Computers and Electronics in Agriculture 150 (2018) 62–73

Contents lists available at ScienceDirect

Computers and Electronics in Agriculture

journal homepage: www.elsevier.com/locate/compag

Original papers

A model for Lean and Green integration and monitoring for the coffee sector

Lucas Vinícius Reis[a], Liane Mahlmann Kipper[a,*], Fáber Danilo Giraldo Velásquez[b], Nicholas Hofmann[c], Rejane Frozza[a], Sofia Aldana Ocampo[d], Cesar Augusto Taborda Hernandez[d]

[a] Post-Graduation in Industrial Systems and Processes, University in Santa Cruz do Sul (UNISC), Santa Cruz do Sul, RS, Brazil
[b] Faculty of Engineering – Post-Graduation in Engineering, University del Quindío, Armenia, Quindío, Colombia
[c] Mechanical Engineering Course, University in Santa Cruz do Sul (UNISC), Santa Cruz do Sul, RS, Brazil
[d] University del Quindío, Armenia, Quindío, Colombia

ARTICLE INFO

Keywords:
Lean management
Green management
Lean green synergy
Maturity model
Sustainable operations

ABSTRACT

Companies have been under pressure from different sectors of society to make their processes more environmentally sustainable, a fact that drives the joint adoption of Lean and Green production systems. Studies relating these systems have intensified in the past decade and follow a growth trend. However, this can be considered a relatively new field with many gaps to be filled. One of these gaps is found in the agricultural sector, where no studies relating Lean and Green have been identified. The main contribution of this article is to develop a model for the evaluation of the integration of Lean and Green systems (Lean Green Synergy – LGS) through the formulation of a conceptual framework. In order to demonstrate the viability of the model, a case study was carried out on a set of six specialty coffee producing properties, located in the state of Quindío, Colombia. The research carried out provides a non-subjective means to establish the maturity of the Lean and Green systems and establishes 20 metrics capable of providing the information necessary to carry out the LGS calculations. The calculation method described allows the replication of the model and its adaptation to other sectors by defining the appropriate metrics for it, encouraging the joint adoption of Lean and Green systems.

1. Introduction

The Lean production system developed by Taiichi Ohno is directly related to sustainability issues investigated by various authors (Rolo et al., 2014; Verrier et al., 2014; Dhingra et al., 2014; Fercoq et al., 2016). These authors have found possibilities of integration between the Lean philosophy and sustainable production from the environmental point of view, which is usually identified as Green production, or the Green system.

Sustainable development is a central theme for our era (Hsu et al., 2013; Sachs, 2015) and is a subject that is present in the strategic planning of companies and in the academic environment. The discussion of this topic is growing somewhat and is a response of policy-makers to environmental concerns (Porter and Kramer, 2006), and the Green supply chain is one of the areas where more attention has been given (Ben Brik et al., 2013), mainly in emerging economies (Hsu et al., 2013).

In this sense, there is a need to improve production systems and improve existing methodologies. Green thinking was born of this need for improvement, and its integration into the Lean system has provided good results (Jabbour et al., 2013), creating the need for companies to align commercial practices with principles of environmental sustainability (Caldera et al., 2017).However, concern about environmental issues is still seldon discussed in smaller companies. Fonseca and Jabbour (2012) make this finding in their study and propose a framework to evaluate the inclusion of Green concepts in Brazilian incubators.

In the coffee sector, studies on the use of Lean and Green systems are scarce. Nevertheless, the expansion of tropical agricultural commodities, such as coffee, has been considered a major threat to biodiversity (Donald, 2004; Haggar et al., 2017), requiring that practices of optimization of productive processes and reduction of environmental impacts be introduced. With an average annual production of 5.9 Mtons, coffee is one of the most commercialized drinks in the world (Battista et al., 2016) and is the economic backbone of countries throughout Latin America, Asia, and Africa (RAINFOREST, 2017), and its popularity and volume of consumption continues to grow every year (Tsai and Chen, 2017).

In Colombia, the production of specialty coffees is extremely important for the national economy, with the livelihoods of about 2

* Corresponding author at: Post-Graduation in Industrial Systems and Processes, University in Santa Cruz do Sul (UNISC), Av. Independência, 2293 -53 (5340), 96800-000 Santa Cruz do Sul, RS, Brazil.
E-mail address: liane@unisc.br (L.M. Kipper).

https://doi.org/10.1016/j.compag.2018.03.034
Received 23 November 2017; Received in revised form 29 March 2018; Accepted 30 March 2018

