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Sustainability Performance Measurement Framework for Supply Chain Management

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Abstract
Sustainability of supply chains has been recognized as a competitive indicator for business. The most widely used framework for implementing sustainability practices from both company and supply chain perspectives is the triple bottom line (TBL). The TBL divides sustainability into three dimensions, i.e. economic, environmental and societal. Moreover, several existing approaches have been developed based on the TBL concept to measure sustainability performance. However, the TBL is a holistic view for the measurement of sustainability performance. A good sub-dimensioning or categorization in each TBL dimension is one of the challenges in the sustainable supply chain management (sSCM) research field. This work fills this gap by developing a conceptual framework, which transforms the TBL concept into strategic, tactical and operational levels of implementation. One of the challenges in sSCM is dealing with a wide range of objectives, criteria and elements in the supply chain. Because sSCM has to consider the whole supply chain, the complexity of the supply chain itself makes establishing a sustainability strategy very hard. A clear border of supply chain scope helps companies and their supply chains obtain a precise strategic direction and performance measurement system. This paper proposes a framework to identify sub-dimensions of the TBL aspect by analyzing the context of sustainable development and the engagement level of the supply chain. The proposed framework can be applied to establish and construct sustainability metrics in supply chain management.

Keywords: sustainability performance, supply chain management, performance measurement

1 Introduction

Though sustainable supply chain management (sSCM) is a hot topic in both academic research and from the corporate practice side, the limits of implementation and integration between sustainability and supply chain management can be observed (Carter and Rogers, 2008; Seuring and Muller, 2008; Teuteberg and Wittstruch, 2010). One possible reason is that sustainability is an immaterial value that eludes a precise mathematical definition or economic monitoring.

There are various conceptual frameworks in sSCM, but one of the conceptual frameworks most often referred to is the triple bottom line (TBL), which is proposed by Elkington (1998). This framework divides sustainability into three dimensions, i.e. economic, environmental and societal. The other frameworks are derived from the TBL. Figure 1 shows the six conceptual frameworks of sustainable development and sSCM. The first three frameworks (Figure 1 (a) to (c)) (Elkington, 1998; Gidding et al. (2002)) relate to three components (economic, environmental and social) with different perspectives among the components. The others three frameworks (Figure 1 (d) to (f)) (Carter and Rogers, 2008; Mongsawad, 2009; Teuteberg and Wittstruch, 2010) are derived from the TBL model and add business functions or support contributions for sSCM.

A quick comparison of these frameworks shows that the first group points out that economic, environmental and social dimensions have an interrelation among sectors. By considering only economic/environmental or economic/social sectors, one cannot achieve sustainability goals. We cannot separate the impacts of human actions into distinct compartments. Thus, sustainable development will be an integration of three dimensions with a relation among components. The second group shows that sustainability from the supply chain management perspective does not focus only on the three dimensions but also on other support components. The long-term perspective is enhanced in terms of risk management, transparency, knowledge and morality conditions, and ethical issues.

