A study on the convergence of lean and green management goals

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Abstract. Goal setting determines the transformation of production management methods and approaches. Real practice often differentiates Lean and Green approaches. At first glance, the indicators and metrics are so different that there is a feeling of the need to build the company's organizational structure accordingly, allocate different budgets and implement different activities. This is largely due to the different standards and rules governing these approaches. The study examines the hypothesis that the goals of Lean and Green Management are convergent at the current stage of development. Understanding the possibility and even the need (in accordance with the Lean approach) to combine and minimize resources will increase the efficiency of manufacturing enterprises. The study showed that, despite the initial apparent difference of Lean and Green management goals, in fact, at least two of the three stated goals are convergent: 1) goals aimed at reducing resource consumption and 2) goals aimed at ensuring the growth of enterprise performance indicators. The third group of goals aimed at forming a conscious "lean" attitude of personnel to work, equipment, and the environment, apparently implies different understandings and interpretations. This may probably be due to the fact that Lean management operates more with material resources, while Green management is aimed at energy resources and the environment.

1 Introduction

The peak of interest to Lean approach worldwide falls on the 2010s. A study of publications on the topic of lean production since 1990 shows that the maximum number of publications is observed in the period 2018-2023.

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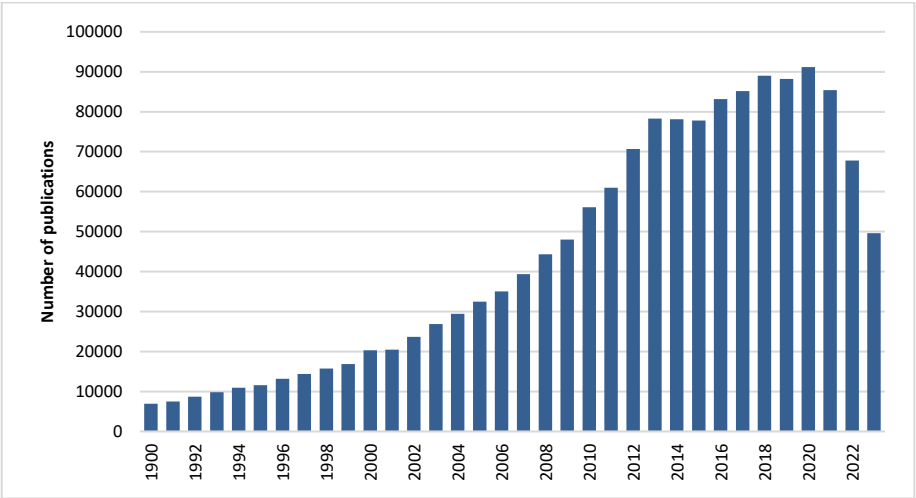

Fig.1. Number of publications on lean production topics
Source: The basis for the analysis of publications was the Google Scholar database.

It is possible to conditionally divide all research in the field of lean manufacturing into three global periods or, to be more precise, three approaches that dominated in a limited time period (not always clearly separated, but clearly traced in publications):

- lean manufacturing as a tool for getting rid of unnecessary actions in the process of creating value for the consumer;
- lean manufacturing as a worldview aimed at constant analysis of the balance of costs and benefits from any actions;
- lean manufacturing as a resource-saving tool for reducing the negative impact on the environment.

Despite the fact that one approach does not exclude the other, however, it is obvious that the approaches as a whole are based on different goal-setting, which has changed along with consumer behavior and technologies.

The first period falls on the 1990s - 2000s, when the main emphasis is placed on the elimination of losses in the production process, as well as on continuous improvement, as a fundamental basis for all lean manufacturing. The most cited works are the publications of J. Womack, D. Jones, D. Roos [1,2] and T. Ohno [3], which compare Japanese and Western production systems based on the example of the automotive industry. S. Shingo and A. Dillon [4] emphasize the importance of a detailed analysis of production processes to identify and eliminate losses, and focus on the technical aspects of implementing lean manufacturing. M. Rother, J. Shook [5] and P. Hines, N. Rich [6] delve even deeper into the technical implementation of process analysis. J. Liker and D. Meier [7] adhere to the same direction.

