DE GRUYTER
OPEN

10.1515/jbe-2016-0006

Embending Sustainability Dynamics in the Lean Construction Supply Chain Management

Begum Sertyesilisik

Department of Architecture, Istanbul Technical University, Istanbul, Turkey
begum_sertyesilisik@hotmail.com

Abstract: *The world's habitat is being deteriorated despite of the precautions taken. Construction industry is among the industries which highly effect the environment adversely not only through its outputs but also through the construction process and its inputs. The main focus in dealing with the reduction of its footprint has been on sustainable building certificates which mainly analyse the output of the construction activies. There is need to analyse the construction supply chain as a whole and to embed sustainability dynamics in construction supply chain management. Lean construction project management contributes to the reduction of the environmental footprint of the construction industry, enabling reduction in waste, and increasing value added activities. For this reason, based on an in depth literature review, this paper analyses and establishes the principles of the integration of the sustainability dynamics into lean construction supply chain management.*

Keywords: *sustainable construction supply chain management; value creation; lean; lean construction project management.*

1. INTRODUCTION

The climate is changing, the earth's temperature is rising, and the earth resources are being exploited. All these occur despite of the precautions (e.g. Kyoto protokol, green building certificates, etc.) taken. Einstein defines insanity as "doing the same thing over and over again and expecting different results." There is a need to act more strategically to protect the earth's environmental habitat for the survival of humankind. The data about the state of the world, as presented in the Rio+20 summit, revealed that today's humanbeings live less sustainably than they did in 1992 and that the economic activities' environmental impacts have the potential for causing uncontrollable global disasters [1] (p. 282). The report from the Intergovernmental Panel on Climate Change (IPCC) called for immediate action to reduce greenhouse gas emissions to keep global warming below 2°C [2]. Reduction in the CO_2 emmissions is within the agenda in the EU policies, and targets. The European Commission's Roadmap for moving to a low-carbon economy in 2050.

Sustainability needs to be an integrated part of the strategic management of the companies. 'Green' needs to be the way the companies operate. This requires transformation in the working culture of the companies and of their supply chains. Based on the pareto principle, this transformation in working culture needs to be launched especially in the industries which have high adverse impacts to the environment. Construction industry is among the industries which

highly effect the environment adversely. As the construction industry effects the environment not only through its outputs but also through the construction process and its inputs, its footprint needs to be reduced. Currently the main focus in dealing with the reduction of its footprint has been on green building certificates which mainly analyse the output of the construction activies. There is need to look for other effective solutions to prevent the deterioration of our home planet. There is need to analyse the construction supply chain as a whole and to embed sustainability dynamics in construction supply chain management. This will be not only beneficial for the humankind and the earth but also for the companies as green practices have positive effects on quality, customer satisfaction and efficiency [3].

As the companies are key players on the societal path towards sustainability, it is necessary to find practical approaches for sustainable development inside the companies themselves, as well as with regard to their supply chains [4] (p. 1060). Effective supply chain management plays key role in securing competitive advantage and improving organizational performance [5] (p. 107). Companies start to look at their supply chain to enhance their overall sustainability profile especially due to the fact that the focal companies are held responsible for environmental and social problems caused by their suppliers as well as due to the fact that an increasing share of value is created at the supplier level [4] (p. 1053). [6] (p.18) states that a company ''is no more sustainable than its supply chain''. There is literature on environmentally friendly supply chain management in different industries [7], [8], [9], [10], [4], [11], [12], [13], [14], [15]. There is, however, limited literature on the sustainable construction supply chain management. Furthermore, for the efficient and effective construction project management, benchmarking can be carried out with management principles and applications in different industries such as manufacturing industry. The 'lean' principles have been originated from manufacturing industry and adapted to the construction under the name of lean construction project management which contributes especially to reduction in the environmental footprint of the construction industry, resulting in reduced waste, and increased value added activities. The lean supply chain strategy focuses on embedding lean principles and practices across the supply chain and on reducing waste in the supply chain, enabling companies to improve quality, delivery times and customer service and to reduce costs [16], [17], [18]. Embedding sustainability principles in the lean construction supply chain can help the construction industry to reduce its environmental footprint. For this reason, based on an indepth literature review and referring to the construction project phases, this paper aims to analyse and establish the principles of the integration of the sustainability dynamics in lean contruction supply chain management. It investigates how to integrate 'sustainability' and 'lean' principles to the construction supply chain management. Furthermore, the drivers for and barriers against integration of the sustainable and lean principles to the construction supply chain management have been analysed; the relationship of sustainable and lean construction supply chain management with strategic management, value creation, and contracting have been investigated.

2. EMBEDDING SUSTAINABILITY AND LEAN IN CONSTRUCTION SUPPLY CHAIN MANAGEMENT

2.1. Embedding Sustainability and Lean in the Main Construction Project Phases

Design, contracting, planning, construction, and control phases have been analysed with respect to the sustainability and leagility principles.

2.1.1. Design

Designers play an important role on sustainable outcomes. Design decisions influence the sustainability performance of the construction phase as well as of the operation and maintenance phase of the constructions. For example, arranging the size of the rooms considering tile size can reduce the amount of tiles wasted in the construction phase. Similarly, the material chosen in the design phase can affect the maintenance cost and need for replacement in the operation and maintenance phase. 'Sustainable and lean' design needs to reflect sustainability principles (i.e. sustainable building certificates requirements) as well as the lean construction principles as appropriate. [20] recommended that green should be incorporated upstream in the supply chain, i.e. in the product design phase [21]. [18] stated the lean construction principles as: specifying value from the customers' view, identifying the value stream, making the value-creating flow, achieving customer pull at the right time and pursuing perfection for continuous improvement. Similarly, the lean construction principles loop, as identified by [22], starts with identification of value followed by successive principles of mapping the value stream; creation of flow; and establishment of "pull" and seek perfection. According to the lean construction, design needs to reflect the value identified based on customers' point of view. The value created can be influenced relatively easier and less costly in the design phase than in successive phases, as the construction proceeds the changes are costly and time consuming [23]. From sustainability point of view, the scope of 'value' needs to be broadened to include the 'value' for the nature and the 'value' for the future generations. The broadened version of the 'value' concept can enhance the integration of lean and sustainability concepts. Construction supply chain is a chain for production where the value is created. Porter's value chain illustrates this fact focusing on primary activities and support activities so that efficiency in these activities can be increased resulting in increased profit margin of the company. Primary activities directly deal with the creation or delivery of a product or service, whereas support activities help to improve the effectiveness of primary activities. As the design process affects the sustainability and lean performance of the supply chain as well as the value created in the supply chain, there is need to update the Porter's generic value chain. Porter's generic value chain defined primary activities (inbound logistics, operations, outbound logistics, marketing and sales; and service) and support activities (firm infrastructure; human resource management; technology development; and procurement). Porter's generic value chain needs to be updated with the contemporary and future needs covering lean and sustainability principles (Figure 1) so that the lean and sustainability performance of the supply chain is supported:

- *Design as primary activity:* Primary activities need to include design as design is the most effective stage which influences the value created and the carbon footprint not only in the product but also in the supply chain. [29] emphasized the influence of design on the carbon footprint in the products and in their supply chain. Furthermore, value engineering of the product or construction can be achieved relatively less costly at the design stage.
- *Lean management as support activity:* Throughout the value chain, lean and agile management principles need to be applied as appropriate to the primary activities depending on the decoupling point.
- *Value engineering as support activity:* Throughout the value chain, the value created in the primary activities needs to be improved with the help of value engineering.
- *Sustainable management as support activity:* Throughout the value chain, the primary activities' sustainability need to be improved and their footprint needs to be reduced. For this reason, primary activities need be analysed from sustainability point of view (including economical, environmental and social aspects) so that their sustainability performance can be improved.