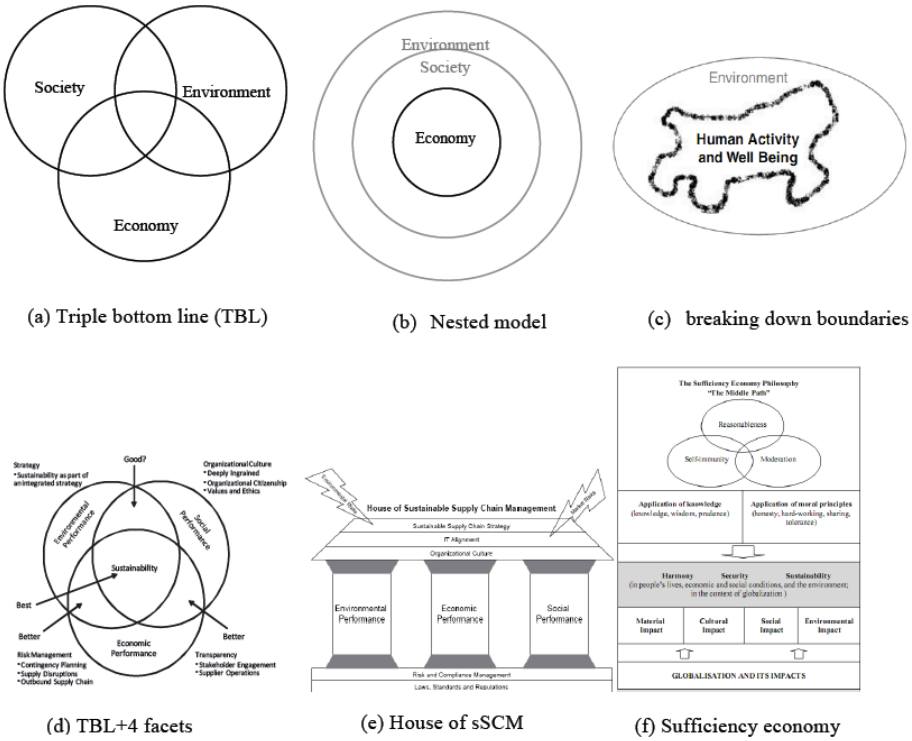

Figure 1 The perspective models of sustainable supply chain

The three categorical dimensions can explain sustainable development context on a philosophical level, but do not provide much guidance on how these models should be implemented at company and supply chain levels. Elkington (1999) suggested that businesses need to measure and report economic, social and environmental performance in order to achieve corporate sustainability. It requires an interpretation of economic, social and environmental performance in order to investigate sustainability strategy and transfer to tactical and operational implementation. However, the complexity of sustainability in the supply chain is due to the presence of a large number of factors and interactions among the supply chain elements. The presence of directly or indirectly related elements complicates the structure of the system. It becomes difficult to deal with such a system in which the structure is not clearly defined. Thus, a process is required that transforms unclear sustainability terminology into a visible and well-defined structure.

This paper aims to develop a conceptual framework that assists in clarifying sustainability criteria in supply chain performance measurement. The conceptual framework is composed of two features: the component of measures (sustainability criteria) and the measured component in the supply chain. The sustainability criteria are derived from the concept of human needs in sustainable development and categorized according to the TBL dimension. The measured component in the supply chain is the boundary for measurement. Companies can adopt this new conceptual framework for design of their sustainability performance measurement system.

This paper is organized into three main sections. First, the conceptualization of supply chain management is introduced in terms of sustainability and the supply chain management context. The missing points in the sSCM concept are recalled. Then the analysis approaches are introduced to cater for the identified missing points. The issues of sSCM challenges are identified and an analysis of supply chain complexity is introduced. Finally, a framework for measuring the sustainability performance of a supply chain is proposed.

2 sSCM: The topic of conceptualization

Seuring and Muller (2008) defined sSCM as "the management of material, information and capital flows as well as cooperation among companies along the supply chain while taking goals from all three dimensions of sustainable development, i.e. economic, environmental and social, into account that are derived from customer and stakeholder requirements". Carter and Rogers (2008) defined sSCM as "the strategic achievement and integration of an organization's social, environmental and economic goals through the systematic coordination of key inter-organizational business processes to improve the long-term economic performance of the individual company and its value network". This definition of sSCM is based on the TBL and the four supporting facets of sustainability – risk management, transparency, strategy and culture.

In a 'macro' view, the concept of sustainable supply chain was developed to support the sustainable development and supply chain management context. Thus, a conceptualization of sSCM in this work was established according to the sustainable development framework from the World Commission on Environment and Development (WCED, 1987) and supply chain management theory.

This work defined the term of 'sustainability' from the supply chain perspective as "the ability to achieve needs of an individual company and its network through the coordination of activities to improve economic performance by conserving and enhancing resources usage efficiency, reducing risk of human health and safety, and improving human capabilities and human well-being".

2.1 Supply chain management context

Lambert et al. (1998) stated that supply chain management is the integration of key business processes from end users through original suppliers that provide products, services and information that add value for customers and other stakeholders. Mentzer et al. (2001) identified three degrees of supply chain complexity: (1) a direct supply chain; (2) an extended supply chain; and (3) an ultimate supply chain (shown in Figure 2). A direct supply chain consists of a company, a supplier and a customer involved in the upstream and/or downstream flows of products, services, finances and/or information. (Figure 2 (a)). An extended supply chain includes suppliers of the immediate supplier and customers of the immediate customer, all involved in the upstream and/or downstream flows of products, services, finances and/or information (Figure 2 (b)). An ultimate supply chain includes all the organizations involved in the upstream and

downstream flows of products, services, finances and information from the ultimate supplier to the ultimate customer (Figure 2 (c)).

Regarding the relationships in a supply chain, Mentzer et al. (2001) defined supply chain management as "the systemic, strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across businesses within a supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole".

