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Customer Satisfaction and Standard Adoption Practices on the Sustainable Performance of Supply Chain Management: A Manufacturing Firm Case Study

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ABSTRACT

Manufacturing companies are critical resources because they include social sustainability characteristics into their operations and employ supply chain management strategies to maintain strong supplier-to-customer connections. This research suggests a novel standard adoption approach in manufacturing organisations that focuses on customer satisfaction, manufacturing firm competences, and operational uncertainty. The membership function in fuzzy control theory and a practical practise in manufacturing business windows were used to develop the customer satisfaction model. Create a taxonomy of SCSS concerns and processes utilised by enterprises at the same time. The method in this article is broken into two steps. The taxonomy comes first, and then we use non-financial data to conduct a first-hand assessment of a sample of 29 organisations to identify the standard adoption approach. Ultimately, the organisation got varied faces of social sustainable development practises in the higher and lower supply chains cantered on many distinct industries by using the particle algorithm. Moreover, for supply chain professionals who do not understand the composition of SCSS, the research results are highly important and exciting, and they have a unique understanding of adoption techniques.

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1. Introduction

In the modern era, artificial things and behaviours have put a huge demand on natural resources. Companies and investors are more aware of the value of ecosystems and social well-being. Experts have linked environmental degradation to health and safety problems, as well as industrial development (Irshad et al., 2019). As a consequence of this increased awareness, adaptive practises and customer satisfaction have become a hot topic in social sustainability measurements. Moreover, investors want businesses to disclose to the public their manufacturing methods, resource usage, and sustainable processes (Geldart, 2014). Adaptable practises and customer satisfaction have emerged as hot themes in social sustainability measures as a consequence of this increased awareness. Moreover, investors want firms to publicly disclose their manufacturing methods, resource use, and sustainability practises (Hosseini, Ivanov, & Dolgui, 2019). As a result, researchers are interested in learning more about supply chain sustainability concerns that may impact society at different stages (Hosseini et al., 2019).

Using integer programming approaches, a large number of researchers investigated manufacturing company adoption trends (Ansari & Kant, 2017), incorporating natural resource constraints, the unpredictability of incorporating social sustainability principles into operational time, and developing a taxonomy of SCSS techniques utilised by enterprise (Jakhar, 2015).Chand, Thakkar, and Ghosh (2018) Customer satisfaction and manufacturing firm adoption techniques were used to test and assess the operation sequence Xu and Gursoy (2015) Based on interactions between suppliers and consumers, we investigated the relationship between incorporating social sustainability concepts into operations and using supply chain management approaches to improve customer satisfaction. Mokhtari and Hasani (2017) A mathematical approach for implementing supply chain management methods and improving customer satisfaction was proposed (Hou, Khokhar, Sharma, Sarkar, & Hossain, 2023). He used an optimisation approach in combination with the single parent genetic algorithm to solve the mathematical model of the goal function.

2. Theoretical Background and Hypothesis Development

Supply chain social sustainability (SCSS) has been well-defined by the contextualization, (Everard & Longhurst, 2018) "meeting today's needs without compromising the ability to meet future generation's needs." Sustainable development goals (SDGs) related to supply chain dimensions (Hou, Weng, Gao, Wang, & Khokhar, 2020), such as environment, economics and scholars, need interpretation for punter and investor necessities (Hou, Khokhar, Khan, Islam, & Haider, 2021). From an economic perspective, this definition emphasizes environmental and social characteristics of SCSS and the need of cooperation between manufacturing companies and supply chain in addition to fulfilling customer satisfaction not only meeting the requirement of focal firms (Garmendia, Prellezo, Murillas, Escapa, & Gallastegui, 2010). Therefore, SCSS may be considered for the entire multi-tier supply chain and its respective customers.

Many studies have shown links between SCSS concerns and practices, manufacturing company sustainability, supplier social performance, and focus business supply chain performance, with the former promoting the latter. For instance, Testa, Nielsen, Bogers, and Cincotti (2019) suggest the adaptation practices in manufacturing firm are internal sustainable procedures that benefit the outside sustainable supply chain. Fedorova and Pongrácz (2019) have indicated that coordination between manufacturing firms and supply chain business partners, customers are high-order capabilities which rests on skills generated by the manufacturing procedures implemented by the firm (Shahbaz, Mubarik, Mubarak, & Irshad, 2019).

2.1 Customer Satisfaction and SCSS

Manufacturing company data on customer environment (customer happiness) is a vital motivation for manufacturing companies to pursue sustainability and supplier's social performance, concentrating businesses' supply chain performance; current literature presents two facts in building our projections (Mokhtari & Hasani, 2017). While deciding on manufacturing firm adaptation practises, consumers may assess a manufacturing company's sustainability actions, including SCSS; and customers are entirely unsatisfied with a firm's SCSS activities with supplier social performance, concentrating companies' supply chain performance.

Possibly there are sustainability theories and research studies that particularly address sustainability and improved financial performance. For example, recent study revealed that manufacturing organizations engage in sustainable practices that optimize earnings (Murray-Clay, Chiang, & Murray, 2009) and "do well by doing well". The pivotal and critical function of stakeholder theory lies at the heart of these points of view (Ashraf, Muhammad, & Hopper, 2019). There may be sustainability concepts and research initiatives that are explicitly aimed at increasing financial performance and sustainability. For example, recent study found that manufacturing organisations engage in sustainable practises that optimise earnings (Murray-Clay et al., 2009) and "do well by doing well". The crucial and vital function of stakeholder theory lies at the heart of various points of view (Zaid, Jaaron, & Bon, 2018). Solangi, Tan, Mirjat, and Ali (2019); Valasai et al. (2017) claim that firm with higher sustainability status can obtain stakeholder compensation by increasing productivity, consumption and investment, and reducing regulatory pressure; Therefore, better results should be achieved when competing in the market. Customer trust and coordination with stakeholders can also decrease the explicit and implicit costs of contracting and negotiating. Zaid et al. (2018) proposed from the perspective of over-reliance on resources that stakeholders influence organizational behavior by affecting access to critical resources, such as the movement of organizational resources. Herazo and Lizarralde (2016) confirmed that stakeholders can mobilize public support, which is the sustainability performance of the organization.

We concentrate on customer channels and inspect customer satisfaction roles in encouraging manufacturing firms to achieve sustainability through supplier social performance, focal companies' supply chain performance, and SCSS performance (Khokhar, Hou, Sethar, Amin, & Shakib, 2019). At the same time, other channels are also influenced by the data environment. Supplier channels provide promising research areas on the impact of consumer satisfaction on manufacturing firm's trades and financial performance like, (Kornuta et al., 2019). This study proposes that customers are ready to pay higher prices for products of manufacturing firms with higher sustainability arrangements, while other studies suggest that customers are more expected to buy products from manufacturing companies that have better social responsibility. The surge in society's hopes for manufacturing companies to fulfil their social responsibilities has led to increased demand for environmentally friendly products and services and has established market openness for manufacturing companies with good sustainability performance (Quarshie, Salmi, & Leuschner, 2016). For example, a survey result shows that more than 40% of administrators believe that green movement and related consumer demand growth for good adaptation practices in manufacturing firms and the timely delivery of goods and services provided sustainable market openings(Rive, Bonnet, Parmentier, Pelazzo-Plat, & Pignet-Fall, 2017).

