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# The Relationship of Lean Production and Sustainable Supply Chain by Using Group TOPSIS Method

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**Abstract:** The aim of this project is discovery the relationship of lean production and sustainable supply chain by using group TOPSIS method. So far, many studies is provided to provide a logical relationship between of lean manufacturing and green supply chain. As we know, green supply chain is only due to environmental factors. While, to achieve a sustainable supply chain in addition to environmental factors, social factors should also be considered. Since, the removal of waste from the production process and maximize system performance is the main basis for of lean manufacturing, we will have cleaner production. This aim is to comply with environmental factors. If show the basic elements of lean manufacturing thinking are in line with social factors, we can conclude that thinking of lean manufacturing is the perfect tool to achieve sustainable supply chain. Concurrent with the implementation of these two ideas together may not be simple but in case of possible causes will make more profit.

**Key words:** Lean production, sustainable supply chain, thinking of lean manufacturing, production, environmental factors

## INTRODUCTION

Globalization and outsourcing have increased the complexity of the supply chain. Despite this complexity, stability and sustained recovery is considered more than before. World commission on environment and development will present to the world the concept of sustainability. This concept of sustainability is defined as follows: needs of the present without compromising and agreed with ability of future generations to satisfy their needs. The United Nations repeatedly has announced their participation in the system stability by measures such as agenda 21 and millennium development goals. On the other hand, stable is outlook for many companies and organizations large and small.

Sustainable supply chain has its roots in the supply chain; this means that sustainable supply chain is based on the basic concepts of supply chain. Harland (1996) defined supply chain as follows: managing a network where a number of sectors in order to meet the needs of customers are interacting with each other. With the addition of the concept of sustainability into the supply chain cannot form a new phenomenon called sustainable supply chain. As defined by Carter and Rogers sustainability is a combines of concepts of social, environmental and economic point out that. Srivastava (2007) sustainability as follows: reduction long-term risks that destroys of sources, reduction fluctuations in energy prices, reduction product liability, reduction environmental pollution.

As you know, in this definition is considered only an environmental standpoint and social perspective not seen it yet. But in contrast to this definition, Sikdar (2003) has another perspective which includes perspective social, environmental and economic. According to this definition, sustainability means: balance between economic growth, environmental stewardship and social justice.

According to this view, the new definition was shaped by Carter and Rogers in the supply chain in order to balance the concepts of environmental, social and economic, it called sustainable supply chain and defined as follows: the success integrating a strategic and economic objectives, environmental and social sectors that interact over a network. This success the improved economic situation of the individual parts of the network and increase network value in the long term.

Figure 1 (home sustainable supply chain) shows different concepts of sustainable supply chain. This figure is displayed for a house. The house consists of three main pillars that are necessary to balance this required column. Table 1 review articles in the field of social and environmental sustainable supply chain.

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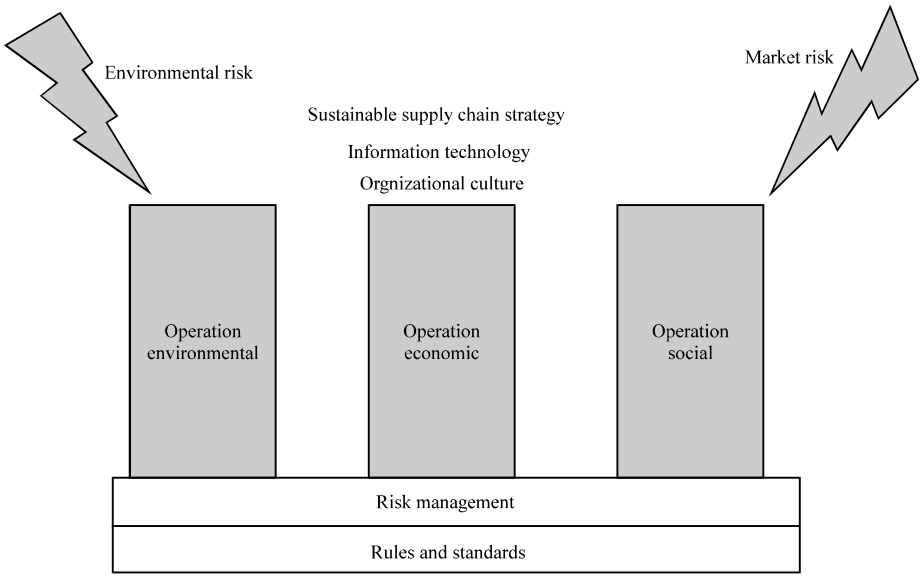