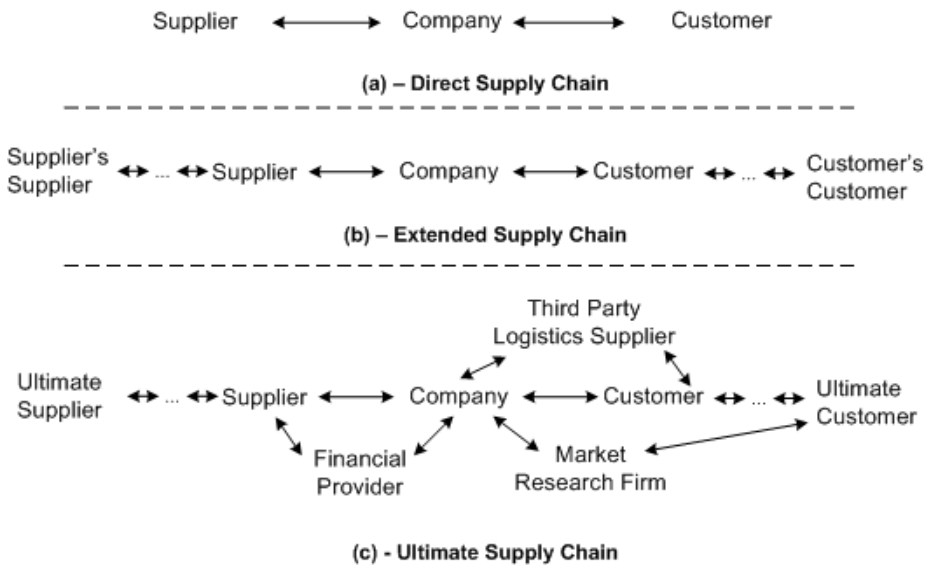

Figure 2 The complexity level of supply chain

One of the challenges in sSCM is dealing with a wide range of objectives, criteria and elements in the supply chain. Because sSCM considers the long part of a supply chain (Seuring and Muller, 2008) the complexity of a supply chain makes establishing sustainability strategy complicated. A clear border of supply chain scope helps companies and their partners obtain a precise strategic direction and a clear performance measurement system. Thus, the border of supply chain scope has to be identified based on the complexity level of the supply chain.

2.2 Sustainable development context

Reasons to develop sustainable development concept

According to the *Our Common Future* report (WECD, 1987), the sustainable development concept was developed in regard to a reorganization of a threatened future. Many regions face risks of irreversible damage to the human environment. Environmental stress has often been seen as the result of the increasing growth of the population, technology growth and development, and the rising living standards of the affluent.

Growth of population

The impact of increasing growth of population can be seen as a growing demand on scarce resources, which includes raw materials, fossil fuels, food and other natural elements, but also as a source of poverty. An increasing amount of resource consumption intensifies the lack of resources for future generations. Poverty can cause environmental pollution, i.e. by destroying the environment in order to survive, e.g. cutting down the forests and overusing marginal land. Moreover, a deficiency of basic management in the community of poor people is one of the causes of communicable diseases and negative impacts on human health.

Technology growth and development
An increase of growth and development of technology and industry also impact the increasing use of resources. Moreover, much of the improvement in the past created more pollution by using hazardous chemicals and disposing of toxic waste. These situations are caused by the greenhouse effect, depletion of atmospheric ozone and lack of quality natural resources (air, water, soil, ocean, etc.). The consequence of environmental pollution is negative impacts on both human health and the ecosystem.

Rise of human living standards
Although the rising living standards of humans can improve the quality of life and increase human well-being, it leads on the other hand to an increase in the amount of resource consumption, i.e. raw-materials, food, energy and natural resources as well. Consequently, future generations will face scarcity of resources.

