize the distance from its ideal points. Compromise Programming is mathematically formulated as follows:

$$Minimum d_\infty \text{ .Subject to} \tag{3.3}$$

$$\alpha_k^p \left[\frac{Z_k^* - Z_k(x)}{Z_k^* - Z_k^-} \right] \le d_\infty \,.\, \alpha_s^p \left[\frac{W_s(x) - W_s^*}{W_s^- - W_s^*} \right] \le d_\infty \,.\, x \in X \,.$$

$Z_k(x)$. kth objective function to be maximized,

$W_s(x)$: .sth objective function to be minimized,

Z_k^* : .Positive ideal solution value for kth objective,

Z_k^-. Negative ideal solution value for kth objective

W_s^* : .Positive ideal solution value for sth objective,

W_s^- : .Positive ideal solution value for sth objective,

α_k : .weigth of kth objective,

α_s : .weigth of sth objective,

X . feasible area.

The result of compromise programming solution must fall between 0 and 1 $(0 \le d_\infty \le 1)$.

$d_\infty = 0$ .signifies that ideal values of objective functions is achieved. Whereas $d_\infty = 1$ .means objective functions are solved at non ideal values. Considering d_∞ .value, normalized value of distance indicates the success level of the objective function solutions.

Compromise Optimal System Design

This solution, which we call *Compromise Optimal System Design*, is a result of hybrid methodology and includes Multiobjective Linear programming, Multiobjective De

Novo programming, and Compromise Programming. To determine this solution, first (3.1) and (3.2) should be taken into consideration. In (3.1), the Novo assumption can easily be applied for quantities to be purchased from suppliers. Based on the budget constraint in (3.2), De novo-based Multiobjective Supplier Selection problem is created as follows.

$$\mathrm{Max}\,TC(x) = \sum_{i=1}^{n} T_i(x) \,.\, \mathrm{Max}\,Q(x) = \sum_{i=1}^{n} Q_i(x) \,.\, \mathrm{Max}\,S(x) = \sum_{i=1}^{n} S_i(x) \text{ .Subject to} \tag{3.4}$$

$$\sum_{i=1}^{n} x_i \geq D_1 \;.\; \sum_{i=1}^{n} x_i \leq D_2 \;.\; \sum_{i=1}^{n} C_{i2} p_i \text{�} B \;.\; x_i \geq C_{i1} \;.\; i = 1, 2, \ldots, n,$$
$$x \geq 0 \text{ and integer.}$$ .where;

x_i . The product amount to be received from ith supplier,

D_1 . Aggregate Minimum quantity demanded,

D_2 . Aggregate Maximum quantity demanded,

C_{i1} :.Minimum quantity to be purchased from *i*th supplier,

C_{i2} :.Maximum quantity to be purchased from *i*th supplier,

n :.The number of suppliers,

TC_i :.Technological capability of *i*th supplier,

Q_i :.percentage of quality level of *i*th supplier,

S_i :.After-sale Services percentage,

p_i :.The unit price of the product to be purchased from the i-th supplier,

B .: Budget.

Firstly, the sets of positive and negative ideal solutions of the objective functions are determined to solve (3.4) by using Compromise Programming. For (3.4), positive ideal solution set is $I^* = \left\{TC^*, Q^*, S^*\right\}$ .and negative ideal solution set is $I^- = \left\{TC^-, Q^-, S^-\right\}$. Afterward, the model that will obtain a "Compromise Optimal System Design" solution using Compromise programming is created as below:

$Minimum d_\infty$ .Subject to (3.5)

$$\alpha_{TC}\left[\frac{TC^* - TC(x)}{TC^* - TC^-}\right] \le d_\infty .$$

$$\alpha_Q\left[\frac{Q^* - Q(x)}{Q^* - Q^-}\right] \le d_\infty .$$

$$\alpha_S\left[\frac{S^* - S(x))}{S^* - S^-}\right] \le d_\infty . \sum_{i=1}^{n} x_i \ge D_1 . \sum_{i=1}^{n} x_i \le D_2 . \sum_{i=1}^{n} C_{i2} p_i � B . x_i \ge C_{i1} .i=1,2,\ldots,n,$$

$x \ge 0$andinteger.α_{TC}, α_Q .and α_S .representthe relative importance or weights of each objective function with $\alpha_{TC} > 0, \alpha_Q > 0$. $\alpha_S > 0$ .and $\alpha_{TC} + \alpha_Q$. $\alpha_S = 1$.

Burada;

x_i . The product amount to be received from ith supplier,

D_1 . Aggregate Minimum quantity demanded,

D_2 . Aggregate Maximum quantity demanded,

C_{i1} : .Minimum quantity to be purchased from *i*th supplier,

C_{i2} :.Maximum quantity to be purchased from ith supplier,

n :.The number of suppliers,

TC_i :.Technological capability of ith supplier,

Q_i :.percentage of quality level of ith supplier,

S_i :.After-sale Services percentage,

p_i :.The unit price of the product to be purchased from the ith supplier.

B .: Budget.

TC^*. Positive ideal solution value for Tecnical Capability

TC^-. Negative ideal solution value for Tecnical Capability

Q^*. Positive ideal solution value for Quality

Q^-. Negative ideal solution value for Quality,

S^*. Positive ideal solution value for Service

S^-. Negative ideal solution value for Service

Using (3.5) that we call the Compromise optimal system Design, the amount of products to be purchased from suppliers will be at an optimal level. The de novo assumption, depending on the budget constraint, will both redesign the amount to be purchased and increase the achievement level of the objectives.

APPLICATION

An enterprise produces milling machines. This enterprise purchases a blending machine, which is the major component of the product they produce, from five different suppliers. This enterprise has been doing business with these suppliers since 2011 and knows their positions in the sector well. The enterprise was founded in 2010, and it adopts the idea of green production.

The business manager is planning on purchasing from current suppliers within the framework of Technical Capability, Quality, and Service criteria. Technical Capability criterion contains green product, water consumption, renewable energy, and energy consumption sub-criteria, Quality criterion " green R&D", "green manufacturing", "Environmental product performance" and "Recycling" sub-criteria, and Service criterion "reputation", "green logistics", "waste management and pollution", "respect for the policies", and "service cost" sub-criteria. According to these main criteria, information about the products to be purchased from each supplier is given in Table 1.

In Table 1, product cost information and minimum and maximum quantities to be purchased from each supplier are given with Technical Capability, Quality and, Service information. The monthly production capacity of the enterprise is minimum 900 and maximum 1200. Also, the company has created a total purchase budget of $ 303250 based on the maximum amount of information it will receive from its suppliers. In light of this information, the solution steps of problem are below:

Solution Steps of the Problem

For the Green Supplier Selection Problem, the Multi Objective Supplier Selection problem (3.1) is modeled below using the information in Table 20.

$$Technicalcapability : MaxZ_1 = 0.95x_1 + 0.9x_2 + 0.96x_3 + 0.95x_4 + 0.9x_5 .$$

Table 1. Supplier ınformation

	Technical Capability (%)	Quality (%)	Service (%)	Cost ($)	Maximum Miktar	Minimum Miktar
Supplier 1	0.95	0.92	0.85	215	280	200
Supplier 2	0.90	0.96	0.90	220	275	220
Supplier 3	0.96	0.98	0.80	235	320	250
Supplier 4	0.95	0.95	0.95	230	235	190
Supplier 5	0.90	0.92	0.98	205	260	175

$Quality : MaxZ_2 = 0.92x_1 + 0.96x_2 + 0.98x_3 + 0.95x_4 + 0.92x_5$.

$Service : MaxZ_3 = 0.85x_1 + 0.90x_2 + 0.80x_3 + 0.95x_4 + 0.98x_5$ .Subject to (P3.1)

$x_1 + x_2 + x_3 + x_4 + x_5 \geq 900$. $x_1 + x_2 + x_3 + x_4 + x_5 \leq 1200$.

$x_1 \geq 200; x_1 \leq 280$. $x_2 \geq 220; x_2 \leq 275$.

$x_3 \geq 250; x_3 \leq 320$. $x_4 \geq 190; x_4 \leq 235$. $x_5 \geq 175; x_3 \leq 260$.

$x_1, x_2, x_3, x_4, x_5 \geq 0 andInteger$.

(P3.1)'s solution is made based on 3 different scenarios. For the solution of (P3.1) using Compromise Programming, the objective functions should be given relative weight factor by the decision-maker. In this study, it is assumed that the objective functions are given equal weights in 3 scenarios $\left(w_1 = w_2 = w_3 = 0.333\right)$.

Scenario 1: For each objective function of (P 3.1), firstly, positive and negative ideal solutions are determined. Positive and negative ideal solutions are given in Table 2.

According to the information in Table 2, the value of each objective function is achieved at different values of the variables. Therefore, a feasible solution could not be obtained. To determine the compromise solution of (P3.1), Compromise Programming model created using (3.3) is given below.

$Mind$ .Subject to (P3.2)

$$\left(0.333\right)\frac{1123.45 - \left(0.95x_1 + 0.9x_2 + 0.96x_3 + 0.95x_4 + 0.9x_5\right)}{1123.5 - 966} \leq d .$$

$$\left(0.333\right)\frac{1141.1 - \left(0.92x_1 + 0.96x_2 + 0.98x_3 + 0.95x_4 + 0.92x_5\right)}{1141.1 - 981.70} \leq d .$$

$$\left(0.333\right)\frac{1077.55 - \left(0.85x_1 + 0.90x_2 + 0.80x_3 + 0.95x_4 + 0.98x_5\right)}{1077.55 - 920} \leq d .$$

Table 2. Positive and negative ıdeal solutions for (P3.1)

According to the information in Table 2, the value of each objective function is achieved at different values of the variables. Therefore, a feasible solution could not be obtained. To determine the compromise solution of (P3.1), Compromise Programming model created using (3.3) is given below.	$Mind_5$ to (P3.2)	$(0.333)\frac{1123.45-(0.95x_1+0.9x_2+0.96x_3+0.95x_4+0.9x_5)}{1123.5-966}\le d\cdot$ $(0.333)\frac{1141.1-(0.92x_1+0.96x_2+0.98x_3+0.95x_4+0.92x_5)}{1141.1-981.70}\le d\cdot$ $(0.333)\frac{1077.55-(0.85x_1+0.90x_2+0.80x_3+0.95x_4+0.98x_5)}{1077.55-920}\le d\cdot$ $x_1+x_2+x_3+x_4+x_5\ge 900.x_1+x_2+x_3+x_4+x_5\le 1200.$ $x_1\ge 200;x_1\le 280x_2\ge 220;x_2\le 275x_3\ge 250;x_3\le 320.$ $x_4\ge 190;x_4\le 235.x_5\ge 175;x_3\le 260.$ $x_1,x_2,x_3,x_4,x_5\ge 0 andInteger$ .The variable values obtained from the solution of (P3.2) are given in Table 3.
Table 3. Solution of (P3.2)	Decision Variabled	Technical Capability %
Quality %	Service%	
210	210	210
		220

$$x_1+x_2+x_3+x_4+x_5\ge 900.$$

$$x_1+x_2+x_3+x_4+x_5\le 1200.\ x_1\ge 200;x_1\le 280.\ x_2\ge 220;x_2\le 275.$$

$$x_3\ge 250;x_3\le 320.$$

$x_4\ge 190;x_4\le 235$. $x_5\ge 175;x_3\le 260$. $x_1,x_2,x_3,x_4,x_5\ge 0 andInteger$. The variable values obtained from the solution of (P3.2) are given in Table 3.

