Applying lean manufacturing, corporate social responsibility and the Hungarian method for supply chain project management

Malika-Sofi Akhmatova[1*], *Antonina* Deniskina[1], *Dzhennet-Mari* Akhmatova[2], *Svetlana* Sergeeva[3], and *Alexandr* Orlov[4]

[1]Moscow Aviation Institute (National Research University), 4, Volokolamskoe shosse 125993, Moscow, Russia
[2]Shanghai Jiao Tong University, Shanghai, China
[3]Voronezh State Technical University, 20-letiya Oktyabrya Street, 84, 394006, Voronezh, Russia
[4]Moscow State University of Civil Engineering", 129337, Yaroslavskoe shosse, 26, Moscow, Russia

Abstract. Supply chain project management is a comprehensive process allowing managers to coordinate resources, functions and actions to achieve a specific goal within a set time frame, scope and budget. One of the problems in the context of improving the quality of the Supply Chain Project Management is the creation of a favorable social environment for employees who are a crucial part of the supply chain management (SCM) system. In this article, this issue is considered from the perspective of the assignment problem. First, this article proposes the Corporate Social Responsibility (CSR) as a platform for introducing Lean practices within the supply chain. It strongly contributes to filling the research gap in the field of the CSR and Lean philosophy coordination. The ultimate goal is to promote the culture of continuous improvements, human resources (HR) development and satisfaction of workers' social needs for the sustainability of the Supply Chain Project Management. Second, the Hungarian method is implemented in the context of the coordination of CSR and Lean management for right decisions in assignment problem concerning the issues of supply chain employees' engagement and development. The results reveal the possibility of achieving positive effects in creating an employee-friendly supply chain environment and unlocking untapped human potential while maintaining long-term benefits. The research findings would assist the scientific community and practitioners in applying proposed ways to enhance labor productivity and ensure the development of employee-friendly social environment. **Keywords:** supply Chain Project Management, Lean manufacturing, Hungarian method, Corporate Social Responsibility.

1 Introduction

The APICS Dictionary, defines project management as "the management system that enables business imperatives and strategic goals to be accomplished". Supply chain project management is a multifaceted process that integrates resources, functions and actions of its

* Corresponding author: malika_sofi@mail.ru

participants to deliver a defined goal within a specific time frame, scope and budget. It spans the dynamic relationships of supply chain participants and actors located both inside and outside organizations. It allows to create order and predictability among complex and variable supply chain requirements [1].

Currently, continuous changes in the business environment have made the management of supply chain projects a complex task, requiring a range of competencies and skills to effectively perform, control and manage functions and tasks throughout the supply chain. As a result, academics and practitioners are increasingly paying attention to one of the most crucial tasks of the supply chain project management known as human resource management (HRM) to find the ways to unlocking untapped human potential. The explanation for this is as follows. First of all, employees ensure the productive use of all types of resources available to the organization. Secondly, the economic performance and competitiveness of both supply chain project management and the organization as a whole depend on the employees and the quality of their work. As scholars suggest, there are effects of HRM factors on supply chain management (SCM) success and strategy [1].

In the context of Supply chain project management, HRM is an essential area of action, but one that lacks visibility and maturity in many companies. Scholars have attempted to address the issues affecting HRM in supply chains in the different ways.

For instance, some authors discovered the possible integration of HRM and SCM practices to improve supply chain performance by developing an intra HRM–SCM and joint HRM–SCM. Survey data was collected from 109 supply chain managers from different Indian logistics firms. The results of the study suggested that supply chain performance is significantly influenced by joint HRM–SCM, compared to intra HRM–SCM practices [2].

Taking an interdisciplinary approach, some researchers proposed to combine concepts from HRM and SCM areas and analyze the effects of high-involvement HRM practices on the processes of supply chain integration.

Besides, other scholars proposed conceptual model depicting relationships among HRM, SCM implementation, SCM outcomes, organizational performance and customer satisfaction aimed at improving both HRM and SCM processes [2].

Additionally, several studies discussed the implementation of green practices in the area of supply chain project management and HR development.

Although the issue of HRM in Supply chain project management research grabbed the attention of numerous scholars, very few researches attempted to investigate the opportunities for unlocking untapped human potential to make better use of the human capital in firms. In that regard, the purpose of this research is to investigate the opportunities for beneficial coordination of the CSR and Lean Manufacturing from the perspective of their social component, encompassing issues of employees' engagement and untapped human potential.