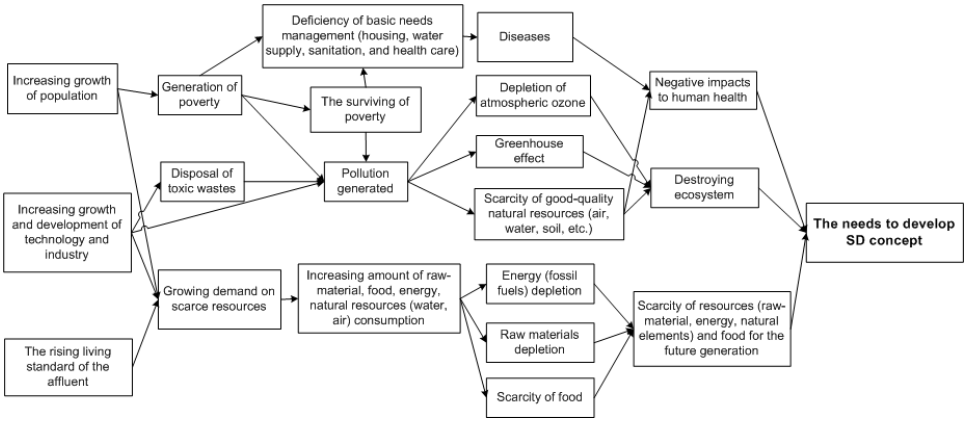

Figure 3 Causes and effects for developing sustainable development concepts

Figure 3 shows the negative impacts from these root causes according to three resulting categories: i.e. the negative impacts on human health, ecosystem distortion and lack of resources. An establishment of a sustainable development concept begins with an environmental concern and its impacts on both humans and the environment. However, the concept of sustainable development does not only prevent these negative impacts but also aims to enhance human resource capability.

The role of human resources in sustainable development can be considered according to two perspectives. On the one hand, it can be considered simply as numbers in terms of population. Increasing population growth rates lead to a scare natural resources situation. On the other hand, human resources can be considered as a societal asset because people

are a creative resource. In order to enhance human assets, people's physical well-being must be improved. Also, education must be provided to help people to become more capable, creative, skillful and productive.

However, dealing with managing population growth is out of scope of this research work. Thus, we consider human resources only in terms of the assets of society. Human resources in supply chains are the company's employees, customers and people in the local community. To improve human well-being, supply chain managers should provide safe working condition for their employees, encourage education to improve skills and knowledge and ensure that the company's activities will not affect the health and safety of their customers and people in the local community.

2.3 Human needs and sustainable development

According to the definition of the WECD (as mentioned in Section 1), sustainable development consists of two key concepts: the concept of 'need' and the idea of limitation imposed by the state of technology and social organization on the environment's ability to meet present and future needs. It emphasizes the importance of long-term considerations in the development process and draws attention to the needs of people in the present and in future generations. This definition raises two questions. Firstly, what are the needs of present and future generations? Secondly, how does the supply chain contribute to sustainable development to meet these needs?

The work on fundamental human needs was developed by Abraham Maslow (1943). He argued that people are motivated by a series of five types of needs arranged in a hierarchy and represented as a pyramid (as shown in Figure4). These needs consist of physiological needs, safety needs, belongingness, self-esteem and self-actualization. In summary, *physiological needs* include requirements for food, water, sleep and warmth. *Safety needs* are the needs for security, structure, shelter and protection. *Belongingness* involves the need to feel a sense of belonging and acceptance among social groups. *Self-esteem* includes self-respect and recognition by others (i.e. our worth and competence). *Self-actualization* needs encompass the attainment of an individual's full potential. Maslow suggested that these needs must be satisfied in order of importance. As soon as needs on a lower level are fulfilled, the needs on the next level will emerge and demand satisfaction.

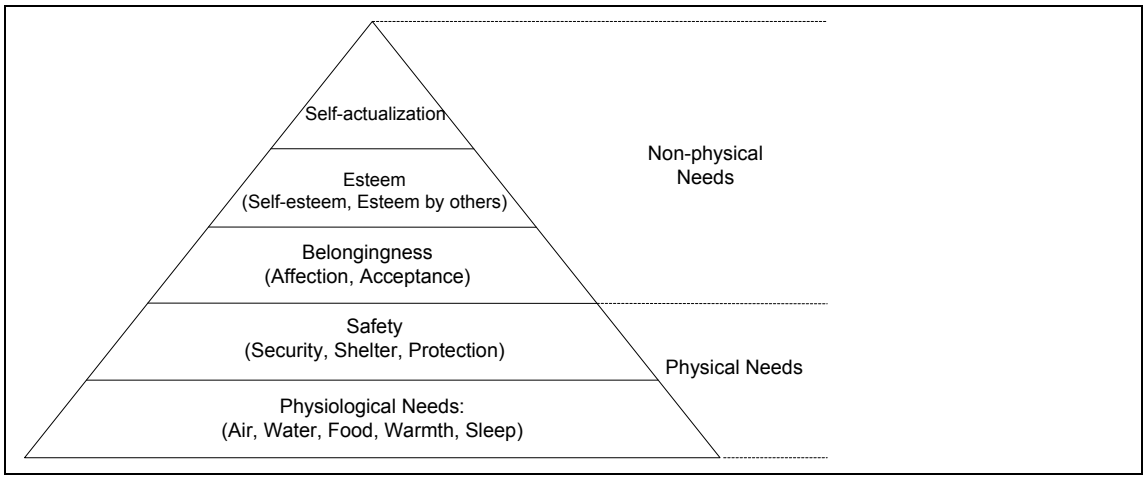

Figure 4 Maslow's hierarchy of human needs

Another work on human needs categorization that is much discussed in the literature is that by Max-Neef (1992). He identified nine types of fundamental human needs which are subsistence, protection, affection, understanding, participation, idleness, creation, identity and freedom. According to the categorizations of Maslow (1943) and Max-Neef (1992), this study divides human needs into two types: physical and non-physical needs.