Fig. 1: Sustainable supply chain

Table 1: The literature review of published papers in various spheres of sustainable supply chain

| | | Sustainability methodology | |
|---|---|---|---|
| Researchers | Titles | Environmental | Social |
| Vachon, Mao | Linking supply chain strength to sustainable development: a country-level analysis | ✓ | ✓ |
| Cote | Influence, practices and opportunities for environmental supply chain management in Nova Scotia SMEs | ✓ | |
| Kovacs | Corporate environmental responsibility in the supply chain | ✓ | ✓ |
| Ciliberti | Investigating corporate social responsibility in supply chains, a SME perspective | | ✓ |
| Sigala | A supply chain management approach for investigating the role or tour operators on sustainable tourism: the case of TUI | ✓ | ✓ |
| Preuss and Walker | Fostering sustainability through sourcing from small business: public sector perspectives | ✓ | |
| Bala | Experiences with greening suppliers,the Universant Autinima de Barcelona | ✓ | |
| Ellarm | Applying 3DCE to environmentally responsible manufacturing practices | ✓ | |
| Lai | An economic and environmental framework for analyzing globally sourced auto parts packaging system | ✓ | |
| Tsoulfas and Pappis | A model for supply chains environmental performance analysis and decision making | ✓ | |
| Schmidt and Schwegler | A recursive ecological indicator system for the supply chain of a company | ✓ | |
| Georgiadis and Besiou | Sustainability in electrical and electronic equipment closed-loop supply chains: a system dynamics approach | ✓ | |
| French | Improving sustainability through effective re-use of product returns-minimizing waste in a batch blending process environment | ✓ | |
| Hutchins, Sutherland | An exploration of measures of social sustainability and their applicationto supply chain decisions | | ✓ |
| Seuring and Muller | Literature review of peer-reviewed publications on sustainable supply chain management | ✓ | ✓ |
| Cruz | Dynamics of supply chain networks with corporate social responsibility through integrated environmental decision-making | ✓ | ✓ |
| Perry and Towers | Determining the antecedents for a strategy of corporate social responsibility by a small-and medium-sized enterprises in the UK fashions apparel industry | ✓ | ✓ |
| Amaeshi | Corporate social responsibility in supply chains of global brands: a boundary less responsibility? | ✓ | ✓ |

According themes introduced by these articles can be concluded that majority papers have considered sustainable supply chain environment and few in the social sphere or a combination of these two areas examined in the study. Recent studies have been in the field of combining these two and as we continue, we will express the combination of the three areas of sustainable supply chain issue new papers in the field. Kolk and Van Tulder reviewed the role of social indicators and promote sustainable in their international careers. Kates *et al.* (2005) began to study some of the environmental and social standards for extracting main to social and environmental indicators to supply chain.

Table 2: Review of published articles until 2008 in the field of sustainable supply chain

| Parameters | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Technological | 0 | 2 | 1 | 1 | 2 | 0 | 0 | 1 | 2 | 2 | 3 | 4 | 2 | 1 |
| Organizational | 1 | 2 | 1 | 1 | 1 | 3 | 2 | 2 | 1 | 2 | 3 | 4 | 4 | 2 |
| Legal | 1 | 3 | 0 | 1 | 1 | 0 | 4 | 1 | 0 | 2 | 4 | 1 | 2 | 5 |
| Economic | 2 | 2 | 1 | 3 | 4 | 0 | 2 | 6 | 5 | 9 | 6 | 5 | 5 | 4 |
| Psychology | 0 | 1 | 0 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 1 | 2 | 4 | 2 |
| Social | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 0 |
| Total | 4 | 11 | 3 | 7 | 10 | 4 | 10 | 12 | 9 | 16 | 17 | 17 | 19 | 14 |

Teuteberg and Wittstruck reviewed papers published articles in 2010 that focused on sustainable supply chain. Papers published until 2010 in terms of solutions, methods and mentioned concepts in the field of sustainable supply chain and published journals. Table 2 review of published articles until 2009 in the field of sustainable supply chain.

In 2009, Adam Werbach proposed two theories: first theory is implementation strategies for the sustainability of the supply chain and improve the durability of jobs in the supply chain. The second theory, only economic index or environmental cause will not be a sustainable supply chain. But should be considered together all the parameters. Fourth index is culture index and the new definition for every four indices was as follows.