Table 3. Solution of (P3.2)

<table>
<tr><td colspan="2">As can be seen from Table 3, all objective functions are realized at the same value of the same decision variables. The objective function value of (P3.2) is d = 0.009061. Now, taking into account the solution value of the objective functions; we determine the (%) value of each objective.</td><td>$\text{Technical Capability}(\%)\frac{1119,17}{1200}=0.933$
$\text{Quality}(\%)\frac{1136.77}{1200}=0.947.$
$\text{Service}(\%)\frac{1073.29}{1200}=0.894.$</td><td>Technical Capability = 0.933 indicates the average of the technical capacity of all suppliers, considering the products purchased from suppliers. Quality = 0.9474 shows the average quality of the final product. Similarly, Service = 0.894 represents the average service performance percentage for the final product. When the enterprise purchases 201, 220, 282, 235 and 253 units from the suppliers, the total cost will be $ 265735</td></tr>
<tr><td colspan="2">Scenario 2: The problem modeled according to (3.2) is given below using the information in Table 20. In this model, depending on the assumption of De Novo, the budget constraint is created according to the maximum amounts that can be purchased from suppliers. The minimum amounts to be obtained from the suppliers have not been used for the budget because the use of these values will result in a degenerate solution. In Scenario 2, it is considered that products should be purchased from each supplier.</td><td></td><td>$Technical\ capability: MaxZ_1 = 0.95x_1 + 0.9x_2 + 0.96x_3 + 0.95x_4 + 0.9x_5$
$Quality: MaxZ_2 = 0.92x_1 + 0.96x_2 + 0.98x_3 + 0.95x_4 + 0.92x_5$
$Service: MaxZ_3 = 0.85x_1 + 0.90x_2 + 0.80x_3 + 0.95x_4 + 0.98x_5$
Subject to (P3.3)</td></tr>
<tr><td colspan="2">$x_1 + x_2 + x_3 + x_4 + x_5 \geq 900$
$x_1 + x_2 + x_3 + x_4 + x_5 \leq 1200$
$x_1 \geq 200; x_2 \geq 220$
$x_3 \geq 250; x_4 \geq 190; x_5 \geq 175$
$215x_1 + 220x_2 + 235x_3 + 230x_4 + 205x_5 \leq 303205$
$x_1, x_2, x_3, x_4, x_5 \geq 0 and Integer.$
The positive and negative ideal solutions determined for each objective function in (P3.3) are given in Table 4.</td><td>Table 4. Positive and negative ideal solutions for (P3.3)</td><td></td></tr>
<tr><td>Technical Capability %</td><td>Quality %</td><td>Service%</td><td></td></tr>
<tr><td>PIS</td><td>1124.400</td><td>1143.40</td><td>1081.70</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td>NIS</td><td>966</td></tr>
<tr><td>981.7</td><td colspan="3">920</td></tr>
</table>

As can be seen from Table 3, all objective functions are realized at the same value of the same decision variables. The objective function value of (P3.2) is d =

0.009061. Now, taking into account the solution value of the objective functions; we determine the (%) value of each objective.

$$\text{TechnicalCapability}(\%)\frac{1119,17}{1200}=0.933\,.\,\text{Quality}(\%)\frac{1136.77}{1200}=0.947\,.$$

$$\text{Service}(\%)\frac{1073.29}{1200}=0.894\,.$$

Technical Capability = 0.933 indicates the average of the technical capacity of all suppliers, considering the products purchased from suppliers. Quality = 0.9474 shows the average quality of the final product. Similarly, Service = 0.894 represents the average service performance percentage for the final product. When the enterprise purchases 201, 220, 282, 235 and 253 units from the suppliers, the total cost will be $ 265735

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$$Technicalcapability: MaxZ_1=0.95x_1+0.9x_2+0.96x_3+0.95x_4+0.9x_5\,.$$

$$Quality: MaxZ_2=0.92x_1+0.96x_2+0.98x_3+0.95x_4+0.92x_5\,.$$

$Service: MaxZ_3=0.85x_1+0.90x_2+0.80x_3+0.95x_4+0.98x_5$ .Subject to (P3.3)

$$x_1+x_2+x_3+x_4+x_5\geq 900\,.\,x_1+x_2+x_3+x_4+x_5\leq 1200\,.\,x_1\geq 200;x_2\geq 220\,.$$

$$x_3\geq 250;x_4\geq 190;x_5\geq 175\,.$$

$$215x_1+220x_2+235x_3+230x_4+205x_5\leq 303205\,.$$

$x_1, x_2, x_3, x_4, x_5 \geq 0 andInteger$ .The positive and negative ideal solutions determined for each objective function in (P3.3) are given in Table 4.

As can be understood from Table 4, while the Technical Capability and Quality objective functions are realized at the same values of decision variables, the Service objective function is realized according to different variable values. As can be understood from Table 4, while the Technical Capability and Quality objective functions are realized at the same values of decision variables, the Service objective function is realized according to different variable values. Therefore, there is no feasible solution. Now, to obtain a compromise optimal system design solution using the information in Table 4, (P3.3) is rearranged as follows using (3.5).

$Mind$. Subject to (P3.4)

$$(0.333)\frac{1124.4-\left(0.95x_1+0.9x_2+0.96x_3+0.95x_4+0.9x_5\right)}{1142.9-966} \leq d .$$

$$(0.333)\frac{1143.4-\left(0.92x_1+0.96x_2+0.98x_3+0.95x_4+0.92x_5\right)}{1143.4-981.70} \leq d .$$

$$(0.333)\frac{1081.7-\left(0.85x_1+0.90x_2+0.80x_3+0.95x_4+0.98x_5\right)}{1081.7-920} \leq d .$$

$$x_1+x_2+x_3+x_4+x_5 \geq 900 .$$

Table 4. Positive and negative ideal solutions for (P3.3)

	Technical Capability %	Quality %	Service%
PIS	1124.400	1143.40	1081.70
NIS	966	981.7	920
		$x_1 = 200; x_2 = 220$. $x_3 = 250; x_4 = 190$. $x_5 = 175$	

$$x_1 + x_2 + x_3 + x_4 + x_5 \leq 1200\,.\, x_1 \geq 200; x_2 \geq 220;.\, x_3 \geq 250; x_4 \geq 190; x_5 \geq 175\,.$$

$$215x_1 + 220x_2 + 235x_3 + 230x_4 + 205x_5 \leq 303205\,.$$

$$x_1, x_2, x_3, x_4, x_5 \geq 0 andInteger\,.$$

Variable values obtained from the solution of (P3.4) and the objective function values are given in Table 5.

The objective function value of (P3.4) is determined as *Min d* = 0.010204. As in Scenario 1, the (%) value of each objective function is calculated below.

$$\text{Technical Capability}(\%)\frac{1122,75}{1200} = 0.935\,.\,\text{Quality}(\%)\frac{1138,45}{1200} = 0.949\,.$$

$$\text{Service}(\%)\frac{1076,75}{1200} = 0.898\,.$$

Similar calculations in Scenario 1 can be made for the above calculations. According to the results in Table 5, the quantities to be purchased from each supplier are 200,220,250,355 and 175, respectively. The budget used for these purchased products is calculated as \$ 267675.

Scenario 3: The problem was solved from a different point of view than the information in Table 20. Here, only the maximum and minimum capacity amount of the enterprise is handled without using the maximum and minimum quantities to

Table 5. Compromise optimal system design for (P3.4)

Karar Değişkenleri	Technical Capability %	Quality %	Service%
	200	200	200
	220	220	220
	250	250	250
	355	355	355
	175	175	175
Objective Function Value	1122,75	1138,45	1076,75
Min d			

be purchased from suppliers. The budget constraint is given below using the price of the products to be purchased from suppliers:

$$215x_1 + 220x_2 + 235x_3 + 230x_4 + 205x_5 \le 303205.$$

According to this information, De Novo programming model of the problem is as follows.

$$Technicalcapability: MaxZ_1 = 0.95x_1 + 0.9x_2 + 0.96x_3 + 0.95x_4 + 0.9x_5.$$

$$Quality: MaxZ_2 = 0.92x_1 + 0.96x_2 + 0.98x_3 + 0.95x_4 + 0.92x_5.$$

$Service: MaxZ_3 = 0.85x_1 + 0.90x_2 + 0.80x_3 + 0.95x_4 + 0.98x_5$. Subject to (P3.5)

$$x_1 + x_2 + x_3 + x_4 + x_5 \ge 900 . x_1 + x_2 + x_3 + x_4 + x_5 \le 1200.$$

$$215x_1 + 220x_2 + 235x_3 + 230x_4 + 205x_5 \le 303205.$$

$$x_1, x_2, x_3, x_4, x_5 \ge 0 andInteger.$$

The positive and negative ideal solutions obtained from the solution of (P3.5) are given in Table 6.

It can be seen in Table 6 that the technical Capability and Quality objective functions were realized at the same values of the decision variables. The service objective function was realized according to different variable values. Therefore, there is no feasible solution. Using the information in Table 6, (P3.5) was rearranged for the "compromise optimal system design" solution.

Table 6. Positive and negative ıdeal solutions for (P3.5)

	Technical Capability %	Quality %	Service%
PIS	1152.000	1176.000	1176.000
NIS	810	828	720

$Mind$ .Subject to (P3.6)

$$(0.333)\frac{1152-(0.95x_1+0.9x_2+0.96x_3+0.95x_4+0.9x_5)}{1152-810}\le d\ .$$

$$(0.333)\frac{1176-(0.92x_1+0.96x_2+0.98x_3+0.95x_4+0.92x_5)}{1176-828}\le d\ .$$

$$(0.333)\frac{1176-(0.85x_1+0.90x_2+0.80x_3+0.95x_4+0.98x_5)}{1176-720}\le d\ .$$

$$x_1+x_2+x_3+x_4+x_5\ge 900\ .$$

$$x_1+x_2+x_3+x_4+x_5\le 1200\ .$$

$$215x_1+220x_2+235x_3+230x_4+205x_5\le 303205\ .$$

$$x_1,x_2,x_3,x_4,x_5\ge 0 andInteger\ .$$

Variable values obtained from the solution of (P3.6) and objective function values are given in Table 7.

The objective function value of (P3.6) is determined as Min d = 0.032787. The calculation of average (%) value for each objective function using the information in Table 7 is as follows.

Table 7. Compromise optimal system design for (P3.6)

Decision Variables	Technical Capability %	Quality %	Service%
	0	0	0
	0	0	0
	59	59	59
	1141	1141	1141
	0	0	0
Objective Function Value	1140.59	1141.77	1131,15
Min d	0.032787		

$$\text{Technical Capability}(\%)\frac{1140.59}{1200}=0.950\text{ . Quality}(\%)\frac{1141.77}{1200}=0.949\text{ .}$$

$$\text{Service}(\%)\frac{1131{,}15}{1200}=0.943$$

Considering the quantities to be purchased from suppliers, the average Technical Capability is 95%, the quality of the products produced is 94.9%, and the average service value is 94.3%. All results from the three scenarios are shown in Table 8.

The results of each scenario are given in Table 8 Beginning with the budget, it can be seen that the total budget of \$303250 as determined initially was utilized in the scenario-1. The solution of multiobjective supplier selection problem (P3.1) was done with "compromise programming" in this scenario. In the scenario 2, (P3.1) was solved with "compromise optimal system design" which is proposed in this study, and \$267675 were used from the initial budget of \$303250. Scenario-3 is based only on the firm's own capacity constraint without the maximum and minimum amounts to be supplied from suppliers and was solved with "compromise optimal system design" proposal. \$276295 of \$303250 were used in scenario-3. It is seen that the solutions based on "compromise optimal system design" used less from the budget and therefore improved the goal function values. It stems from De Novo hypothesis.

The application problem was solved again by using different weights for the goal functions in Scenario-1, Scenario-2, and Scenario-3. Based on the determined

Table 8. General evaluation for three scenarios

Scenarios	Objective Functions	S-1	S-2	S-2	S-4	S-5	Objective Function Value	*d*	Budget ($)
Scenario -1	TC (%)	210	220	282	235	253	1119.17	0.009061	303250
	Q (%)						1136.77		
	S(%)						1073.29		
Scenario -2	TC (%)	200	220	250	355	175	1122,75	0.010204	267675
	Q (%)						1138,45		
	S(%)						1076,75		
Scenario -3	TC (%)	0	0	59	1141	0	1140.59	0.032787	276295
	Q (%)						1141.77		
	S(%)						1131,15		

weights as $w_1 = 0.25, w_2 = 0.45$ and $w_3 = 0.30$ for the goal functions, the determined solutions for the three scenarios are given in Table 9.

It is seen in Table 9 that purchases use less from the budget in Scenario-2 and Scenario-3. However, there is a decrease in the value of "Technical Capability" goal in Scenario-3. It is because "Technical Capability" goal is given the lowest weight. Therefore, the weights attributed to the goals directly effect the final solution.

CONCLUSION

Supplier selection problems include the processes of determining the amount of materials to be supplied from present suppliers or the selection of suppliers among many. When determining the amounts to be supplied from present providers, there are goals to be considered which are defined at the purchasing process. The most significant instance is how to define the criteria that make up the goals. It is because the purchasing process starts based on them. Therefore, different criteria for one problem would provide different results. Similarly, different methods in determining the amounts to be supplied from suppliers would also present different results. It is actually the selection of both the criteria and the method that effect the purchasing process. Additionally, the relative weights of the goals which are created after the selection of criteria directly influence the solution. This study assumes that the relative weights of the goal functions in the present problem are equal and conveys the solution for three scenarios. Then different weights were attributed to the goal functions, and the results were defined.

Table 9. Solutions based on new weights

Senaryolar	Objective Functions	S-1	S-2	S-2	S-4	S-5	Objective Function Value	*d*	Budget ($)
Senaryo-1	TC (%)	200	270	269	235	226	1117,89	0.008828	265995
	Q (%)						1137,99		
	S(%)						1072,93		
Senaryo-2	TC (%)	200	220	262	343	175	1122.87	0.012774	267735
	Q (%)						1138.81		
	S(%)						1074.95		
Senaryo-3	TC (%)	0	999	0	0	201	1080	0.052632	260985
	Q (%)						1143.96		
	S(%)						1096.08		

De Novo hypothesis may improve the goals with the utilization of a smaller budget as it redefines the resource amounts. It may additionally guide decision makers towards the variables that would contribute most to the decision or lower the costs. Therefore, De Novo based solutions define degenerate solutions. This study determines the amount of materials to be supplied according to the firm's capacity constraint in Scenario-3, which provided the degenerate solution. This type of solution means that, if the purchases go through two of the present suppliers, it would use a smaller budget and provide from the suppliers which would contribute most to the goals. Additionally, "compromise optimal system design" determines the best supplier among present suppliers. Therefore, supplier selection may be done using "compromise optimal system design", or the suppliers which do not contribute to the goals may be eliminated from the Sustainable Supply Chain.