Concerning the paucity of quantitative studies devoted to identifying capabilities for the professional development of supply chain project management employees, this paper proposes a model providing rational and efficient distribution of labour based on the Hungarian method. The major concern is to minimize or eliminate wastes associated with untapped human potential through personal development and a focus on individuals' innate strengths [3].

The remainder of the article is organized as follows. The following section presents the research methodology. Section 3 provides the results of the research, including the definition of the proposed conceptual framework and the case study. Section 4 represents discussions. Section 5 is devoted to concluding remarks.

2 Model and method

The research methodology is based on the in-depth literature review and analysis of internationally recognized guidelines applicable to the field of CSR, Lean management, Supply chain project management and HRM. The study consists of three major parts.

The first part provides a definition of the CSR framework, its components and divers. Besides, it explains the scope of Lean manufacturing.

The second part focuses on the development of conceptual model, including but not limited to the following components: philosophy, working environment, HR development, Lean concepts and tools.

The third part represents the case study devoted to building capabilities for unlocking untapped human potential in the context of Supply chain project management.

The conclusions meet the objective of this research and create a basis for enhancing the social component by unlocking untapped human potential in the context of Lean Manufacturing and CSR coordination.

3 Research and results

Plenty of common people claim that the CSR practices are "just cosmetic, rhetoric, and in paper only without any substantial impact in real life". However, society is changing, maturing, realizing its identity, interests and needs, demonstrating a growing demand for morality. The companies cannot afford to consider only the financial side of their activities as they should adapt the business processes and supply chains to the interests of stakeholders, including employees.

In general, the CSR consists of social policies and practices that businesses implement to be sure that the stakeholders, including society, are considered and protected. The socially responsible practices primarily involve employees, encompassing the investments in human capital, health care and safety, while environmentally responsible practices primarily relate to the natural resources management [3].

The CSR is facilitated only when the basis is created for the application of a variety of organizational forms and means to regulate the interaction of companies and society by acceptance of common interests and values, achieving synergy. Emphasizing comprehensiveness of the CSR, the CSR activities promote cause-related marketing, corporate social marketing, corporate philanthropy, community volunteering, and socially responsible business practices. This way, expanding the scope of the CSR is a direct response of the business environment to the problem of sustainable development as the socially protected and supported HR are the precious asset and key factor of company and supply chain development in the competitive environment.

As customers, shareholders, citizens, politicians, and managers start to have a clear understanding of what is important, the considerable normative pressure on the companies and the CSR increasingly becomes a necessity for success [4].

Given the specifics of the SCM processes consisting of a large number of stages where previous actions and operations seriously affect the subsequent and final properties of the product, the competent HR management helps to effectively seize the experience and knowledge of employees and minimize production defects. It also should help employees to realize their full potential and identify the areas of responsibility as well as provide the desired economic benefits for the enterprise.

The concept of Lean manufacturing was introduced in Japan, and Toyota company was the first implementer of lean practices. At that time, Japan was faced with the tasks of restoring the economy and industry and entering the international automotive market. This way, Lean production is a combination of the entire experience of the Toyota Production

System (TPS). The cornerstone of Lean is that its pillars are in contrast with the traditional approaches to production as they are focused on incremental improvements in operations [5].

Lean has a strong logical relationship with Total Quality Management (TQM) and promotes a practical and scientific base for quality management in system development. The Lean manufacturing is a time-tested approach whose relevance is that the enterprises operating in the conditions of growing competition, globalization of the economy, limited resources, instability in the market, fluctuations in prices for currency, changes in the stakeholders' expectations, investigate the production processes from the other side to ensure resource-saving, cost reduction, quality improvement and productivity.

The Lean framework is still relevant for study, promoting plenty of tools, approaches and methods to be implemented on a case-by-case basis [6]. However, the successful implementation of Lean is not only focused on the mandatory introduction of Lean tools but suggests the transformation of organizational culture. Apart from this, Lean manufacturing accelerates the operational, social and cultural environment that is highly conducive to waste minimization. Besides, Lean manufacturing facilitates the achievement of positive effects for firm value in the long run. There are significant quantitative (processing time, cycle time, inventory, defects and scrap, and overall equipment effectiveness, etc.) and qualitative (improved employee morale, effective communication, job satisfaction, team decision making, etc.) benefits of Lean. Thus, Lean is not limited by methods on wastes reduction as its major focus is to establish the environment where system processes are built to create additional value for stakeholders and contribute to the economic performance while supporting the optimal working conditions. Lean production paradigm acts as a promoter of thinkers.