**Economic index:** The set of all activities affecting on the people economic and businesses.

**Social index:** The set of all activities that affect all parts of society. Including health, security, poverty, violence, education and so on.

**Environmental index:** The set of all activities that affect all parts of environmental. Including climate change, pollution, conserve natural resources and so on.

**Culture index:** The set of all activities that people with identity, traditions, culture, habits and values reveal (Adam, 2009).

Pagell and Wu (2009), examined 10 companies presented case studies where the output of social and environmental indicators. In these companies, social indicators are taken into consideration. Based on the continuity of the supply chain, tracking materials and complete price transparency and the relationship between well-being and social responsibility for each member shows the supply chain.

Uysal (2012) by using DEMATEL measured relationship between sustainable supply chain evaluation criteria and their impact on chain operator. DEMATEL is a comprehensive method for forming and analysis a structural model and by using the theory of graphs showing the relationship between the variables (Uysal, 2012).

Razmi *et al.* (2013) provided a model of the three-level supply chain inventory control and transportation. This model has two objectives. The first objective is minimizing the total cost of transportation and inventory costs and lack of maintenance and the second objective is to maximize the social indicators in the chain (Razmi *et al.*, 2013).

So far, many studies is provided to provide a logical relationship between of lean manufacturing and green supply chain. As we know, green supply chain is only due to environmental factors. While to achieve a sustainable supply chain, in addition to environmental factors, social factors should also be considered. If demonstrate that the basic elements of lean manufacturing thinking, are in line with social factors, we can conclude that thinking of lean manufacturing is the perfect tool to achieve sustainable supply chain.

Is the core concepts of lean production contribute to the implementation of sustainable supply chain? What is the impact of each factor lean production on the implementation of sustainable supply chain? Whether companies can of lean production framework as a catalyst to achieve their sustainable supply chain (Cadozier, 2002).

## MATERIALS AND METHODS

**Explain the relationship between lean production and social indicators by using questionnaires:** In this part of the study, we consider to explain the relationship between lean production and social indicators by using questionnaires. The aim of this questionnaire is to explain the relationship between sustainable supply chain and lean approach and whether lean approach can check whether to apply or not to implement sustainable supply chain. At first, some of the most important criteria are defined and listed in the following questionnaire. Social indicators mentioned in the questionnaire is derived from article of Razmi *et al.* (2013).

### Key indicators on social issues

**Moral responsibility:** In an organization moral responsibility (accountability quality) improved internal standards and individual guidance and group. Quality response will lead to economic stability and environmental (WCED, 1987). Quality response has a fundamental role in improving the economic quality.

Kadvizer about the characteristics of people who have professional ethics states the following: responsibility, hegemony and competitiveness, honesty, respect for others, respect towards the values and norms of society, justice and judgment, empathize with others.

**Human resources in the range of legal age:** Human resources underage work means recruitment of children for economic activity either part-time or full-time. The use of children as labor force will be reduced physical capacity and mental. Poverty, lack of education causes this phenomenon is appropriate.

**Cultural heritage:** Create new job opportunities should not be such that loss and destruction of cultural monuments and community.

**Freedom:** Freedom of having chosen the right partner or rejection in collaboration with a group.

**Transparence:** Transparency in science, engineering, business and the community is used indicates a clear, accurate communication and moral responsibility. In fact, transparency means implementation of an act of so that the implementation of the action to be absolutely clear and evident.

**Environment:** Environment includes all external factors and the company that affects a company's operations or affected on the performance of organizations and companies. These factors include: customers, competitors, shareholders, suppliers, industry and so on. On the other hand, business environment, social environment, technology, economy and politics is a business which it operates.

**The definition of suitable work environment**: The physical conditions of the workplace including work space, type tables and chairs, tools that work with them, computer equipment, type of layout tables, a breakdown by type of work spaces various groups and so on. The suitability of these circumstances, the basic requirements for increasing the efficiency of individuals.

The next item is the workplace mental conditions. Psychiatric conditions, including those who work with them. Despite friendly relations between individuals could have played a role in increasing the quality of work. Mutual trust between managers and employees of other items in the field. Many people want to progress in their work and love their work environment available it possible. Existence a balance in the workplace can be a very important factor, for example, the balance between the rights of individuals and their expertise, treat people the same company law, the timeliness of the payment.

