The position of green logistics in sustainable development of a smart green city

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Abstract

Today’s business world ceases to expose as its main objectives only economic categories. More often other components of sustainable development are raised, where a special attribute is assigned to green color. Cities also face the same phenomenon. This article presents the issues of general relationships, which can be identified by analyzing the position and role of green logistics in a smart green city. The solution to this problem depends on the types of factors that make up the basic cause-and-effect relationships.

Keywords: Sustainability, Green Logistics, Smart Green City;

1. Introduction

Green is often the color of money, but green is also the color of corruption...

The modern economic world treats the phenomenon of global warming extremely seriously, which was confirmed by the award of the 2007 Nobel Peace Prize to Albert Arnold (Al) Gore Jr. Team and the Intergovernmental Panel on Climate Change (IPCC) (www.nobelprize.org). It was a very clear signal regarding the growth of environmental awareness, which became the impetus for making more intensive efforts to find efficient, but also cost-effective solutions to reduce first of all greenhouse gas emissions. This is mainly due to the fact that

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the carbon dioxide has the greatest impact (over 50 percent) on the real risk of negative consequences caused by the so-called “greenhouse effect”. However, attention should also be paid to the fact that the greenhouse gases in the atmosphere cause the average global air temperature prevailing at the Earth's surface to be about 15 °C, and if they were not there, the temperature would be more than 30°C lower, which would be about -18°C, making it impossible, in practice, for life to exist. But the late twentieth and early twenty-first century was the warmest period in the last millennium in the history of the Earth, and for the last 100 years the average temperature has risen by 0.8 °C and in Europe by 0.95 °C. Therefore, according to climate scientists from the Intergovernmental Panel on Climate Change, this increase is much faster than the Earth's temperature changes caused by natural factors, such as the activity of the sun (A. Arcipowska, A. Kassenberg, 2007). Attention should also be paid to the fact that CO₂ emissions in 2010 reached their highest level, exceeding by 5 percent the highest state recorded in 2008. International Energy Agency (IEA), which represents the interests of industrialized countries and is affiliated with Organization for Economic Co-operation and Development (OECD), treats it as a “serious failure” in the fight against global warming.

At the same time, more and more frequently eco discussions, primarily about renewable energy sources (RES), which is a clean energy from perpetual renewable sources (e.g. solar radiation, wind, water, geothermal and biomass), also raise the issues of so-called “Green logistics”.

In addition, this particular concern for sustainable development is included primary in the initiatives undertaken in the cities, due to the concentration of many problems of the environmental, social and economic nature in their centers. The aim of this article is to identify the relationship between green logistics and green supply chain management and the concept of green cities. This approach is accompanied by a shift from the current paradigm of “growth first and cleaning second” in favor of responsible, sustainable development, because of the production of intermediates, i.e. capital, needs measures derived from natural capital (J.Kronenberg, T.Berger, 2010).

2. Green logistics

The first clear “green” concept appeared in the seventies of the twentieth century, when relationships between economic development, the development of social relationships, environment and natural resources was noticed and defined. The expression of these demands was primarily the Declaration of the United Nations Conference on the Human Environment adopted on 16 June 1972 in Stockholm, Sweden, (1st United Nations Conference 1972). As a result, work was undertaken to define so-called sustainable development in the political, ecological, economic and social context, and the concept of “sustainable development” was defined as the right to meet the development aspirations of the present generation without limiting the rights of future generations to meet their development needs. Thus, the environment has been identified as the primary function of the state. The definition itself indicates that economic and civilization development of the present generation should not be at the expense of non-renewable resource depletion and environmental destruction for the sake of future generations, which also have the right to their own development. Officially, however, the concept of sustainable development was adopted at the second Earth Summit, which was held between 3-14 June 1992 in Rio de Janeiro, Brazil (www.un.org). During this summit, two key documents were adopted: the Rio Declaration (Declaration on Environment and Development) - which was the general philosophy of sustainable development and Agenda 21 (the Global Programme of Action), and a document outlining the rules and mechanisms for the practical implementation of the assumptions of this concept into practice. The mechanism of operation of this global concept comes down to achieve three main objectives:

(i) ecological – meaning preventing a degradation of the environment and eliminating their risks,
(ii) economic – expressing itself in satisfying basic material needs of humanity by using techniques and technology that does not destroy the environment, and
(iii) social and humanitarian - that is to secure the social minimum (ending hunger, misery and poverty), healthcare, development of the spiritual sphere (culture), safety and education.