The transition to a new period of understanding lean manufacturing as a worldview begins with the work of S. Spear and H. Bowen [8], who focus on the culture and way of thinking that should be formed as a result of continuous personnel training. Also significant is the work of Y. Monden [9], who emphasizes the importance of adapting the production system to market changes and flexibility. Issues of integrating lean culture into an organization to achieve sustainable results are raised in the publication of S. Bhasin and P. Burcher [10]. D. Mann proves the importance of leadership for maintaining a corporate culture aimed at continuous improvement [11].

The formation of deeper views on lean manufacturing leads to an attempt to apply this approach not only in all sectors of human economic activity, but in general in the daily

routine. This gives an unexpected resource-saving effect in all areas. First of all, this becomes noticeable in the field of environmental protection, which provokes interest in the integration of Lean and Green Manufacturing. Environmental sustainability and business responsibility has become a kind of benchmark for success, since companies promoting this approach were already a priori in the system of continuous improvement. P. Gordon [12], A. King and M. Lenox [13] have proven the positive impact of Lean on environmental performance. A. Chiarini [14] and A. Cherrafi, S. Elfezazi et al. [15] have shown the long-term effects of integrating Lean and Green. Even the terminology itself is gradually changing: researchers are moving from Lean Manufacturing to Lean Management. T. Netland and D. Powell show how Lean Management can be integrated into everyday life practices to create meaningful goals and sustainable value [16].

Real practice often differentiates between Lean and Green approaches. This is largely due to the existence of different standards and rules governing these approaches. At first glance, the indicators and metrics are so different that a feeling of the need to build the company's organizational structure accordingly, allocate different budgets and implement different activities is formed. To understand the possibility and even the need (in accordance with the lean approach) to combine and minimize resources, a more in-depth analysis is needed, which does not always appear in routine production practice. The purpose of the study was to identify the degree of disunity between Lean and Green approaches in the minds of manufacturing enterprise managers.

2 Materials and Methods

The initial data were two questionnaires, which were aimed at identifying the understanding of managers and decision makers of the content of the provisions, goals, objectives and tools of lean manufacturing and environmental management.

Pilot surveys were conducted among 34 managers of industrial enterprises in the mechanical engineering industry: 17 people for each of the surveys. The objective of the pilot surveys was to collect possible answer options to form the most complete list. The final lists presented in the questionnaires are presented in the table 1.

Table 1. Final lists presented in the questionnaires.

	Lean Manufacturing			**Ecological (Green) Management**
Concept & Goal				
X_1	Reduce resource consumption in production		Y_1	Reduce the volume of resources consumed
X_2	Reduce production costs		Y_2	Reduce disposal costs
X_3	Reduce laboriousness of production		Y_3	Reduce the amount of production waste
X_4	To direct the staff to a careful attitude towards the equipment and other property of the enterprise		Y_4	Teach staff to think about the environmental impact of any action in the production process
X_5	Reduce the WIP volume and the need for warehouse space		Y_5	Establish processes for the continuous search for more environmentally friendly materials and technologies
X_6	Reduce the number of personnel required for the production process		Y_6	Reduce the environmental monitoring indicators by the relevant authorities

Source: Compiled by the authors.

As a toolkit for achieving the set goals, both groups proposed:

- personnel training;
- organization and provision of vertical and horizontal communication in the organization;

– provision of information transparency within the organization;
– development of a motivation system aimed at stimulating the appropriate behavior of personnel.

Next, a contextual analysis was carried out, which helped to understand the true meanings of the provisions laid down by the authors and draw parallels between the provisions of Lean and Green management.

The second stage of the study was a survey of the main group of respondents - heads of structural divisions of industrial enterprises, one way or another implementing one of the approaches or both (it does not matter whether this happens simultaneously or at different times). At this stage, the assessment was carried out by determining the dynamics of changes for each parameter on a 5-point scale:

– 5 points, if significant positive changes are observed,
– 4 points, if moderate positive changes are observed,
– 3 points, if no changes are observed,
– 2 points, if minor negative changes are observed,
– 1 point, if significant negative changes are observed.

The subsequent analysis was supposed to show the presence of a direct relationship between the Lean and Green management indicators in the case where the use of the same approaches simultaneously satisfies the goals of both approaches, or the absence of relationships if changes in some indicators do not affect other indicators..