Most studies suggest a positive correlation between sustainable edges and firm value, the alarm is that sustainable procedures are expensive, and cost does not always compensate for profits (Khaskhelly et al., 2022). There are many variables that deduce the incentive for manufacturing companies to greater involvement in SCSS. First, the propagation of sustainability values with a supply chain requires managerial efforts and additional cost from the focal firms (Shahbaz et al., 2019). For example, sub-tier suppliers are often situated in countries that do not require high environmental and social rules and principles, and the distance between institutional and geomorphic compounds becomes a problem in dealing with such relationships, (Das, 2017). Secondly, Sub-tier suppliers may lack knowledge, resources, and proficiency on the sustainability challenges that worry consumers; they tend to have an unbalanced relationship with major companies (Huo, Gu, & Wang, 2019). Secondly, not fully understand the sustainability practices of the sub-tier suppliers of main firms (Ahi, Searcy, & Jaber, 2018). As articulated by Rodrigue, Magnan, and Boulianne (2013) if customers are not satisfied with the company's sustainability practices, they will not be able to respond to this practice. Clients 'lack of a company's sustainable development advantage often makes these struggles futile. Johnson, Clark, and Barczak (2012) assume that there is a positive link between advertising enthusiasm and sustainability performance. To subsidy for sustainability efforts, firms demand to ensure that their customers understand the situation (Khokhar, Hou, Rafique, & Iqbal, 2020). On the contrary, the presence of additional translucent information environment between a main firm's suppliers and customers, as well as higher revenues generated through involvement in SCSS (Baloch, Samo, Bhatti, Bhughio, & Zeb, 2021), has allowed firms to be more active while dealing with their sustainability and move to the next tier sustainability level (Khokhar et al., 2019).

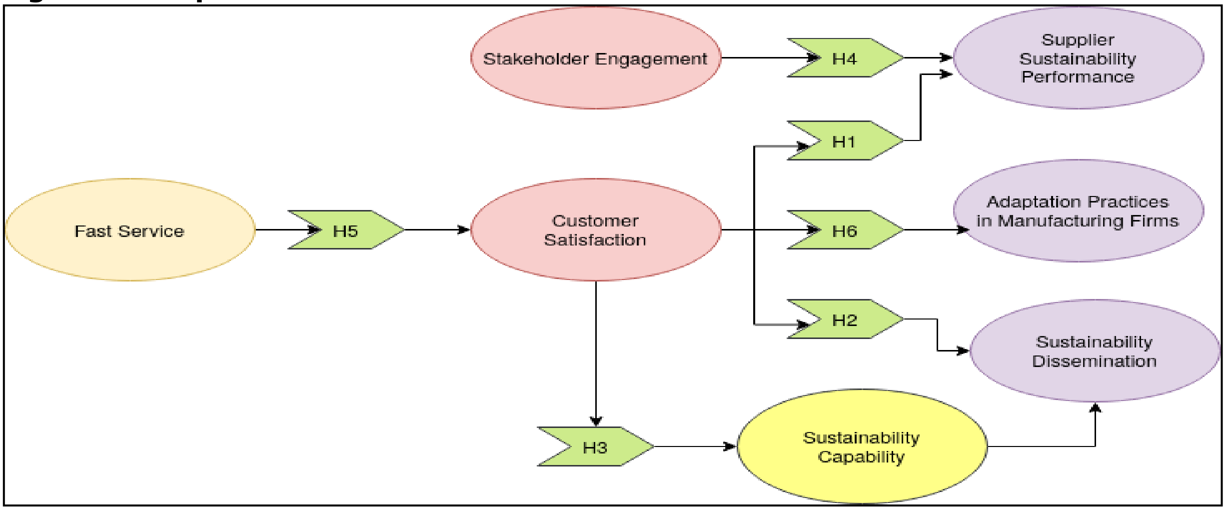
All of those arguments contribute to our major prediction that customer satisfaction is a very important enabler for a firm to develop its sustainability capacity and SCSS. The research model is given in figure 1. Hence, we hypothesize that:

H1. High customer satisfaction has a positive impact on the supplier's sustainability performance.

H2. High customer satisfaction has a positive impact on the dissemination of sustainability to the upstream supply chain via SCSS.

Grimm, Hofstetter, and Sarkis (2016) believe that the main reason why companies are reluctant to be more active on sustainability issues is the lack of knowledge, resources, and proficiency, resulting in a reduced ability to promote sustainability processes.

Figure 1: Proposed theoretical research model



Atef, Sadeqinazhad, Farjaad, and Amatya (2019) proposed that the company's ability to develop sustainability in internal processes (such as skilled employees responding to sustainability) is an important requirement for them to respond quickly to the wishes of other customers disseminate sustainability to supply chain business partners. Information irregularities between customers and company suppliers are more serious than those between customers and companies (Hou et al., 2021). This gives companies more room to deal with the challenges they face in dealing with the sustainability performance of their supply chain. Then cover the sustainability performance of their customers (BHATTI). Therefore, resource preparation plays an important role in controlling the sustainability of the supply chain. There are no experts and resources to apply the company's sustainability procedures, so they lack the ability to allocate sustainability through SCSS. hence, we hypothesize:

H3. The impact of customer satisfaction on the focal firm’s performance to disseminate sustainability on their supply chain is mediated by the focal firm’s sustainability capability.

H4. Stakeholder engagement improves the sustainability performance relationship between the focal firm and its supply chain partners.

H5. Customer satisfaction is the highest at a faster time.

H6. Customers' satisfaction has a positive impact on the adaptation practices in manufacturing firms.

3. Customer Satisfaction Model

During the adaptation practices of manufacturing firms, customers’ satisfaction is mainly determined by the sustainable measures taken by the society in the process of incorporating social sustainability practices into their operations and adopting supply chain management strategies (Khokhar et al., 2022). The adaptation practices in manufacturing firms are inversely proportional to their customers' satisfaction. At the same time, customer satisfaction is not the difference between pure satisfaction and dissatisfaction (Khan et al., 2022). Customers can endure and be satisfied within the specified time. In this paper, a customer satisfaction model based on fuzzy membership and fuzzy control theory is introduced. This model truly reflects the exact situation of customer satisfaction.

3.1 Establishment of Customer Satisfaction Model

Customer i from the manufacturing firms m in the market j to the k countdown adoption practices window of $\left[T_{ijmk}^{F}, T_{ijmk}^{M}, T_{ijmk}^{L}\right]$, and the customer's satisfaction objective function was:

$$Max\left\{\sum_{i=1}^{N}\sum_{j=1}^{J}\sum_{m=1}^{M}\sum_{k=1}^{K}\mu_{ijmk}(x)\right\} \quad \textbf{(i)}$$

Among them, $\mu_{ijmk}(x)$ are the manufacturing firms m and the i customer in the market j countdown SCSS issues with adoption practices the k orders for customer satisfaction model, customer satisfaction objective function.

$$\mu(T_{ijmk}) = \begin{cases} 1 & T_{ijkm}^{F} < T_{ijmk} < T_{ijkm}^{M}, T_{ijmk} < T_{ijkm}^{F} \\ \cos\left(\frac{\pi\left(T_{ijmk}-T_{ijkm}^{m}\right)}{2\gamma(T_{ijkm}^{L}-T_{ijkm}^{m})}\right) & T_{ijkm}^{M} < T_{ijmk} < T_{ijkm}^{L} \\ 0 & T_{ijmk} > T_{ijkm}^{L} \end{cases} \quad \textbf{(ii)}$$