On the other hand, the term “green economy” appeared between 6-8 June 2007 at the 33rd G8 Summit (+5) in Germany, where was presented the report of the German government called, “The importance of global biodiversity loss” (www.unep.org). The purpose of this analysis, developed under United Nations Environment Programme (UNEP), was to identify the phenomenon known as The Economics of Ecosystems and Biodiversity (TEEB)
Mariusz Jedliński / Procedia - Social and Behavioral Sciences 151 (2014) 102 – 111

(www.teebweb.org), with particular emphasis on financial aspects of biodiversity. The authors, however, focused not only on the issue of valuation of natural resources and the environment, but above all on defining complex ecological processes in economic terms. It turned out that the economic dimension can be given to all interactions (benefits) between all living beings and the environment in which they live, and all the interactions between living organisms, the environment and other organisms. Undoubtedly, this was an important observation, which had its repercussions for further parametric considerations on this issue. But unfortunately, much more important became the danger of bringing nature into the category of commercial goods. With this fact, every ecosystem, each species may be at risk, regardless of the degree of its rarity.

As a result of this appeal, in 2010 the World Business Council for Sustainable Development (WBCSD) published a report entitled, “Vision 2050”, which is a new agenda for business, signed by the 29 largest member associations. In the following year, the United Nations published a report entitled, “Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication”, formulating the path of economic growth until 2050, which constitutes an essential element that supports the Rio +20 process. In this report the “green economy” was redefined as: improvement of the situation of human and social equity, with significant reduction of environmental risks and wasting of natural resources. Unfortunately, the lack of its precision, and especially strengthening the belief that the nature is a natural resource, has not resulted in its full positive reception, despite the fact that it postulated that in every year until 2050 there should be invested 1.3 trillion USD, which is about 2% of the world's income, in ten strategic sectors such as: energy, agriculture, fisheries, forestry, crafts, tourism, transport, water and waste. It seems, however, that such targeting of efforts on physical and biological life support systems cannot divert attention from the fundamental problem, which is the ethical and moral crisis occurring in the economy. Hence, first of all, what should be strengthened are the mechanisms of solidarity culture with the people and nature, and especially environmental justice, which is the promotion of the common good of humanity and nature. However, there is a fundamental question of whether we can speak of ecological economics or of the presence of two contradictory dogmas, which are “economic imperialism” or “eco-imperialism”. The first position involves a situation in which companies, similarly to living organisms, compete for environmental resources, thereby creating such categories as “market” or “the price system”. Economics is the art of making rational choices in a situation of limited resources. In turn, green thinking is the change of this focus, because according to Darwin, companies (organisms) struggle for existence. However, this analogy forces the conclusion that with such an approach, in each ecosystem there can be seen a tendency to minimize the size of the area of rotation of matter. In short, companies, just like organisms, should conserve resources.

Undoubtedly, such an approach is represented by green logistics, which is an integrated management of all activities required to move the product along the supply chain to meet the expectations of customers at minimum global cost including also the external costs related to, among others, climate change, air pollution, noise, vibration and accidents. It is being generally accepted that it is primarily designed to measure and reduce the negative impacts of the overall logistics activities on the ecology, and the parameterization of the effects increases the state of awareness of the consequences of the actions taken, and at the same time gives the possibility of indicating potential areas for optimization.

It should be noted, however, that E.Haeckel (1869) treated the ecology as, “knowledge related to the economics of nature”, which is to examine the relationship of plants and animals with their organic and inorganic environment, including above all the friendly and hostile relations with these animals and plants with which they enter into direct or indirect contact. Therefore, it can be said that ecology means building all these complex interactions that Charles Darwin called, “terms of struggle for existence” (Darwin, 2006). Thus, it was more about the study of animals and their relationship with the surrounding inorganic and organic worlds, with particular emphasis on friendly or hostile interactions, with the plants and animals with which they come into contact. Therefore, F.di Castri believed that in its essence, ecology is not synonymous with knowledge about the environment or the science including the problems of environment, although often it is being described in such a way (S.Ziemba, 2004). The aim of sustainable logistics is, therefore, to strive for optimization of the relationship between society, economy and the natural environment, so that they are balanced. It is therefore important to ensure sustainable economic growth, but with the use of renewable energy sources in an environmentally friendly way, taking into account the management of natural resources (especially water and energy) in such a way as to achieve the optimum in
integrating the requirements of legal and executive security. This striving is reflected in the idea of “co-opetition”, because on the one hand companies compete, and on the other, they cooperate in creating a green supply chain using green technologies (and adjust their activities to legal regulations). This strengthens their powers, and especially the so-called “green experience”. The point is to provide a product with as small losses, i.e. with the operational efficiency. Thus, the “green supply chain” should be understood primarily as an integrated environmental thinking sequential and comprehensive oriented supply chain management, including in particular: product design, material sourcing, manufacturing process, delivery of the final product to customers and product management at the end of its useful life. Thus, the area of “green supply chain” is included in a reactive monitoring of environmental management programs to increase the use of proactive practices implementing various “Rs”, for example: Reduce, Re-use, Rework, Refurbish, Reclaim, Recycle, Remanufacture, Reverse logistics, etc. Based on these principles, especially with regard to resource efficiency 2020-2050, the European Union began work on the development of legislative systems, introducing the obligation to responsible supply chain management (RSCM) (S. Lillywhite, 2004). Through appropriate purchasing policy (responsible sourcing of resources), it is possible to interfere constructively, e.g. social and environmental contractors. The aim is thus to create, protect and strengthen the long-term environmental, social and economic values for everyone involved in providing products and services to the market (the United Nations Global Compact).