The coordination of Lean and CSR could be a significant opportunity as there is a relationship between Lean production and CSR, encompassing the common nature of the potential benefits in terms of environmental protection and working conditions for employees.

The conceptual CSR-oriented Lean model for Supply chain project management suggest the following pillars focused on addressing the problem of untapped human potential.

Generally, the definition of Lean, its principles and main concepts, come under Lean philosophy [7]. The original Lean approach goes beyond the totality of methods and tools. The focus of Lean philosophy from the very top of the company is to add value to customers and society.

Womack and Jones stated the key principles of Lean manufacturing: value specification, value stream mapping, flow optimization, pull production system and perfection or continuous improvement. Lean philosophy (i.e., thinking) strongly related to the continuous improvement, i.e., Kaizen that covers the entire system of production and working conditions. This drives a long-term approach to building a learning organization, one that can adapt to changes in the environment and survive as a productive organization. Without this foundation, none of Toyota's investments in continuous improvement and learning would be possible. The major strategy for enabling continuous improvement is to facilitate a high-level involvement of the workforce in sustained incremental problem-solving [8].

The responsibility of enterprises owners for their activities and obligations of brand companies for their supply chain trigger the capabilities to achieve the highest quality of produced products, ensuring continuous development of engaged employees and executed business processes. This social Lean pillar is also reflected in the CSR theory, as A.B. Carroll considered four kinds of social responsibilities that constitute the total CSR:

1. Economic responsibility is in the purpose of the business to produce for society the products and services that society needs and to ensure the profit.
2. Legal responsibility is that any business should follow regulations to be operated.
3. Ethical responsibility is an obligation to perform the activities that are right, fair and

just to respect stakeholders' rights and avoid harm.

4. Philanthropic responsibility is in voluntary involvement of the company to the activities, facilitating goodwill and welfare.

Described levels of the CSR pyramid embodies the four levels of social responsibilities that society expects companies to do [9]. As well as in Lean concept, in the context of the CSR, obtaining a formal commitment of the company's top management to start the CSR initiative is required. Thus, in both cases, the driving force of change is the companies' leadership and social responsibility of managers. The businessmen decisions and actions affect their stakeholders, employees, and customers. This way, for the supply chain project management, the successful introduction of Lean requires accepting and promoting the social ideology of the CSR to the working and social areas of enterprises' activities. It does not suggest the pursuit of short-term results, but it focuses on the continuous improvements aimed at re-thinking of the company, starting from small incremental improvements to achieve radical and fundamental innovations.

The source of TPS entropy is the loss of management effectiveness when the relationships between management and employees are unbalanced. This way, from the perspective of Lean manufacturing, to achieve a performance in the long run, it is required to create an open environment for employees in which they can feel comfortable, confident and purposeful to consciously improve their work and propose ideas for innovations. Toyota's practices on change management as they are related to Kaizen mean that employees can take a small risk without fear of losing their job [10].

The legal requirements to the industry, such as cleanliness, disposal of wastes and effluents, ventilation and temperature, artificial humidification, overcrowding, lighting, drinking water, latrines and urinals, spittoons, working place, etc. should be ensured properly to maintain optimal working environment and productivity and protect employees from the injures. The driving force of Lean it is not only in enhancing the production efficiency through the use of specific tools or Key Performance Indicators (KPIs) but also in respecting the employees as a key link of change. In this context, any company is associated with a growing organism consists of a set of social relationships, processes, and chain links, and if the relationship is broken, then there is a degradation of all system [11].

Engaging organizational stakeholders (i.e., employees, unions, management, stockholders, etc.) is one of the crucial steps for the CSR implementation. This way, expanding Lean environment in compliance with the CSR practices is relevant since there is a generality of approaches to employees as stakeholders in both concepts. By establishing employees-friendly working environment, it becomes possible to consider HR the cornerstone for achieving sustainability of business and supply chains.

When developing Lean-friendly working environment in accordance with the CSR provisions, management should understand that pseudo socially-oriented actions and superficial treatment of social programs will not ensure long-term benefits. Moreover, the social programs, as well as lean-supported activities, should be extended primarily to workers, as changes should be started at the root. During the implementation of the proposed methodology, the CSR practices at the enterprises should act as an integral part of the company's strategy and corporate governance tactic, not just as activities for advertisement in the mass media.