Among them: i : A customer numbered i ,$T_{ijmk}^{F} < T_{ijmk}^{M} < T_{ijmk}^{L}$; $T_{ijmk}^{F} < T_{ijmk}^{M} < T_{ijmk}^{L}$: The market numbered $T_{ijmk}^{F} < T_{ijmk}^{M} < T_{ijmk}^{L}$, $T_{ijmk}^{F} < T_{ijmk}^{M} < T_{ijmk}^{L}$; $T_{ijmk}^{F} < T_{ijmk}^{M} < T_{ijmk}^{L}$: A manufacturing firms numbered m ,$T_{ijmk}^{F} < T_{ijmk}^{M} < T_{ijmk}^{L}$; $T_{ijmk}^{F} < T_{ijmk}^{M} < T_{ijmk}^{L}$: Customer $T_{ijmk}^{F} < T_{ijmk}^{M} < T_{ijmk}^{L}$ in the countdown SCSS issues with adoption practices number of in-market $T_{ijmk}^{F} < T_{ijmk}^{M} < T_{ijmk}^{L}$, $T_{ijmk}^{F} < T_{ijmk}^{M} < T_{ijmk}^{L}$; T_{ijmk} : Customer i was waiting for the focal company's supply chain performance by the manufacturing firms $T_{ijmk}^{F} < T_{ijmk}^{M} < T_{ijmk}^{L}$ in the k countdown SCSS issues with adoption practices in market j ; $T_{ijkm}^{F}$is the shortest waiting window time customer i was performed by the manufacturing firms m in the k countdown SCSS issues with adoption practices of market $T_{ijmk}^{F} < T_{ijmk}^{M} < T_{ijmk}^{L}$; $T_{ijkm}^{M}$is the conservative waiting window time customer i was performed by the manufacturing firms m in the k countdown SCSS issues with adoption practices of market $T_{ijmk}^{F} < T_{ijmk}^{M} < T_{ijmk}^{L}$; $T_{ijkm}^{L}$is the longest waiting window time customer i was performed by the manufacturing firms m in the k countdown SCSS issues with adoption firms of market j ; γ : The customer's emotional arousal coefficient.

Through formula (ii), when $T_{ijmk}^{F} < T_{ijmk}^{M} < T_{ijmk}^{L}$, the customer's satisfaction is the highest at a faster time, but as the customers' waiting time increases, customer's satisfaction will gradually decrease. When customers' waiting time is more than ~~the~~ customer's patience, that is to say, $T_{ijmk} >> T_{ijmk}^{L}$ the customer will have a stronger emotional response and satisfaction. It will be zero. According to the formula (ii), as the customers' waiting time prolongs, the customer's mood fluctuates. It can effectively ensure the authenticity of the process through the setting of the customer's emotional arousal coefficient.

3.2 Constraints of Customers' Satisfaction Model

Based on the customer satisfaction model of membership function, we need to calculate the maximum customer satisfaction according to the customer waiting time (Begum Siddiqui et al. 2023). In the process of solving the problem, we will establish relevant constraints for this model to ensure the convergence of this function.

T_{ijmk}^{F} 、 T_{ijmk}^{M} and T_{ijmk}^{L} represent the shortest waiting window time, the conservative waiting window time, and the longest waiting window time customer i, was performed by the manufacturing firms m in the k countdown SCSS issues with adoption firms of the market respectively. So, we can get $T_{ijmk}^{F} < T_{ijmk}^{M} < T_{ijmk}^{L}$.

In this article, we assume that the customer i does not have a focal company's supply chain performance in advance. Secondly, prolonged waiting time will make the customer's mood fluctuate. The shorter the customers' waiting time, the more stable the customer's attitude is and the higher the value. Therefore $1<\gamma<2$ and $J < M$ because if $M > J$, it shows that the market is always idle, this situation dramatically increases the cost of the target market, which does not conform to the actual situation of target market management. Finally, $i>0$, $j>0$, $m>0$, $k \geq 0$, than is to say the number of customers, market, manufacturing firms, and standard adoption practices in manufacturing firms should be positive.

4. Supply Chain Management Strategies Model

In the supply chain control and processing, in addition to the service waiting time that affects customer satisfaction, the timetable also includes the social performance time adopted by the supplier, the social sustainability of the supply chain, and the standard adoption process time of the manufacturing company. Based on the longest and average time of enterprise customer supply chain performance, this paper establishes a minimum mathematical model based on the influencing factors of the supply chain's social sustainability issues and the adoption practices to rationally arrange the adoption practice schedule.

4.1 Constraints of Adoption Practices Scheduling Models

In this paper, a plan of a particular manufacturing firm's adoption practices is conducted based on the consideration of customer service waiting time (affecting customer satisfaction), the supply chain performance of focal company customers, and the social performance of suppliers to customers. When considering customers with supplier social performance time from different manufacturing firms, the impact of their experience on the supplier social performance time to complete a total duration of the adaptation practices and the truncation parameter learning effect determines the social performance of suppliers from different companies Factors affecting the experience time (Khokhar et al., 2022).

$$Min\{\alpha TLE + (1-\alpha)TV\} \tag{3-1}$$

$$TLE = Max\{T_{ijmk} + T_1 + T_2\} \tag{3-2}$$

$$TV = \frac{1}{k}\{Min[T_{ijmk} + (T_1 + \beta_m T_2 k)]\} \tag{3-3}$$

$$T_{ijmk} = \sum_{i=1}^{N}\sum_{j=1}^{J}\sum_{m=1}^{M} t_{ijmk}\cdot x_{ijmk} \tag{3-4}$$

$$T_1 = \sum_{i=1}^{N}\sum_{j=1}^{J}\sum_{m=1}^{M} t_{1ijmk} \bullet x_{ijmk} \tag{3-5}$$

$$T_2 = \sum_{i=1}^{N}\sum_{j=1}^{J}\sum_{m=1}^{M}\sum_{k=1}^{K} t_{2ijmk} \bullet x_{ijmk} \tag{3-6}$$

$$\beta_m = (1+E_m)^{-k_m} \tag{3-7}$$

$$t_{1ijmk} = \sum_{i=1}^{N}\sum_{j=1}^{J}\sum_{m=1}^{M}\left(t_{1ijmk}^{ed} - t_{1ijmk}^{st}\right) \tag{3-8}$$

$$t_{2ijmk} = \sum_{i=1}^{N}\sum_{j=1}^{J}\sum_{m=1}^{M}\sum_{k=1}^{K}\left(t_{2ijmk}^{ed} - t_{2ijmk}^{st}\right) \tag{3-9}$$

$$t_{ijmk} = \sum_{i=1}^{N}\sum_{j=1}^{J}\sum_{m=1}^{M}\left(t_{ijmk}^{ed} - t_{ijmk}^{st}\right) \tag{3-10}$$