- *Sustainability margin:* The primary and support activities should not only enable profit margin but they should also enable sustainability. For this reason, there should be two margins one for the profit and the other for the sustainability. Profit is needed for the companies' survival so is the sustainability of the nature due to the fact that the production processes are dependent on the nature (i.e. raw materials, re-used materials, water, energy, etc.).

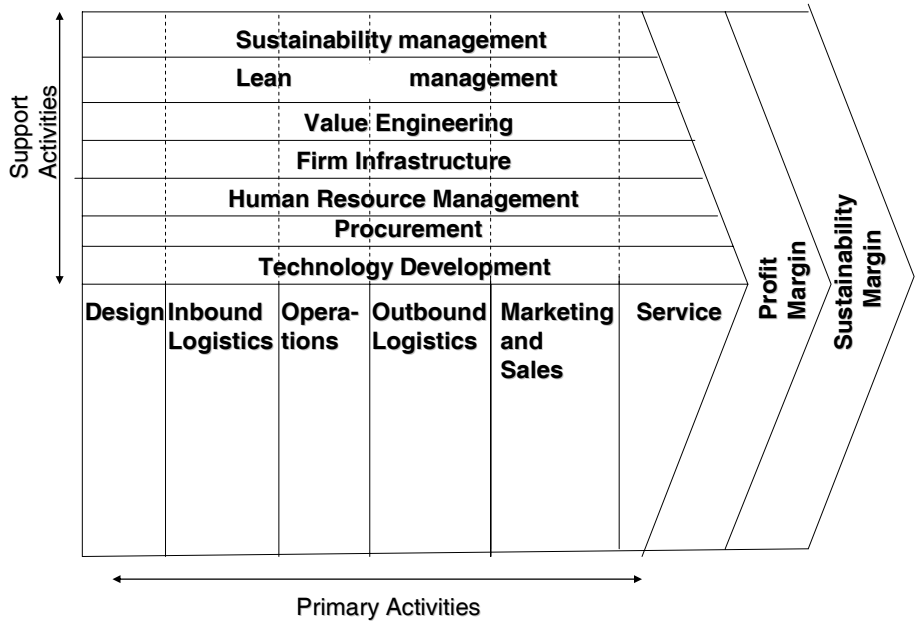

Figure 1. Extended version of Porter's generic value chain (adapted from [30])

The design phase needs to cover interdisciplinary team work considering the construction phase so that the need for re-work and variations in the construction phase are reduced. Re-work and variations can cause waste both in terms of lean principles (i.e. waste of making defective parts) as well as in terms of sustainability principles (i.e. adverse effect to the environment due to inefficient use of resources). Interdisciplinary team work in the design phase can also enhance lean and sustainability principles as it can enable development of the design foreseeing difficulties in the construction phase and creation of the design which is relatively more easy to construct. This collaboration at the design phase can also influence smooth progress of the construction work on site supporting lean construction principles such as reducing the waste of time on hand (waiting). The constructability analysis of the design in an interdisciplinary way complies with the lean construction principles [24]: reducing the share of non value-adding activities considering site specific factors; reducing variability; minimising the number of steps, parts and linkages. Furthermore, the end-users'involvement in the design process, where appropriate, can also reduce the need for the variation orders in the construction phase and can support the leanness and sustainability principles with the help of reducing the waste. The sustainable and lean design phase should be supported by the BIM and ICT [25].

Design process should start with optimum site location determination unless it is determined by the Employer as the site location affects the leaness and sustainability of the construction process as well as the operation phase of the building and its environmental footprint.

The site location should be selected based on the sustainability and leaness principles which can require optimum trade-offs to achieve a design which has both sustainable and lean construction characteristics. For example, lean construction requires the reduction of waste in transportation which complies with the sustainability principles as it can reduce the amount of CO_2 emmission. The best site location with respect to the vicinity of materials, however, might not provide the best solutions with respect to factors such as natural ventilation, and daylighting affecting the operational cost of the building and its impact to the environment. The principles of the lean tools which can be adapted to the design process in the construction industry are: poka-yoke [26] to support correct, and fast constructable design; 3R (reducing, reusing and recycling) to support material determination in the design phase [27]; and value based management (VBM) to consider product value for the customers as well as for the workers and project participants [28].

2.1.2. Contract

Contracts and specifications determine the quality requirements including sustainability and lean performance requirements. Competent subcontractors and suppliers need to be assigned to the work so that the waste in terms of lean [wastes types (as defined by Ohno): overproduction; time on hand (waiting); transportation; processing itself; stock on hand (inventory); movement; and making defective parts] and sustainability are minimized. Partnering can support both lean and sustainable construction. It can support lean construction as described by [31] in the following statements:

"Partnering is a solution to the failure of central control to manage production in conditions of high uncertainty and complexity…Partnering…provides the opportunity for collaborative redesign of the planning system to support close coordination and reliable work flow… Partnering relationships coupled with lean thinking make rapid implementation possible. Where Partnering is about building trust, lean is about building reliability." [31]

Similary, partnering can support sustainable construction as emphasized by [8] (p. 140) in the following statements: "*A cooperative approach builds trust and suggests commitment to the relationship on part of the buyer as well as the supplier. In such relationships suppliers are more inclined to invest in development initiatives such as green supply chain management activities.*"

Both standard contracts (i.e. FIDIC, ICE) and company specific contracts needs to be updated covering sustainability clauses (i.e. ethical sourcing, carbon footprint in the supply chain). [29] (p. 1218)'s study on the automobile industry and carbon footprint in supply chain management revealed the importance of analysing the supply chain's carbon footprint which can be facilitated through carbon auditing at product, company, and supply chain levels as well as through a carbon footprint manual and measurement tools as developed by HMC, a focal company, in the automobile industry. With the help of benchmarking from the automobile industry, similar carbon auditing and preparation for carbon footprint manual and measurement tools can be adapted to the construction industry and the construction contracts can be updated reflecting these requirements. Environmental criteria should form part of the specifications [4] (p. 1055). Social aspects of the production/construction process needs to be addressed in the contracts so that 'ethical' sourcing is ensured. The contract clauses should prohibit unethical sourcing activities (i.e. illegal child and forced labour, and discrimination) and it should refer to the Social Accountability 8000 standard [32]." [4] (p. 1056). The contract should enable effective control mechanism for ensuring the sustainability performance required. The contract

should include control mechanisms for inspections and arrangements for visits to the production sites of suppliers [4] (p. 1058) as well as to the sites for subcontractors' performed works. All these requirements should be reflected in all subcontractors' and suppliers' contracts in all tiers.