It also mentions widely accepted four steps of implementation of green sustainable supply, through such activities as: (EPA, 2000):

(i) identification of environmental costs associated with the logistics process,
(ii) determination of barriers that cause the situation in which the waste does not create cost savings and reduction of environmental impact,
(iii) estimation of the financial and environmental benefits or proposed alternative solutions, and
(iv) decision, implementation and monitoring of improving solutions.

Table 1 Sustainable development indicators and leading indicators

<table>
<thead>
<tr>
<th>Sustainable development indicators (thematic area)</th>
<th>Leading indicators</th>
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<tbody>
<tr>
<td>Socio-economic development</td>
<td>GDP growth per capita</td>
</tr>
<tr>
<td>Climate Change</td>
<td>Greenhouse Gas Emissions, Consumption of energy from renewable sources</td>
</tr>
<tr>
<td>Sustainable Transport</td>
<td>Energy consumption in the transport sector in relation to GDP</td>
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<tr>
<td>Sustainable consumption and production</td>
<td>Efficiency of resources</td>
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<tr>
<td>Natural Resources</td>
<td>Occurrence of birds common, Protection of fish stocks</td>
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<tr>
<td>Public Health</td>
<td>The average life expectancy in good health</td>
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<tr>
<td>Social inclusion</td>
<td>Risk of poverty</td>
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<td>Demographic changes</td>
<td>Employment rate of older people</td>
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<tr>
<td>Global partnership</td>
<td>Official Development Assistance</td>
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<tr>
<td>Good governance</td>
<td>(no leading indicator)</td>
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As rightly noted by H.Ch. Pfohl, the objective of logistics is to provide economic and ecological, yet effective movement in achieving these objectives, (which includes time-space transformation) (H.Ch.Pfohl, 2002). If, therefore, the objective is to satisfy the customer's requirements, then such a definition points to the need to take into account both the customers, to whom this transformed good is addressed, as well as all those who participate in the movement both actively and passively (system environment). Obviously, there appears an ecological aspect, where the ecological interest of the society should be duly guaranteed. Logistics can thus become an attractive source of new opportunities and the development of new competencies for the purpose of creating added value in the “green supply chain”. Logistics is in fact focused on the co-ordination of these activities to meet the needs of customers at minimum cost. The key issue is, therefore, internalization of the logistics costs associated with environmental...
pollution. It aims to achieve the balance between the three values, i.e. the economy, the environment and impacts on society. The role of logistics is particularly important, because in fact it is an art of conflict management, but to achieve these goals it does not require e.g. the reduction in road transport, or increased environmental taxes, only to find the optimal balance point. This requires, however, logistic activity parameterization based on the general indicators of sustainable development, a sample list of which is presented in Table 1.

However, so-called “green indicators”, especially those that support the rationalization of activities, such as CO₂ reduction, point to the need to achieve the required balance between the level of emission reductions and cost savings. This relationship is shown in Figure 1.

![Figure 1: Categorization of measures according to their monetary and ecological impact](source)

3. **Smart Green City**

As highly urbanized areas cities are subject to the phenomenon of internalization, due to the transition of their systems to the hierarchical network systems. This requires the adoption of logistics optics in the analysis of movements within them. City logistics is, after all, intentionally structured and integrated movement of people, materials and information in an urban area. At the same time, leading become issues such as: accessibility, the supply of networks and commercial units in the goods, the supply of water and energy, network management, removal and disposal of industrial and municipal waste, the development of telecommunications networks and care for the environment. In addition, among the reasons for the increased interest in the problems of urban logistics, usually there also appear the arguments that are associated with: the spatial expanding of cities, the increase in density of population, and the growing number of localized manufacturing plants and public institutions (J.Szoltyszek, 2009).