**Development of social:** Development means is improving of social current state of a group of people to implement incentive policies to expand employment opportunities. This can be by taxing policies and long loans by governments. Development of social servers need to know about how to work with people and how to influence the community as well as potential locations in the country are completely familiar with. Creating job opportunities is very important due to its indisputable role in reducing poverty and inequality. Population explosion of births during 1983-2006 and its appearance as the labor supply in the years 2004-1989 led to the rate of labor force were more job opportunities. Problem of unemployment, especially among the educated classes and university expands with acceleration and loss of huge human resources and a large majority of the population is suffering and poverty. Therefore, we can create job opportunities and reduce poverty, prevent economic power in the macro and micro levels.

**Hours of work:** Working hours is said for a period of time to have a person to do a specific job to do. Many countries have specific rules for the maximum working hours per week, minimum daily rest periods and annual holidays. Working hours is different for people and depending on the individual, the individual and society to work together.

Standard working hours (the normal working hours) to the legislation on working time limits daily, weekly, monthly or annual reference. If a human resources need to overtime, the employer must pay wages for overtime hours to him. Typically, normal hours of work in most countries is about 40-45 h per week and overtime pay is about 25-50% of normal working hours. Maximum working hours is maximum working hours which is a human resources can work and most of the work permit is not required by law.

**How to select personnel:** In some organizations, people are used to that, there is not proportional between the content of the post office and attitudes, desires, motivations and abilities. In the absence of skilled manpower and efficient or inability to use correctly and efficiently with the forces available, organizations will be able to affect the environment and don't succeed in competition.

**Key indicators on environment issues**

**Pollution:** There are different forms of pollution, air pollution, water pollution, radioactive pollution, soil pollution and heat pollution. Pollution standards provide

a uniform system for measuring pollution levels. This standard has been provided by the Environmental Protection Agency (USEPA) and that is offered on a daily basis in the media. These standards are reported in the range of 0-500. Each number indicates whether, contaminants in surface area has a low, medium or high.

**Key indexes of lean production**

**Speed increase production, reduce times and cost for device settings:** Training employees for device settings, causes time of settings device reduced significantly and low volume production will be economically.

**Production of low volume products:** Caused the flexibility in the acceptance by the customer for products with low circulation or that is same product at a specified time (JIT).

C**ompetent or responsible for the personnel:** This principle, from the organization and the team staff and training them and giving responsibility to the trained teams for the purpose of maintenance work, check on the quality, minimizing repair and rework also to encourage them to group discussions and find ways to improve the process takes place.

**Production within the specified time (JIT):** By establishing this principle, the quantity and amount of work done in each stage of the process, the process depends only on the needs and input. With this principle, garlic conduction time (lead time) as well as reduced investment costs.

C**ontinuous maintenance for equipment:** As in traction systems reduced manufacturing and warehousing, therefore, the machine downtime has to be reduced. This principle applies only be able to be empowered operators have primary responsibility for the maintenance of their devices. Because they are the first people in the event of a defect in the device's performance, understand them.

**Using versatile workforce:** Empowering employees, causing them to be able to perform several tasks simultaneously so the ability to transfer them with adequate training.

**Warranty of providers:** The manufacturer must train their suppliers as long partner as well as suppliers should be responsible for supplying parts or social services in the best way and the fastest time. So, a permanent suppliers (guaranteed) to provide a piece or a particular product, reduced many delays, shortages and other problems in the cycle of the organization.

## RESULTS AND DISCUSSION

**Research purposes:** In this part of the project will study the relationship between of lean production and environmental indicators. For this purpose, a TOPSIS group method is chosen as one of attribute method. By using this method to determine the most efficient index on a particular index. As well as determine the effectiveness of each of the indicators.

S**teps of TOPSIS group on target problem:** Sometimes in some of the decisions that need to be measured in terms of several file expert about an important issue. TOPSIS group method is a structured approach to decision-making by taking some of the decision maker. The steps of a TOPSIS group is similar to the steps of TOPSIS. The difference is that final decision matrix we use for the next steps that is geometric or arithmetic mean of the decision is the decision matrix. This matrix is called the matrix judgment and to calculate the matrix of each individual judge should be assigned a specific weight. To study that, we put equal weight on each individual person together. Matrix judgment as summarized in Table 3.