The choice of suppliers/subcontractors is critical in the implementation of a sustainable sourcing strategy [33] (p. 207). The focal companies can do the followings for the supplier/ subcontractor appointment/assignment:

- General sustainability requirements (i.e. in-house guidelines; environmental management systems such as ISO 14001; social standards such as; SA 8000 or AA 1000; and company's own code of conduct) need to be determined in the relationships to business partners, so that company's understanding of development is reflected to the supply chain the placing such requirements on suppliers/subcontractors who are required to pass them on in their own supply chains [4] (p. 1058-1059)
- Environmental and social values need to be considered in addition to economic ones that will help the organization achieve its overall goals in a profitable and sustainable manner. [34] (p. 258)
- Suppliers'/subcontractors' carbon management performance need to be analysed [29] (p. 1222)
- Purchasers need to go beyond financial metrics and to monitor new sets of risks such as employees' security, pollution, and waste of resources [64], [33] (p.208).
- Supply related environmental and social risks as well as suppliers' weak points need to be detected via internal and external issue screening with the help of: internet inquiries; expert panels; media and specialized journalism screening; contact to watchdog organisations; noting legal drafts; and regular dialogues with NGOs; internal staff members are also able to detect related issues; and introducing an internal reporting requirement for all divisions. [4] (p. 1058-1059)
- Suppliers/subcontractors who do not fulfil environmental and social standards specified in the contract should be required to initiate an internal improvement and development process so that they ensure that they will meet the quality as specified in the contract [4] (p. 1058-1059)

2.1.3. Planning

Continuous work flow [25] (p. 182) is important for the lean construction and can be achieved with the help of effective and integrated planning [26] (p. 303-304). Planning needs to enable stabilizing the work environment, moving upstream to reduce in flow variation, Improving downstream performance [35]. Planning phase can be supported by the adaptation of the principles of the heijunka, just-in-time, value stream mapping, and last planner system lean tools. Heijunka aims at production levelling to stabilize the operations and to reduce variability in resource utilization [26] whereas just-in-time enables the production process to make what is needed only when it is needed and in the exact quantity needed, avoiding overproduction and reducing inventories to the minimum required for smooth flow [24]. Value stream mapping focuses on material and information flow. LPS supports the lean goals by making a planning mutual attempt and by increasing the reliability of team members' commitments [36] as cited from [21]. These lean tools can support the planning for smooth and continuous workflow keeping wastes as low as possible supporting sustainability. The work items and production processes which require resources but which do not create value (i.e. transport, inventory, motion, waiting) should be identified in the planning phase and they should be minimized [37].

In case of high uncertainty in the project, the planning phase can be supported by the agile methods. Based on the principle of difficulty in predicting what will happen in the future, planning in the agile management consists of the following levels [19]: vision; roadmap (product breakdown structure and logical network as tools), and deliverance plan (including all milestones and their schedule); cycle plan (determining the cycles for each milestone and their duration); and daily plan. Vision and the roadmap are established at the beginning of the Project whereas the others are revised during the project.

2.1.4. Construction

Construction phase needs to be started with an effective mobilization. Based on the lean principles, site planning needs to be carried out in a way that it supports smooth flow of material, information, equipment, and labor, reducing or eliminating non value-adding activities (i.e. waiting, transportation). Site planning can effect the health and safety as well as sustainability performance of the construction (i.e. unprotected inventories can cause waste). Value stream mapping lean tool can support the mobilization phase as it focuses on the physical flow of material [26] (p. 11-57).

Phases	Site planning and mobilization	Construction				
To do's	Enabling smooth flow of material, information, equipment, and labor, reducing or eliminating non value-adding activities (i.e. waiting, transportation).	Enhancing the sustainability performance of the supply chain	Enhancing the sustainability performance of the construction phase	Controlling of the performed works	Controlling of the carbon footprint of the works	Controlling of the health and safety performance
Enablers	Value stream mapping focusing on physical flow of material Last planner system BIM	Trainings on sustainability topics and site waste management	Application of lean operational practices	Inspections, site visits Kaizen principles Jidoka Visual management 5S Total productive maintenance Five why's BIM	Carbon auditing throughout the supply chain Complying with in-house guidelines; environmental management systems; SA8000 or AA1000 code of conduct [4]	Complying with the OHSAS 18001

Table 1. Summary of to do's and enablers in mobilization and construction phases

Throughout the construction process, in addition to the effective contract administration, the followings need to be carried out to make the process lean and sustainable:

- Trainings (such as health and safety trainings) should be provided to the suppliers/ subcontractors on sustainability topics and site waste management.
- Based on the early detection of supply related environmental and social risks as well as weak points at suppliers [4] (p. 1059), necessary precautions need to be taken for the smooth flow of the works complying with both leanness and sustainability principles.
- Performed works needs to be controlled in accordance with the control mechanism determined in the contract (i.e. inspections; visits to the site) so that all waste types are eliminated or kept at minimum.
- With the help of benchmarking from [29] (p. 1218)'s study on the automobile industry, the construction process need to include carbon auditing at product, company, and supply chain levels and checking the compliance of the performance with carbon footprint manual and measurement tools so that carbon footprint in supply chain management can be reduced. Furthermore, the contracting parties and suppliers/subcontractors who have the tendency of failing to reach the targets specified in the contract can be trainned so that their carbon footprint performance is improved.
- Subcontractors need to comply with OHSAS 18001 in managing their occupational health and safety risks [38] as it can enhance the lean construction through improved work environment, and productivity as well as increased job satisfaction [21].
- Subcontractors/suppliers need to comply with the normative requirements for sustainable supply management (In-house guidelines; environmental management systems; SA 8000 or AA 1000; code of conduct) [4] (p. 1058-1059).
- The construction process and the suppliers/subcontractors can get benefit from the last planner system as well as from application of lean operational practices (i.e. pay for performance wage systems; payment for ability; developing and rewarding multiple skill operators).
- Kaizen principles can be adapted to the construction process to reduce the need for re-work and not to cause defective work, as Kaizen empowered the employees actually doing the work to remove waste as well as to design and implement more effective processes. Similarly, even Jidoka tool is suitable and invented for line production, its principle of stopping everything at the first sign of quality problems so that the problem can be corrected before production resumes, to limit the waste being produced [26] (p. 12), can be adapted to the construction process to prevent defective work.
- The construction phase and site management can be enhanced via visual management lean tool as it requires keeping the process areas clean and well organized through the use of tools like 5S, and usage of signs, labels, and color coding [26] (p. 148).
- Site management can be supported by the *total productive maintenance tool* to ensure that machines in production lines perform required tasks without interruption to avoid poor equipment performance related problems (i.e. over-production, inventory, defects, transportation, and waiting) [26].
- Site waste management can be enhanced through 5S and 3R tools as 5S tool deals with five-step process for workplace organization, housekeeping, cleanliness, and standardized work [37] (p. 51) enhancing productivity, quality, speed, and safety of the work [27] whereas 3R is focusing on "reducing, reusing and recycling" to become lean and green [27]. Furthermore, site waste management requires [39]: a well structured waste management plan; agreements between contractors and sub-contractors to determine who is responsible for waste on-site; usage of waste companies that offer free waste skip disposal or usage of colour coded bins to segregate waste for recycling;

and appointment of a designated waste manager to deal with the delivery and storage of materials.

- Control should be actively carried out throughout the project life [21] (p. 91) to identify the variances and to take necessary precautions on time. Controlling can be supported by the building information modeling (BIM) and geographic information systems (GIS) [40]. Regular meetings, covering management, design, user liaison, cost and progress are also important for the control [41] (p. 189). Shared resources need to be coordinated [35]. Furthermore, plan, do, check, and act cycle as well as inspection and testing needs to be pursued. Five whys lean tool can support controlling phase as it is based on asking 'why' as many times as needed so that the root causes of the problem as well as the causes of waste in value stream map are identified [26].