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Chapter 17
Lean Logistics in the 2020s and a Cast Study About Logistics and Supply Chain Management in Toyota Boshoku Turkey

Ibrahim Cil
https://orcid.org/0000-0002-1290-3704
Sakarya University, Turkey

Halil Ibrahim Demir
https://orcid.org/0000-0003-1949-9676
Sakarya University, Turkey

Berfin Yaman
Sakarya University, Turkey

ABSTRACT

Logistics, getting the right product in the right place at the right time to the right customer, is one of the most important functions in large companies. Toyota is one of the world's leading companies in many aspects of successful business practice, particularly in logistics. The techniques developed in the company since the 1950s provide a competitive advantage to Toyota and provide efficiency in many business functions with supply chain management. For that reason, it is imperative to understand how lean logistics practices are applied in the Toyota Boshoku Turkey(TBT). This chapter examines practical logistics applications in TBT, one of the suppliers of Toyota located outside of Japan. In addition to theoretical research, it is also important that practical applications in enterprises such as a Toyota plant contribute to the literature. Consequently, as a case study, discussion and explanation of logistics and supply chains of TBT will spark reader interest.

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INTRODUCTION

Lean Logistics is the logistics dimension of lean production that is a management philosophy that aims to meet customer expectations by eliminating wastes in the production flow (Bhasin and Burcher, 2006). Logistics, on the other hand, is part of the supply chain responsible for the planning, implementation and control of the transport and storage of goods, services and related information (Bowersox, 1997). Mentzer et al. (2001) point out that the idea of SCM arises from the concept of logistics. Supply Chain Management is a set of processes to integrate suppliers, manufacturers, and final consumers to ensure that the products are produced at the right quantities, to the right locations and at the right time in order to satisfy requirements (Simschi-Levi, Kaminsky, & Simschi-Levi, 2003).

Lean Logistics (LL) takes its basic philosophy from Toyota Production System (TPS) and is based on expanded TPS throughout its supply chains, from customers to raw materials purchase (Daniel et al, 1997). It has been developed to overcome some fragmentation problems of traditional functional and business thinking. The concept of the LL has become an indispensable element for enterprises with the adoption of the Lean Manufacturing (LM) philosophy that has emerged years ago and is constantly developing (Jones, et al. 1997; Baudin, 2005; Elfving et al. 2010; Cooper, 2017). The most important point emphasized in the implementation of the LL is the distribution and the collection activities of materials, parts, and products (Zylstra, 2012). The collection of raw materials from suppliers is an important step for the producers as well as the distribution of the final products to the customers, which cause an important cost in supply chain management (SCM). The most important decision in Logistics Management (LM) is the correct selection of the methods to be used in distribution and collection activities. After the development of lean thinking in Toyota, it became popular in companies of various types and sizes, including service companies (Battini et al. 2013, Vlachos, 2015, Gollan et al. 2014). There are many studies in the literature on the LL applications for the automobile industry (Womack and Jones, 1996; Takita, et al. 2018). In this study, the information obtained from the observations made about the Toyota Boshoku Turkey (TBT), which is the supplier of Toyota Motor Manufacturing Turkey (TMMT) from the same family, about the activities of the SCM and the LL concept and the basics of these studies are given. This study has a guiding feature for examining the existing systems and for future studies.

TMMT is one of Toyota's vehicle production bases in Europe in which located in Sakarya – Turkey. The Corolla and C-HR models are produced in TMMT and majority of the production is exported to around 100 countries. Today, with an increased annual production capacity of 280,000 units, TMMT is one of the ten biggest overseas manufacturing operations of Toyota, and one of the biggest manufacturing companies of Turkey (www.toyotatr.com). The TBT is one of the main suppliers of the TMMT from the same family and manufactures seat set, door trim, instrument panel garnish and air cleaner. The annual production capacity of over 280000 vehicle sets, the TBT's exports reaches as far as the whole of Europe and Africa. The TBT also has many suppliers, such as TMMT and provide the parts needed for production of these suppliers. In addition to theoretical research, it is also important to investigate practical applications in terms of contributing to the literature (Khanna & Shankar, 2008; Khan et al. 2016; Rashid et al. 2016; Khan et al. 2019). For that reason, it is very imperative to understand how the LL practices currently applied to TBT, which is outside of Japan. At the same time, the LL practices that support the main idea of green SC increase sosyo - environmental sustainability. Consequently, as a case study, discussion and explanation of logistics and the SC of the TBT will increase the interest of the reader on the issue.

The chapter is organized as follows; Firstly, information about the methodology is presented. Then, brief explanations about emergence and characteristics of the LM, supply chain and logistics management, the LL are presented. Finally, as a case study, the logistics and supply chain applications of Toyota Boshoku Turkey was presented and explained in detail.

METHODOLOGY

The methodology used in this study based on a case study. The LL and the SC activities currently being carried out at TBT factory are explained, which is one of the main suppliers of TMMT that was established in the early nineties. It is one of Toyota largest manufacturing plants in Europe. Before continuing the study, it is important to understand how the LL and the SC work effectively in the TBT and the conceptual references described in this study. Nowadays, the SC is facing new challenges of globalization. The aim of this study is to present the case study of successful applications to contribute to this area. A goal of the study is to provide a research direction for many companies will be an example to them.

Toyota Motor Corporation is currently one of the world's leading companies in many aspects of successful business practice, particularly in the SCM. The principles and methods developed in the company since the 1950s provide a competitive advantage for Toyota and provide efficiency in many business functions with the SCM. Other companies who want to increase their productivity and apply them to their own businesses provide significant gains for these companies. Therefore, other companies may adopt some of the methods and principles implemented by Toyota with some adjustments.

SUPPLY CHAIN AND LOGISTICS MANAGEMENT

Strong competition in today's global markets, introducing a short product life cycle, rising customer expectations, forces businesses to concentrate and make new investments in the SC. This, together with evolving communication and transport technologies (mobile communication, immediate delivery), has led to a continuous evolution of the SC and the development of techniques to manage the SC (Paul et al., 2008; Simchi-Levi et al., 2000). The SC is the entire set of steps or elements that make up the value needed to fulfill demands for a product or service. The SC includes all direct and indirect phases of meeting customer requirements. At the same time, carriers, warehouses, retailers and customers are part of the SC. Within a manufacturer and all such organizations, the SC includes all the functions in responding to customer demand. These functions are; new product development, marketing, operations, distribution, finance and customer service (Chopra and Meindl, 2001). The various phases of a typical SC are shown in Figure 1.

In fact, all elements from the production process to the consumption process can participate in the structure of the SC.

The high level of marketing customer service coincides with maximum sales objectives, production and distribution goals. Much production processes; designed to maximize output and reduce costs, regardless of their impact on inventory levels and deployment opportunities. Purchasing contracts are negotiated with little information beyond the old ones. Because of these factors, there is no single, integrated plan for the enterprise. There is a need for a mechanism for integrating these different functions. The SCM is a strategy for achieving such integration (Yao, 2008, Roder and Tibken, 2005). The SCM is typically observed to be among fully integrated firms where a single firm as a whole owns the material flow and where each channel member operates independently.

There are three types of flows in a business environment. These are:

- The flow of the product from acquisition to consumption
- Information flow from vendors to the business environment and from there to customers

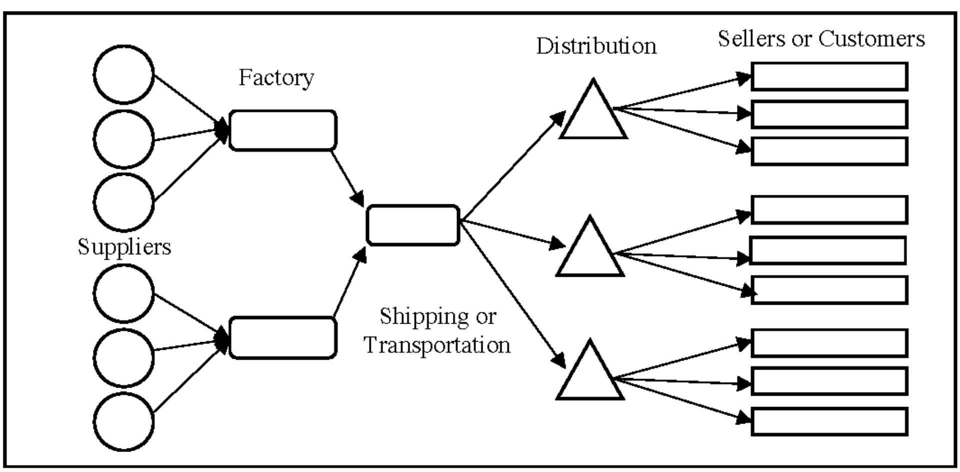
Figure 1. Supply chain phases

- Purchase etc. is the financial flow from the customers to the business environment.

All of these stages are in the SC structure. The structure of an SC is i) Suppliers (sub-industry, subcontractor, main industry manufacturing workshops, ii) Main industry (producing the final product) and iii) Distributors (general distributors, wholesalers, resellers) and iv) Customer (Last user)

As can be seen in Figure 2, the SC resembles the network rather than the chain structure. Because there are no rings connected to each other in the chain. For example, the manufacturer obtains its raw material from different suppliers. Similarly, the same manufacturer can market their products using different distributors, and these distributors can also deliver the final products to multiple retailers. The first step for effective SC is the integration of information. The close link between decision-making and execution mechanisms is indispensable for an effective SC. The information and communication technologies that are developing today enable the flow of information among the members in the SC. Enterprises that strengthen their SC with new technologies will be ahead of the competition. As a result, this standard covers all information technologies used in the SC, supply design, product planning, production planning, material management, order fulfillment, inventory management, and transportation, storage and customer service. The SC is a network of tools and distribution options that fulfill the functions of supplying materials, converting these materials to intermediate and finished products, and distributing

Figure 2. Supply chain elements



finished products to customers, including the three flow types mentioned above. Although the complexity varies depending on the area of the SC, it is found in both service and production enterprises.

Supply Chain Management

SCM can be defined as the activities that involve the production and assembly, storage, stock control, order management, distribution and delivery of the product to the end customer, starting from the procurement of raw materials and the information systems necessary for monitoring all these activities (Lummus and Vokurka, 1999; Basu, 2011). It can be expressed as the ability of companies to work with their suppliers to provide high quality materials and components at competitive prices (Simchi-Levi et al, 2000; So and Sun, 2010; Cil et al. 2016). The SCM uses advanced technology, advanced programs, operations research, information management, relational databases and similar technical tools to plan and control the expanding factors component to produce and deliver products and services for the satisfaction of the customer. The SCM's functions can be operated on three levels: strategic level, tactical level and operational level. Each level is distinguished by a period for decisions and the frequency of decisions taken during that period (Nordin, 2003). At the strategic and tactical level where production will be allocated? and what will be the best sourcing strategy? forecasting, planning, ordering of materials with short lead times and whether overtime will be scheduled to meet production needs or not will be answered. At the operational level; inventory distribution, detailed scheduling, and what to place as an order? when a machine breaks down? will be determined. The SCM also requires coordination with customers and suppliers. There is a need for systems that respond quickly to market dynamics while minimizing lead times and inventory. Critical criteria of success in the SCM take into account of the right product, the right amount, right time, the right place, high flexibility, minimum total cost, minimum cycle time, minimum total stock level.

Logistics Management

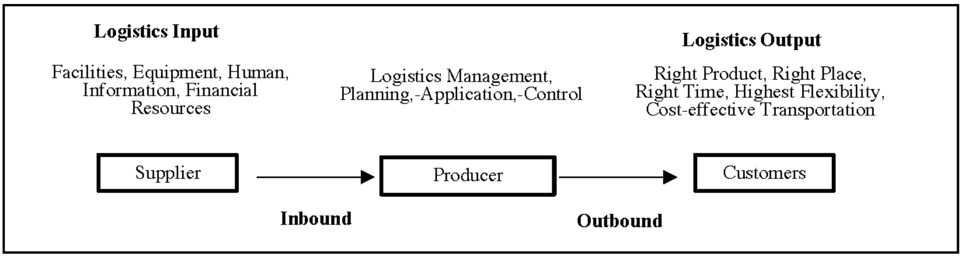
Logistics is considered to be the strategic management of the procurement, shipment and storage processes of raw materials, semi-finished and finished products and related information flows both within the enterprise and throughout the distribution channel and to ensure current and future profit maximization through cost effective order fulfillment methods (Christopher, 1998). Logistics is inherent in forecasting, planning, organizing, coordinating and controlling. The aim of logistics is to make the organization resilient to vital market variables such as quality, price, time and service in order for the company to survive. The reasons why logistic function gains importance in business management day by day can be explained as follows:

- Increased transportation distances and costs,
- As the production technologies reach the saturation point in many areas, managers turn to the logistics area to reduce the costs,
- JIT, material requirement planning, kanban etc. widespread use of systems,
- The increase in the variety of products with consumer demands,
- Extension of computer usage and development of communication systems,
- Processing of materials used for environmental protection for re-use,
- The proliferation of large international production and sales companies.
- Taking into account the function areas and support areas of logistics enterprises, they can be classified as follows:
  - Supply logistics (at the inter-firm and / or super-firm level),
  - Production logistics (within the enterprise, at the inter-firm level),
  - Distribution (product and spare parts) logistics (direct, inter-enterprise level and / or e-commerce),
  - Information logistics (in-house, in-enterprise, on-enterprise),
  - Industrial waste logistics (Logistic Reverse Logistics at inter-firm or super-firm levels).