The socially responsible company is focused on providing work that is meaningful for performers and helps them develop and seize their potential. From this perspective, the internal social programs can be aimed at supporting the children of employees of enterprises, paying the cost of their training in the context of talent cultivation, charity, etc. Thus, employees should be considered not as simple performers but as owners of knowledge, whose skilful and productive work directly contributes to the competitiveness of the socially oriented enterprise. The significant support of the professional development and retraining processes should be the task of the state, employers, and trade unions to facilitate the high price of labour associated with professionalism [12].

The Lean tools are applicable and can be effectively utilized only under Lean-friendly environment. The CSR may provide the sustainability of Lean tools implementation as the worker operates in the conditions not contradicting his comfort and encouraging his development and socialization.

3.1 5S initiative

Most of the companies applying the concept of Lean consider 5S as an essential component of Lean-thinking and Lean-Kaizen. The 5S initiative is associated with TQM as a method of organizing work, including the establishment of purity, order, strengthening discipline, and formation of a safe working environment for employees. The individual items within 5S are called as the "pillars": Seiri (i.e., sort – utilise only the necessary items); Seiton (i.e., set – put each item in its specific place); Seiso (i.e., shine – clean the workplace); Seiketsu (i.e., standardization – develop rules of order in the workplace); Shitsuke (i.e., sustain – maintain the discipline and improve standard).

The 5S initiative significantly contributes to quality, safety, and effective utilisation of workspace, maintaining the sustained organizational improvements [13]. Two important aspects of safety climate, such as management commitment and involvement, can be positively influenced by 5S events [Srinivasan et.al. 2016].

3.2 Visualization and Value Stream Mapping (VSM)

As people perceive about 83% of information through vision, the next important component of Lean manufacturing is the visualization of processes and activities. In this context, transmitting and sharing information to the employees are provided in the form of the various images, diagrams, maps, tables, etc. to be perceived more adequately. Concerning this, one of the most important tools of Lean can be indicated, such as Value Stream Mapping (VSM) by which any activity can be transformed into a stream (i.e., information flow) where the wastes and losses are determined.

The models obtained through VSM vary depending on the specific of processes, objects, tasks, etc. However, the results are significant. For instance, in manufacturing, the implementation of VSM accompanied by ARENA simulation helped the organization to reduce the cycle time significantly (by 30 per cent) over the entire production time.

3.3 Kanban

Toyota's whole operation of using Kanban is known as a system for managing the production in Just-in-Time (JIT) production system [14]. Kanban acts as a special scheduling system providing information about what to produce, when to produce and how much to produce in a specific case. It can be considered a strong driver for supply chain project management performance.

3.4 Just-in-Time (JIT)

The effective Kanban system allows implementing JIT in the enterprise. JIT consists of different elements including change-over reduction and preventive maintenance programmes to support the pull principle, i.e., demand-oriented system. Following JIT, the necessary components and materials arrive in the right amount at the right place and at the right time that contributes to the reduction in wastes. The successful implementation of JIT, as well as other Lean tools, is in the clear coordination of employees work since they are all involved in the related processes and interested in the successful problem-solving. The operational benefits of JIT concerning the production performance are widely stated.

3.5 Single-Minute Exchange of Dies (SMED) and Total Productive Maintenance (TPM)

The SMED is a system that provides time reduction during equipment changeovers. The practical application of the SMED was characterized by positive results [15].

The TPM is a holistic approach to equipment maintenance to ensure the perfect production processes. TPM methodology provides organizations with a guide to fundamentally transform their shop floor by integrating culture, process, and technology. The key idea is in independent maintenance of the equipment by the employee that makes the difference from the traditional approach.

The fact of particular importance is that the TPM ensures achievement of three vitally important goals such as zero defects, accidents and breakdowns. Implementing the TPM in the working environment leads to understanding equipment not only as an ordinary mean of production but as the basis for the prosperity of the enterprise and the guarantee of the financial well-being of its employees. The benefits include favourable changes in the attitude of the operators, achieving goals by working in teams, sharing knowledge and experience. As all Lean tools, the TPM and SMED boost the employee involvement and accelerate his relations with colleagues by recognizing him as a thinker that can contribute to the company success that is highly relevant for supply chain project management.

3.6 Wastes

Generally, the wastes take many forms and may be found hidden in policies, procedures, process designs, operations, etc. This way, the wastes are all actions that consume resources but cannot create the value for the customer.

There are seven original wastes (i.e., Muda) that Lean philosophy seeks to eliminate through the implementation of Lean tools: (a) overproduction; (b) waiting time; (c) unnecessary transportation; (d) unnecessary processing; (e) excess inventories; (f) motion; (g) defects [16].