Construction phase needs to be accomplished with the environmental friendly demobilization.

2.2. Key success factors

Successul implementation of lean and sustainability practices requires change in the company culture and a strategic approach [57], [58], [44], [59], [60], [17], [51], [61]; lean organisational thinking [57], [59], [60], [17]; and management leadership [58], [60], [17]; integration of operations management and human resource management practices [17].

Lean and sustainability principles need to be embraced not only by the first tier supplier and subcontractors but also by all tiers (i.e. second and third tiers). As sustainable practices need to be implemented throughout the supply chain, relationship with suppliers is important [8] (p. 139). SC (supply chain) needs to be both environmentally and socially responsible [4]. SC can be economically responsible in case environmental criteria/standards are integrated into the whole supply process and in case environmental compatibility of purchased goods are optimized [49], [4] (p. 1055); environmental performances of suppliers/subcontractors are assessed with respect to standardised environmental management systems [63]. Adherence to the standardised environmental management systems can be pre-qualification criterion for subcontractor/supplier appointment and these systems can be referred to in the product requirements specifications [4] (p. 1055) or the contract can refer to the green/sustainable building certificates. SC can be socially responsible so that unethical sourcing (i.e. illegal child and forced labour, and discrimination) can be avoided throughout the supply chain). Unethical sourcing can be prevented in case the focal companies work only with the companies addering to the ethical requirements (i.e. the Social Accountability 8000) and monitor their performance [4] (p. 1056). Similarly, knowledge capacities have to be aligned throughout the SC according to changing market requirements. [62] (p. 82). "…for a … future oriented sustainable supply management, the ability for development in the supply chain based on collective learning processes is the decisive factor in creating win-win situations for both partners." [4] (p. 1058) The focal companies need to integrate environmental and social criteria into their supply policies and processes [4] (p. 1056). They should enable close collaboration and shared best practices among the companies in the SC [42], [43], [44], [45]. Close relationship with suppliers [46] and subcontractors as well as enabling their participation in sustainable and lean practices is important for reducing footprint of the SC. Factors influencing supplier participation include [8], [44]: customer requirements, supplier readiness, relational norms and customer investment. internal capabilities of suppliers, e.g. relevant knowledge and know-how, are positively related to participation in GSCM initiatives. Similarly, employees' involvement needs to be encouraged through empowering them [47], [48], [49], [50], [51].

A sustainability move relies on the adoption of new manufacturing technologies, and of sustainable products as well as on the integration of sustainability practices into the supply chain [62] (p. 73).

Sustainability supply management concept requires accomplishment of the following levels [4] (p. 1058-1060): (1) normative requirements (i.e. in-house guidelines; environmental management systems; SA 8000 or AA 1000; code of conduct) (2) early detection of supply related risks; (3) operational implementation of supply process; and (4) monitoring and supplier development (creation of control mechanisms for inspections; visits to the production sites of particular suppliers; a revision and qualification system to obtain professional competence and routine in the processes).

Lean performance needs to be monitored and evaluated [44], [52], [53] for enhancing the lean performance of the supply chain. Effective communication [54], [17], [55] is important for monitoring the supply chain's performance. ICT can facilitate this process. [17] empasized that for the results in the lean supply chain to be sustained logistics and distribution systems need to be improved, ICTs implemented to integrate customers and suppliers, and cooperative relationships with customers and suppliers continuously improved [56].

It is important to consider and take necessary precautions against possible barriers which might be encountered in the transformation process of the supply chain. These barriers might include: suppliers' lack of technical know-how to comply with sustainability requirements [8]; suppliers' lack the financial means to invest in green initiatives [8]; enforcing unreasonable contracts on small suppliers obstacling their stay in business [8] (p. 139); risks arising due to the implementation of sustainable procurement [64], [33] (p. 207); conflicts among companies in the same SC upon launching new sustainability-oriented activities [7] (p. 549); the consumers' unwillingness/reluctance-to-pay for sustainability efforts [65], [66], [62] (p. 74); high initial buyer and supplier investment costs associated with adapting SSM [34] (p. 267); cost issues and economic uncertainty." [34] (p. 267); rising transaction costs due to embedding environmental standards in the purchasing criteria [46], [44] and the difficulty in developing and managing environmental specifications [44], [46]; suppliers' reluctance in environmental upgrading due to fuziness in the sufficient business rationale for investing in environmental upgrading." [10] (p. 73); difficulties in supplier relationship management due to potential risks and financial disadvantages of collaborative partnerships (i.e. overinvestment in supplier integration [67], [68].

It is important to consider and take necessary precautions against the following challenges which might be encountered in the transformation process of the supply chain:

- Purchasing good or services complying with environmental and/or ethics policy might not result in the lowest costs [4] (p. 1054).
- Lean might not be always green or sustainable as they can have conflict of interests causing trade-offs. For example, when the supply chain is expended geographically, lean and sustainability practices start to conflict due to CO_2 emissions [69]. Furthermore, not all lean practices can contribute to the CO_2 emmissions (e.g. JIT can cause high frequency of transportation with small batches resulting in CO_2 emmissions) [44].

Key success factors for successful integration of lean and sustainability principles into the supply chain have been summarized in the Table 2.

Main classification of key success factors	Key success factors	References
Monitoring	monitoring lean performance	[44], [52], [53]
	monitoring supplier development	[4]
Communication	enabling effective communication	[54], [17], [55]
	enabling involvement of top management	[34] (p. 262)
	paying attention to the relationship with suppliers	[8] (p. 139)
Collaboration	enabling close collaboration among the companies in the SC so that they can share best practices and improve themselves with the help of collective learning process	[4], [42], [43], [44], [45]
Collaboration	integrating operations management and human resource management practices	[17]
Culture and thinking	changing the company culture and a strategic approach	[17], [44], [51], [57], [58], [59], [60], [61]
	complying with lean organisational thinking	[57], [59], [60], [17]
Leadership	management leadership	[17], [58], [60]
Supply Chain	establishing environmentally and socially responsible supply chain	[4]
	requesting companies in all contracting tiers to be both environmentally and socially responsible	
	aligning knowledge capacities of the companies throughout the supply chain	[62] (p. 82)
	enabling supplier to be ready for embracing sustainability practices	[8] (p. 134)
	complying with normative requirements	[4]
	detecting supply related risks at early stages	[4]
Contract	considering adherence to the standardised environmental management systems as pre-qualification criterion for subcontractor/supplier appointment and referring to these systems in the product requirements specifications referring to the green/sustainable building certificates in the contract	[4] (p. 1055)
New technologies	adopting new manufacturing technologies, and sustainable products as well as integrating green practices into the supply chain	[62] (p. 73)

Table 2. Key success factors

2.4. Strategic Aspects of the Sustainable and Lean Construction Supply Chain Management

[62] (p. 74) emphasizes the importance of strategic management for adaptation of the companies to the developments in the sustainability as follows: "*Developments in the sustainability have significant implications on the strategic decision-making process of the firm as the sustainability challenge requires the revision of current management practices.*" The SWOT analysis needs to be carried out by the companies so that they can benefit from opportunities in the environment and convert threads into opportunities. The tendency in society and environmental legislation towards environmentally friendly products reveals market opportunity for the companies who can adapt themselves to these new trends. The companies who fail to adapt themselves to these new trends might encounter market entry barriers or shrinkage in their markets. Enhancing sustainability performance of the SC requires competence for sustainable production methods and manufacturing [8].