**First step (normalization of judgment matrix; matrix decision):** In this step, since the aim is to explain the relationship between the two indices, we don't need to normalize the matrix and the matrix judge as of our judgment for next steps.

**Second step (weight of normalized decision matrix):** In this step since the aim is to explain the relationship between the two indices we don't need to normalize the matrix and the matrix in first step as of our judgment for next steps.

By using this matrix we can influence each of lean production index to be determined on social indicators and vice versa. For example "Quality of accountability" is the most effective factor "involving the suppliers".

**Third step (determine the positive ideal solution and negative ideal):** Since, the ideal point should not definitely be a feasible solution in this study, positive and negative ideal an ideal spot respectively are presented in Table 4 and 5.

**Fourth step (determine the distance between positive ideal solution and negative ideal):** Suppose, social indicators has i index and value 1-34 and lean production indicators has i index and value 1-12 ij. Note that i = 1 is

Table 3: Judgment matrix

| Indexes of lean production/Indexes of sustainable supply chain | Timely delivery | Reduce inventory levels | Flexible manufacturing | Less manpower | Empowerment of workforce | Less equipment | Lower transport | Less space | The close relationship between supplier and customer | Increase production speed | Reduce complexity | Warranty of providers |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Social index** | | | | | | | | | | | | |
| Quality of accountability | 6.80 | 5.9 | 7.4 | 0.0 | 0.0 | 7.2 | 0.0 | 0.0 | 7.064 | 7.6 | 6.6 | 7.7 |
| Workforce in the range of legal age | 0.00 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.0 | 0.0 | 0.0 |
| Cultural heritage | 0.00 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.0 | 0.0 | 0.0 |
| Customer complaints | 8.27 | 5.6 | 6.4 | 0.0 | 5.4 | 7.0 | 4.2 | 0.0 | 6.790 | 6.4 | 4.9 | 6.8 |
| Discipline | 8.02 | 0.0 | 0.0 | 6.0 | 3.2 | 8.0 | 4.9 | 3.6 | 4.850 | 0.0 | 5.8 | 4.6 |
| Environmental | 0.00 | 0.0 | 0.0 | 4.6 | 4.1 | 5.0 | 4.4 | 4.3 | 4.930 | 0.0 | 0.0 | 0.0 |
| Ethical issues | 0.00 | 0.0 | 0.0 | 0.0 | 0.0 | 6.3 | 0.0 | 0.0 | 3.980 | 0.0 | 0.0 | 5.9 |
| Freedom | 0.00 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.0 | 0.0 | 0.0 |
| Health and reliability | 0.00 | 5.6 | 0.0 | 0.0 | 3.4 | 5.8 | 4.2 | 0.0 | 5.160 | 0.0 | 4.9 | 5.8 |
| Human rights | 5.79 | 0.0 | 0.0 | 0.0 | 3.2 | 7.2 | 0.0 | 1.6 | 2.820 | 0.0 | 0.0 | 4.0 |
| Management commitment | 0.00 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.0 | 0.0 | 0.0 |
| Improve management | 0.00 | 0.0 | 0.0 | 0.0 | 0.0 | 8.3 | 0.0 | 0.0 | 6.200 | 0.0 | 0.0 | 6.7 |
| Reward | 0.00 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.0 | 0.0 | 0.0 |
| Accountability | 0.00 | 0.0 | 0.0 | 0.0 | 0.0 | 5.6 | 0.0 | 0.0 | 6.120 | 0.0 | 0.0 | 6.3 |
| Social behavior | 0.00 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 4.000 | 0.0 | 0.0 | 3.8 |
| Social development | 0.00 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 4.950 | 0.0 | 0.0 | 4.2 |
| Transparency | 0.00 | 0.0 | 0.0 | 0.0 | 0.0 | 6.2 | 0.0 | 0.0 | 6.120 | 0.0 | 5.7 | 3.9 |
| Salary | 4.50 | 5.5 | 5.9 | 5.6 | 4.5 | 7.0 | 3.6 | 0.0 | 0.000 | 5.5 | 0.0 | 0.0 |
| How to select personnel | 0.00 | 0.0 | 6.9 | 0.0 | 0.0 | 6.5 | 0.0 | 0.0 | 0.000 | 0.0 | 0.0 | 0.0 |
| Organizational performance management system | 0.00 | 0.0 | 6.5 | 0.0 | 0.0 | 5.1 | 0.0 | 0.0 | 5.810 | 0.0 | 5.9 | 0.0 |
| Work conditions | 2.94 | 4.7 | 6.6 | 6.5 | 6.3 | 6.4 | 6.5 | 3.0 | 6.120 | 0.0 | 0.0 | 0.0 |
| Hours of work | 0.00 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.4 | 0.000 | 5.7 | 0.0 | 0.0 |
| Social security | 3.94 | 3.4 | 0.0 | 0.0 | 2.8 | 3.5 | 0.0 | 0.0 | 2.810 | 0.0 | 0.0 | 4.0 |
| Poverty | 0.00 | 0.0 | 0.0 | 0.0 | 0.0 | 4.6 | 0.0 | 0.0 | 0.000 | 0.0 | 0.0 | 0.0 |
| Education | 0.00 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.0 | 0.0 | 0.0 |
| Total amount of taxes | 0.00 | 6.1 | 0.0 | 0.0 | 5.7 | 0.0 | 0.0 | 4.7 | 0.000 | 0.0 | 0.0 | 0.0 |
| Climate changes | 0.00 | 0.0 | 0.0 | 0.0 | 4.7 | 0.0 | 6.4 | 0.0 | 0.000 | 0.0 | 0.0 | 0.0 |
| **Environmental indicators** | | | | | | | | | | | | |
| Reduce pollution | 0.00 | 0.0 | 0.0 | 0.0 | 4.2 | 0.0 | 7.0 | 2.7 | 0.000 | 0.0 | 0.0 | 0.0 |
| Conserve natural resources | 0.00 | 3.7 | 0.0 | 0.0 | 3.3 | 4.2 | 5.0 | 2.5 | 2.740 | 0.0 | 0.0 | 0.0 |
| The number of ISO standards | 0.00 | 0.0 | 0.0 | 0.0 | 0.0 | 4.3 | 0.0 | 0.0 | 2.530 | 0.0 | 0.0 | 3.2 |
| The use of renewable energies | 0.00 | 0.0 | 0.0 | 0.0 | 3.5 | 0.0 | 5.1 | 2.3 | 0.000 | 0.0 | 0.0 | 0.0 |
| Recycling | 0.00 | 0.0 | 0.0 | 0.0 | 0.0 | 2.7 | 0.0 | 0.0 | 0.000 | 0.0 | 0.0 | 0.0 |
| The total amount of sales | 6.12 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 5.900 | 6.2 | 0.0 | 5.4 |
| **Economic indicators** | | | | | | | | | | | | |
| Increase in investment | 3.04 | 5.3 | 3.6 | 5.8 | 5.9 | 4.2 | 3.8 | 6.0 | 5.000 | 0.0 | 0.0 | 5.0 |