However, within the framework of Lean production, it is important to consider not only the technical process but also HR, including HR abilities and aspirations. In the supply chain project management framework, the problem of HR development strongly refers to a new (eighth) waste of Lean that means not stimulate or use the complete employee capacity in identifying opportunities for improvement. This waste factor is also emphasised in the CSR theory, indicating that the corporations are responsible for worker's human dignity and status, and worker's training and development are corporation's resource and not cost.

Thus, it is required to consider the problem of reasonable distribution of work among the supply chain project management employees concerning their capabilities and opportunities for professional development and socialization.

To achieve the research objective, the case study considers the problem of HR development and involvement from the perspective of Lean and CSR to tackle the issue of untapped potential of employees involved in the supply chain operation.

The conventional solution to the assignment problem is given by the Hungarian or Kuhn-Munkres algorithm, originally proposed by H.W. Kuhn and refined by J. Munkres in 1957 [33]. It can be stated as follows: given a set of workers, a set of jobs, and a set of ratings indicating how well each worker can perform each job, determine the best possible assignment of workers to jobs, such that the total rating is maximized [17].

The Hungarian method is applicable for the following issues:

1. The tasks of appointing employees to positions: it is necessary to distribute workers to positions so that maximum efficiency can be achieved, or a minimal cost of work can be ensured.
2. Assignment of equipment to production sections: distribution of machines so that during their work the production is as profitable as possible, or the cost of maintaining them is minimal.

The basic idea of the Hungarian method is to move from the original cost matrix C to its equivalent cost matrix C_0 with nonnegative elements and a system of n independent zeros. For a given n, there are $n!$ feasible solutions. If we arrange n units in the assignment matrix X so that in each row and column there is only one unit arranged in accordance with the n independent zeros of the equivalent cost matrix C_0, then we obtain valid solutions to the assignment problem. Each assignment problem has a matrix associated with it. Indeed, the row contains the specific number of people or equipment we strive to assign, and the column comprises the jobs or tasks we want them assigned to [18].

The applicability of the Hungarian method in the context of coordination of Lean and CSR is dictated by a fact that it is a combinatorial optimization algorithm, providing the solution for the assignment problem in polynomial time and anticipating the primal-dual methods thereby allowing considering the personal experience and capabilities of the employee to ensure the optimal policies on HR development. This phenomenon creates prerequisites for expanding the application of the Hungarian algorithm in practice.

The advantage of this method is the ability to assess the proximity of the result of each iteration to the optimal plan of distribution of labour resources to control the calculation process and stop it when certain accurate indicators are reached. The best value of the target function and corresponding plan are the optimal solution to the problem.

By converting this problem to a formal mathematical definition, it is possible to formulate the following. There are m groups of people (or machines) numbering $a_1, a_2, \dots, a_m$ that are responsible to perform n types of works (i.e., operations) with the volume $b_1, b_2, \dots, b_n$. There is information (i.e., accumulated statistics) about the level of possession of various working skills, that is, the performance of each i - th group of people when performing each j-th type of work c_{ij}, $i = 1, 2, \dots, m$, $j = 1, 2, \dots, n$. As a task, it is necessary to effectively realize the working potential of employees to perform a large order to achieve the maximum total volume of work while optimally distributing areas of responsibility for technology among workers considering their abilities.

In general, the mathematical model of the problem can be developed as follows (1)-(3):

$$L(X) = \sum_{i=1}^{m} \sum_{j=1}^{n} c_{ij} x_{ij} \rightarrow min\ (max) \quad (1)$$

$$\sum_{i=1}^{m} s_{ij} x_{ij} = (\leq) 1, \quad j = \overline{1,n}, \ \sum_{j=1}^{n} s_{ij} x_{ij} \leq (=) 1, \quad i = \overline{1,m}, \quad (2)$$

$$x_{ij} \in \{0, 1\}, i = \overline{1,m}, \quad j = \overline{1,n}. \quad (3)$$

where x_{ij} – number of people of i-th group, performing j-th type of work or operation [35]. C is an arbitrary matrix while S matrix of prohibitions, where (4):

$$s_{ij} = \begin{cases} 1, & if\ value\ of\ x_{ij}\ is\ allowed \\ 0, & otherwise \end{cases} \quad (4)$$

When the objective function is maximized, the transition to the equivalent matrix C_0 is as