Where TLE is the maximum duration of SCSS practices adopted for a customer; TV is the average time of SCSS practices adopted for a customer; T_{ijmk} is the Customer waiting time ; T_1 is the focal company's supply chain performance of customer's time; T_2 is the ssupplier social performance to customer's time; t_{1ijmk} is the customer i was served by the mmanufacturing firms m in the market J, t_{2ijmk}: The service time of the customer i in the penultimate sequence k in the market j by the manufacturing firms ; α is the weight of the customer's longest duration of SCSS practices adopted for a customer; β_m is the experience of the manufacturing firm m in performing the same type of SCSS adoption practices affects factors ; E_m is the total length of time a mmanufacturing firm m performs a similar strategies ; K_m is the mmanufacturing firm m completed the amputation learning effect parameters of the same kind of strategies ; t_{ijmk}^{st} is the customer i begins to wait for the start of the SCSS adoption practice to be performed by the mmanufacturing firm m in the market j ; t_{ijmk}^{ed} is the deadline for customers i to finish waiting to enter the market j for service by the mmanufacturing firm m ; t_{ijmk}^{st} is the starting time for the customer i to be served in the market j by the mmanufacturing firm m ; t_{1ijmk}^{ed} is the deadline for customers i to be served in the market j by a mmanufacturing firm m ; t_{2ijmk}^{st} is the start time of a customer i 's SCSS adoption practice in the market j by a mmanufacturing firm m ; t_{2ijmk}^{ed} is the deadline for customers i to be operated on in the market j by a mmanufacturing firm m and m_i is the manufacturing firm M_i is responsible for the number of supplier social performance customers。

Among them, taking formula (3.1) as the objective function and formula (3.2) as the social sustainability problem of the supply chain, the longest time, formula (3.3) represents the average supply chain performance time of the enterprise, formula (3.3) and formula (3.8) show that the waiting time of customers served by the manufacturer team in the company can be set to a fixed value by the customer satisfaction model based on the supplier's service time. Formula

(3.5) and (3.9) show supplier social performance customer by focal company during adaptation practices, service time, formula (3.6) and formula (3.10) show customers in the service zone by supplier social performance during a firm's supply chain performance time, formula (3.7) find out the influencing factors of manufacturing enterprises on the social sustainability of supply chain and the adoption of practice time.

4.2 Constraints of Focal Company's Supply Chain Performance Scheduling Model

In the process of supply chain performance scheduling, we will set constraints based on the relevant national laws and regulations, target market rules and regulations, service provided by supplier performance experience of the focal company and customer satisfaction. There are two main types of constraints, mainly hard and soft constraints, rigid constraint includes the supplier performance, labour laws and focal company, etc. This constraint must be met when generating supply chain performance scheduling. Each constrained supplier's customer service must meet all hard constraints; Soft constraints in this article mainly refer to manufacturing firms' workers, teamwork hours, supply chain social sustainability issues and adoption activities time, etc., suppliers are best not to work overtime, but due to various complications, this issue can't be avoided. Hard and soft constraints are listed and explained respectively below.

$$\sum_{m=1}^{M} y_{mb} = 1,\ \forall b = 1,2,\dots,M \tag{3-11}$$
$$\sum_{j=1}^{m_i} x_{mjr} = 1,\ \forall r = 1,2,\dots,m_i,\ \forall m = 1,2,\dots,M \tag{3-12}$$
$$m_1 + m_2 + \cdots + m_M = N \tag{3-13}$$
$$\sum_{r=1}^{m_i} x_{mjr} = 1,\ \forall m = 1,2,\mathrm{K},M,\ \forall j = 1,2,\mathrm{K},J \tag{3-14}$$
$$\sum_{i=1}^{N}\sum_{j=1}^{J}\sum_{m=1}^{M} t_{ijmk} > 0 \tag{3-15}$$
$$\sum_{i=1}^{N}\sum_{j=1}^{J}\sum_{m=1}^{M} t_{1ijmk} > 0 \tag{3-16}$$
$$\sum_{i=1}^{N}\sum_{j=1}^{J}\sum_{m=1}^{M} t_{2ijmk} > 0 \tag{3-17}$$
$$0 < \alpha < 1 \tag{3-18}$$
$$0 < \beta_m < 1 \tag{3-19}$$
$$E_m > 0 \tag{3-20}$$
$$0 < k_m < 1 \tag{3-21}$$
$$\sum_{j=1}^{J} t_{2ijmk} < 8 \tag{3-22}$$
$$\sum_{m=1}^{M} t_{2ijmk} < 8 \tag{3-23}$$

Formula (3.11) indicates that the focal company can accommodate manufacturing firm; Formula (3.12) indicates that manufacturing firm can employ many standard adoption practices; Formula (3.13) shows that the sum of the number of customers that each manufacturing firm is responsible for should be the total number of customers N ;Formula (3.13) indicates that focal company's supply chain performance can be performed for any customer; Formula (3.15), formula (3.16) and formula (3.17) respectively indicate that the customer *i* waiting time, supplier social performance time and adaptation practices time must be greater than zero; The probability of the maximum performance time of the customer is low, and the sum of the performance time and the average performance time of the customer should be 1. Therefore, in formula (3.18), α is less than 1; After manufacturing company employees with practical experience in providing similar services based on supplier performance should be more proficient, so the formula (3.19) $\beta_m$is less than 1 and greater than zero, the equation (3.20) as a result of the manufacturing firm staff in truncated learning effect, k_m is also within the range of less than 1 and greater than zero; Formula (3.22) indicates that the market (focal company) j of a department should be open for 8 hours in order to save service costs; Formula (3.23) stipulates that the working hours of the manufacturing firm staff m should be 8 hours, and the overtime should be avoided as much as possible, that is also in lane with the actual needs of focal firm's supply chain performance personnel.

5. Supplier Service Scheduling Mode

Social issues of the companies scheduling problem is a very complex mathematical optimization problem; this article uses a genetic algorithm founded on particle swarm optimisation for solving the established supplier social performance-scheduling model.

5.1 Particle Swarm Optimization and Genetic Algorithm Introduction

The particle swarm algorithm first initializes the particle's position and velocity randomly. In the one-dimensional search area where n random particles make a group, location and flight speed of the i-th particle in the dimension space is expressed as $X_i = (x_{i1}, x_{i2}, \cdots, x_{iD})$, $V_i = (v_{i1}, v_{i2}, ..., v_{iD})$, among them, $i = (1,2,\cdots,n)$, $d = (1,2,\cdots,D)$.The best place experienced by the i-th particle($pbest_i$) is recorded as $P_i = (p_{i1}, p_{i2}, \cdots, p_{iD})$. The best $gbest$ place () for all particles in the entire population is, $P_g = \left(p_{g1}, p_{g2}, \mathrm{L}\ , p_{gD}\right)$ its track-type equation is as follows:

$$v_{id}^{k+1} = wv_{id}^{k} + c_1 \mathrm{rand}_1^k (P_{id}^k - x_{id}^k) + c_2 rand_2^k (P_{gd}^k - x_{id}^k) \tag{4-1}$$

$$x_{id}^{k+1} = x_{id}^{k} + v_{id}^{k+1} \tag{4-2}$$

Among them, v_{id}^k : The speed of particle i in the d-th dimension of the k-th iteration; x_{id}^k : The current position of particle i in the d-th dimension of the k-th iteration; w : Inertia weight; c_1, c_2: Learning factor, or acceleration factor; c_1 $rand_1^k$, $rand_2^k$: Increases the randomness of particle flight, taking a random number between [0,1]; p_{id}^k : The position of the particle i in the d-dimensional individual extreme point; P_{gd}^k : The position of the entire population in the d-dimensional global extreme point. Maximum speed $V_{\max}$: It determines the strength of the problem space search, and the particle's speed v_{id}^k will be limited to $\left[-V_{\max}, +V_{\max}\right]$, assume that the search space is defined as interval $\left[-X_{\max}, +\mathrm{X}_{\max}\right]$, then usually $V_{\max} = kX_{\max}$, $0.1 < k < 1.0$ and each dimension is provided by the same method.