Physical needs

Physical needs are the basic human needs for a livelihood. Maslow (1943) and Max-Neef (1992) were talking about the same things. Maslow referred to the physiological needs and safety while Max-Neef referred to subsistence and protection. People need food, materials, water supply, air, energy, health sanitation and safety for their physical well-being (UN, 1993). These physical needs require economic security such as employment to allow people to pay for their food, housing, clothing and necessary goods. Moreover, sufficient energy and natural resources, a clean environment and safe conditions for physical health are desirable. It means that the physical needs consist of economic, environmental and social dimensions of sustainability. The satisfaction of these needs can be met through reductions in poverty, economic protection and improvements in human health.

1. *Employment* is a component of economic security for people. It is an essential activity towards meeting the physical requirements. Compensation for work allows people to pay for food, housing, clothing and other necessities (goods and services).
2. *Natural resources* are useful materials from the Earth. People use natural resources (water, air, soil) and raw materials to manufacture or create products and services (Giddings et al., 2002).
3. *Clean environment*: for good physical well-being, people must have access not only to the sufficient natural resources but also to a clean environment. The prevention and reduction of air and water pollution will remain a critical task of resource conservation. Air and water quality come under pressure from such activities as fertilizer and pesticide use, fossil fuel burning, the use of certain chemicals and the various other industrial activities. Each of these is expected to increase the pollution load on the biosphere substantially. Hence, it is necessary

to prevent these pollution problems by enforcing emission standards, promoting low-waste technologies and anticipating the impact of new products, technologies, and wastes (WCED, 1987, chap. 2).

4. *Energy* is necessary for daily survival. Future development crucially depends on its long-term availability from sources that are dependable, safe and environmentally sound. Energy provides essential services for human life such as heat for warmth, cooking and manufacturing, as well as power for transport and mechanical work. The energy resources which provide these services come from fuels – oil, gas, coal, nuclear, wood – and other primary sources (solar, wind or water power). The primary sources of energy are mainly non-renewable: natural gas, oil, coal and conventional nuclear power. However, there are also renewable sources, including solar, water, wind and geothermal sources. The key elements of sustainability energy that have to be consolidated are sufficient growth of energy supplies to meet energy consumption, utilization of energy usage efficiency and public health impacts from energy usage (WCED, 1987, chap. 7).
5. *Sanitation, health and safety* are also important. Good health is the foundation of human welfare and productivity. Deficiencies in these areas are visible manifestations of environmental stress. The failure of meeting sanitation, health and safety needs is one of the major causes of many communicable diseases (WCED, 1987, chap. 2), as well as accidents and injuries (Wood, 1991). Critical ill health is related to environmental conditions and developmental problems. Examples of links between development, environmental conditions and health are air pollution and respiratory illness. This includes the impacts of housing conditions on the spread of tuberculosis, the effects of toxic substances and the exposure to hazards in the workplace. Beyond these negative impacts to human health, it is necessary to identify vulnerable groups and take their health risks into account in sustainable development policy (WCED, 1987, chap. 9).

Non-physical needs

Non-physical needs are the emotional and moral needs of humans which need to be fulfilled. Maslow (1943) referred to belongingness, esteem and self-actualization. Max-Neef (1992) referred to affection, understanding, participation, idleness, creation, identity and freedom. The non-physical needs relate to individual and social psychology. They are more about processes (personal, social and cultural) than about objects (financial, material, natural resources, products, etc.) (Hutchins and Sutherland, 2008).

These needs can be met through human development, equity and ethical issues. According to the TBL concept, non-physical needs are focused on only in the social dimension.

1. *Human capabilities development*: all humans have a desire for self-respect or self-esteem and the esteem of others. Satisfaction of self-esteem needs leads to feelings of self-confidence, worth, strength, capability and adequacy of being useful and necessary in the world (Maslow, 1943). Education and training would help people to find and improve their potential capability.
2. *Harmony among human beings and between humanity and nature*: humans need to live in harmony among other human beings; yet harmony between humanity

and nature is also necessary. In order to live in harmony among human beings, people have a responsibility to respect the human rights of one another. There are two categories of human rights. The first category concerns civil and political rights and includes such rights as the right to life and to liberty and equality. The second category concerns economic, social and cultural rights and includes such rights as the right to work, the right to health, the right to education and the right to social security (WCED, 1987, chap. 2). The reorientation of technology is the key link between humans and nature. The capacity for technological innovation needs to be enhanced and to pay attention to environmental factors. Technologies are needed to produce social goods, such as improved air quality or increased product life (WCED, 1987, chap. 2).