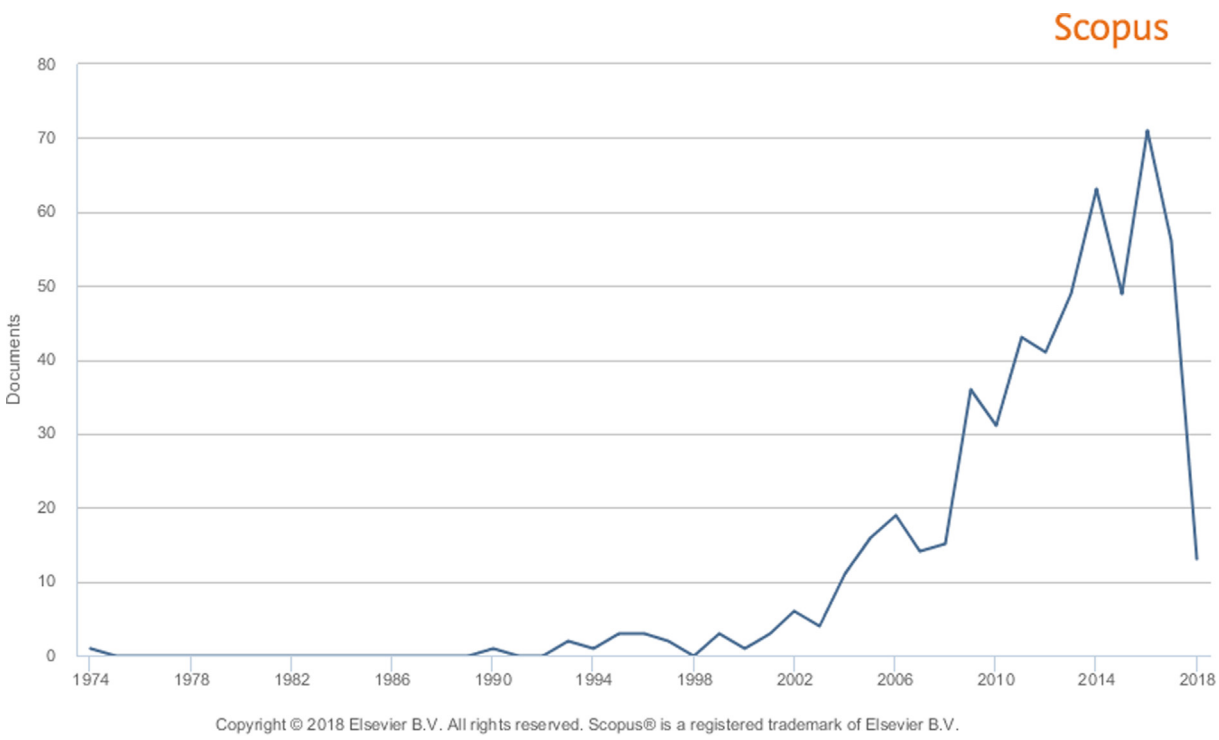

Fig. 1. Research evolution of the Lean and Green systems.

million people dependent on this activity (Cano et al., 2012). Special crops are characterized by the small size of the properties, non-mechanized production, and high added value. This type of crop has received good acceptance since consumers have changed their preferences, demanding a greater variety of products of higher value and with specific characteristics (Niederhauser et al., 2008). Introducing Lean and Green systems in this sector allows improvement in property productivity and a reduction in costs. Tinoco et al. (2014) commented that the Colombian coffee harvest is very expensive since it is done manually. Monitoring the productive process of this sector is crucial to ensuring the viability of the properties since they are small areas.

Also, the integration of Lean and Green systems is presented as an alternative that minimizes the negative effects of coffee production. Hartman (2015) found good results with the use of the Lean system in food production. Dora et al. (2015) suggest that it is time to introduce Lean concepts in agriculture, given the magnitude of the residues and losses in that field. However, it is also necessary to develop models to evaluate the application of systems from industry related to agricultural production.

In this study, the main objective is to develop a model for the evaluation of the integration of Lean and Green systems in special coffee producing properties. This model, which herein we call LGS, will be supported by a web platform and has flexible features that allow easy adaptation to other industrial sectors.

The article is structured as follows. Section 2 discusses the conceptual basis for the LGS model based on a literature review, Section 3 presents the characteristics of the LGS and its form of application. Section 4 addresses a case of application in the coffee sector, and Section 5 presents the conclusions of the study.

2. The conceptual basis for the LGS model

This chapter will discuss the motivations for research and the structuring of the bibliographic research that guided the development of the LGS model.

2.1. Research motivations

To support Lean and Green integration, deployment, and evaluation, models of these systems have been developed. These include: the LARG-ANP model (Cabral et al., 2012), which also integrates Agile and Resilient systems; the framework for Lean and Green of Verrier et al. (2014); the methodology of Faulkner and Badurdeen (2014), which uses Value Stream Mapping - VSM to evaluate the environmental performance (SUS-VSM); the Lean and Green matrix of Fercoq et al. (2016), which integrates the seven types of Lean waste with the hierarchy of the 3Rs of the Green system and the maturity model proposed by Verrier et al. (2016).

Another model is the model of ROBECOSAM (2017). It does not directly use the terms Lean and Green, but it makes an evaluation of sustainability based on the social, environmental and economic pillars. ROBECOSAM, in association with S & P Dow Jones Indexes, offers an important tool that uses the results of over 600 performance indicators and a set of 80–120 questions that are applied annually to define business maturity. Although it is an extremely complete tool, this model is limited to a select set of companies and has a level of complexity that limits its use by smaller companies.

The integration of Lean and Green systems is a research topic that is arousing great interest (Verrier et al., 2014) but which still needs to be developed further, particularly regarding studies on the synergy of these systems and the ways of measuring an organization's Lean and Green maturity level. Analysis of the research already carried out shows that the majority of the studies on this subject are dedicated to literature review, concentrating more on the conceptual field. There are a large number of issues that still need to be addressed (Garza-Reyes, 2015) as well as the need to follow up the research already published.

Among the models mentioned above, it can be shown that all of them present positive results, being able to partially or fully meet the proposed end. However, there are some limitations. Cabral et al. (2012) mention problems of inconsistency in their multicriteria decision method besides the need for a large number of comparisons to define the indicators. SUS-VSM (Faulkner and Badurdeen, 2014) is an excellent tool for the preliminary assessment of sustainability, but it is not