In course of time, logistic management has been given various names due to changing needs and developments in this field, which are physical distribution, distribution, distribution engineering, trade logistics, marketing logistics, distribution logistics, material management, material logistics management, logistics, fast-response systems, supply and chain management, industrial logistics (Mears-Young & Jackson,1997). As can be understood from this definition, logistics is primarily a management process aimed at meeting customer requirements. According to the above definition, all goods, services and information flow activities from supplier to manufacturer or from manufacturer to end user. In this context, the logistics activities from the supplier to the manufacturer can be examined under the name of Supply Logistics, the logistics activities within the production are Production Logistics and the logistics activities from the manufacturer to the end user can be examined under the name of Distribution Logistics. Accordingly, the steps of a logistics system are shown in Figure 3.

Today, all the markets come together to form a single global market, and so the number of competitors of each business gradually increases, alarmed managers who can see the facts (Rashid et al. 2016). Realizing the importance of competitive advantage in such an environment, business executives have the chance to save the future of their businesses with appropriate behavior and decisions. Today, the fact

Figure 3. Stages of logistics management

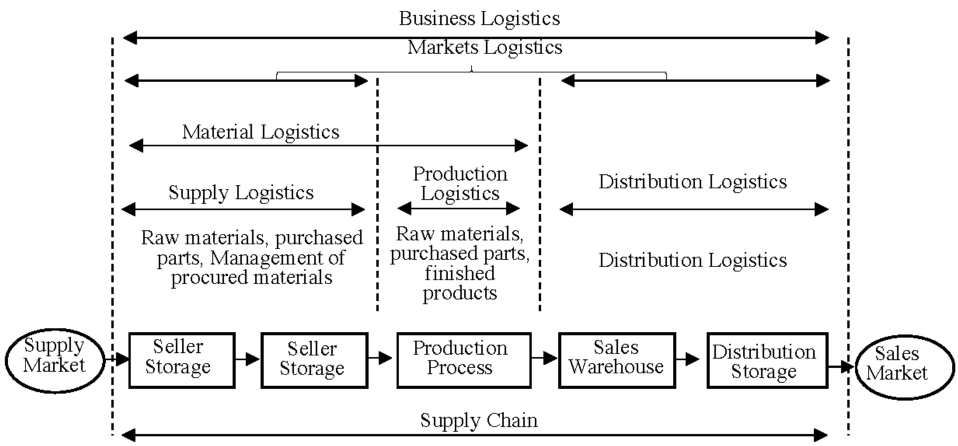


that "A good product sells itself" has competitive advantages in terms of saving the future of that product is considered. Successful enterprises often have either an efficiency advantage or a value advantage. Sometimes both of them coexist. While the efficiency advantage brings a low-cost profile to the enterprise, the value advantage provides various competitive advantages related to the product as well as price. Productivity advantage is the result of low costs or successful efforts to reduce costs. Reducing costs depends in part on a larger sales volume. The size of the sales volume depends entirely on the size of the competitors' sales volumes and their production costs. Within the scope of logistics management, there are many ways to increase efficiency and to reduce unit costs. For this purpose, it is easier to provide efficiency advantage in logistics management. In addition, in order to gain value advantage, the product or service with the business output must have a position superior to that of other competitors. In practice, an enterprise must have both of the described value and efficiency advantages, or it must be in a position that includes at least both advantages. In the case of a company's competitive advantage, it is possible to examine its current position with a simple matrix.

Logistics and Supply Chain Relation

Logistics is a part of the SC process that plans, implements and controls the efficient and efficient flow and storage of goods, services and related information from the starting point to the point of consumption to meet customer needs. The SC approach can be expressed as an approach that handles the event from a wider perspective, as the LM approach that tries to organize the logistics activities in the company and its immediate environment is expanded throughout the distribution channel including the customers and suppliers. Since it is based on logistics, the activities it deals with are logistics activities. Figure 4 shows a categorized version of the logistics activities carried out on the SC.

Figure 4. Logistics activities in supply chains



Logistics solutions should be solutions that rationally combine the experience and capabilities of key members of the SC. The SC members are the core competency and the logistics system should combine these competencies into a channel arrangement. Structure of the distribution channel; it should be in the form of an integrated chain engaged in a coordinated effort, as opposed to the traditional approach as a group of loosely connected independent firms. Within the SC, effective time-based LM is a strategy that facilitates competitiveness.

CHARACTERISTICS OF LEAN LOGISTICS AND LEAN MANUFACTURING

Lean Manufacturing

Lean manufacturing was called "Toyota Production System" until the 1980s, is a philosophy of Japanese business organization that emerged in Toyota Motor Company. In the period when the LM spread to the whole world as an alternative production philosophy, it was defined with similar features but different expressions in various countries and enterprises. Krafcick developed this concept in order to express the essence of the new production organization created at Toyota Motor Plant. The reason Krafcick uses the term lean manufacturing is that the new system demands everything less than Fordism production. (Holweg, 2007). Lean manufacturing is considered to be one of the most basic works of the "Changing the World" in the production history; it is defined as the production system which does not carry any unnecessary elements in its structure and minimizes the elements such as error, cost, stock, labor, development process, production area, waste, and customer dissatisfaction. (Womack, et al. 1990).

The fact that Henry Ford activated automobile production in the early 1900s and that the automotive sector was accepted as the industry of industries attracted all the attention to this field. Toyota Motor Company, which had to produce vehicles for military purposes during the Second World War, wanted to activate automobile production within its own structure after the war and started to work in this direction under the leadership of Eiji Toyoda and Taiichi Ohno. Eiji Toyoda first examined the Ford Automobile Factory in the USA to obtain Toyota's production level to compete with rival companies and gained detailed information on automotive production in assembly lines, also called Detroit Style Automation, which is far from flexible. As a result of his observations he ended up witfh the following observations (Paladugu and Grau, 2019);

- With the use of both production tools and labor force in only one job, the system wastes production factors,
- The machines are only suitable for large batch production due to the very long setup time,
- Inventory costs are observed,
- Quality, scrap and reprocessing problems in production due to push system,
- Due to the strict hierarchy stemming from the Taylorism approach, employees were only evaluated in line with the economic human approach.

After deciding that the huge waste generated by the observations would not fit Japan's economic conditions and scarce resource structure, Toyota entered into a search for a new production system. The main features of the LM put forward by Ohno that can be listed as follows:

- Demands less than all production factors to eliminate waste at each stage.
- In order to ensure just-in-time production, it envisages non-stock production based on the drawing system.
- Relations with suppliers are among the most important building blocks of the system.
- Based on internal and external customer expectations.
- Production and product flexibility.
- It aims to continuously develop and produce quality in all processes.

The key word for the LM is muda that means waste. Muda, in particular, shows activities that have no added value, but also consume resources. Lean transformation shows the ways of defining the value, ordering the steps that create value in the best and correct way, taking these steps without interruption and performing them with higher efficiency. Taiichi Ohno lists waste causing activities such as defective products that require reprocessing, production produced without demand and consequently accumulated in inventories, process stages that are not really necessary and moving products and employees from one location to another, although not compulsory (Kiran, 2017).

Lean manufacturing is a set of techniques that consist of constantly developed applications in the Toyota plant and other LM environments (Melton, 2005; Monden, 1984; Womack and Jones, 1996). These standardized methods will be briefly described below:

Kanban: It is a tensile-based production system. It is the name given to the cards and this system for production planning and supply of raw materials based on customer orders. The aim is to keep the in-stock and warehouse stock levels at zero level and to ensure that the required raw material or material is in place at the right time. For example, the card flow starting from the automobile dealer flows to the main industry; the cards of the raw materials needed there flow to the sub-industry and then to the suppliers of the sub-industries, and then the raw materials or materials produced then reach the exit point of the card with the cards.

One-Piece Flow: In any workshop, all the machines required for a piece to take its final shape are placed based on the workflow of the part.

U-Type Layout Plan: Eliminating unnecessary labor movements. Loading and unloading parts to machines are automated as much as possible, enabling one worker to operate more than one machine. For this purpose, the machines must be placed in a U-shape (Cil, 2004).

Autonomy: Provide machines and operators with the ability to detect when an abnormal condition occurs and stop the job immediately. In case of a problem during production, stop the system and give the workers the authority to decide to intervene immediately. It was put forward to quickly identify the source of the problem and solve it immediately.

Just in Time (JIT): The product requested by the customer is to produce at the requested amount and to deliver at the requested time. With outlines, it is aimed to supply the required materials from the supplier industry in a timely manner, to supply the required quantity, to produce in a timely manner and to reach the customer in a timely manner. Since JIT uses a pull system instead of a push system, it greatly reduces inventory problems (Womack and Jones 1996).

Poke-Yoke: The elimination of errors that may occur due to forgetfulness, carelessness and misunderstanding. Equipment and auxiliary elements such as warning boards, templates, guides, counters and sensors are used for this purpose. What is essential is the elimination of human error. When operators choose the wrong part in doing their job, forget to install a part or reverse it, etc. then these methods help them to avoid mistakes. For example; product design in physical forms that makes it impossible to insert parts in any direction other than the correct direction (Pekin & Çil 2015).

One-Piece Flow: One-piece flow is a technique. In any workshop, all the machines required to take the final shape of a part are placed on the basis of the workflow of the part. This ensures material flow without waste of time and long transport times. The aim of this technique is to make a single part smoothly at any time of production and to achieve this without unplanned interruptions and long waiting times.

Balanced production (Heijunka): Leveling the production type and quantity in a fixed period. Balanced production eliminates batch production and enables production to meet customer demands efficiently. As a result, inventories, investment costs, labor and production flow times throughout the entire value stream are minimized (Duman et al, 2018).

Total Job Control: This is one of the most efficient systems developed for zeroing or keeping stock as small as possible. By synchronizing the machines on the line, it is ensured that all machines process the same amount of parts within the same time duration. For example, as the next machine in the line pulls parts from the previous high-capacity machine, and finally the parts are completely pulled out, a limit switch on the high-capacity machine automatically starts the machine so that the machine operates during the day-to-day standstill and adapts to low-capacity machines. Synchronizing high capacity machines to low capacity machines or bringing machine capacities closer to each other is called total job control.

Work Rotation (Shojinka): Flexible line of labor. It is sometimes called "labor linearity to indicate the ability of the assembly line to stabilize, even in fluctuations in production volume.

Continuous Improvement (Kaizen): Improving a flow of value or a single process to create more value with minimal waste. The most important feature of Kaizen applications is that all employees in the organization respect the creative potential. In this case, it creates a democratic and participatory environment.

5S: five interrelated terms starting with the letter S that describe the LM and visual control, describe workplace practices. Seiri means classification; Seiton means to arrange the rest properly. Seiso means clean. Seiketsu means standardization and shitsuke means providing discipline to achieve the first 4S.

Experimental Design: Main philosophy; "Quality is designed together with the product" is a design that will eliminate the critical problems in production. The previous design validation results are taken as data and design is made to prevent problems that may occur during production in later designs.

Total Productive Maintenance: It covers all the works such as failure maintenance, preventive/preventive maintenance and efficient maintenance of the machinery and equipment in the company to increase the efficiency and eliminate the machine stops. The main purpose; to extend the life of machinery and equipment and to eliminate labor, material and time wastes caused by failures. The main thing is to inform the operator. The concept, which aims to increase the efficiency of the factory by improving my machine understanding in the employees.

Mold Changing in One Minute (SMED): Minimizing mold changing times to the lowest possible level to work with just in time production and kanban systems. It is based on the goal of reducing model change times to single digits or to less than 10 minutes.

3M (Muda, Mura, and Muri): Three terms that refer to waste-containing practices that need to be eliminated. In its simplest terms; if five people are enough to do a job and six people do it, there is muda. If work is done with four people, there is an excessive workload; in this case, there is muri. Mura is an irregular workload. Describes the situation in which the previous two situations are mixed.

Lean Logistics

Baudin (2005) defines the LL as a convenient way of eliminating waste and supplying the required material in the required amount and in the required amount. The LL involves developing a long-term strategy for the supply chain, which includes market research and development of suppliers. Lean Logistics emphasizes the ability to design and manage systems to control the movement and positioning of raw materials at the lowest cost by eliminating waste during entry and finished stocks (Jim Wu, 2002). The LL is an advanced competence used to create and manage systems designed to control the physical placement and movement of raw metals, in-process stocks and finished products at the desired service level and at the lowest cost (Sheu et al. 2006; Myerson, 2012). In today's conditions, it is not enough to produce the highest quality goods at the cheapest price, at the same time, the end user needs to be reached in a timely manner and market share must be increased, all of which is achieved through efficient logistics management. In today's highly competitive environment, efficient logistics activities are not an optional phenomenon but a necessity (Ugarte et al. 2016; Cil et al, 2016). The main elements underlying the concept of the LL are:

- Elimination of wastes,
- Simultaneous flow with suppliers,
- Defining the value flow across the supplier network,
- Minimizing production and business (supplier selection, ordering, etc.) costs,

- Ensuring transparency,
- Establishing a mutual cooperation structure,
- Improving the ability to respond quickly,
- Managing uncertainty and risk,
- Establishing strategic partnerships between the core and complementary companies,
- Increasing creativity and knowledge sharing.