The initial application of genetic algorithms is the human use of computer simulation technology for a more in-depth study of biological systems. By simulating the phenomenon of species evolution in nature, the genetic algorithm has gradually evolved into a random global search and optimization method for model functions concerning Darwinian evolution theory and Mendelian genetics theory, tracing its roots. It is a method that can perform a worldwide search and is more efficient high optimization algorithm. In the course of finding the best solution, the genetic algorithm can automatically obtain, gradually accumulate, and effectively save the relevant information. At the same time, the search process can be controlled by an adaptive method, and the best solution can be obtained finally.

The speed of particle swarm optimization cannot be effectively adjusted dynamically, which results in a decrease in its search capability and a low convergence accuracy. This will make it difficult to jump out from local optimal traps. At the same time, for different problems, how to choose the right parameters to achieve the optimal effect is a particle one of the difficulties with the swarm algorithm is that the search performance depends excessively on the settings of the parameters. However, genetic algorithm coding is cumbersome, and it has an absolute dependence on the initial population selection. Genetic algorithm can effectively solve the problem of coding and the initial population. Therefore, the genetic algorithm founded on particle swarm optimisation is used to address the social issues of the companies and supplier social performance scheduling model.

5.2. The Algorithm Design Process

The design flow of the genetic algorithm based on particle swarm optimization is as follows:

(1) Determine the population size, the number of iterations, the maximum update speed, the minimum update speed, the starting inertia weight, the inertia weight to the maximum number of iterations, the learning factor c 1, the learning factor c 2, the maximum crossover probability, and the maximum crossover probability. For criteria such as minimal crossover probability, maximum variation probability, and minimum mutation probability, non-inferior solution sets are established.

(2) Using the particle encoding and decoding methods and the fitness function, compute the fitness value and obtain the fitness value of particle x.

(3) Based on the fitness value, individual extremum updating and population extremum updating are performed to establish the optimum particle swarm solution and replace it with the appropriate heredity.

(4) Determine the cumulative probability using the roulette strategy P. (i). Recalculate the particle swarm's fitness, update it, and perform particle swarm mutation. Choose the value with the best fitness after variation to do particle swarm update, individual update, and genetic update.

(5) In genetic operations, the non-inferior solution set is directly chosen using the better specific retention strategy, and the remaining individuals are chosen using random values; the crossover rate is calculated using the maximum and minimum crossover probability, the highest number of iterations, and so on, and in accordance with the random strategy, if the judgement is random. When the number is less than the crossover rate, the parents are crossed using the multi-parent (MPX) crossover technique to produce new offspring individuals; finally, the particle mutation rate is calculated using the highest and lowest variation probability as well as the maximum number of repetitions. If the rate of mutation exceeds the random number, then Determine the changed gene's location, use the insertion approach to modify the particle, recalculate individual fitness, and carry out particle swarm renewal, individual renewal, and genetic renewal;

(6) Do a neighbourhood search to discover the best solution, save the search result as the starting point for the next quest, and calculate both the optimal and average solutions simultaneously.

(7) Determine if the algorithm satisfies the termination requirement (maximum number of iterations or fitness value). If so, go to step 8; otherwise, return to step 2 to finish the solution.

(8) Make Gantt charts to determine the optimum option.

5.3 Main ideas of algorithm design

5.3.1 Particle Encoding and Decoding

(2) Decoding strategy

The market code is a randomly generated natural number code and dispatched to the customer's service task. It can clearly show the corresponding customer task for each target market. As shown in Table 1, market 1 has the task 1 4, 7, so we can get the supplier service schedule of No. 1 focal company for one day:

$$T = T_{(1,1)} + T_{(1,4)} + T_{(1,7)} \tag{4-3}$$

Inertia weight has a more significant impact on particle velocity but also affects the search accuracy and search speed of this algorithm. Therefore, a reasonable inertia weight setting is one of the considerable challenges to the algorithm. This paper sets the initial inertia weight ws and the inertia weight we when iterating to the maximum number. At the same time, according to the maximum number of iterations and the number of repetitions, the adaptive weight setting is performed. The specific formula is as follows:

$$\mathrm{w}(gn) = ws - (ws - we) \bullet [\frac{2 \bullet gn}{gn\max} - (\frac{gn}{gn\max})^2] \tag{4-4}$$

In the formula, gn is the number of repetitions, gnmax is the maximum number of iterations. The inertia weight obtained after the formula (4.4) is calculated can enable the particles to be adjusted in real-time according to the initial inertia weight, the number of iterations, and the maximum number of iterations when the speed is updated, which further enhances the performance of the algorithm in speed update.

Table 1: Coding strategy table

Customer	1	2	3	4	5	6	7	8
Market(Focal Company)	1	2	2	1	3	3	1	2

5.3.2 Fitness function

The fitness function in this article is performed by the customer during the supplier service in the market (focal company), as follows:

$$f_j(x) = \sum_{\mathrm{i}=0}^{n} T_{ij}(x) \tag{4-5}$$

$f_j(x)$ is the fitness value of the particle x, that is, it represents the time when a particular customer i is undergoing service by supplier in the market (focal company) j, and $\sum_{\mathrm{i}=0}^{n} T_{ij}(x)$ is the total length of time the customer i is experiencing service by supplier in the market (focal company) j (sum of service by supplier waiting time, supplier social performance time, and focal company's supply chain performance time).

5.3.3 Updating Strategy of Globally Optimal Solution

In this paper, the non-inferior solution set of particle population is judged by Roulette, and the optimal solution is finally screened. This paper randomly selects one particle as P_{besti} and the cumulative probability of individual i being selected by roulette is:

$$P(i) = \sum_{j=1}^{i} q(j) \tag{4-6}$$

Among them

$$\mathrm{q}(j) = \frac{f_j(i)}{\sum_{i=1}^{N} f_j(i)} \tag{4-7}$$

In the formula, N is the population number; $f_j(i)$ is the fitness value of the individual i.Generate a $[0,1]$-interval random number r, find the subscript value in array P that satisfies

$$P(i) \le r < P[i+1] \tag{4-8}$$

5.3.4 Population Diversity Conservation Strategy

The particle swarm optimization algorithm and ~~the~~ genetic algorithm are merged in parallel in this paper. The better individuals generated by the particle swarm algorithm are added into the genetic algorithm. The specific design is as follows:

(1) Select Performance

we use the method of retaining the best individual and roulette method in the process of selecting individuals. The non-inferior solution set generated by the particle swarm algorithm is the better value, and it directly enters the next generation of the genetic algorithm. The remaining individuals compare the random number based on the market method to find a better individual and join the next generation of the genetic algorithm.

(2) Crossover Performance

After the completion of the field selection performance, the second step is to perform the crossover performance. This article crosses through the multi-parent (MPX) crossover method [10]. The individual parent particles are denoted as p_1, p_2 respectively. After crossover, the generated child particles are indicated as c_1 and c_2, respectively.