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follows: (1) identify the maximum element of the matrix *C,* i.e $max c_{ij} = B$; (2) move to the matrix C_0 with elements $t_{ij} = B - c_{ij}$; capture prohibitions as follows (5):

$$t_{ij} = \begin{cases} c_{ij}, & \text{если } s_{ij} = 0 \\ M, & \text{если } s_{ij} = 1 \end{cases} \quad (5)$$

where *M* is a penalty, $M > \max c_{ij} m$ in a way that: if $(m < n)$, then $(n\text{-}m)$ zero rows are to be added in matrix C_0; if $(m > n)$, then $(m - n)$ zero columns are to be added in the matrix C_0; if $(m = n)$, then the Hungarian algorithm should be implemented for assignment problem solving with a square matrix C_0 .

It is necessary to consider the solution of the assignment problem based on the decomposition of the original problem into several optimization problems. The problem is based on the nominal values to present the methodology and is formulated as follows.

In the apparel supply chain, the garment factory *K* received a large order from a foreign client for the manufacture of women clothing but previously had no experience of fulfilling such orders. The factory managers should competently organize the production process in the conditions of limited time and financial resources but should not violate the rights of garment workers and force them to put up with excessively long working hours. Thus, a key objective is a reasonable implementation of working potential and ensuring the individual approach to workers so that all workers are employed, thus providing maximum total efficiency of the selected distribution (i.e. benefits).

The main production process consists of five different types of work such as: b_1 – making templates; b_2 – automatic cutting of cloth; b_3 - sewing application; b_4 – fastening details of the clothing; b_5 – corrugation. It is known that every employee can perform different functions with different productivity depending on work experience, qualifications, and individual characteristics. When considering this task, it is assumed that the number of workers is equal to the number of works: the first worker is a_1, the second worker is a_2, the third worker is a_3, the fourth worker is a_4 and the fifth worker is a_5. The accumulated indicators of the degree of possession of a certain working qualification by each employee are presented in the efficiency matrix *C* as follows (6):

$$C = \begin{pmatrix} 15 & 16 & 17 & 18 & 19 \\ 1 & 1 & 3 & 1 & 16 \\ 2 & 8 & 8 & 6 & 17 \\ 2 & 2 & 2 & 8 & 18 \\ 4 & 6 & 7 & 8 & 19 \end{pmatrix} \quad (6)$$

The solution of stated problem is provided as follows.

At the preparatory stage, the maximum element of the first column of the matrix *C* is equal to 15. From this, to obtain the first column, it is necessary to subtract the elements of the first column of the matrix from 4. Similarly, to obtain the columns from the second to fifth, subtract the elements of these columns from the maximum elements (from 16 to 19) as follows (7):

$$\widetilde{N} \sim \begin{pmatrix} 0 & 0 & 0 & 0 & 0 \\ 14 & 15 & 14 & 17 & 3 \\ 13 & 8 & 9 & 12 & 2 \\ 13 & 14 & 15 & 10 & 1 \\ 11 & 10 & 10 & 10 & 0 \end{pmatrix} \quad (7)$$

From all elements of each row, subtract the minimum element of this row to obtain the matrix C_0 with non-negative elements. The independent zeros should be marked: in the first column we select an arbitrary zero, then in other columns there are no independent zeros. Among the unselected elements of the matrix C_0 there are zeros, and the row containing the unselected zero also contains $0*$. The elements are to be market as follows (8):

$$C_0 \sim \begin{pmatrix} 0* & 0' & 0 & 0 & 0 \\ 11 & 12 & 11 & 14 & 0' \\ 11 & 6 & 7 & 10 & 0 \\ 12 & 13 & 14 & 9 & 0 \\ 11 & 10 & 10 & 10 & 0 \end{pmatrix} \tag{8}$$

Further, we create a sequence of elements $0'$ and $0*$ of the matrix C_0 as follows: (1) the sequence starts with the original $0'$; (2) from $0'$ move to $0*$ by column (if applicable); (3) from $0*$ move to $0'$ by row and after repeat step (2).