According to Toyota manager Ohno, value and price should not be confused. When a customer buys a product, it does so because that product has value for itself (Ohno, 1988). When the costs increase, increasing the price of the product is easy and it should not be done. If a firm keeps its value constant while increasing its price, it means that the firm will lose its customers in a short time. From this point of view, it is very important to reduce costs in today's conditions where it is almost impossible to realize price increases. In addition to production costs, it is also necessary to reduce waste in SC. Better, faster and unique response to customer needs should be ensured. The purpose of the new model; to ask questions first, and then to respond to tailored objectives, to allow customer demands to withdraw material and finished product from the system. The most effective way to fulfill customer demands is to communicate and share information. Compliant companies will use the LL, instead of pushing products into the SC in bulk, using information technologies to pull them out of the system (Mariotti, 1997).

The goal in lean thinking is to produce only the products that the customer wants (in terms of function, quality and price), at the time the customer wants (when it is placed on the market, delivery time, frequency of shipment), with less resources (labor, equipment, time, space, etc.) and constitutes a value for the customer. The LL is based on a detailed understanding of wastes and ineffective flows within the system. After detecting such flows, radical or remedial studies will serve the LL. The framework for doing this is called Value Flow Mapping only. (Jones et al. 1997). The LL, based on the logic of lean thinking, aims to eliminate wastes and inefficiencies in logistics activities (Table 1).

The LL has a significant impact on the supply chain. The SC that has three parts which are procurement, production and distribution components have been independently managed for many years. The logistics chain management in question has now changed; in particular, manufacturers focus overall chain rather than focusing on a part of the SC and improving its performance. To see where the value stream starts and ends, the part with the longest flow time processed can go back to the raw material. On the other hand, every business should know that the customer's purchase of the product does not end the flow of value. The SC is quite long, even if it is counted backwards only from the point of purchase. The best model and

Table 1. The measurable results of lean logistics

Increase	Decrease
Use of Equipment’s	Box Volume
Field Efficiency	Total Logistics Costs
Effectiveness of the SC	Stand by Time
Shipping Frequency	Material Transportation
Quality	Processing Time
Loading Speed	Cycle Time
Accuracy	Stock Space Requirement
Standardization	Vehicle Traffic

still the most influential SC in the world is Toyota’s aftermarket parts distribution system, also described in Lean Thought (Nemotoa et al., 2010). This system still sets the global standard on how to operate a lean supply system through milk run, mixed-load deliveries that select lean distribution centers, products, and cross-fields (Cil and Turkan, 2013).

Relations with Suppliers in the LL differs from traditional logistics systems. It is based on a long-term mutually win-win relationship with fewer suppliers. One task of the main industrial organizations is to provide comprehensive training opportunities to their suppliers on the LL applications and to provide consultancy services to their suppliers during the implementation. Japanese companies have achieved their invincible position thanks to their approach to the side industries with great seriousness and responsibility (Jones et al., 1997). As a requirement of the concept of the LL, considerations for establishing a synchronized structure with suppliers:

- Delivery times and delivery plans combined with suppliers,
- Transferring the product from the suppliers only as a result of the manufacturer’s withdrawal,
- Reducing stocks due to tightness of supply network,
- The supplier brings the necessary material to the desired place at the exact time,
- Minimize the access control of the product,
- Establishing a bilateral communication channel with the supplier regarding product schedules and production,
- Striving for zero quality defect,
- Increasing efficiency and profitability throughout the supply network.

Lean Logistics Techniques

Third Party Logistics (3PL)

Why the third party logistics is defined as third can be understood by explaining the first and second party logistics. The fourth party logistics emerged later.

- First-party logistics: manufacturer, wholesaler, retailer or shipper,
- Second party logistics: direct customer of the first party,
- Third party logistics: Logistics agents; service provider, carrier, warehouse operator,
- Fourth party logistics: A logistics product is an entity that coordinates and integrates information flow processes.

The international competitive environment forces businesses to transfer activities outside their areas of expertise to professional companies that are experts in their fields. Logistics companies experienced in their fields have great responsibilities in structuring this series of activities in a fast and economical manner without disruption. Within this understanding, which is called Third Party Logistics, the transportation of raw materials from the emergence to the factory, the internal processes and the timely delivery of the completed final products to the consumption centers and buyers require a certain level of knowledge, experience and management skills.

Third-party logistics companies are in the process of material supply from the sub-industry to the business, i.e., in the physical procurement phase; it has the ability to provide services in three areas: production processes, i.e. internal processes and material flow activities ranging from business to buyers. Many manufacturers outsource some or all of their SCM functions.

The reasons why manufacturers cooperate with 3PL service providers can be listed as follows:

- Reducing logistics costs
- Optimizing logistics capabilities
- Provide expertise and resources for unavailable skills
- Focusing on the company's core business
- Avoid employee problems and improve customer service
- Improving core competencies for better service to customers
- Improve operations
- Avoiding capital binding
- Avoidance of control, correction and new instruction costs

- Gain flexibility in the market and agility against the changing expectations of the market
- Meet demand fluctuations
- Not having sufficient information and communication technology.
- To be more flexible against customer demands and to have the capacity to meet these expectations in order to increase customer satisfaction
- Providing strategic solutions and obtaining strategic partners in addition to the advantages in operational activities

Fourth Party Logistics (4PL)

In the 4PL approach, the knowledge, experience and technology of the external expert company are also taken and the business processes are redesigned and developed. With the understanding of providing logistic services, companies provide solutions to each customer's specific problems that concern them only. 4PL companies carry out the SC activities of different customers. The most successful 3PL companies that will optimize the logistics activities are selected and 4PL coordinates them. Information technology plays an important role in coordination. The need for 4PL businesses is increasing with the development of logistics and becoming important for companies. The biggest mistakes of 3PLs are that they act only for cost reduction, do not try to create value for the customer, and do not emphasize continuous development and restructuring. Considering the Fourth Party Logistics and the SCM activities as a whole, improvements in both cost and quality will be achieved. 4th party logistics companies can offer various services. These services are:

- To provide integrated logistics services such as distribution and storage as well as transportation services
- Combining the changes in logistics with the developments in organizational issues
- To learn the business of the companies they work for in a short time and to produce better solutions for their customers
- To create a successful SC with strong technological infrastructure

Direct Shipments

Large retailers ask suppliers to send products directly to warehouses instead of sending them to the distribution center and storing them there. This eliminates steps that add time and cost to the product, but do not add value. This also means fewer trucks on the roads and lower transport costs (Wall, 2003). In the direct transport option, all transports are transported directly from suppliers to manufacturers or from manufacturers to retailers without having to visit any center. In the direct transport network, the routing of each transport is carried out in a manner specific to that transport. Advantages of the direct transport system; eliminating warehouses, providing ease of operation and coordination. The direct transport network should be implemented if retailers are sufficiently large and the optimal retransmission sizes from each supplier to each vendor are close to full shipment.

Milk-Run System (Cyclic Motion)

Milk-run is an English term, meaning for cars that collect milk from farms for dairy farms. A car that roams the farms on a daily basis collects fresh milk from the producers (Gyulai et al. 2013). In the system, producers must raise the milk to the car in time, otherwise they will not be able to sell the milk; it will have to send it on its own or it will be in danger of milk spoilage.

For daily or hourly deliveries, automobile manufacturers are willing to travel around the manufacturers with their own organized trucks, picking up the required amount of material according to the desired frequency and raising it to production (Nemoto et al. 2010). For this reason, in the number of daily truck requirements calculated according to volume, the truck traveling on a certain route at a time receives the required material from each manufacturer. In the automotive industry, this type of truck transport is called milk-run.

Continuous shipment is to collect parts with the minimum number of vehicles in certain routes and queues from the supplier groups that are divided into regions before, instead of collecting the necessary parts by sending vehicles separately to the suppliers. In this system, the need for internal stock space is considerably reduced. Coordinating shipments to a group of customers with the same truck is a good practice if you have your own trucks. Continuous shipment can be daily or weekly, depending on the business model and customers' geographic location. The tools needed to determine the optimal continuous shipment route, a map and a list of customers and orders according to the shipping times (Iyer et al. 2009).

Cross-Docking System

The cross-docking system is a process used to facilitate the movement of products along the distribution center (Wall, 2003). It enables the product to move without being stocked from the supplier to the buyer. Integrates products that move from one or more points of departure to one or more destinations. Instead of taking the product, putting it in the warehouse, pulling it out of the warehouse, labeling and then sending it, the cross-shipment, as the name suggests, pulls a pallet or container from one truck or reloads it or moves it directly to another truck in the dock. This reduces time and eliminates many non-value-adding steps. Having advanced information about what is coming from advanced shipping information to distribution centers and pre-labeling cartons or pallets by suppliers are effective ways to enable cross-shipping.

Cross-Shipment Integration With Cyclic Cycle

Milk-run systems combine small loads to reduce output transport from DCs. Combining cross-docking and milk-run systems in this way lowers the cost of transport as well as loads with small amounts of filling, and goes economically to retailers or manufacturers.

Specialized Transport Networks

A specialized transport network consists of a combination of the options described in the preceding sections. In this way, costs can be reduced to the desired levels and the sensitivity of the SC can be increased. Here, a combination of transport, cross-docking, milk-run, TL and LTL carriers and package carriers is used to make the appropriate option available in each case. With large volume products, direct transport to high volume sales locations; low volume products or shipments are made by joining DCs to relatively smaller marketplaces. Since different shipping procedures are required for each product and each retailer, managing this transport network is a challenging process. Managing and coordinating a specialized transport network requires significant investment in information technology infrastructure (Chopra and Meindl, 2001).

LOGISTICS AND SUPPLY CHAINS OF TOYOTA BOSHOKU TURKEY

This article has investigated Japanese investments in Turkey. It deals with the case study of how LM between the TMMT and the TBT works according to lean logistic rules. The study explores how automotive parts could be procured effectively from suppliers under the conditions of Turkey's logistics infrastructure. TMMT is one of Toyota's vehicle production bases in Europe. Located in Sakarya - Turkey, Toyota Turkey manufactures Corolla and Toyota C-HR models. Majority of the production is exported to around 100 countries. Today, with an increased annual production capacity of 280,000 units, TMMT is one of the ten biggest overseas manufacturing operations of Toyota, and one of the biggest manufacturing companies in Turkey. The TBT is TMMT's supplier from the same family and manufactures seat set, door trim, instrument panel garnish and air cleaner. The annual production capacity of over 280 000-vehicle sets, the TBT's exports reach as far as the whole of Europe and Africa. The TBT also has many suppliers, and they provide the parts needed for production of the TBT. The TMMT is the largest automotive company in the world according to 2016 data, with a wide range of models manufacturing in changing areas. Toyota, the world's second largest automobile company, recently passed Ford and was the world's largest automobile manufacturer in 2007. However, it is thought that it will depose General Motors in a major economic crisis. According to world sales figures in the first quarter of 2007, it surpassed General Motors and became the best-selling automobile brand. As of 2008, it is the world's largest automobile manufacturer. General Motors, who has held this title for 77 years, succeeded in gaining this title. Global Toyota sales have evolved over the years. Since its inception in 1937, Toyota's product range has expanded to include the world's first mass-produced hybrid vehicle Prius and the first hydrogen-ready vehicle Toyota FCHV has become a legend in its class thanks to its land capability and quality. Furthermore, the Corolla model is the world's best-selling model since 1966, with close to 42 million sales. The SCM of Toyota is part of a company's operational strategy that is entirely based on the TPS and was developed in the 1940s by Shigeo Shingo and Taiichi Ohno. Liker (2005) lists the following components of the SCM in the Toyota are mutual trust, information sharing, joint improvement activities, learning and kizen.

Toyota Company

The Toyota Company was founded in 1933 by Toyoda Kiichiro, which has achieved great success against its competitors with its high quality and low cost. In 1950, Ohno began to examine and improve Ford's manufacturing process in order to increase Toyota's production capacity, and firstly, JIT developed in the production (Ohno, 1988). Based on the JIT production, Toyota Corporation has developed the Kaizen concept, the Kanban management system and the idea of flexibility. After that, Toyota expanded the internal and external logistics modes of Toyota's supply chain, which forms the "lean supply chain". By helping suppliers eliminate loss of time and cost in the supply chain, Toyota made a wide range of collective customizations and quickly turned customer needs into profit margins in the supply chain. A good supply chain partnership and benefit-sharing mechanism enabled the overall competitive advantage of the supply chain. Toyota SC activity is based on a series of integrated flow activities. It is based on Toyota's supply chain traction system and always aims to reduce flow time. Thus, the pull-type supply chain provides competitive advantage. (Christopher, 1998).

Toyota's supply chain activities include; sales activities, production plans, production instructions and parts procurement activities. Toyota's retail outlets have an extensive sales network spread around the world. Retail stores record detailed information of each vehicle sold to the management system over the network. Toyota automobile sales company collects, compiles and calculates information from all over the world and sends the information related to the production plan to the production facility. The production management departments responsible for production management, planning and logistics purchasing in factories accept the information. The production management department is responsible for preparing a production plan, introducing new vehicles and handling customs. Production planning uses a global production plan system that is linked to the Toyota automobile sale company management system.

Toyota is a modern company and, like any modern company, makes extensive use of information technologies. Computers are used to perform financial transactions, to pay invoices, to track millions of customer orders and tens of millions of service part transactions, to collect data to develop new products, and to plan many jobs. Information technologies are critical to Toyota, but Toyota realizes technology as a means to support people and the process, as in other vehicles

Background of Production Processes and Supply Chains of Toyota Boshoku Turkey

Toyota Boshoku Turkey Co., Ltd. (TBT) is a manufacturer of automobile interior parts such as seat set, inside door panel, dashboard components, and air filters, seat cover, which are shown in Figure 5. The TBT was founded in Sakarya-Turkey in 1997.