The specific steps are: First, randomly generate a set of binary sequences, where the series maintains the same dimensions as the particles, and then form a one-to-one correspondence between the values in the series and individual particles; then look at the random sequence, and set the random sequence value to 1 The parent particles exchanged each other and passed the result of the exchange to children c_1 and c_2. This crossover operation adjusts the numbering of the operating room and completes the actual scheduling. Finally, the remaining individuals in the p_1, p_2 parent particles are copied into the corresponding c_1 and c_2 respectively. This results in a new individual.

In the mutation operation, this article uses the insert method to deal with it. This method is based on keeping the original gene sequence, randomly searching for a gene (except for the first sequence), and then randomly inserting it into the progression of the gene before it. The other genes can only be translated backward in series. In this way, a new individual can be found. For example, as shown in Figure 4. Inserting the eighth position in the parental individual, that is, the gene of the market (focal company) 1 into the fourth position, the gene after the fourth position is sequentially copied to the middle, and finally, the last gene is discarded, and the individual is established.

Figure 4 Schematic diagram of mutation operation

P_1	1	2	2	3	1	3	2	1	3	3	2	1
C_1	1	2	3	1	3	1	3	2	1	3	3	2

The above algorithm can fully guarantee the avoidance of local optimal traps in the process of solving and improve the performance efficiency and stability of the algorithm through the design of the above vital steps. The verification of the example can prove the effectiveness of the algorithm in solving the social issues of the companies and supplier social performance scheduling model.

6. Results Analysis

6.1 Analysis of Customer Satisfaction Model

In this work, we collected a large amount of experimental data from M focus company (target market) and investigated the relationship between the experimental data and the applied model. It is important to note that when the supplier on duty informs the customer of the supplier social performance time, he or she should explain that the time is uncertain due to factors such as manufacturing firm preparation and adaptation practises, the uncertain state of the focal company, and the preparation and call of the focal firm's social issues. While the majority of customers understand and actively participate in the company's activities, a few customers and family members complain.

Figure 5 the relationship between statistical data and this model

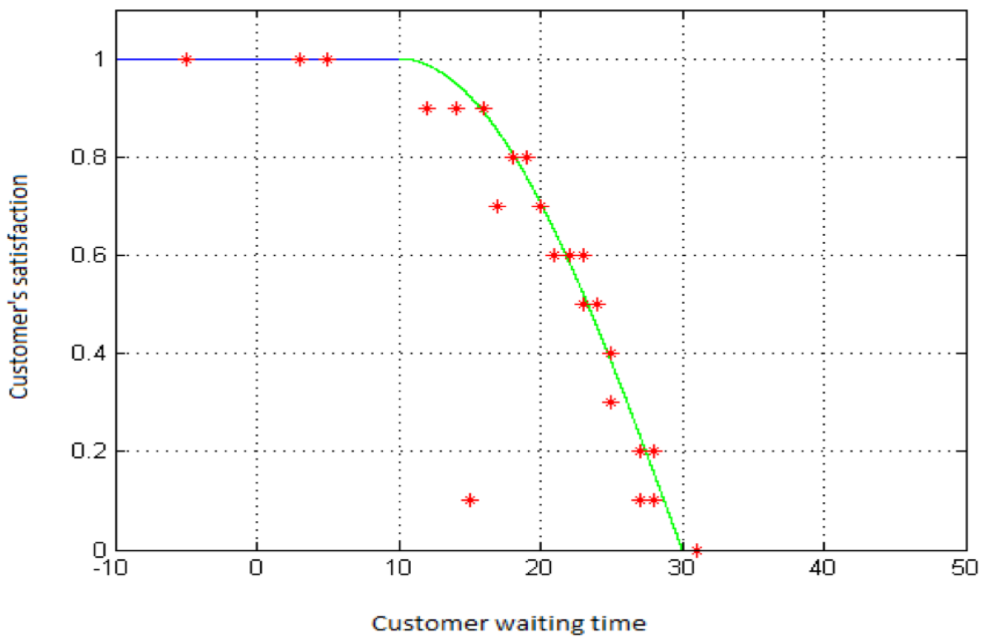


Table 2 is part of the customers' waiting time and satisfaction statistics, which shows the data of 25 customers. The data include the expected social performance time, actual supplier social performance time, waiting time, and customer satisfaction survey results. In order to see the correctness of the model intuitively, we combine the statistical data with this model and generate the relationship diagram between statistical data and the model as shown in figure 5.

From figure 5 and Table 2 we can see that the customer satisfaction model based on fuzzy membership is consistent with reality. The customer's service time is likely to be short, but the probability of this is very low, and the possibility that the customer's mood swings are very low because the supplier will communicate with the customer before the service is performed. Overall, the customer satisfaction model in this paper is in line with the actual situation of customer satisfaction.

Through investigation and analysis of M target market (focal company); it is found that customer's satisfaction is more reasonable when customers' waiting time is between 15.74 minutes and 21.8 minutes. However, in the actual service provided, customers' waiting time should be a definite value; otherwise the supplier social performance schedule cannot be carried out. The service by supplier time in this article is 18 minutes.

Table 2 data on customer waiting time and satisfaction statistics

Customer number	Notify the service time	Actual service time	Waiting time /	Satisfaction survey
1	8:30	8:33	3	1.0
2	10:30	10:46	16	0.9
3	9:00	9:28	28	0.2
4	10:00	10:05	5	1.0
5	9:20	9:37	17	0.7
6	9:30	9:19	19	0.8
7	13:00	13:21	21	0.6
8	14:20	14:32	12	0.9
9	15:00	14:55	-5	1.0
10	16:10	16:35	25	0.3
11	16:20	16:47	27	0.1
12	9:00	9:14	14	0.9
13	9:30	9:53	23	0.5
14	10:00	10:20	20	0.7
15	10:00	10:18	18	0.8
16	10:30	10:52	22	0.6
17	11:00	11:23	23	0.6
18	14:00	14:25	25	0.4
19	15:00	15:28	28	0.1
20	15:20	15:44	24	0.5
21	16:00	16:27	27	0.2
22	17:10	17:41	31	0.0
23	9:00	9:15	15	0.1
24	9:30	9:48	18	0.8
25	10:20	10:42	22	0.6

6.2 Analysis of the results of supplier service scheduling in this paper

6.2.1 Original data description

By operating M target market (focal company) and the condition of the manufacturing firm, we can conclude that each target market (focal company) has its own separate manufacturing firm. Since the total length of E m differs per manufacturing firm and the shorter learning effect k m differs, so does the time spent on the identical service performance. Therefore, we first calculate the empirical effect factor _m for each manufacturing business. We utilize M target market (focal company), company 1 and company 2 to verify the thesis. Tables 3 and 5 reveal the number of the manufacturing business in the first row. The total service time of any manufacturing business is E m hours. The first row numbers in tables 4 and 6 reflect customer numbers. In table 4, for example, customer 1 in focused firm 1 has 1.2-hour operation.