After completion of initial steps, obtain a matrix C_0 where the number of independent zeros ($0*$) is increased by one to move to step (3) as follows (9):

$$C_0 \sim \begin{pmatrix} 0 & 0* & 0 & 0 & 0 \\ 11 & 12 & 11 & 14 & 0* \\ 11 & 6 & 7 & 10 & 0 \\ 12 & 13 & 14 & 9 & 0 \\ 11 & 10 & 10 & 10 & 0 \end{pmatrix} \tag{9}$$

Let provide all the steps with the resulting matrix C_0. Among the unselected elements of the matrix C_0 there are zeros, and the row containing the unselected zero also contains $0*$. The elements are to be market as follows (10):

$$C_0 \sim \begin{pmatrix} 0 & 0* & 0' & 0 & 0 \\ 11 & 12 & 11 & 14 & 0* \\ 11 & 6 & 7 & 10 & 0 \\ 12 & 13 & 14 & 9 & 0 \\ 11 & 10 & 10 & 10 & 0 \end{pmatrix} \tag{10}$$

Since there are no zero elements among the unselected elements in the matrix C_0, then: (a) select the minimum element among the unselected elements and mark it as h=6; (b) the value h>0 is subtracted from all elements of the matrix C_0 located in the unselected rows; (c) the value h is added to all elements of the matrix C_0 located in the selected columns.

As a result, obtain the equivalent matrix C'_0 with unselected zero elements that is supposed to be equal to C_0. After that, move to the required step to formulate the following (11):

$$C_0 \sim \begin{pmatrix} 0* & 0 & 0 & 0 & 6 \\ 5 & 6 & 5 & 8 & 0* \\ 5 & 0* & 1 & 4 & 0 \\ 6 & 7 & 8 & 3 & 0 \\ 5 & 4 & 4 & 4 & 0 \end{pmatrix} \tag{11}$$

Among the unselected elements of the matrix C_0 there are zeros, and the row containing the unselected zero also includes $0*$. The elements are to be market as follows (12):

$$C_0 \sim \begin{pmatrix} 0* & 0 & 0' & 0 & 6 \\ 5 & 6 & 5 & 8 & 0* \\ 5 & 0* & 1 & 4 & 0 \\ 6 & 7 & 8 & 3 & 0 \\ 5 & 4 & 4 & 4 & 0 \end{pmatrix} \quad (12)$$

Since there are no zero elements among the unselected elements in the matrix C_0, then repeat the steps from (a) to (c) with a condition that h=1. As a result, obtain the equivalent matrix C'_0 with unselected zero elements that is supposed to be equal to C_0. After that, move to the required step to formulate the following (13):

$$C_0 \sim \begin{pmatrix} 0* & 1 & 0 & 0 & 7 \\ 4 & 6 & 4 & 7 & 0* \\ 4 & 0* & 0 & 3 & 0 \\ 5 & 7 & 7 & 2 & 0 \\ 4 & 4 & 3 & 3 & 0 \end{pmatrix} \quad (13)$$

Among the unselected elements of the matrix C_0 there are zeros, and the row containing the unselected zero also contains $0*$. The elements are to be marked as follows (14):

$$C_0 \sim \begin{pmatrix} 0* & 1 & 0' & 0 & 7 \\ 4 & 6 & 4 & 7 & 0* \\ 4 & 0* & 0' & 3 & 0 \\ 5 & 7 & 7 & 2 & 0 \\ 4 & 4 & 3 & 3 & 0 \end{pmatrix} \quad (14)$$

Since there are no zero elements among the unselected elements in the matrix C_0, then repeat the steps from (a) to (c) with a condition that h=2. As a result, obtain the equivalent matrix C'_0 with unselected zero elements that is supposed to be equal to C_0. After that, move to the required step to formulate the following (15):

$$C_0 \sim \begin{pmatrix} 0* & 1 & 0 & 0 & 9 \\ 2 & 4 & 2 & 5 & 0* \\ 4 & 0* & 0 & 3 & 2 \\ 3 & 5 & 5 & 0* & 0 \\ 2 & 2 & 1 & 1 & 0 \end{pmatrix} \quad (15)$$

Among the unselected elements of the matrix C_0 there are zeros, and the row containing the unselected zero also contains $0*$. The elements are to be marked as follows (16):

$$C_0 \sim \begin{pmatrix} 0* & 1 & 0' & 0 & 9 \\ 2 & 4 & 2 & 5 & 0* \\ 4 & 0* & 0' & 3 & 2 \\ 3 & 5 & 5 & 0* & 0 \\ 2 & 2 & 1 & 1 & 0 \end{pmatrix} \quad (16)$$