It is important that the companies in the supply chain notice the advantages and synergies of sustainability embedded into the lean supply chain management so that they can adapt

their strategic management accordingly. Integration of lean and sustainability practices creates synergy as lean can contribute to the sustainability practices which can contribute to the lean business practices and enhance companies' lean performance [44] (p. 93). Other areas of synergies include:

- increase in the value delivered to customers.
- increase in the profit margins due to differentiation in sustainability practices [50]. [44] (p. 95-98).
- possibility in implementation of common tools (i.e. value stream mapping [17], [70], [20]) in both lean and sustainability practices
- improved resource efficiency through lean management [71], [72] lead to the reductions in environmental pollution preventing waste emergence [71], [74], reducing materials and energy consumption as well as reducing the dispersion of toxic substances through the use of fewer raw products [74], [75], [73].
- fostering innovation in the supply chain [71]
- lean practices' and lean supply chain management's contribution to the accomplishment of environmental goals and adoption of environmental practices as well as to the accomplishment of the green supply chain strategy [50], [74], [17], [51], [73], [74]
- reductions in inventory levels, excess capacity, and transport and production times, and increased levels of integration and frequency of information sharing throughout the supply chain [75] as quoted by [17].
- common requirements of lean and sustainability for external auditing and on-going reviews [44]
- increase in the competitiveness and in organizational performance [82], [83], [9] (p. 118), [76] (p. 232), [4] (p. 1058), [5] (p. 109), [84].
- enhancement in their operational performance due to socially and environmentally responsible supply chain management [9] (p. 118)
- increase in the efficiency through the elimination of errors and breakdowns. [4] (p. 1058)

The companies should consider the advantages of addressing environmental concern in the supply chain management (e.g. achievement of the economic success of a company's supply chain due to complying with environmental and social standards [4], [81]) for their investment decisions in their strategic plans. The companies can be encouraged in their strategic plans to invest in enhancing the sustainability of their supply chain management due to the various drivers including: government regulation [86], [34] (p.262); financial benefits [34] (p. 262); desire to gain competitive advantage [33], [34] (p. 262), [87]; customers' demand [8] (p. 134); [34] (p. 262); demand for environmental protection [88] (p. 577); desire to reduce costs through minimization of waste and pollution [87]; return of investments in environmental upgrading [10] (p. 81); differentiation for the brand with the help of embedding sustainability into brand knowledge and brand value [85] (p. 287); prevention of loss of reputation that might arise from insufficient environmental and social problems [9] (p. 118), [76] (p. 232), [77], [78], [79] and lacking social standards at suppliers [80]. [4] (p. 1055). Similarly, companies can be encouraged in their strategic plans to invest in enhancing the lean performance of their supply chain due to the potential benefits of lean management including: lean practices can enhance sustainability [89]; and health and safety in the work place [17], [90], [74]. Furthermore, lean practices might enhance the workers' commitment and increase their motivation [91], [92], [18] through increased responsible autonomy [93] and personel empowerment.

3. EXTENDING THE SCOPE OF THE PORTER'S DIAMOND FRAMEWORK

Porter's diamond framework can be a useful tool for strategic analysis. Porter's diamond model provides insight into how a company's environment influences its competitive advantage over time and how to set strategy in order to outperform international competitors. Porter [30], [94]'s diamond framework defines factors which affect the competitive advantage of the companies working abroad. This framework includes 4 main factors (firm strategy, structure, and rivalry; factor conditions; demand conditions; and related and supporting industries) and 2 outside factors (chance and government). The diamond model focuses on: production factor conditions; demand conditions for industry's products/services; availability of the related and supporting industries capable to compete internationally as well as chance and government factors. Porter's diamond framework, however, does not cover the sustainability conditions and future generation factor which need to be considered by the companies and their suuply chain when they set strategy to outperform their competitors. For this reason, Porter's diamond framework needs to be extended considering sustainability and lean requirements. Porter [30] [94]'s diamond framework can be redefined embedding sustainability perspective as follows (Figure 2):

- *Future generations requirements as outside factor:* Future generations requirements (i.e. living in the habitable world) influences all main factors encouraging the companies to produce more sustainably in an efficient and effective way reducing/minizing waste. Increased efficiency in the production/construction can support competitive advantage of the companies through reduced cost. Sustainability conditions need to be another main factor which needs to be covered by the diamond framework.
- *Sustainability conditions as main factor:* Sustainability conditions influence economical, social and ecological aspects of the production/construction environment enabling long term competitive advantage affecting all other 4 main factors.

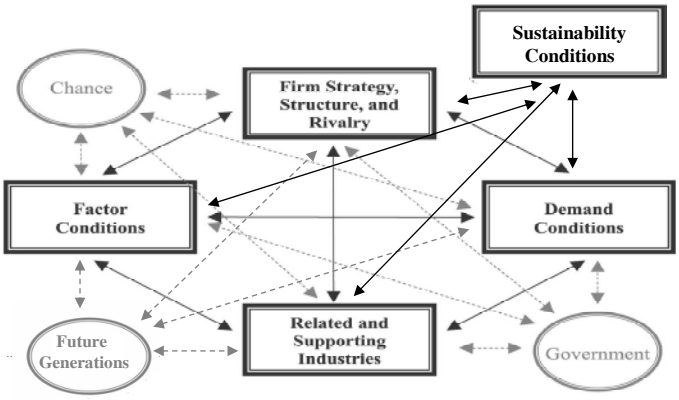

Figure 2. Extended version of the Porter's diamond framework (adapted from [30])

4. CONCLUSIONS AND RECOMMENDATIONS

As the world's habitat is being deteriorated despite of the precautions taken, and as there is need for immediate action [95], [2], this paper focuses on embedding sustainability in leagile construction supply chain management. The main findings and recommendations of this research can be summarized as follows:

- *Redefinition of the Porter's value chain:* Porter's generic value chain needs to be updated with the contemporary and future needs covering lean and sustainability principles so that the leanness and sustainability of the supply chain is supported. The changes required are: adding *'design'* as primary activity; adding *'lean management', 'value engineering'* and *'sustainable management'* as support activities; and adding *'sustainability margin'* extending the margin concept.
- *Redefinition of the Porter's diamond framework:* Porter [30], [94]'s diamond framework can be redefined embedding sustainability perspective adding *'future generations requirements'* as an outside factor and '*sustainability conditions'* as main factor.
- *Redefinition of the 'value' concept:* 'Value' concept needs to be broadend throughout the supply chain so that the value for the nature, as well as the value for the next generations are considered.
- *Redefinition of the 'stakeholder' concept:* 'Stakeholder' concept needs to include the next generations and the nature as well. As Brudtland report (WCED, 1987: 43) defined 'sustainable development' as "*... development that meets the needs of the present without compromising the ability of future generations to meet their own needs*". This needs to be reflected in the supply chain management.
- *Redefinition of the 'project manager's duties':* Integration of the sustainability, leanness and agility principles to the construction supply chain requires the project managers to deal with additional parameters (i.e. reduction of waste) to fullfill.
- *Redefinition of the scope of the strategic management:* Sustainability, leanness and agility need to be an integral part of the strategic management as they require change in the company culture and commitment of the top level managers as well as of the staff. They require long term commitment of the company/suppliers and their staff. They can be referred to in the company's/supplier's mission and vision statements.
- *Integration of the sustainable and lean construction project management principles into the construction supply chain:* Lean and sustainability create synergies especially through their common goals (i.e. elimination of waste), their common tools (i.e. value stream mapping and sustainability value stream mapping) and their common requirements for external auditing and on-going reviews. Leanness, and sustainability require transformation in the working culture and strategetic approach.
    - Design is the most convenient phase to influence the value created and the footprint of the project. Design process can be enhanced by the lean tools (such as value stream mapping, sustainable value stream mapping) or by the agile tools (such as daily scrum, cycles, involvement of scrum manager) as appropriate to the project and its uncertainty levels.
    - Contract needs to define sustainability criteria and refer to ethical sourcing and carbon footprint topics.
    - Planning process can be enhanced by the lean tools such as Last Planner System as appropriate to the project and its uncertainty levels.
    - Construction phase can be enhanced by the lean tools (such as 5S, 3R, total productive maintenance) as appropriate to the project and its uncertainty levels. Control of the sustainability performance achieved is important to take necessary precautions (i.e. training the subcontractors/suppliers).
- *Role of government in the establishment of the sustainable and lean construction supply chain management:* The governments can play key roles in motivating the companies to adapt sustainable and lean construction process through providing incentives, posing taxes to the externalities, as well as through pre-qualification criteria in the tenders.