It has three factories in Turkey location; one of them produces textile related parts, the second factory produces metal parts and the third factory produces car interior parts and seats. Each factory procures different parts in which each raw materials come from their local and global suppliers after carried out the necessary operations on parts and then the completed products are sent to TMMT. The TBT is one of the 150 largest private industrial companies of Turkey, which has RandD center and production capacity of 280.000 sets per year. It exports to a wide market from Europe to Africa. A brief history of the TBT organizations in Turkey and major milestones listed in Table 2.

In the Toyota logistic system, the Production Control group carries out the monitoring of daily production and the synchronization of thousands of parts. The LL is the main means of doing this. Toyota Turkey 'piece collection method from the supplier "Mixed Transportation" system. There are trailers dedicated to transporting materials from suppliers regularly. Each supplier supplies the ordered parts in small quantities and at exactly the right time. Thus, trailers take full boxes from suppliers

Figure 5. The TBT factory and basic products manufactured in the factory

and leave the empty boxes of the previous shipment to the supplier. Toyota Turkey, Toyota Motor Europe and effective teamwork between business logistics partners are available. The manufactured vehicles are lined up in the finished vehicle waiting area and then loaded onto the trailers. The trailers transport the manufactured vehicles to the port of Derince and transported from these ports to the final shipping point in Europe. This method is the application of the Toyota Production System in Turkey. The main feature of TPS is that the production is carried out according to the “Pull” system from raw material to product stage. As the vehicle moves along the production line, materials and parts are brought to the factory at the right time from the supplier (Monden, 2011).

The TBT adopts the JIT concept with its door, seat, air filter and door front components production and makes direct shipment to TMMT. From the company’s point of view, procurement expenses are among the most important expense items for the vast majority. Inefficiencies and disruptions in the procurement process are also reflected in other areas of the company, such as stock control, transportation planning, and production planning and customer relations. SC procurement of goods and services from the stage production and it covers all the rings to reach the final consumer successive The TBT supply chain in Turkey; sales process, production, inventory management, material supply, distribution, procurement is included in many areas such as. TMMT is almost and single customer of the TBT and all the

Table 2. History of the TBT in Turkey

• January 2019: Mass production started for the new model Corolla.
• January 2018: Production of 2 million vehicles was reached.
• September 2016: Serial production started for the new Toyota C-HR • Air filter production started.
• August 2016: Third shift work order was started.
• February 2014: R and D Center was established.
• September 2013: Mass production for BMW seat cover started.
• June 2012: New Seat Cover factory TB Sewtech Turkey (TBSTR) was established.
• February 2009: New Corolla Verso Mass Production Start
• July 2007: Metal Factory Official Opening Ceremony was held.
• April 2006: 500,000-vehicle sets production was reached. • Construction of Metal Factory has been completed.
• October 2005: The new name of the Company “TOYOTA BOSHOKU TURKEY” has been changed.
• February 2004: Mass production started for the new model Corolla Verso.
• May 2003: The production amount reached 100,000 car sets.
• March 2003: Second shift work order was started.
• October 2002: Sponge production facility construction completed.
• August 2002: Mass production started for the new model Corolla Station Wagon.
• January 2002: Mass production started for the new Corolla Sedan.
• November 2001: Moving to the new factory is complete.
• August 2000: The foundation for the construction of the new factory was laid.
• July 1998: Seat and door interior production started for the new model Corolla.
• January 1998: Seat and door interior production started for Corolla.
• October 1997: The Company was established as TakaNichi Interior Furnishing.

amount of production from the TBT to be sent by Telemail system to the TBT, which is specific information system customer service and sales forecast is removed from the SCM. In the TBT all kinds of products, services, and information flows are effectively to plan, implement, transport, storage and control under retention since the first time it was established. Without a hitch, all materials and information flow systematically and continuously from the starting point of the raw material to the movement of the SC up to the last point where the products are consumed. In order to reduce the total cost, great importance is given to the coordination and cooperation strategies between these elements. The TBT aims to integrate the logistics concept throughout the SC. The SC of the TBT is based on the strategy of winning all the parties in the chain. A pull system is a technique that provides products or services only when the need arises. It is synonymous with just-in-time production philosophy. A process in the value stream pulls from its predecessor. For example, parts from the suppliers will be transferred directly to the shelves in the factory. Going to the stock and then to the production line will increase the labor force of the operator and cause the shelf to remain empty in the production line.

In the event that the SC envisaged works well, it will reduce the risks in the logistics process and increase productivity by adopting a cooperative working approach by requiring the companies in the chain to share information and make joint planning. It will also ensure the elimination of waste and economic use of power. The SC and logistics activities of the TBT is one of the most important parts in the TBT is constantly evolving and changes. The selected product family is the seat part of Toyota cars, which is considered in this case (Figure 7.). For Auris and Verso models, two types of seats are produced. These parts are produced in the TBT factories. Due to the security of company information, some information has been given approximately. Some images of the production processes are given in Figure 7. Production Processes: Production processes for this product family consists of; cutting, sewing, sponge, Auris assembly line and verso assembly line. The parts are then shipped daily to the Toyota Assembly Factory. Raw materials: 7 times a day, 10 sets of pieces are delivered from the TBT Metal Company. Seat and accessory materials from Texia Company are delivered 350 products 3 times a day. Besides 200 products are delivered 3 times a day from Redin Company. The TBT factory operates three shifts per day. A total of 700 sets, 400 Verso and 300 Auris, are sent per day according to the order number. One set includes the seats and doors of the vehicle. Seventy shipments are made to the TMMT factory by truck every day.

The TBT Production Control Department ensures the continuity and flow of information obtained by Assembly Line Control and Telemail system before assembly line to meet the needs of Toyota. It always has the finished product ready to meet the demand in Toyota's assembly plant. It ensures that the materials needed for production from the suppliers are met on time and in full. The internal logistics activities of the TBT and its logistical relationship with TMMT are shown in Figure 6. All "Material and Information Flow" is given above and briefly, explained in the following sections. The delivery of the material and components from the suppliers are carried out by truck.

Key Components of the TBT's Logistics

The following sections describe the key components of the TBT's logistics and supply chain:

Figure 6. Pull system

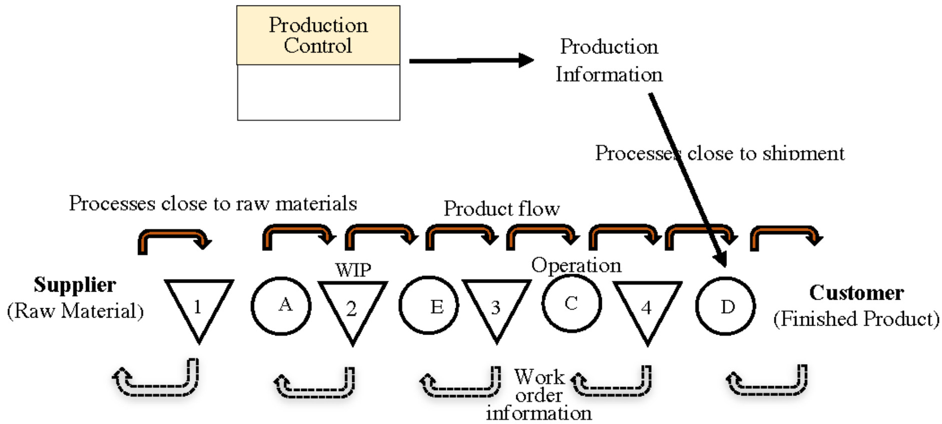


Figure 7. Some production processes in the factory

Supplier Networks

In lean manufacturing, supplier networks are developed together with the main industry and applications are realized by growing together with the main industry. The trust is two-sided in the LM system, making use of it to keep the relationship strong on both sides. It should not be forgotten that without trust, there is no partnership. Sharing trust and information clearly is crucial to success. The amount of shared information indicates the measure of the business relationship between the business and the supplier. When both parties trust each other, they can share their confidential information, invest in understanding each other's business, adapt their information systems to the customer's wishes, or provide the opportunity to serve each other better. In lean manufacturing, parts are delivered to the parent company on time and without control. Suppliers are evaluated regularly and their grades are compared with their competitors. Improvements are generally carried out in areas where problems are found with the support of personnel from the parent company. Suppliers continue to work together as long as they want to improve themselves. Developing a supplier involves a set of challenges that you need to take to meet goals. Suppliers want to do a trade because they know they will improve and develop mutual respect with other suppliers and customers. Being soft and rude without teaching them anything is nothing but disrespect, and changing suppliers is unthinkable just because another supplier cost two points low. It is completely contrary to the spirit of the LM system to succeed in raising business performance by intimidating suppliers. Parts are delivered to the parent company on time and without control in the lean system. Lean companies teach their suppliers the LM principles at every level, and select their suppliers carefully and are cautious about which suppliers they will recruit to their extended family, and how closely these suppliers will intertwine with their partners.

Telemail System

The Telemail system is a high efficiency application based on sequential production and shipment used between TMMT and suppliers. TMMT provides the TBT with estimated daily production quantities annually (Figure 9.). The line stops that may

Figure 8. Lean logistics and supply chain of Toyota Boshoku Turkey

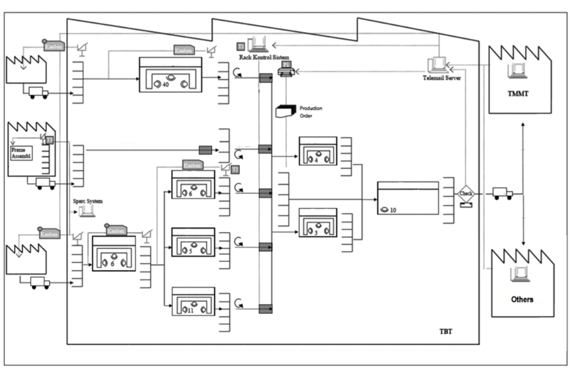
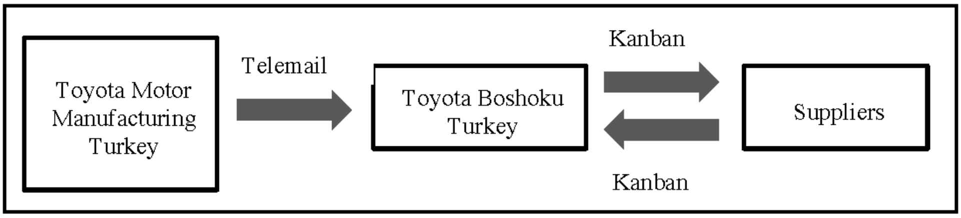


Figure 9. Relations of TMMT and TBT



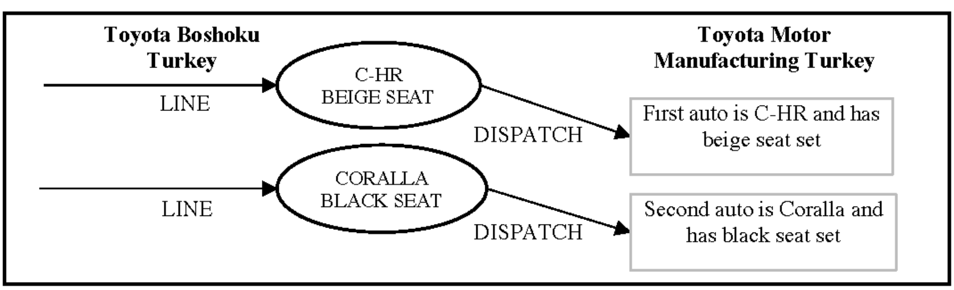
occur in the TBT stop TMMT after 3 hours. TMMT provides this Telemail system with which part and how much to send.

TMMT, which has a large number of suppliers, brings together the parts obtained from its suppliers in the fastest way so that a vehicle leaves the line every 79 seconds. For example, if the first vehicle to be produced in TMMT is determined as C-HR model and beige color, the first seat set produced in the TBT should be C-HR model and beige color. The products coming from the TBT are sent to TMMT in the same order. An example of the operation of the Telemail system between the TBT and TMMT is shown in Figure 10.

Kanban System

Kanban is a subsystem of the TPS, which was created to control stock levels, production and supply of components and raw material (Ohno, 1982). Kanban provides both vertical and horizontal information flow both within the enterprise and between the enterprises. If the LM system is applied correctly, kanban combines and systematizes all movements within the enterprise. Kanban always moves in the opposite direction to the production flow and connect the production steps, moving from end to head with physical units. Working with the Kanban system provides a highly efficient and flexible communication system that covers the production of thousands of parts.

Figure 10. The operation of the Telemail System



When the flow is provided by kanban, no workshop or subsidiary industry need to know in advance which model to produce and which part to produce. According to experts, no matter how advanced a computer system can communicate between production departments with this punctuality and flexibility. Kanban system provides this complex communication network and synchronization between workshops and factory-side industry in an extremely effective way without requiring any investment. One of Kanban's biggest advantages is its visual inspection. Kanban is not just for controlling production levels, at the same time, it keeps the stock levels under control and reveals the production problems and starts the improvement process. When and where wastes occur are determined quickly. Kanban is the Japanese equivalent of the word card or sign. In the Kanban system concrete objects cards contain information about the type of work and the amount of work. It is very important to apply a kanban type application in production management. With the movement of the cards, the information becomes concrete and easily understood (Figure 11).