Official EPA criteria for measuring the effectiveness of reducing “carbon footprints” in cities include i.a. air and water quality, efficient recycling and management of waste, percentage share of LEED-certified buildings, the size of “green” areas, renewable energy use, ease of access to products and services creating “green lifestyle”, including healthy food products, local shopping and clean transport methods.

The American system of granting green certificates LEED to buildings, next to the British BREEAM system, is a key certification system for commercial and office buildings, less frequently for warehouses. It was created in 1998 by the U.S. Green Building Council - USGBC, which includes the Green Building Certification Institute - GBCI (www.gbci.org). Currently, the valid standard is LEED v4 emphasizing environmental statements. This confirms the fact that the construction products of the particular manufacturer meet the highest environmental and safety requirements and standards.
On the other hand, the rankings showing the natural condition of the cities, so-called Green City Index, was compiled by the Economist Intelligence Unit (EIU) on behalf of Siemens and it measures the environmental performance of more than 120 cities in five continents, i.e. Europe, Latin America, the United States and Canada, Asia and Africa. It was first published in December 2013 in Copenhagen, Denmark, in parallel to the conference COP15 UN on Climate. It shows the ranking of cities based on eight categories, namely: CO₂ (emissions, reduction strategy), energy (energy consumption, use of renewable resources, policy of clean and efficient resources), construction (energy saving), urban transport (no-car transport, communication network volume, promotion of green transport, congestion reduction policy), waste management and natural resource management (production of municipal solid waste, recycling, waste reduction policy, the policy of the use of natural resources), water (consumption, water quality), air quality and environmental management (care, planning). The guiding idea is to help urban authorities, investors and infrastructure providers to know the strengths and weaknesses of selected cities and to present the experiences of others. For example, Warsaw was in the 16th place in Europe, reaching a score of 59.04 points out of 100 possible, with the weakest indexes being: “Water” (25th place), “Waste” (24th) “Transport” and “CO₂ emissions” (20th), due to the high dependence on coal (90%). (Report “European Green City Index”, 2012 - www.siemens.pl)

There is also a second way, which is to withdraw from the conversion of existing solutions to more environmentally friendly ones in order to build a modern city from scratch, focusing primarily on ecological functions. Especially, since the knowledge-based economy places an emphasis on, “the use of knowledge and the development of technology enabling fast and cheap access to information, where the basis of its development is the ability to generate and diffuse innovation” (Borowiec, Dorocki, Jenner 2009).

In this spirit, Panasonic is currently working on the project called Fujisawa Sustainable Smart Town (SST) along with eight partners. In this project, the sustainable smart town occupies an area of 19 hectares and includes 3 000 residents. But Smart City, the leader of which is London, is also an experimental “green neighborhood”. After entering the restricted access zones in the city center, the speed of vehicles has increased by 15-20 percent and public transportation delay decreased by 30 percent. (M.Cewiński, Kapsh Telematic Services).

4. Basic correlations

However, if effort was made to restore the original meaning of the supply chain management, it would appear that the intensity and structure of supply to urban centers results primary from the demand represented by individual customers or groups, as well as the supply of consumption effects. It is the desire to fully meet this demand, both in terms of time, quality and cost, that is a major driving mechanism of logistics solutions in the city. Therefore, it can be called the “Mirror effect”. Hence, any measures to reduce the external costs of logistics activity undertaken must, however, face a crucial dilemma: sustainable development or quality of life of residents of city centers. This does not only refer to the residents, i.e. natural persons, but also to the so-called industrial population (e.g. manufacturers, merchants and service providers).

Given the interdependence between expectations (e.g. quality of life and reduction in consumption), effects (e.g. increase/decrease) or conditions (e.g. level of environmental awareness of urban residents), one can distinguish the following sample relationships:

A) Min/Min,
B) Min/Max, and
C) Positive/Positive.
A) **Min/Min relationship**

![Figure 2 Min/Min effect](image)

The aggregate effect of sustainable development, including eco-friendly logistics activity, as in urban freight, becomes higher as the total demand represented by the whole population of consumers of urban space and resources taking into account the existing resource constraints, strives for a minimum (reduction), while the effects of the use of this concept also aim to achieve the minimum (through increased ecological awareness of city residents translated into supply effects of consumption). In this case (Figure 2), one can talk about the occurrence of the “MIN/MIN” effect.