- *Changes required in the contract documents:* Both standard contracts (i.e. FIDIC, ICE) and company specific contracts needs to be updated covering sustainability clauses (i.e. ethical sourcing, carbon footprint in the supply chain). All these requirements should be reflected to all subcontractors/suppliers in all tiers in the whole supply chain.
- *Selection/appointment process of the suppliers/subcontractors in the sustainable and lean construction supply chain management:* Pre-qualification phase in the tenders should include sustainability performance related criteria. The subcontractors/suppliers in all tiers in the supply chain can be trainned (just like health and safety trainings) on the sustainability topics, and on the normative sustainability requirements.

This paper aimed to analyse and establish the principles of the integration of the sustainability dynamics into the lean construction supply chain management. Further research is recommended to be carried out on how to widespread sustainability dynamics integrated lean construction supply chain management practices throughout the construction industry. This paper is expected to contribute to the achievement of the goals set in the agenda of the EU policies, and targets with regard to CO_2 emission reductions as well as to the researchers and practioners in the relevant field.

REFERENCES

[1] **DITTMAR, M.** Development towards sustainability: How to judge past and proposed policies? *Science of the Total Environment, 472, (2014),* 282–288.

[2] http://ec.europa.eu/clima/news/articles/news_2014041401_en.htm

[3] **AZEVEDO, S.G., CARVALHO, H., MACHADO, V.C.** The influence of green practices on supply chain performance: A case study approach, *Transportation Research Part E 47, (2011),* 850–871.

[4] **KOPLIN, J., SEURING, S., MESTERHARM, M.** Incorporating sustainability into supply management in automotive industry - the case of the Volkswagen AG. *Journal of Cleaner Production 15, (2007),* 1053-1062.

[5] **LI, S., RAGU-NATHAN, B., RAGU-NATHAN, T.S., RAO, S.S.** The impact of supplychain management practices on competitive advantage and organizational performance. *Omega 34 (2006),* 107 – 124.

[6] **KRAUSE D. R., VACHON, S., KLASSEN, R. D.** Special topic forum on sustainable supply chain management: Introductionand reflections on the role of purchasing management. Journal of Supply Chain Management, *Volume 45 (2009), No.4,* 18-24.

[7] **DE BRITO, M.P., CARBONE, V., BLANQUART, C.M.** Towards a sustainable fashion retail supply chain in Europe Organisation and performance. *Int. J. Production Economics, 114, (2008),* 534–553.

[8] **CANIELS, M.C.J., GEHRSIZT, M.H., SEMEIJN, J.** Participation of suppliers in greening supply chains: an empirical analysis of German automotive suppliers. *Journal of Purchasing and Supply Management, 19 (2013),* 134-143.

[9] **FOERSTL, K., REUTER, C., HARTMANN, E., BLOME, C.** (2010) Managing supplier sustainability risks in a dynamically changing environment-Sustainable supplier management in the chemical industry. *Journal of Purchasing and Supply Management, 16, (2010) 118-130.*

[10] **GOGER, A.** The making of a 'business case' for environmental upgrading: Sri Lanka's eco-factories. *Geoforum. 47 (2013),*73-83.

[11] **LEE, K.H.** Why and how to adopt green management into business organizations? The case study of Korean SMEs in manufacturing industry. *Management Decision, 47 (2009),* 1101-1121.

[12] **LEE, K.H., KIM, J.W.** Current status of CSR in the realm of supply management: the case of the Korean electronics industry. *Supply Chain Management: An International Journal 14, (2009),* 138-148.

[13] **ZHU, Q, SARKIS, J, LAI, K.H.** Green supply chain management: pressures, practices and performance within the Chineseautomobile industry, *Journal of Cleaner Production, 15 (2007a),* 1041-1052.