Table 4: The positive ideal answer

| Indexes of lean production/indexes of sustainable supply chain | Timely delivery | Reduce inventory levels | Flexible manufacturing | Less manpower | Empowerment of workforce | Less equipment | Lower transport | Less space | The close relationship between supplier and customer | Increase production speed | Reduce complexity | Warranty of providers |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Social index** | | | | | | | | | | | | |
| Quality of accountability | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| Workforce in the range of legal age | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| Cultural heritage | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| Customer complaints | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |

Table 4: Continue

| Indexes of lean production/Indexes of sustainable supply chain | Timely delivery | Reduce inventory levels | Flexible manufacturing | Less manpower | Empowerment of workforce | Less equipment | Lower transport | Less space | The close relationship between supplier and customer | Increase production speed | Reduce complexity | Warranty of providers |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Discipline | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| Environmental | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| Ethical issues | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| Freedom | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| Health and reliability | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| Human rights | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| Management commitment | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| Improve management | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| Reward | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| Accountability | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| Social behavior | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| Social development | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| Transparency | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| Salary | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| How to select personnel | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| Organizational performance management system | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| Work conditions | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| Hours of work | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| Social security | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| Poverty | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| Education | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| Total amount of taxes | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| **Environmental indicators** | | | | | | | | | | | | |
| Climate changes | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| Reduce pollution | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| Conserve natural resources | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| The number of ISO standards | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| The use of renewable energies | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| Recycling | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| **Economic indicators** | | | | | | | | | | | | |
| The total amount of sales | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| Increase in investment | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |

Table 5: The negative ideal answer

| Indexes of lean production/indexes of sustainable supply chain | Timely delivery | Reduce inventory levels | Flexible manufacturing | Less manpower | Empowerment of workforce | Less equipment | Lower transport | Less space | The close relationship between supplier and customer | Increase production speed | Reduce complexity | Warranty of providers |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Social index** | | | | | | | | | | | | |
| Quality of accountability | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Workforce in the range of legal age | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cultural heritage | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Customer complaints | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Discipline | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Environmental | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Table 5: The negative ideal answer

| Indexes of lean production/Indexes of sustainable supply chain | Timely delivery | Reduce inventory levels | Flexible manufacturing | Less manpower | Empowerment of workforce | Less equipment | Lower transport | Less space | The close relationship between supplier and customer | Increase production speed | Reduce complexity | Warranty of providers |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ethical issues | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Freedom | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Health and reliability | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Human rights | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Management commitment | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Improve management | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Reward | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Accountability | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Social behavior | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Social development | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Transparency | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Salary | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| How to select personnel | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Organizational performance management system | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Work conditions | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Hours of work | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Social security | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Poverty | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Education | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total amount of taxes | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Environmental indicators** | | | | | | | | | | | | |
| Climate changes | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Reduce pollution | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Conserve natural resources | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| The number of ISO standards | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| The use of renewable energies | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Recycling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Economic indicators** | | | | | | | | | | | | |
| The total amount of sales | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Increase in investment | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Table 6: Distance from the negative ideal

| Rank | Values | Ranks | Values | Ranks | Values |
|---|---|---|---|---|---|
| 1 | 5.796651 | 12 | 3.572331 | 23 | 2.453862 |
| 2 | 0 | 13 | 0 | 24 | 1.348264 |
| 3 | 0 | 14 | 3.187054 | 25 | 0 |
| 4 | 5.753938 | 15 | 1.600011 | 26 | 2.770186 |
| 5 | 4.931511 | 16 | 1.890487 | 27 | 2.318067 |
| 6 | 3.244164 | 17 | 3.236958 | 28 | 2.491722 |
| 7 | 2.763466 | 18 | 4.399187 | 29 | 2.616526 |
| 8 | 0 | 19 | 2.746776 | 30 | 1.727341 |
| 9 | 3.872151 | 20 | 3.379572 | 31 | 1.913705 |
| 10 | 3.193747 | 21 | 4.908882 | 32 | 0.792447 |
| 11 | 0 | 22 | 1.931870 | 33 | 3.418775 |
| - | - | - | - | 34 | 4.476321 |

social indicators “quality of accountability” and i = 34 is social Index “increased investment” and j = 1 is lean production index “timely delivery” j = 34 is lean manufacturing index “involves the suppliers”. According to these assumptions, for every social indicator distance from the ideal point of positive and negative ideal is calculated as follows in Table 6 and 7. According to these assumptions, for every lean production index distance

Table 7: Distance from the positive ideal

| Ranks | Values |
|---|---|
| 1 | 5.446893 |
| 2 | 9 |
| 3 | 9 |
| 4 | 4.585622 |
| 5 | 5.619510 |
| 6 | 7.095490 |
| 7 | 8.012789 |
| 8 | 9 |
| 9 | 6.594133 |
| 10 | 7.359280 |
| 11 | 9 |
| 12 | 7.866307 |
| 13 | 9 |
| 14 | 7.905112 |
| 15 | 8.473780 |
| 16 | 8.409490 |
| 17 | 7.634412 |
| 18 | 6.063017 |
| 19 | 8.268506 |
| 20 | 7.579791 |
| 21 | 5.579246 |
| 22 | 8.422382 |
| 23 | 7.488892 |
| 24 | 8.707010 |
| 25 | 9 |
| 26 | 7.993116 |
| 27 | 8.338305 |
| 28 | 8.139402 |
| 29 | 7.444686 |
| 30 | 8.294031 |
| 31 | 8.257344 |
| 32 | 8.803993 |
| 33 | 7.563393 |
| 34 | 5.387191 |

Table 8: Distance from the positive ideal

| Ranks | Values |
|---|---|
| 1 | 7.24 |
| 2 | 8.29 |
| 3 | 8.38 |
| 4 | 6.78 |
| 5 | 8.17 |
| 6 | 7.76 |
| 7 | 7.55 |
| 8 | 6.37 |
| 9 | 8.41 |
| 10 | 8.13 |
| 11 | 7.98 |
| 12 | 7.98 |

Table 9: Distance from the negative ideal

| Ranks | Values |
|---|---|
| 1 | 3.55 |
| 2 | 2.40 |
| 3 | 2.43 |
| 4 | 3.84 |
| 5 | 1.98 |
| 6 | 2.93 |
| 7 | 2.87 |
| 8 | 4.62 |
| 9 | 2.22 |
| 10 | 2.87 |
| 11 | 2.67 |
| 12 | 2.99 |

from the ideal point of positive and negative ideal is calculated as follows in Table 8 and 9.