Guiding principles on sustainable development

Table 1 shows the concepts of sustainable development that are summarized in the term of principles and guidance. The interventions needed to achieve sustainable development must be conceived by integration between the three pillars of economic development (income, productivity, innovation technology), social equity (sanitation, health care, human potential capabilities, education, etc.) and environmental protection (natural resources, material, energy). It must be realized that all of these dimensions are connected and cannot be treated in isolation from each other. For example, emissions from human activities impacts the quality of an ecological system and also human health and safety; education and training can help people to develop their attitudes, skills and knowledge, which leads to an increase of productivity from an economic point of view. Moreover, it also leads to an innovation of technology to shift to less polluting (or non-polluting) products or technologies from an environmental point of view.

Table 1 Objectives and guiding principle to achieve sustainable development

	Needs	Principles	Guidance for sustainable development
Physical	1) Economic security	• Reduce poverty • Better income distribution	• Equitable income distribution
	2) Natural resources (raw materials, air, water, soil)	• Sufficient materials, water and land for livelihood • Reduced vulnerability to natural disasters and technological risks	• Improving material usage efficiency • Conserving and efficiently using natural resources. Efficiency can be improved by considering use, recycling and substitution capability • Promote less material products and technologies • Assess potential impacts of new technologies before they are widely used, in order to ensure that their production, use and disposal do not overstress environmental resources
	3) Clean environment	• Living in a clean environment (clean air, water, soil)	• Prevent and reduce air, water and soil pollution.
	4) Energy	• Sufficient energy needs for livelihood	• Conserving and efficiently using energy by reducing energy consumption • Using renewable energy

Needs		Principles	Guidance for sustainable development
			• Assess potential impacts of new technologies before they are widely used, in order to ensure that their production, use and disposal do not overstress energy sources • Improvements in energy efficiency and a shift towards less energy-intensive sectors • Encourage a shift to non-polluting sources and technologies
	5) Sanitation, health and safety	• Living in good conditions (safe and healthy) • Improving health care condition	• Providing primary health care facilities and making sure that everyone has the opportunity to use them are appropriate starting points • Reduce environmental and development problems which impact on health and well-being • Health care must be supplemented by effective health education • New techniques and technologies for safety design and control, accident prevention, contingency planning, damage mitigation and provision of relief • Assess potential impacts of new technologies before they are widely used, in order to ensure that their production, use, and disposal do not negative impact human health
Non-physical	6) Human capabilities development	• Improved individual potential capabilities • Improved community potential capabilities	• Encourage education to improve human skills and knowledge performance • Embed sustainability, equity, social justice and security regarding safe, environmentally sound energy as a component of decision-making
	7) Harmony among human beings and between humanity and nature	• Encourage and promote harmony among human beings and between humanity and nature • Encourage long-term development • Community knowledge and support, which entails greater public participation in the decisions that affect the environment	• Changes in attitudes and objectives and in institutional arrangements at every level to integrate economic and ecological considerations in decision-making • Policy decisions must focus on the source of environmental damage rather than the symptoms • Changing people's values, attitudes, perspectives and lifestyles in respect to the environment and development – indeed, towards society and work at home, on farms and in factories

Source: Analyzed by the Brundtland Commission (WCED, 1987)

Goals of sustainable supply chain

The sustainable development objectives are increasing prosperity; preventing environmental pollution; protecting human health and the environment from negative impacts; and improving environmentally sound technology and human skill and actions in the industrial sector. The sSCM goals and activities to achieve these goals are identified by contexts extracted from these two contexts, which are shown in Table 2 . The goals of sSCM are divided into seven categories as follows:

1. Increasing economic performance.
2. Reducing resource depletion.
3. Reducing environmental pollution.
4. Reducing negative impacts on humans in terms of health and safety.
5. Encouraging ethical management in the supply chain.
6. Encouraging innovation and technology development.
7. Encouraging human capability development.

In terms of short-term and long-term perspectives in sSCM, the first to fourth goals are outcomes supporting short-term sustainability and the fifth to seventh goals are the factors to encourage a sustainable supply chain in the long term.