Table 3 Department 1 manufacturing firm parameters

	1	2	3	4	5
E_m	86	82	102	95	93
k_m	0.008	0.009	0.004	0.007	0.006
β_m	0.9736	0.9611	0.9816	0.9686	0.9731

Table 4 Department 1 focal company for initial supplier service schedule

No. of Firms	1	2	3	4	5	6	7	8	9
Manufacturing Firm 1	1	0	0	0	0	0	1	0	0
Manufacturing. Firm 2	0	1	0	0	2	0	0	0	0
Manufacturing Firm 3	0	0	2	0	0	0	0	1	0
Manufacturing Firm 4	0	0	0	0	0	1	0	0	0
Manufacturing Firm 5	0	0	0	1	0	0	0	0	1
	10	11	12	13	14	15	16	17	18
Manufacturing Firm 1	0	1	0	0	0	0	2	0	0
Manufacturing Firm 2	0	0	0	2	0	0	0	2	0
Manufacturing Firm 3	0	0	0	0	2	0	0	0	0
Manufacturing Firm 4	2	0	0	0	0	2	0	0	0
Manufacturing Firm 5	0	0	1	0	0	0	0	0	2

Table 5 Department 2 medical team parameters

	1	2	3	4	5	6
E_m	96	86	83	75	112	80
k_m	0.006	0.009	0.007	0.009	0.006	0.007
β_m	0.9730	0.9607	0.9695	0.9618	0.9720	0.9698

Table 6 Department 2 operation room for initial operation schedule

	1	2	3	4	5	6	7	8	9	10
Manufacturing Firm 1	1	0	0	0	0	0	0	0	2	0
Manufacturing Firm 2	0	2	0	0	0	0	2	0	0	2
Manufacturing Firm 3	0	0	0	0	1	0	0	0	0	0
Manufacturing Firm 4	0	0	0	2	0	0	0	1	0	0
Manufacturing Firm 5	0	0	2	0	0	1	0	0	0	0
Manufacturing Firm 6	0	0	0	0	0	0	0	0	0	0
	11	12	13	14	15	16	17	18	19	20
Manufacturing Firm 1	0	0	1	0	0	0	0	0	2	0
Manufacturing Firm 2	0	0	0	2	0	0	1	0	0	0
Manufacturing Firm 3	0	0	0	0	2	0	0	0	0	1
Manufacturing Firm 4	2	0	0	0	0	0	0	0	0	0
Manufacturing Firm 5	0	0	0	0	0	0	0	2	0	0
Manufacturing Firm 6	0	3	0	0	0	2	0	0	0	0

Tables 3 and 5 include formulae for calculating the overall duration E m, the reduced learning effect k m, and the performance influence factor. (3-7). The performance effect factor _m of each manufacturing business was calculated. These values are entered into the associated table. The initial timeline for each manufacturing enterprise is as follows. Department 1 has 5 manufacturing businesses, 5 supplier workers, and 18 daily scheduled clients; Department 2 has six manufacturing firms, 6 supplier personnel, and 20 regular schedule customers.

Manufacturing businesses employed M market (focal business) adoption methodologies. Consequently, this table computes the length of the adaptation processes as well as the model calculation based on the linear relationship between the customer satisfaction model and the customer waiting time. Customer satisfaction and unanticipated events that may occur during the supplier's operation are considered. The waiting time has been cut in half to 0.3 hours (18 minutes). Following the gathering of raw data, we establish the supplier service schedule and output it using a Gantt chart and a fitness convergence diagram.

6.2.2 Analysis of Adaptation Practices Procedure

The test findings are shown in Gantt charts in this article. The axis of this chart is time, while the axis of this chart is the number of manufacturing firms. The Gantt charts for sections 1 and 2 of the adaptation practices. The abscissa indicates the total time spent by each manufacturing firm, the ordinate shows the number of manufacturing businesses, and the colour blocks represent the customers in the diagram. How the fitness curve changes throughout the supplier service scheduling procedure. The number of iterations is represented by the cross coordinates, the size of the fitness value is represented by the ordinate, the red line represents the change in the algorithm's fitness curve, the green line represents the transformation of the particle swarm optimization's fitness curve, and the blue line represents the average solution of the two algorithms. At the same time, the graph represents the perfect fitness response. The best solution in all manufacturing organizations is the longest total length of service performance. The maximum total length of standard adaptation practices in Section 1 is 7.3112, and the maximum total length of standard adaptation practices in Section 2 is 6.976.

Adaptation practices section 1 can be used to calculate the supplier service time of each manufacturing firm. The time for the standard adoption practices j is the time for each customer in this supplier service multiplied by the number of customers then by the waiting time. For example, in manufacturing firm 1, we can obtain the total length of supplier service, from table 2 we have the customers 1, 7, 11, 16 are undergoing adaptation practices in manufacturing firm 1, they are served on 1.2, 1.3, 1, 2, respectively. $T_1 = 1.2+1.3+1.0+2.0+4*0.4 = 7.1$ hours. The total time for supplier service in manufacturing firm 2 is $T_2 = 1.0+1.6+1.8+2.1+4*0.4 = 8.1$, the full length of the 3, 4 and 5 adaptation practices in the manufacturing firm is $T_3 = 6.5$, $T_4 = 5.4$, $T_5 = 7.1$. Thus, 2 had exceeded the working time, and 4 had more free time. Using the adaptation practices of this algorithm, we can calculate the working hours of each manufacturing firm according to the customer's service time (ignoring the effect of the mmanufacturing firm on the adaptation practice time). For example, four customers 11, 7, 16, 2 who have been served on firm 1. The service time of firm 1. $T_1' = 1.0+1.3+2.0+1.2+0.4*4 = 7.1$, similarly, manufacturing firm 2 service time is $T_2' = 7.5$, $T_3' = 6.5$, $T_4' = 6.3$, $T_5' = 7.1$, the time arrangement is more reasonable.

Similarly, we analyzed the service schedule of 2 of M focal company. Before the schedule, the total length of the service in 1, 2, 3, 4, 5, 6 of the manufacturing firm were $T_1 = 7.2$, $T_2 = 10.4$, $T_3 = 5.4$, $T_4 = 5.4$, $T_5 = 5.5$, $T_6 = 5.5$; after the scheduling, $T_1 = 7.2$, $T_2 = 6.4$, $T_3 = 6.8$, T_4=6.1, $T_5 = 6.0$, $T_6 = 6.5$. Through the above analysis, the model has a significant effect on optimizing the supplier service schedule, which is practical and reasonable for scheduling and analysis.

We also output the fitness curve of particle swarm, the fitness curve of the algorithm and the average value of the two algorithms. We can see that the application of particle swarm and this algorithm almost output the same optimal solution. At the same time, we can see that when the two algorithms begin to iterate, the PSO algorithm has a significant fluctuation. The algorithm is relatively stable. In the iterative process, it is evident that the convergence of the algorithm is relatively fast, and the optimal solution can be found quickly, and it has an advantage in the rate. Therefore, it can be concluded that the algorithm is stable as the particle swarm optimization algorithm, and it is optimization speed is fast.

6.3 Discussions of the Study

This research aims to solve the social problems highlighted in the company report and the way those themes are linked to SCSS. In addition, the study aims to evaluate the implementation of these activities in various industrial fields through a hypothetical perspective of stakeholders and legal concepts. The data examination from the Pakistani companies reports indicated so many supply chain social sustainability issues belong to various orientations that are inspired by stakeholder teams. We divide all research activities into three categories, applicable to three supply chain activities: (1) social issues related to suppliers, (2) social issues of companies, and (3) all issues associated with customers. Our research conclusions are consistent with (Zulfiqar & Thapa, 2017) 's conclusions obtained through data analysis of 100 globally renowned companies that implement institutional perspectives, and prove that institutional pressure is forcing companies to incorporate social and environmental activities into their supply chains.