Table 10: Calculation of relative proximity to lean production index

| Ranks | Values |
|---|---|
| 1 | 0.515554 |
| 2 | 0 |
| 3 | 0 |
| 4 | 0.556497 |
| 5 | 0.467397 |
| 6 | 0.313759 |
| 7 | 0.256440 |
| 8 | 0 |
| 9 | 0.369964 |
| 10 | 0.302638 |
| 11 | 0 |
| 12 | 0.312304 |
| 13 | 0 |
| 14 | 0.287325 |
| 15 | 0.158829 |
| 16 | 0.183543 |
| 17 | 0.297751 |
| 18 | 0.420484 |
| 19 | 0.249360 |
| 20 | 0.308373 |
| 21 | 0.468042 |
| 22 | 0.186577 |
| 23 | 0.246799 |
| 24 | 0.134085 |
| 25 | 0 |
| 26 | 0.257373 |
| 27 | 0.217529 |
| 28 | 0.234380 |
| 29 | 0.260061 |
| 30 | 0.172366 |
| 31 | 0.188152 |
| 32 | 0.082577 |
| 33 | 0.311302 |
| 34 | 0.453826 |

Table 11: Efficacy rate any of lean production index to below in order of priority are

| Index numbers | Priority |
|---|---|
| 1 | 3 |
| 2 | 10 |
| 3 | 9 |
| 4 | 2 |
| 5 | 12 |
| 6 | 5 |
| 7 | 4 |
| 8 | 1 |
| 9 | 11 |
| 10 | 7 |
| 11 | 8 |
| 12 | 6 |

**Fifth step (calculation of relative proximity):** Due to the positive and negative ideal distance in the previous step, proximity index for lean production index and the social index obtained as follows in Table 10-13. Using the results obtained in the fifth step, the (effective) lean production index and the (effective) social index was determined. It shows most efficient and least important social and lean production indicators (Table 13). Note that the indices 2, 3, 8, 11, 13, and 25 parameters are ineffective.

Table 12: Calculation of relative proximity to lean production index

| Ranks | Values |
|---|---|
| 1 | 0.329 |
| 2 | 0.224 |
| 3 | 0.225 |
| 4 | 0.361 |
| 5 | 0.195 |
| 6 | 0.273 |
| 7 | 0.275 |
| 8 | 0.420 |
| 9 | 0.209 |
| 10 | 0.261 |
| 11 | 0.251 |
| 12 | 0.273 |

Table 13: Most efficient and least

| Index numbers | Priority |
|---|---|
| 1 | 2 |
| 2 | - |
| 3 | - |
| 4 | 1 |
| 5 | 4 |
| 6 | 8 |
| 7 | 17 |
| 8 | - |
| 9 | 7 |
| 10 | 12 |
| 11 | - |
| 12 | 9 |
| 13 | - |
| 14 | 14 |
| 15 | 26 |
| 16 | 24 |
| 17 | 13 |
| 18 | 6 |
| 19 | 18 |
| 20 | 11 |
| 21 | 3 |
| 22 | 23 |
| 23 | 19 |
| 24 | 25 |
| 25 | - |
| 26 | 16 |
| 27 | 21 |
| 28 | 20 |
| 29 | 15 |
| 30 | 25 |
| 31 | 22 |
| 32 | 28 |
| 33 | 10 |
| 34 | 5 |

## CONCLUSION

The aim of this project is discovery the relationship of lean production and sustainable supply chain by using group TOPSIS method first, by studying various sources extracted indicators related to lean production and environmental indicators and we have defined some of these indicators. A questionnaire prepared and completed by 10 experts. Then, using a TOPSIS techniques to express the relationship between these indicators. Output of TOPSIS method indicated that, customer complaints is the most effective and indicator of social Index and empowerment of workforce is the most effective and indicator of lean production Index.

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