Table 2 Goals of sSCM

Sustainable development objectives	Activities of sustainable supply chain to support sustainable development	Sustainable supply chain goals
Increasing prosperity	Provide trading, employment and livelihood opportunities in economic and social systems	Increasing economic performance
Reducing negative impacts on resource use and the environment	Through more efficient production processes, preventive strategies, cleaner production technologies and procedures throughout the product life cycle; minimizing or avoiding wastes	Reducing resource depletion Reducing environmental pollution
Reducing negative impacts on human health and society	Implementing responsible care and product stewardship policies; fostering openness and dialogue with employees and the public; carrying out environmental assessment of compliance; and ensuring responsible and ethical management of products and processes	Reducing negative impacts on humans in term of health and safety Encouraging ethical management in supply chain
Improving environmentally sound technology and human skill	Support for research and development in improving technological and managerial requirements for sustainable development. Providing human resource training and knowledge management for sustainable development	Encouraging innovation and technology development Encouraging human capability development

3 The Proposed Framework of sSCM

The proposed framework for measuring sustainability in sSCM consists of three elements: needs of supply chain, sustainability perspective and complexity of supply chain as shown in Figure .

Sub-dimension of sustainable supply chain

Conceptualizing sustainability in three dimensions seems to be widely accepted (Dyllick and Hockert, 2002). It allows easy comprehension of the integration of economic, environmental and social issues. But these three dimensions are too large to identify sustainability metrics. There are various aspects to be considered when categorizing sustainability criteria. Beamon (2008) categorized sustainability based on inputs (human resources, materials and fuel) and outputs (products, services and solid waste) of the supply chain.

In this work, sustainability criteria are categorized regarding the definition of human needs and goals of a sustainable supply chain. We can divide the criteria into eight categories: (1) financial; (2) non-financial; (3) material; (4) natural resources; (5) energy; (6) health and safety; (7) human capabilities; and (8) ethics. All sustainability criteria are based on the long-term development perspective. The risk management and innovation points of view are adopted as a lens to consider the long-term perspective. The categorization of sustainability criteria is illustrated in this work schematically in Figure .

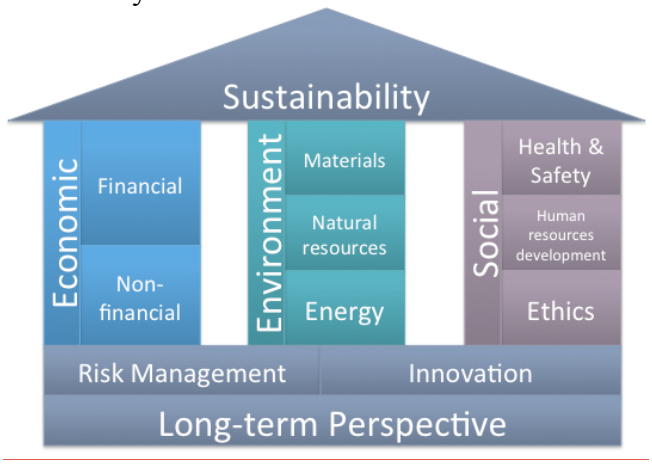

Figure 5 Sustainability criteria categorization

sSCM perspective

In order to implement sustainable development in companies and their supply chains, the guiding principles in Table 1 can be used to set supply chain strategy direction. These principles lead to a sustainable development within both short- and long-term perspectives as shown in Table . Sustainability from a short-term perspective is the ability of activities to meet the needs of present and future generations. On the other hand, sustainability from a long-term perspective is the ability of activities to shift human activities to non-polluting products and non-polluting technologies; less material and energy usage; as well changed attitudes, lifestyle and behavior towards a sustainable path. An increase of sustainability performance must be considered both within short- and long-term perspectives.