Kanban system is an information system in JIT to increase the efficiency of the system by controlling the quantity and timing of production at every stage and monitoring of the product flow. Kanban moves in the opposite direction of the production flow and indicates how much of which part to produce. Producing everything, which is one of the basic principles of the LM, when and when necessary,

Figure 11. Kanban system of TBT

does not only mean producing as soon as possible and in the quantity and variety determined by the demand. The same principle applies to a factory's own internal production flow. The aim is to prevent unnecessary production of all production stages or production stations, and to achieve this goal, each production station works on the principle of "just-in-time" to produce the quantity, not more of the parts that the next station can process immediately. The system pioneered by Taiichi Ohno is actually very rational and simple (Ohno, 1988). The system is based entirely on the fact that a worker in the next production stage goes to the previous stage and "pulls the required amount of parts for his production station (Figure 12.). For this reason, it is the signal of start new production for the previous station; on the other hand, it specifies the quantity and diversity of the new production: in the previous stage, only the quantity and variety of the drawn quantity will ve produced.

In the previous production process, the production kanban are collected after a certain number of production has been made in the kanban acceptance box and these cards are left in the production order kanban box. Parts are produced according to the order of production kanban in the box. When the physical production is completed in the previous process, the parts and the production kanban are placed at the stock point. Thus, the carrier of the next production process will be able to pick up the parts at any time. The TBT kanban system is renewed day-by-day developing in Turkey. System, logistics and production are integrated in the factory. Thanks to the kanban cycle with its suppliers, the TBT provides parts in production lines on time and saves time from continuous ordering. The TBT Kanban Cycle is given Fig.13. It is necessary to follow certain rules in order to obtain efficiency from this system and to minimize errors:

Figure 12. Flow of materials and kanban

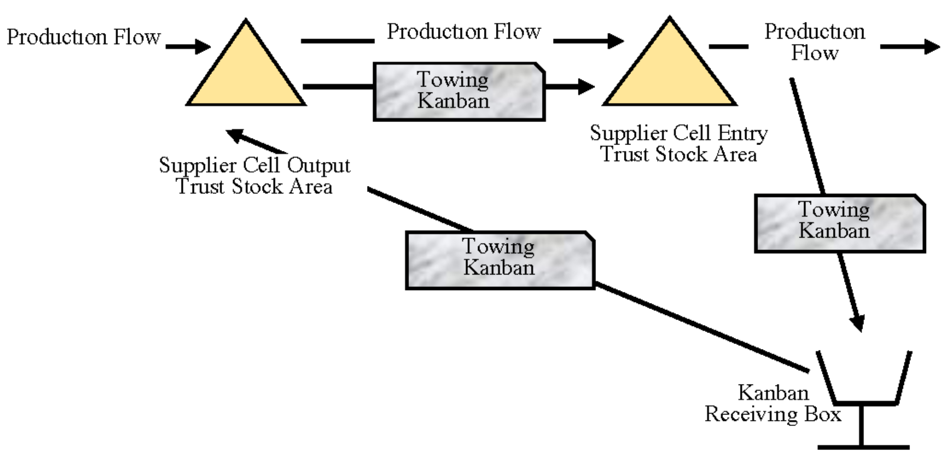
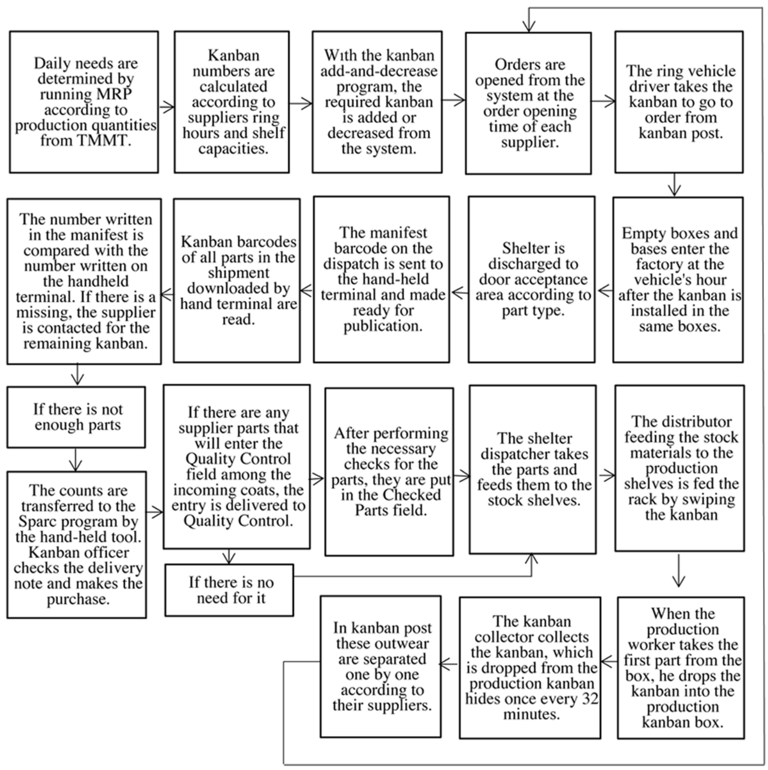


Figure 13. The TBT Kanban cycle



- Kanban should be installed on the correct boxes at the supplier.
- Kanban should be included in all boxes that are not empty except the production line in the TBT.
- Kanban used in production and dropped into the box should be collected every 32 minutes.
- Orders with falling kanban should be opened at the right ring hours.

Supermarket and Pull System

The supermarket is a stock of controlled parts used to schedule the production of the previous process. In the long term, customer demand is stable, but if there are some difficulties in between, setting up a supermarket between the customer and the pacemaker both meet the customer demand and allows production leveling in the manufacturing cell. The cost of the supermarket is much less than the cost of having extra stock of finished products. The left side of the supermarket is facing the supplier process. The "production" Kanban triggers the production of parts, while the "pull" Kanban is necessary for the transport of the parts. The material carrier of the customer process comes to the supplier's supermarket and pulls whatever it needs. These withdrawals previously published kanban triggers the movement from supermarket suppliers to the process. The supermarket pull system is shown in Figure 14.

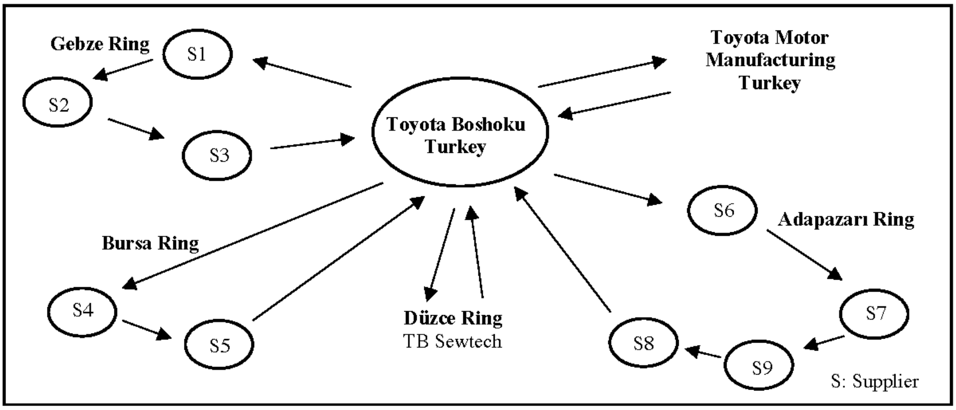
Milk-Run System in Toyota Boshoku Turkey

The TBT applied the milk-run system in Turkey is the return of a kanban system (Figure 15). The high frequency of shipment allows the stock quantity to be reduced with proper programming. Hourly shipments with manufacturers working with Kanban are essential to ensure timely production. Furthermore, when well planned, the milk-run organization is usually lower in shipping costs than delivering to the door. When the cost of transportation is calculated for the entire volume, it can be seen whether the cost of the trucks are covered and the profit situation. The TBT of the milk-run system gives priority to the following advantages:

- Saving the total shipping cost
- Time saving
- Opportunity to convert the package used in the system
- Control over delivery times
- Preventing accumulations in warehouses
- Low inventory cost
- Adequate stock areas
- Controlled material shipment

Figure 14. Supermarket pull system and andons

Figure 15. Milk-run system in the TBT



- Large vehicle use
- High volume usage
- Easier inventory recording and tracking

The expression of this kanban cycle is A-B-C.
A: Number of Days
B: Number of repeated trips
C: How Many Future of Shipment after Shipment
The calculation of the number of kanban from a Back NO is as follows:
Cycle: A-B-C
Safety Stock (hours): D
Total Working Time: E
Number of Kanban = ((A * ((C + 1) / B) * (D / E) * (Maximum Number of Daily Use / Lot))

The minimum and maximum numbers that are required from the Kanban with Back NO in the TBT when cyclic trips are performed are calculated as follows:
SSR: Security Stock Ratio
Minimum Required Kanban = ((Number of Daily Use / Lot) * SSR)
Maximum Number of Kanban Required = Minimum Number of Kanban Required + (Number of Daily Use / (Lot * Number of Shipments)))

In this context, the TBT maintains its relations with different systems in both inbound logistics and outbound logistics. Toyota's approach enables its suppliers to act systematically. Toyota works with different supply-chain partners on the inbound and outbound side of logistics. The inbound side concerns the relationship between thebe and suppliers, while the outbound side deals with how the TBT get products to its customers. In other words, while inbound logistics is responsible for transporting parts and materials from the suppliers to the OEM plants, outbound logistics is responsible for the distribution of vehicles from the assembly plants to the dealers.

Material Handling System

Ensuring the implementation of the LM system is all about the participation of the entire company, especially quality control, purchasing, planning, production and logistics departments. One of the key areas in which the LM application can greatly affect a company's performance is the use of an efficient material handling system. Fig. 16 shows the material transport vehicles inside the factory. Logistics provides the necessary parts with the "kit delivery" method so that a worker does not need to make any decision about the assembly process. The kit delivery means preparing the part as kits for a vehicle and delivering it to the line side only as necessary. Management should consider all basic concepts and techniques, regardless of the focus of the LM practices on the problem. The basic steps for applying LM to material handling systems define the following: developing a plan for each department, establishing a supermarket for purchased parts, designing delivery routes, applying pull signals and improving the system continuously.

Figure 16. Material handling and kit delivery within the factory

Green Purchasing and the TBT's 2050 Environmental Vision

As the TBT, the company aims to protect the environment and contribute to society in a conscious manner by fulfilling the requirements of the environmental management system while performing the production of in-vehicle flooring parts. The TBT, instead of focusing only on the efforts to reduce CO2 emissions in automotive parts manufacturing processes; will meet the challenge of achieving the "0" CO2 emission targets at all stages, from manufacturing to use in the production cycle, from disposal to reuse of products. The TBT endeavors to produce "clean products, to offer environmentally friendly internal parts produced with low CO2 emissions, to develop heat-insulated internal materials and high efficiency filter powertrains, and to maximize production processes to minimum CO2 emissions. The TBT is very active in giving importance to "3R" activities (Reduce: Reduction, reducing the amount of waste. Reuse: Reuse. Recycle: Recycling, Recycling of disposed materials, usable resource quality) to the target of direct 'solid waste' to zero reached. From now on, it is trying to overcome the challenge of minimizing the wastes produced by the TBT with spreading its activities on a global basis, by using various methods such as design and method development for efficient use of resources, development of recycling technologies and 100% material recycling. To leave a rich, abundant environment for future generations, the TBT prioritizes purchasing parts, materials and indirect materials from environmental suppliers to protect the environment. This approach is described as "Toyota Boshoku Green Purchase". Under the Green Purchasing Guidelines, the TBT requires suppliers: to improve management and continuous improvement of environmental protection across the organization, all suppliers should establish environmental management systems based on external ISO 14001 certification. To ensure the full management of environmentally hazardous substances, when the product is newly accepted, the types and quantities of all chemical substances including parts, materials and indirect materials containing any product should be reported. All information and data on prohibited and controlled substances, CO2 emissions and other environmental information for products must be reported (www.toyota-boshoku.com). The TBT works to prevent pollution reduce waste and reduce environmental impact to zero. The TBT continues its activities as a company that attaches importance to environmental awareness with its efforts to reduce the use of natural resources and energy. Being aware of the fact that the basis of environmental protection activities is to produce solutions for the source of the problem, the principle of environmental protection is actively addressed at all stages from the process development stage to the disposal stage.