B) **Min/Max relationship**

The general rule is the rule of resource efficiency, but on the other hand, what is expected is the maximization of the effects of the actions taken.

Therefore, as already mentioned, to achieve sustainable development also includes seeking for the reduction in the amount and level of resource depletion, resulting in an increase in the quality of life of the city residents. This “Min/Max relationship type” is shown in Figure 3.

![Figure 3 The relationship between actions for sustainable development and quality of life of residents](image)

Source: Own study.
C) Positive/Positive relationship

Finally, the expected reduction in the consumption of resources necessary to meet the needs of residents and the functioning of the city brings positive effects for all stakeholders. This relationship can be expressed in the form of “Positive / Positive” leverage (Figure 4).

![Figure 4 „Positive/ Positive” benefit leverage](image)

It is clear that the above cause-and-effect relationships are based on exemplary variants only, but in their message they present the key elements that must be taken into account in the description, analysis and evaluation of implemented initiatives in the broadly understood meaning of “green”. In addition, at this point occurs a key problem connected with the environmental awareness of inhabitants, i.e. their willingness to take on higher logistics costs (including, in particular external costs), by even greater use of ecological solutions necessary to achieve a reduction in the level of pollution (including CO₂). At the same time, the environmental awareness is most frequently determined as the “consciousness of a man in terms of the natural environment, the group of collected information and beliefs about it, as well as the system of values that the man applies while dealing with this environment” (D. Kielczkowski, 2001). This relationship is shown in Figure 5.

![Figure 5 Acceptance of the increase in logistics costs as a result of growing environmental awareness of city residents](image)
5. Conclusions

Summing up the above considerations, there is a fundamental question of whether it is possible to equate green logistics with a smart green city. It seems, however, that this involves the relationship: smart city - smart inhabitants - smart authorities - wise effects. These wise effects apply especially to the practical reduction of resource depletion necessary to meet the demands of residents and functional needs of the city or maximization of favorability and functionality of the city space for the effective and efficient meeting of the needs of the stakeholders.

Therefore, the question is whether in the face of the more frequently observed positive changes in attitudes towards these solutions, the smart green city of the future will include the following features:

(i) more compact form,
(ii) structure deindustrialization,
(iii) greater heterogeneity,
(iv) holistic thinking,
(v) functionality maximization,
(vi) greater humanization,
(vii) lower power supply cost, and
(viii) increase of the public goods utility.

It seems, however, that in the current socio-economic context, it is not enough just to present “green economy” slogans as a universal solution to all the problems of sustainable development in the contemporary city. Especially, since the modern economy, and thus “green economy”, is also the economy of uncertainty with instable knowledge, where key decision problems faced by decision makers responsible for sustainable development in the city are connected with the needs and limitations.

Therefore, green logistics in the smart city is not seen only as a way of satisfying the needs of a specific entity set to make a profit, the consequence of which is a cost formula. Yet it seems that urban logistics is rather an efficiency asymmetry, since the objects are entities that are not focused on profit in its classical sense, i.e. the relation of effects and costs. Rather, there is the cost added at the individual level, in the name of reducing the overall costs, including external interests of the entire system of the city. Although in recent years, more and more attention is drawn to the problems of environmental protection and ecology in diverse areas of human activity, an open question is still: what is the level of acceptance of these additional costs, in the context of rising social trend? Thus, this is based on the leading indicators for smart green city, which can become, for example: an increase in wealth of residents, improvement in the quality of life (e.g. quality of water, air, the availability of green areas), good governance (stability and the prospects of life), an increase in the economics of life (cheaper life), an increase of modernity (e.g. the availability of telepathic solutions) or the quality of life (e.g. mobile security and traffic flow).

Many cities raise slogans relating to the ongoing process of environmental degradation resulting from manufacturing or consumer actions of humans and a significant depletion of natural resources resulting from the conflict between the progress of civilization (growth) and technological development (development). But it is a problem that still has not been solved, because on the one hand, people seek to increase matter, and on the other hand, they strive for the greater state of ownership by extending the potential or implementing specific capabilities.

Therefore, as a result of numerous discussions and publications concerning these problems, the compromise have been found, which led to the formation of the idea of a new concept for the further development of civilization defined as “sustainable development”.

The concept of sustainable development is a proposal for a qualitatively new form of conscious, responsible individual and social life in smart green city, based on development along with the social and natural environment, including environmental constraints and social expectations of all concurrent users of urban space (stakeholders).
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