Since there are no zero elements among the unselected elements in the matrix C_0, then repeat the steps from (a) to (c) with a condition that h=1. As a result, obtain the equivalent matrix C'_0 with unselected zero elements that is supposed to be equal to C_0. After that, move to the required step to formulate the following (17):

$$C_0 \sim \begin{pmatrix} 0* & 1 & 0 & 0 & 9 \\ 1 & 3 & 1 & 5 & 0* \\ 4 & 0* & 0 & 3 & 2 \\ 2 & 4 & 4 & 0* & 0 \\ 1 & 1 & 0* & 1 & 0 \end{pmatrix} \quad (17)$$

There are five zeros, then, the solution has been found. The value of the target function corresponding to the optimal plan is called as the efficiency of assignment. Maximum efficiency is formulated as follows (18):

$$L\,(x) \;=\; c_{11} + c_{25} + c_{32} + c_{44} + c_{53} = \; 15 + 16 + 8 + 8 + 7 = 54 \quad (18)$$

Thus, the workload sharing should be executed as follows: assign the 1st employee to the 1st job; assign the 2nd employee to the 5th job; assign the 3rd employee to the 2nd job; assign the 4th employee to the 4th job; assign the 5th employee to the 3rd job.

A significant advantage of the considered model is the logical visibility and formalised nature of the optimization algorithm for the problem to be solved. Furthermore, in order to simplify the solution algorithm, this model provides a preliminary evaluation of the complexity of calculations resulting in obtaining a solution by successive decomposition into problems of smaller dimensions [19].

The introduction of this model is also beneficial for the factory owners and supply chain actors, as it does not entail large costs and does not require a stop of production. The efficiency matrix allows to reveal a discrepancy between categories and acquired professional skills to define gaps in competencies and induce workers to study new types of the equipment with respect to their social needs.

The appointment to a position (i.e., the distribution of duties among workers) occurs with the principle of the greatest efficiency (i.e., expected increase in profits), considering the experience and capabilities of the employee in order to implement the individual approach in HR development.

The Lean practices have to be accompanied by introducing the CSR platform that requires a transformation of the traditional business model. The CSR initiative starts from the formulation of formal commitment by coordinated efforts of the government, international brands and enterprise owners, accepting responsibility for the supply chain to balance the social and financial orientation of the enterprise's activities [20].

The involvement and motivation of the workers are keystones of Lean practices implementation to enhance productivity by gradual but continuous improvements. This way, only ensuring employee development, fair and appropriate wages, healthy and safe working conditions can facilitate mutual respect between workers and management. The adopted dynamic Hungarian algorithm would serve as a foundation for appropriate decision-making concerning solving the assignment problem for HR development in the context of Lean manufacturing and CSR coordination.

4 Conclusion

The potential difficulties of following the proposed model can be associated with a normal reaction to innovations: the fear of uncontrolled change; expectations of short-term returns; disbelief in the ability of employees to contribute - 'not everyone is creative'; lack of skills in innovation amongst non-specialists. However, step-by-step application of the model's provisions, training, and motivation of employees in an accessible language, continuous monitoring, revision of ineffective measures, analysis of problems, improvement of methodology, etc. would contribute to the adequate acceptance of changes.

Despite the costs that may occur, by coordinating the CSR with Lean concept, companies may obtain higher stock returns and satisfy the needs of their stakeholders, thereby enhancing the social programs, optimal working conditions, and productivity.

Only when the coordination of Lean and CSR is supported at any level of the management hierarchy, it is appropriate to discuss the effectiveness of the methodology application. In this context, the ultimate driver is a formation of such an environment, where the employee knows his work field and he is not indifferent to existing problems.

This research considered the problem of HR development and involvement from the perspective of Lean and CSR to tackle the issue of untapped potential of employees involved in the supply chain operation. The improvement of the working conditions, hierarchy system and responsibility allocation, promotion of workers' rights and opportunities for professional training and development, have been analysed through the coordination of Lean Manufacturing and CSR.

The scientific contribution of this research is in filling the existing scientific gap concerning the CSR and Lean philosophy coordination. Apart from this, the implemented Hungarian algorithm has been aimed at finding the best combinations of performance, profitability and time factors to solve the assignment problem in the supply chain facilities to balance the efficiency of the distribution of the labor force and employee individual capabilities.

The significance of new findings is that conceptual model developed under this study may serve as the optimal and flexible solution to the assignment problem, enabling to vary the conditions of the stated problem, such as number of employees, work types, enterprise activities scale, level of processes maturity, realized practices, etc.

The joint future of Lean and CSR could be associated with the latest legal innovations, technological advances and mutual reorientation of economic goals into the social context. This way, the empirical study considering the relationship between Lean strategy and CSR can serve as a direction of future research.

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