CONCLUSION

The automotive sector is currently one of the most advanced industries in the world. The Toyota Company developed the lean philosophy, but it has changed dramatically in recent years. In addition to the old techniques, many new techniques and methods have been developed and put into practice in different industries. This study makes important contributions to show the applications in this development trend today. We present a case study about the LL and the SC application in the TBT factory, which has maintained production for 20 years in Turkey. The TBT is a supplier of the TMMT that is producing seats and door sets. This study is thought to contribute to the literature in terms of demonstrating how to implement the LM system in the TBT factory in a country other than Japan. This study is an important research for those who will read this book in terms of the successful implementation of the LM system in a different culture environment for more than 20 years. Based on this study, some conclusions about what is important about the LL applications can be said. Companies that want to make the LM should think long term. First, companies who want to be lean should know the advantages and disadvantages of their culture very well, and implement their applications considering this situation. They should know that they could be a high performance company by increasing the quality of the employees. They should have processes that can improve their employees. Lean leaders should come out of the company, humble, patient, guiding, should consider the problems as a source of progress and see the problems at the source. The company should be cautious of any errors that occur within it, but should not be repeated. Applications in a lean company should be simple, clear and visual. The company should consider activities between suppliers and customers as a whole. Awareness should be placed on increasing value-adding activities, identifying and reducing waste resources and supporting the slightest improvement effort. What is important is not the company's earnings, but the continuous awareness of the employees for the better. Each company should adopt the advantages of the best production system as Toyota does and take into account the current conditions and culture of its own country and create its own production system that can be implemented by its employees in small steps, on the basis of planned continuous improvement, customer focus, value and above all on human basis. It is impossible to imitate Toyota culture. Efforts in this direction will not go beyond applying the methods used. "The longest-standing companies are not just growth or money, but excellence, respect for others, or the ability to make people happy. Some call it spirit. In fact, Toyota's own culture, history, values, philosophy and methods to develop the world's best automotive manufacturer explains. Industry 4.0 is foreseen to reshape future logistics. In this context, in the future studies aim to present case studies on cooperation of people and machines, internet of things, autonomous vehicles and drones, integration of the LM and environmental protection.

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About the Contributors

Syed Abdul Rehman Khan is a teacher of Supply Chain and Logistics Management. Dr. Khan achieved his CSCP—Certified Supply Chain Professional certificate from the U.S.A. and successfully completed his Ph.D. in China. Since 2018, Dr. Khan has been affiliated with Tsinghua University as a postdoctoral researcher. He has more than nine years' core experience of supply chain and logistics at industry and academic levels. He has attended several international conferences and also has been invited as a keynote speaker in different countries. He has published more than 70 scientific research papers in different well-renowned international journals and conferences. He is a regular contributor to conferences and workshops around the world. In addition, Dr. Khan has achieved scientific innovation awards two times consecutively by the Education Department of Shaanxi Provincial Government, China. Also, Dr. Khan holds memberships in the following well renowned institutions and supply chain bodies/associations: APCIS-U.S.; Production and Operation Management Society, India; Council of Supply Chain Management of Professionals U.S.; Supply Chain Association of Pakistan; and Global Supply Chain Council China.

* * *

Lojain Alkhuzaim is a Ph.D. candidate within the Foisie Business School at Worcester Polytechnic Institute. Her research focuses on the applications of Emergy Analysis and System Dynamics within the context of sustainable supply chain management.

Perfecto G. Aquino, Jr. is presently a resident Researcher cum Business Lecturer at the Social Sciences and Economics Research Insitute of Duy Tan University, Danang City , Vieitnam.His research interests are along the following areas:Human Resource Management, Organizatioal Behaviour, Leadership, Marketing Management, Green Business Administration, CSR and Supply Chain Management among others. He received since 2001 his Doctor of Philosophy Diploma as Cum Laude in Public Administration and Management at the Royal and Pontifical University of

Santo Tomas, Manila , Philippines . Likewise, he is also a holder of both MBA and Master in Public Administration (MPA) at the Lyceum of the Philippines University. He has authored/co-authored a number of articles published in peer-reviewed international journals and to date he has a line-up of international papers for publication in Scopus indexed journals . Was a former Assistant Professor cum Head of the Business Administration Department at the Emirates College for Management and IT in United Arab Emirates. He was also an Assistant Professor at the American University in the Emirates, Middle East College-Oman and at the AMA International University-Bahrain. He used to be the Dean at the Saint Francis College of Assisi System and was then a pro-active Assistant to the Vice-President of Academic Affairs of the said institution. Aside from University instruction and research, Dr. Aquino has vast and extensive experiences of more than 23 years in curriculum development, international accreditation and quality assurance. Furthermore, he has contributed 3 chapters with his former professor Avelino P. Tendero in their book entitled" Theory and Practice of Public Administration in the Philippines" which was published by the Fiscal Administration Foundation Inc. in 2000.

Ibrahim Cil is a Professor of Department of Industrial Engineering at the Sakarya University. He holds a B.S. from Istanbul Technical University, and a M.S. from the Yıldız Technical University, and a Ph.D.in Industrial Engineering from Istanbul Technical University. His teaching and research specialties are in the fields of Decision Support Systems, Decision Sciences, Multi Criteria Decision Making, Data Mining, Expert Systems, Artificial Intelligence, Supply Chain and Logistics, Manufacturing Strategies, Lean Manufacturing, Lean Six Sigma, Facility Planning and Layout at industry and academic levels. Prof. Cil has published numerous papers, which have Decision Support Systems, Expert Systems with Applications, Robotics and Computer-Integrated Manufacturing, International Journal of Computer Integrated Manufacturing, Int J Adv Manuf Technol, International Journal of Industrial Engineering - Theory Applications and Practice, The Engineering Economist. Prof. Cil has attended several international conferences in Turkey, US, Japan, England, Netherland, Germany, France and Greek. Prof. Cil also holds Editorial Membership of several international journals.

Samantha Cruz-Sotelo is a professor and researcher at the Autonomous University of Baja California (UABC). Member to the Mexican National Researcher System, Level I. She is a founding member of the Mexican Society of Science and Applied Technology Solid Waste (SOMERS) and member of the Ibero-American Network of Engineering in Environmental Sanitation (REDISA). She has published manuscripts in journals, books and book-chapters and participated as a guest editor of special issues in the international journals. Her research interests are in the areas of Optimization of Productive Processes, Sustainable Development, Life Cycle Assessment, Circular Economy, Sustainable Manufacture, Electronic Waste Management, Artificial Intelligence Tools.

Halil Ibrahim Demir was born in Sivas, Turkey in 1971. In 1988 he got full scholarship and entered Bilkent University, Ankara, Turkey to Industrial Engineering Department. He got his Bachelor of Science degree in Industrial Engineering in 1993. In 1994 he got full scholarship for graduate study in USA from ministry of Education of Turkey. In 1997 he got Master of Science degree in Industrial Engineering from Lehigh University, Bethlehem, Pennsylvania, USA. He is accepted to Northeastern University, Boston, Massachusetts for Ph.D. study. He finished Ph.D. courses at this university and completed Ph.D. thesis at Sakarya University, Turkey in 2005 and got Ph.D. degree in Industrial Engineering. He started to his Academic Position at Sakarya University as Assistant Professor. His Research Areas are Production Planning, Scheduling, Application of OR, Simulation, Artificial intelligence techniques, Genetic algorithms, Artificial Neural Networks, Fuzzy Logic and Decision making.

Petr Fiala holds the Full Professor degree from the University of Economics in Prague, Czech Republic, where he currently works as the Deputy Head of the Department of Econometrics. He is a member of other Czech universities. Professor Fiala is graduated from the University of Economics in Prague, in 1974, Charles University, Prague, in 1981, and Rochester Institute of Technology, USA, in 1996. His current research interests include modeling of production systems, supply chain management, project management, multi-criteria and group decision making. He is a member of professional societies for Operations Research and Multiple Criteria Decision Making and the Czech Republic representative in EURO (The Association of European Operational Research Societies). He has made research visits to many countries. He is the author of books, lecture notes, papers, and reports in quantitative models and methods in management and economics.

Turgut Hacıvelioğulları was born in Aksaray, Turkey. He was graduated from Anadolu University, Department of Public Administration. He did his master degree in 2013-2015 on business administration. He is a Ph. D student in Graduate School of Social Science, Aksaray University. He specializes in Data Envelopment Analysis, Analytical Hierarchy Process, Supplier Chain Management, Transportation Problems, and Multiobjective Linear Programming.

Mahtab Kouhizadeh is a Ph.D. candidate within the Foisie Business School at Worcester Polytechnic Institute. Her research focuses on the applications of blockchain technology in supply chain management and sustainability. She has published papers on these topics in different journals.

Doan Hong Le is currently the Vice-Director of the Social Science and Economics Research Institute and an Associate Professor of Duy Tan University, Danang City, Vietnam. He has co-authored and published a number of papers in Business Management and Customs Administration in Scopus indexed journals. Was a former Manager of Customs Department in Danang City, Vietnam which he held for more than 35 years. He graduated with High Honors Bachelor in Politics (2004); Bachelor of Laws (1996); Bachelor in Foreign Language,major in English (1995) ; Bachelor in Foreign language, Russian. (1989); and MBA from NANTES University, France and a holder of Doctor of Philosophy in Economics (2009) from Da nang University, Vietnam. Furthermore, Dr. Le has been very active in the area of international trade and customs management for more than 35 years and has been a frequent contributor in the training of businessmen, entrepreneurs,students among others for trade and customs in Vietnam. His international experiences includes programs and conferences, trainings at the headquarters of ASEAN, Thailand, Hongkong (UNODC), (United Nations), JICA (Japan); United Nations Environment Programme, Viet Nam. His current research involves study of the trade policy, international investment policy, tax policy and, customs procedures, in context of the world economic integration and strategy for human resource development. He is a known scholar, researcher, practitioner, leader and a great academician.

Renata Majovská earned her degree in Mathematics and Physics at the Ostrava University in Ostrava, Czech Republic. She gained her PhD. at the Constantine the Philosopher University in Nitra, Slovakia in 2008. She is the Assistant Professor at the University of Finance and Administration in Prague, Czech Republic. She is a member of the Czech Society of Operational Research. Dr. Majovská has participated in the solving of several grants and is a co-author of several books and author of many scientific and conference papers in the modeling of production systems, supply chain management, multi-criteria and group decision making. She has prepared many electronic university textbooks.

Mercia Selva Malar Justin has 25 years of teaching experience at higher education level. She has taught at various colleges and business schools like, CMS College of Science and Commerce, SCMS-COCHIN, LEAD College of Management, ECMIT (Dubai) and Wollongong University (Dubai). She earned her doctoral degree in Commerce from Manonmaniam Sundaranar University based on the thesis titled, 'Foreign exchange exposure and risk management in the hotel industry'. She has been part of the international research team on 'Microfinance – Gender perspectives' funded by DFID-DelPHE. She has authored three books. She has published in national and international journals. She is a PRIME Graduate of JCI University. She received the NFP Scholarship of Netherlands Government and completed her Diploma in Housing and Urban Development specializing in FDI and City Financing, from Erasmus University, Rotterdam. She is the recipient of the Jagadish Gandhi Silver Medal for General Proficiency of ISSR, Runner-up Outstanding New Jaycee of JCI-India, Distinguished Educator and Scholar Award of NFED.

Sara Ojeda-Benitez is a researcher at Engineering Institute of the Autonomous University of Baja California (UABC), teaches Environmental Management, Research Activities, Sustainability, Industrial Legislation. Member of National System of Researchers level 2 (México). Member of the Iberoamerican Network of Engineering in Environmental Sanitation (REDISA) in the research line Solid waste management. President of the Mexican Society of Science and Applied Technology Solid Waste (SOMERS).

Joseph Sarkis has been a faculty member at WPI since July 2013. He previously served as a faculty member at Clark University and the University of Texas at Arlington. His teaching and research interests are in the fields of operations, supply chain management, and sustainability. He is the author or co-author of over 400 publications. His research is widely cited and earned the designation of highly cited researcher in 2016, 2017, and 2018 from Thomson-Reuters/Clarivate Analytics (Web-of-Science). He has also been noted as the most productive researcher in the field of supply chain management from the years 1995-2015. He is the Editor-in-Chief of IEEE's Engineering Management Review and Associate Editor of Sustainable Supply Chains for Resources, Conservation and Recycling . He is also Co-Editor of the Greening of Industry Networks Springer-Nature Book Series. He has served as a visiting scholar in universities throughout the world.

Nurullah Umarusman is an Associate Professor Nurullah Umarusman, he was born in Adana, Turkey. He graduated from Erciyes University, Science Faculty, Department of Mathematics. He started working as a research assistant in Niğde University in 1997 in the field of quantitative techniques. He did his master and Ph.D. degree in Graduate School of Social Science, Dokuz Eylül University. His professional fields are Fuzzy Logic, Multi-criteria Decision Making, Goal Programming, De Novo Programming, Vague Sets, and Multiobjective Supplier Selection Problems. He has been working in Aksaray University Faculty of Economics & Administrative Sciences since 2007.

Berfin Yaman received her bachelor's degree in Industrial Engineering from Sakarya University in July 2019.Realized the long-term internship at Toyota Boshoku Turkey in logistics department.Currently working on supply chain and logistics management.

Zhang Yu is a postgraduate student of Chang'an University, China. Her research interest is reverse logistics and packaging. She has published 15 research papers including ISTP, SCIE, and EI indexed. Ms. Zhang also has attended several international conferences in China and Hong Kong.

Qingyun Serena Zhu is an Assistant Professor of Management Science in the Management, Marketing and Information Systems Department at UAH. She earned a Ph.D. in Operations and Supply Chain Management from Worcester Polytechnic Institute. Her teaching interests are at the nexus of Operations and Supply Chain Management, Data Analytics, and Sustainability. Her research focuses on Sustainable Supply Chain Management, Green Marketing, Product Deletion and Blockchain Technology. She is a member of the Academy of Management, the Decision Sciences Institute, and the Production and Operations Management Society.

Index