At the same time, the views of stakeholders indicate that stakeholders continue to increase information on sustainability issues, which will increase the burden on the company and enable them to link their struggles related to sustainability in the sustainability report, thereby Provide necessary knowledge for social and environmental activities Mena, Hult, Ferrell, and Zhang (2019); Veronica, Alexeis, Valentina, and Elisa (2020). Suppliers ’unethical behaviour and philanthropic challenges are reported in the results of all companies’ sustainability surveys. Although the supplier ’s philanthropic challenge is influenced by companies that want to establish legal relationships with their stakeholders, it is reported that strict caution on unethical behaviour is the product of institutional arrangements (García-Herrero, De Menna, & Vittuari, 2019). Those findings suggest that institutional and lawful arrangements have a part in sustainability acceptance and reported activities. Though, their results show that sustainability related to product on the upstream and downstream supply chain are less reported or limited. The results of the current study are different because we searched reports on products related to Pakistani companies for more sustainability reports from various sectors of the industry. This study shows that areas related to the social sustainability of suppliers will lead future scholars to conduct more empirical research in various socially relevant combinations of developing economies.

Secondly, through the implementation of the theoretical basis of stakeholders, we have obtained many sustainable reporting activities of key companies. Use the concept of "social responsibility" to deal with the company's approach to nearby society. The same findings were obtained through the analysis of the sustainability report of German companies (Formentini & Taticchi, 2016).According to stakeholder theory, the activity is stated in the sustainability loophole to effectively connect the company’s good behaviour with society, which will improve the organization ’s position among stakeholders (Ma, Harstvedt, Dunaway, Bian, & Jaradat, 2018). Through data analysis of social activities implemented by the company, our findings are the same as (Morad, Choong, & Tungsanga, 2015).

Thirdly, our study also shows the customer-centric social activities implemented by Pakistani companies. those comprise of diversity, product responsibility, customer education, compliance, health and safety, labelling, philanthropy and privacy. The companies show non-discrimination and diversity in customer selection and promotional practices in all areas. In every system, including service activities, the challenges of product liability are emphasized, including product marking and labelling, compliance with regulations, customer health, safety and privacy of customer. Companies are progressively adept at reporting the best activities of their clients to strengthen relationships with stakeholders, which always affects business and sustainability (Tong et al., 2018). Few researchers have questioned the reliability of sustainability reports. Most reports attempt to strengthen company connections strategically to obtain higher value among stakeholders. Our findings are in lane with (Arcese, Lucchetti, & Massa, 2017) which discovered the sustainability challenges in Pakistan fashion industry, such as health and privacy problems. Therefore, they stressed improved stakeholder connection efforts to develop relationships with additional stakeholders.

Same findings were obtained by (Kronfeld-Goharani, 2018) in European retailers related to health and safety of the customer, customer satisfaction, privacy of customer and labelling issues. But they said that some customers ’concerns have been seriously resolved, including an opportunity to improve the growth of diversity and follow human rights policies at a distance, employee sustainability training, anti-corruption, bribery activities, political assistance and leakage. On the contrary, our survey of Pakistani companies shows that there is no activity other than immorality and corruption. This issue has been widely reported worldwide. Our research presents fertility and new insights, which play a profound role in the sustainable development of the supply chain society organized by Pakistan. Social challenges depend on time, motivation, relatives and future research in various social environments (Lee & Jung, 2019). Our findings are helpful in this regard, because this is the first time Pakistani companies have emphasized how to deal with supply chain academic research. The social sustainability challenge is indeed one of the few issues in the literature about the understanding of developing economies. Therefore, these findings and the given conceptual model can be used as the basis for more and more in-depth research on the social challenges related to the supply chain. In addition, the research contributes to the academic literature by filling developing economies' understanding of supply chain social sustainability (SCSS). For experts and policy makers, practitioners and policy intruders can use the survey results (supply chain social sustainability taxonomy) as indicators or assessment tools. This helps to recognize the main sustainable development space and formulate policies to improve industrial performance and respond to certain variables of social sustainable development challenges. The scope of reporting with the "Sustainable Development Report of Pakistan Companies" is limited. Our research is also used as a standard comparison tool for Pakistani companies to establish sustainability processes in their supply chains.

7. Conclusion

The purpose of this study is to examine the practise of supply chain social sustainability in manufacturing and how it connects to customer happiness as well as supply chain social sustainability. This article defines an acceptable waiting time frame depending on the length of the customer service waiting time. By locating the membership function model, the model is evaluated based on the waiting time window constraints. The number of manufacturing firms, the number of manufacturing firm adaptation techniques, and the accuracy of the customer satisfaction model have all been verified. This article is based on a variety of factors, including the customer care team, the number of manufacturing companies, the maximum service time, and the average service time.

In order to address the social challenges in the supply chain, we created a taxonomy of supply chain social sustainable development techniques in this study. Moreover, based on the actions reported in each organisation, we construct an implementation index, and the selected organisations document their activities using global reporting process standards. Based on the findings of the research area specified in the literature on the social sustainability of the supply chain, we identify and categorise the 29 supply chain social activities carried out by manufacturing organisations. Moreover, we conducted an empirical inquiry to discover where the selected organisations carried out certified activities.

The multi-objective rule theory is used in this research to develop new standard implementation techniques in manufacturing businesses by using customer contentment while waiting for service and the effect of the production team on standard adaptation processes. To do this, we first categorised the firms by industry type and size. 29 SCSS activities have been awarded to businesses from a variety of industries. Next, we recognised each company and its reporting activities based on taxonomy. In addition, we used a pre-set indicator to calculate the rate of activity implementation.

The optimal solution to SCSS (supply chain social sustainability) issues is obtained using particle swarm optimization, and a reasonably fair and feasible scheduling scheme is established, and standard implementation activities in manufacturing companies are compared to the experimental chart to verify the algorithm's effectiveness and practicability. Finally, this study may be valuable for small and medium-sized enterprises (SMEs) seeking to enhance sustainability but without the resources to analyse the steps to be done. Additionally, this delivers first-hand data for academics in poor countries, culminating in supply chain social sustainability for competitiveness.

7.1 Limitations and Future Recommendations

Our research has few limitations. Although we make every attempt to identify reports that are standardised, their standardisation is still relatively low (GRI compliance rate is quite low), therefore there may be some variances. Moreover, since we only choose enterprises that are listed on the Karachi Stock Exchange and members of the Pakistan BCSD, the sustainability report used in this study is biased. In addition, we selected companies that provide sustainability reports in English, but not all of them in Urdu. As a result, several critical firms were excluded from our research.

Moreover, the company's report may provide eco-friendly cleaning and decoupling options. Green cleaning suggests that it is difficult to align customer expectations with unrelated sustainability practise documents. On the other side, the firm has adopted "symbol management efforts". A series of image management initiatives aimed at gaining social acceptability (empty green excuses, sustainability-related rules and policies).

Moreover, it is recommended that the organisation participate in a communication fight to distract stakeholders' attention and so conceal immoral and unethical business practises. The last hurdle is the small size of non-financial disclosures made by industrial businesses. Consequently, only a few suggested outcomes may be randomised and generalised. To alleviate some of these limitations, more samples from Pakistan may be used to do the same analysis on South Asian economies, allowing for further research. Future research derived from this study may serve as a basis for sustainability practitioners and academics to analyse, test, verify, and assess emerging economy statistical results. This study might be improved or extended by comparing the outcomes of East Asian, European, and South Asian economies.

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