[14] **ZHU, Q, SARKIS, J., LAI, K.H.** Initiatives and outcomes of green supply chain management implementation by Chinesemanufacturers, *Journal of Environmental Management, 85 (2007b),* 179–189.
[15] **ZHU, Q., SARKIS, J.,** Relationships between operational practices and performance among early adopters of green supplychain management practices in Chinese manufacturing, enterprises. *Journal of Operations Management 22 (2004),* 265-289.
[16] **LAMMING, R.**, Squaring lean supply with supply chain management. *Int. J. Operations Prod. Manage. Volume 16 (1996),No 2,* 183-196.
[17] **MARTINEZ-JURADO, P.J., MOYANO-FUENTES, J.** Lean Management, Supply Chain Management and Sustainability
A Literature Review, *Journal of Cleaner Production (2013)* http://dx.doi.org/10.1016/j.jclepro.2013.09.042
[18] **WOMACK, J.P., JONES, D.T.**, Lean Thinking. Simon and Schuster, New York. 1996.
[19] **GUSTAVSSON, T.** Agile Project Management. First edition. Stockholm, Sweden: Sanoma Utbildning AB (2011).
[20] **SIMONS, D., MASON, R.**, Lean and green: doing more with less. *ECR J. Volume 3 (2003) No 1,* 84-91.
[21] **MARHANI, M.A., JAAPAR, A., BARI, N.A.A.** Lean Construction: Towards enhancing sustainable construction in Malaysia *Procedia - Social and Behavioral Sciences 68 (2012)* 87 – 98.
[22] **LEAN ENTERPRISE INSTITUTE** Principles of lean Retrieved 25 August 2012 *(2009)* from http://www.lean.org
[23] **GOULD, F.E., JOYCE, N.E.** Construction project management. Pearson Prentice Hall *(2009).*
[24] **KOSKELA, L.** Application of the new production philosophy to construction Tech. Report No. 72, CIFE, Stanford University, CA. *(1992).*
[25] **BREIT, M., VOGEL, M., HAUBI, F., MARKI, F., RAPS, M.** 4D Design and Simulation Technologies and Process Design Patterns to Support Lean Construction Methods. *Tsinghua Science and Technology, Volume 13 (2008) No S1, 179-184.*
[26] **KING, P.L.,** Lean for the process industries dealing with complexity CRC Press Taylor and Francis Group, A productivity press book, 2009.
[27] **BICHENO J.**, The new Lean toolbox towards fast, flexible flow. Buckingham, England: Picsie Books, 2004.
[28] **BERTELSEN, S.** Lean construction: where are we and how to proceed Retrieved 26 August 2011 from http://www.kth.se (2004)
[29] **LEE, K.H.,** Integrating carbon footprint into supply chain management: the case of Hyundai Motor Company (HMC) in the automobile industry. *Journal of Cleaner Production (2011) 1216-1223.*
[30] **PORTER, M.E.** The competitive advantage of nations. New York: Free Press, 1990.
[31] **HOWELL, G.A.** (1999) What is lean construction? IGLC-7 proceedings 26-28 July 1999, University of California, Berkeley, CA, USA
[32] **ROHITRATANA, K.**, SA 8000-a tool to improve quality of life. Managerial Auditing Journal, *Volume 17 (2002) No1-2, 60-64.*
[33] **CRESPIN-MAZET, F., DONTENWILL, E.,** Sustainable procurement: Building legitimacy in the supply network *Journal of Purchasing & Supply Management, 18, (2012), 207–217.*
[34] **GIUNIPERO, L.C., HOOKER, R.E., DENSLOW, D.** Purchasing and supply management sustainability: Drivers and barriers. *Journal of Purchasing & Supply Management,18 (2012) 258–269.*
[35] **BALLARD, G, HOWELL, G.,** Implementing lean construction: stabilizing work flow. In: Proceedings of the second annual conf. of the int.group for lean construction, Santiago, Chile, 1994.
[36] **SEPPANEN, O., BALLARD, G., PESONEN, S.** The combination of last planner system and location based management system (2010). http://www.lean.org
[37] **VAIS, A., MIRON, V., PEDERSEN, M., FOLKE, J.** "Lean and Green" at a Romanian secondary tissue paper and board mill—putting theory into practice. *Resources, Conservation and Recycling 46 (2006) 44–74.*
[38] **OHSAS 18001** Overview of OHSAS 18001 (2012) http://www.vts.net.my
[39] **DOBSON, D.W., SOURANI, A., SERTYESILISIK, B., TUNSTALL, A.** Sustainable construction: analysis of its costs and benefits. *American Journal of Civil Engineering and Architecture, Volume 1 (2013), No 2, 32-38.*
[40] **IRIZARRY, J., KARAN, E.P., JALAEI, F.** Integrating BIM and GIS to improve the visual monitoring of onstruction supply chain management. *Automation in Construction, 31 (2013) 241–254.*
[41] **GABRIEL, E.** The lean approach to project management. *International Journal of Project Management, Volume 15 (1997) No 4, 205-209.*

[42] **CHENG, J.H., YEH, C.H., TU, C.W.** Trust and knowledge sharing in green supply chains. *Supply Chain Management: An International Journal, Volume 13 (2008) No 4, 283-295.*
[43] **COX, A.** Power, value and supply chain management. *Supply Chain Management: An International Journal, Volume 4 (1999), No 4, 167-175.*
[44] **DÜES, C.M., TAN, K.H., LIM, M.** Green as the new Lean: how to use Lean practices as a catalyst to greening your supply chain. *Journal of Cleaner Production, 40 (2013) 93-100.*
[45] **VONDEREMBSE, M.A., UPPAL, M., HUANG, S.H., DISMUKES, J.P.** Designing supply chains: towards theory development. *International Journal of Production Economics, Volume 100 (2006) No 2, 223-238.*
[46] **SIMPSON, D.F., POWER, D.J.** Use the supply relationship to develop lean and green suppliers. *Supply Chain Management: An International Journal Volume 10 (2005) No 1, 60-68.*
[47] **BERGMILLER, G.G., MCCRIGHT, P.R.** Parallel models for lean and green operations; Pdf from Website. In: Proceedings of the 2009 Industrial Engineering Research Conference, (2009). accessed via http://zworc.com/site/publications_assets/ParallelModels.pdf
[48] **BICHENO, J., HOLWEG, M.** The Lean Toolbox - The Essential Guide to Lean Transformation, fourth ed. PICSIE Books, Buckingham, UK. 2009.
[49] **BOWEN F, COUSINS P, LAMMING R, FARUK A.** The role of supply management capabilities in green supply. Production and Operations Management, Volume 10 (2001) No (2), 174-189.
[50] **GORDON, P.J.** Lean and Green - Profit for Your Workplace and the Environment. Berrett-Koehler Publishers, Inc, San Francisco, 2001.
[51] **MOLLENKOPF, D., STOLZE, H., TATE, W.L., UELTSCHY, M.,** Green, lean, and global supply chain. International Journal of Physical Distribution & Logistics Management, Volume 40 (2010) No 1/2, 14-41.
[52] **FULLERTON, R.R., WEMPE, W.F.** Lean manufacturing, non-financial performance measures, and financial performance, *International Journal of Operations & Production Management, Volume 29 (2009) No 3, 214 – 240.*
[53] **MASKELL, B., BAGGALEY, B.** Practical lean accounting: a proven system for measuring and managing the lean enterprise. New York: Productivity Press, 2003.
[54] **LUCEY, J., BATEMAN, N., HINES, P.** Why major lean transitions have not been sustained. *Manage. Serv. Volume 49 (2005) No 2, 9-13.*
[55] **TURESKY, E.F., CONNELL, P.** Off the rails: Understanding the derailment of a lean manufacturing initiative *Organizational Management Journal. Volume 7 (2010) No 2, 110-132.*
[56] **COMM, C.L., MATHAISEL, D.F.X.** Sustaining higher education using Wal-Mart's best supply chain management practices. *Int. J. Sust. Higher Edu. Volume 9 (2008) No 2, 183-189.*
[57] **BHASIN, S.** Lean and performance measurement. *Journal of Manufacturing Technology Management Volume 19 (2008) No 5, 670-684.*
[58] **COMM, C.L., MATHAISEL, D.F.X.** A case study in applying lean sustainability concepts to universities. *I nt. J. Sust. Higher Edu. Volume 6 (2005) No 2, 134-146.*
[59] **HINES, P., HOLWEG, M., RICH, N.** Learning to evolve e a review of contemporary lean thinking. *International Journal of Operations & Production Management, Volume 24 (2004) No 10, 994-1011.*
[60] **HINES, P., FOUND, P., GRIFFITHS, G., HARRISON, R.** Staying Lean: Thriving, Not Just Surviving. Lean Enterprise Research Centre, Cardiff University, Cardiff, 2008.
[61] **SAWHNEY, R., SUBBURAMAN, K., SONNTAG, C., RAO, P.R.V., CAPIZZI, C.** A modified FMEA approach to enhance reliability of lean systems. *Int. J. Qual. Reliability Manage. Volume 27 (2010) No 7, 832-855.*
[62] **SCHRETTLE, S., HINZ, A., SCHERRER-RATHJE, M., FRIEDLI, T.** Turning sustainability into action: Explaining firms' sustainability efforts and their impact on firm performance. *Int. J. Production Economics, 147 (2014), 73–84.*
[63] **NOCI, G.** Designing "green" vendor rating systems for the assessment of a supplier's environmental performance. *European Journal of Purchasing and Supply Management, Volume 3 (1997) No 2, 103-114.*
[64] **CARTER, C., ROGERS, D.S.** A framework of sustainable supply chain manage- ment: moving toward new theory *International Journal of Physical Distribution & Logistics Management Volume 38 (2008) No 5, 360–387.*
[65] **ANSTINE, J.** Consumers' willingness to pay for recycled content in plastic garbage bags: a hedonic price approach. *Applied Economics Letters , Volume 7 (2000) No1, 35-39.*