Table 3 Short-, and long-term perspectives for sustainable development

Dimensions	Short-term	Long-term
Economic		

Dimensions	Short-term	Long-term
Financial	• Increasing revenue, profit, market share of supply chain • Reducing cost of operation	• Equitable income for employees • Equitable income distribution for local community • Equitable income distribution for all
Non-financial	• Increasing quality, delivery performance and reputation of supply chain	• Increasing trust, flexibility, agility of supply chain
Environmental		
Raw materials	• Conserve and enhance the raw materials by efficient usage through reduction, reuse and recycling concepts • Reducing hazardous material usage	• Shift to less material usage (products and technologies)
Natural resources (air, water, soil)	• Conserve and enhance the natural resources by efficient usage and environmental emission reduction	• Assess potential environmental impacts of new technologies before they are widely used • Shift to a non-polluting products and technologies era
Energy	• Conserve and enhance energy resources by efficiently using and reducing energy consumption	• Assess energy usage impacts of new technologies before they are widely used • Substitution of renewable energy • Shift to less energy usage (products and technologies)
Social		
Health and safety	• Providing primary health care facilities • Reduce environmental and developmental problems which impact on health and well-being	• Assess and reduce potential health impacts of new technologies before they are widely used • New techniques and technologies for safety design and control, accident prevention, contingency planning, damage mitigation and provision of relief
Potential capabilities for human well-being	• Encourage education to improve human skills and knowledge performance	• Embed sustainability, equity, social justice and security in regard to safe, environmentally sound energy as a component of decision-making • Changing people attitudes, lifestyles and behavior toward sustainable path
Ethics	• Respect local and international laws on business and human rights	• Encouraging fair operating practice issues which arise in the areas of anti-corruption, responsible involvement in the public sphere, fair competition, socially responsible behavior and relations with other organizations and respect for property rights.

Engagement level

In order to measure sustainability performance for supply chain management, it is necessary to link the concepts of supply chain and sustainability. The term 'supply chain' consists of multiple firms, both upstream and downstream, and the ultimate consumer. The supply chain involves flows of products, materials, information and finances from a source to the customer (Mentzer et al., 2001) Activities in the supply chain concept have to be identified by an engagement level both upstream and downstream. The engagement is divided into five levels as follows:

- Company level considers activities of the focal company. This level does not engage with any external groups or companies.
- Direct supply chain considers activities undertaken to create opportunities for negotiation, consultation or simply exchange of information between or among the company and the first-tier supply chain (suppliers, outsourced companies, customers, users or others).
- Extended supply chain level considers activities in the direct supply chain and includes activities among suppliers to customers from upstream to downstream in the supply chain. It does not consider the financial or logistic providers.
- Ultimate supply chain considers activities within the extended supply chain and financial or logistic providers (upstream to downstream).
- Stakeholder level considers activities undertaken to create opportunities for negotiation, consultation or simply exchange of information between or among company and stakeholders.

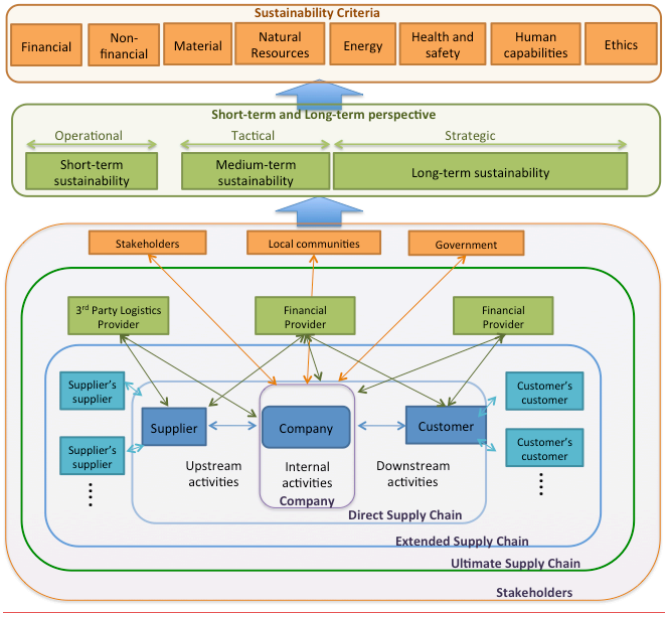

Figure 6 The elements of sustainable supply chain framework

4 Conclusion

The aim of this paper was to propose a sSCM framework to measure sustainability performance in the supply chain. The sustainability criteria identification in the supply

chain management context employs the sustainable development concept from the Brundtland Commission as a framework. The sSCM needs were identified regarding physical and non-physical needs from an industrial side. The main criticism of measuring sustainability in the supply chain is the difficulty to evaluate sustainability along the whole supply chain. It is still a challenge for supply chain performance evaluation. Thus, this research work considered the supply chain as a direct supply chain (focusing on focal company and its first-tier suppliers and customers). There are three main features to construct sustainability metrics: (1) supply chain needs identification must cover all of the three core dimensions; (2) metrics should reflect both the short-term and long-term perspective; and (3) engagement level of activities must cover the supply chain level.

This work proposes eight categories of sustainability criteria. Six of the eight criteria, which are financial, non-financial, material, natural resources, energy, health and safety, can be evaluated at supply chain level but the other two criteria (human capabilities and ethics) can be evaluated only at company level, especially in respect to employees' moral and ethical issues.

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