

Integration of LCA and C-Learn for sustainability assessment of short supply chain related to forest products

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1. Introduction

The challenge for developing a “green production oriented economy”, is the definition of sustainable production and consumption models which are able to enlarge the current approach oriented to the greening of single production towards the creation of a comprehensive sustainable system, involving and integrating different supply chains in the same geographical district. The creation of short supply chains can help to reduce some relevant impacts (e.g. emissions coming from transport) even if there are some management concerns that has to be addressed, especially about technical feasibility and economic profitability. Sustainability evaluation of this kind of systems needs a comprehensive set of tool for the analysis because it is supposed to address a wide range of questions about environmental sustainability (e.g. availability of natural resources and carrying capacity of the ecosystems that should provide them), economic sustainability (e.g. the economic feasibility of the supply chain and its competitiveness) and social sustainability (e.g. the ability to create new job opportunities and to foster local development). Thus, in the present work the overall process optimisation is based on the integration of two methodologies coming from different disciplines: a strategic production planning tool (Lean thinking), originally developed for the economic optimization of production processes and then enlarged to the optimization of eco-efficiency performances (C-lean) and the Life Cycle Thinking (LCT).

2. Integration between Life Cycle Thinking and Lean Thinking

The present work refers to an attempt to create a sustainable short supply chain in Lombardy region, integrating forest management, furniture production and energy generation. To be sustainable, this system should be designed and organized with the aim to optimize use and flows of materials and energy and to reduce the overall impact on environmental compartments [1]. It is important that the whole supply chain is involved in the re-design of the process because, in order to be successful, environmental and sustainability management strategies must be integrated into all stages of the value chain, which includes all the process from product design to procurement, manufacturing and assembly, packaging, logistics, and distribution [2]. Lean thinking can be a useful methodology for identifying strategy for efficiency improvements throughout the whole process and can have positive impacts on environmental performances due to the reduction of wastes and the reduction of material use. Nevertheless, in some cases the implementation of lean management results in less sustainable performances (see, for instance, [3]), so there is the need to combine it with methodologies able to track and to compare environmental impacts of different management solutions. Moreover, there is a lack of research about the relationship between green supply chain management, competitiveness and economic performance [4], so the analysis should also take into account strategic and economic perspectives and evaluate limits and opportunities of this kind of local systems compared to traditional market models. In this perspective, life cycle thinking can be the driving methodology, even if LCA is not sufficient for assessing sustainability of the entire system [5] and, moreover, to communicate the results in a way that can help decision makers in choosing the best option. Thus this work proposes an integration between LCT and Lean Thinking (in its environmental declination, C-Learn), including also sustainability indicators considering aspects usually not included in LCA studies, such as the availability and renewability of wood resource through time, and the economic and social sustainability of different solutions [6]. The Lean Thinking is a management model developed in the context of methods for quality improvement and processes engineering; it identifies 5 principles which should lead any reengineering and reorganization process effort [7]: to identify value; to map the value stream; to create flow (leaning the phases of the production); to establish pull (linking the production to an effective demand); to seek for perfection (continuous improving). Moreover, during the last years, some attempts have been made to enlarge the principles perspective to include environmental waste in the evaluation [3], creating the so-called “C-Learn”. The integration between C-Learn and LCA has the final aim to support decision makers in every phase of the process, providing relevant information about the most effective solutions from the operational and technical point of view, with specific reference to the feasibility in the local context under evaluation: for instance, to the availability and renewability of the materials and to the operational feasibility for the implementation of the selected technology (correct size of the plant with respect to the amount of

resource available, coherence of the production process with the characteristics of the available materials, etc.) integrating managing optimization and process engineering with environmental evaluation.

3. Conceptual framework for sustainability evaluation of a wood-furniture short supply chain

The following figure illustrates the hypothesis of wood-furniture supply chain and highlights the aspects that should be evaluated through LCA and optimized through the implementation of Lean Manufacturing. The most relevant issues seem to be the possibility to convert wood residues to by-products for energy generation and for wood-panels production and the necessity to monitor and to reduce the use of hazardous compounds in the furniture industry.

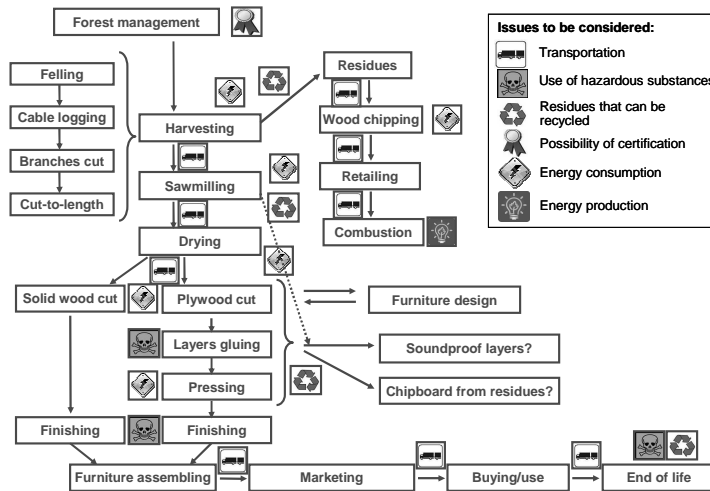


Figure 1: integration of LCT and Lean Thinking to support evaluation of a wood-furniture short supply chain.

4. Conclusions

The present work tries to highlight some critical aspects in the comprehensive sustainability evaluation of a production system in considering limits and possibilities of a short supply chain. The evaluation need to be supported by a set of instruments because it has to address a wide range of questions. Environmental sustainability should consider the resource limits, i.e. the carrying capacity of the forest ecosystem, energy and materialflows (through LCA) and the possible industrial symbiosis within the supply chain. Economic and operational sustainability evaluation requires instruments (such as Lean thinking) to evaluate the operational feasibility of the supply chain, its competitiveness and its ability to create economic and environmental value. Social sustainability refers to the possibility for the system to be effectively implemented (e.g. presence of the relevant actors needed for each activity of the supply chain) and to provide effective opportunities for local development (local employment, training for appropriate job positions, etc). In this perspective, the integration between LCA, enlarged to economic and social issues, and Lean Thinking, in its environmental declination, C-Learn, seems to be promising for performing sustainability evaluation of supply chains.

5. References

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