[66] **LUCHS, M. G., NAYLOR, R. W., IRWIN, J. R., RAGHUNATHAN, R.** The sustainability liability: potential negative effects of ethicality on product preference. *Journal of Marketing, Volume 74 (2010) No 5, 18-31.*
[67] **DAS, A., NARASIMHAN, R., SRINIVAS, T.** Supplier integration-finding an optimal configuration. *Journal of Operations Management Volume 24 (2006) No 5, 563-582.*
[68] **LEPPELT, T., FOERSTL, K., REUTER, C., HARTMANN, E.** Sustainability management beyond organizational boundaries-sustainable supplier relationship management in the chemical industry. *Journal of Cleaner Production, 56 (2013) 94-102.*
[69] **VENKAT K., WAKELAND, W.** Is lean necessarily green? Pdf from Website. In: Proceedings of the 50th Annual Meeting of the ISSS, ISSS 2006 Papers, (2006) accessed via http://www.cleanmetrics.com/pages/ISSS06-IsLeanNecessarilyGreen.pdf
[74] **KING, A.A., LENOX, M.J.,** Lean and green? An empirical examination of the relationship between lean production and environmental performance. *Production and Operations Management Volume 10 (2001) No 3, 244-256.*
[75] **LARSON, T., GREENWOOD, R.** Perfect complements: synergies between lean production and eco-sustainability initiatives. *Environmental Quality Management, Volume 13 (2004) No 4, 27-36.*
[70] **MASON, R., NIEUWENHUIS, P., SIMONS, D.** Lean and green supply chain mapping: adapting a lean management tool to the needs of industrial ecology. *Prog. Ind. Ecol. Int. J. Volume 5 (2008) No 4, 302-324.*
[71] **FLORIDA, R.** Lean and green: the move to environmentally conscious manufacturing. *Calif. Manage. Rev. Volume 39 (1996) No 1, 80-105.*
[72] **ROTHENBERG, S., PIL, F., MAXWELL, J.,** Lean, Green, and the Quest for superior environmental performance. *Production and Operations Management, Volume 10 (2001) 228-243.*
[73] **MOREIRA, F., ALVES, A.C., SOUSA, R.M.** Towards eco-efficient lean production systems. In: Olhager, J., Persson, F. (Eds.), Balanced Automation Systems for Future Manufacturing Networks, 322. Springer, Boston, 2010, pp. 100-108.
[74] **VINODH, S., ARVIND, K.R., SOMANAATHAN, M.** Tools and techniques for enabling sustainability through lean initiatives. *Clean. Tech. Environ. Policy, Volume 13 (2011) No 3, 469-479.*
[75] **CARVALHO, H., DUARTE, S., CRUZ-MACHADO, V.** Lean, agile, resilient and green: divergencies and synergies. *Int. J. Lean Six Sigma, Volume 2 (2011) No 2, 151-179.*
[76] **HOEJMOSE, S.U., ADRIEN-KRIBY, A.J.** Socially and environmentally responsible procurement: A literature review and future research agenda of a managerial issue in the 21st century. *Journal of Purchasing and Supply Management, 18, (2012), 232-242.*
[77] **HOEJMOSE, S.U., ROEHRICH, J.K., GROSVOLD, J.** Is doing more doing better? The relationship between responsible supply chain management and corporate reputation, *Industrial Marketing Management (2013),* http://dx.doi.org/10.1016/j.indmarman.2013.10.002
[78] **PHILLIPS, R., CALDWELL, C.B.** Value Chain Responsibility: A Farewell to Arm's Length. *Business and Society Review, 110 (2005) 345–370.*
[79] **ROBERTS, P.** Economic Restructuring, Regional Development and the Environment: Ecological Moderisation and the European Union's Structural Funds , *International Journal of Environment and Sustainable Development*, *2 (2003) 267-283.* doi: 10.1504/IJESD.2003.003844
[80] **PREUSS, L.,** In dirty chains? Purchasing and greener manufacturing. Journal of Business Ethics, 34 (2001), 345-359.
[81] **PREUSS, L.**, Rhetoric and reality of corporate greening: a view from the supply chain management function. *Business Strategy and the Environment, 14 (2005) No 2, 123-139.*
[82] **CARTER, P.L., CARTER, J.R., MONCZKA, R.M., SLAIGHT, T.H., SWAN, A.** The supply of purchasing and supply a ten-year forecast. *Journal of Supply Chain Management, Volume 36 (2000) No 1, 14-26.*
[83] **CARTER, G.** Competitive Strategy in the Pharmaceutical Industry Pharmaceutical Professionals Pty Ltd. (2005) (http://www.pharmaceuticaljobs.com/articles/ healthcare-pharmaceutical-articles7.asp).
[84] **RAO, P., HOLT, D.** Do green supply chains lead to competitiveness and economic performance?, *International Journal of Operations and Production Management, Volume 25 (2005) No 9, 898 – 916.*
[85] **GUPTA, S., CZINKOTA, M., MELEWAR, T.C.,** Embedding knowledge and value of a brand into sustainability for differentiation. *Journal of World Business, 48 (2013), 287–296.*
[86] **BOIRAL, O.** Global Warming: Should Companies Adopt a Proactive Strategy? *Long Range Planning, 39 (2006) 315-330.*

[87] **WALKER, B.H., ABEL, N., ANDERIES, J.M., RYAN, P.** Resilience, adaptability, and transformability in the Goulburn-Broken Catchment, Australia. *Ecology and Society Volume 14 (2009) No 1, 12.*
[88] **WU, Z., PAGELL, M.** Balancing priorities: decision-making in sustainable supply chain management. *Journal of Operations Management, Volume 29 (2011) No 6, 577–590.*
[89] **H.M., WU, S.** Lean supply chain and its effect on product cost and quality: a case study on Ford Motor Company. *Supply Chain Management: An International Journal, Volume 14 (2009) No 5, 335-341.*
[90] **TAUBITZ, M.A.** Lean, green & safe: integrating safety into the lean, green and sustainability movement. *Prof. Saf. Volume 55 (2010) No 5, 39-46.*
[91] **ANTONAKIS, J.** Leadership: What is it and how it is implicated in strategic change? *International Journal of Management Cases, 8 (2006) No 4, 4-20.*
92] **NIEPCE, W., MOLLEMAN, E.** Characteristics of work organization in lean production and sociotechnical systems: a case study. *Int. J. Operations Prod. Manage. 16 Volume (1996) No 2, 77-90.*
[93] **DE TREVILLE, S., ANTONAKIS, J., EDELSON, N.M.** Can standard operating procedures be motivating? Reconciling process variability issues and behavioural outcomes. *Total Qual. Manage. Bus. Process. Volume 16 (2005) No 2, 231-241.*
[94] **PORTER, M.E.** The competitive advantage of nations. New York: Free Press, MacMillan, 1998.
[95] **IPCC (THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE) REPORT**
http://ec.europa.eu/clima/news/articles/news_2014041401_en.htm (Accessed: 22.04.2015)