3 Results

Contextual analysis of the information obtained in the pilot study helped to identify 3 groups of common (related) goals:

1) Reduce resource consumption (labor, raw materials and energy resources) and, accordingly, production waste – indicators X_1, X_3, X_5, X_6, Y_1, Y_3;
2) Ensure growth in enterprise performance indicators (reduction in cost price, reduction in monitoring indicators of supervisory authorities) – indicators X_2, Y_2, Y_6;
3) Form a conscious “lean” attitude of personnel to work, equipment, the environment – indicators X_4, Y_4, Y_5.

The cross-analysis matrix confirming the corresponding groupings of indicators is presented in Table 2.

Table 2. Cross-analysis matrix.

Green management	Lean management					
	X_1	X_2	X_3	X_4	X_5	X_6
Y_1	0.986	0.866	0.807	0.677	0.834	0.506
Y_2	0.716	0.882	0.465	0.535	0.583	0.855
Y_3	0.854	0.712	0.312	0.492	0.898	0.478
Y_4	0.479	0.830	0.506	0.875	0.901	0.694
Y_5	0.391	0.493	0.284	0.835	0.486	0.392
Y_6	0.756	0.258	0.302	0.185	0.396	0.762

Source: Compiled by the authors.

Next, respondents assessed the dynamics of changes in the indicators, which helped to understand the presence of a direct relationship in 2 of the 3 groups of indicators. At those enterprises where respondents indicated significant positive changes in the implementation of lean manufacturing principles, a similar change was also noted in the area of Green

management, and further accordingly (Table 3). Negative dynamics shows a similar trend: where the assessment of lean manufacturing implementation worsened, the assessment of Green management also worsened. These trends are observed in groups 1 and 2 (Reduction in resource intensity and Increase in efficiency indicators). In group 3 (Formation of a conscious attitude of personnel to work), differences are observed for individual respondents and even multidirectional trends: in some cases, with an improvement in the assessment of lean manufacturing implementation, a deterioration in the assessment of Green management is noted.

Table 3. Dynamics of changes in indicators.

Group	Indicator	Percentage of rating coincidence (Lean management / Green management / %)				
		5/5	4/4	3/3	2/2	1/1*
1	X_1 / Y_1	92	94	98	92	-
	X_3 / Y_1	96	94	96	90	-
	X_5 / Y_1	90	96	90	92	-
	X_6 / Y_1	92	90	96	92	-
	X_1 / Y_3	98	92	94	94	-
	X_3 / Y_3	96	94	96	96	-
	X_5 / Y_3	90	90	96	96	-
	X_6 / Y_3	92	90	90	96	-
2	X_2 / Y_2	86	90	92	88	-
	X_2 / Y_6	88	84	96	88	-
3	X_4 / Y_4	36	28	30	28	-
	X_4 / Y_5	18	14	32	42	-

Source: Compiled by the authors.

** None of the respondents rated any of the indicators as 1 point*

As can be seen from Table 3, none of the respondents indicated that their companies were experiencing significant negative changes. Therefore, there are no interrelations in this assessment. It is noteworthy that in Group 1 (goals aimed at reducing resource consumption), all assessments coincide in 90 percent or more of cases, which indicates the highest consistency. Goals X_1 (Reduce resource consumption in production) and Y_3 (Reduce the amount of production waste) coincided by 98%. A similar coincidence is observed between goals X_1 (Reduce resource consumption in production) and Y_1 (Reduce the volume of resources consumed). Despite the virtually identical wording, different resources were implied: X_1 reflects more raw materials and labor resources, and Y_1 describes energy resources. Formally, a reduction in the use of raw materials does not necessarily entail a reduction in the use of energy resources, and even vice versa, it can entail greater energy costs [17]. Thus, with more thorough processing with less waste, more equipment operating time may be required [18]. However, the respondents' assessment demonstrates unidirectional development vectors. This effect can be achieved by improving the qualifications of personnel, when the operator performs his work more accurately and quickly.

It is important to note the uniformity of the spread of respondents' answers. Diagram 1 shows that the assessments of the indicators of groups 1 (goals aimed at reducing resource consumption) and 2 (goals aimed at ensuring growth in the performance indicators of the enterprise) vary in range between 84 and 98, while in group 3 (goals aimed at forming a

conscious "thrifty" attitude of personnel to work, equipment, the environment) - the absolute values are almost 3 times lower and vary in the range between 14 and 42.

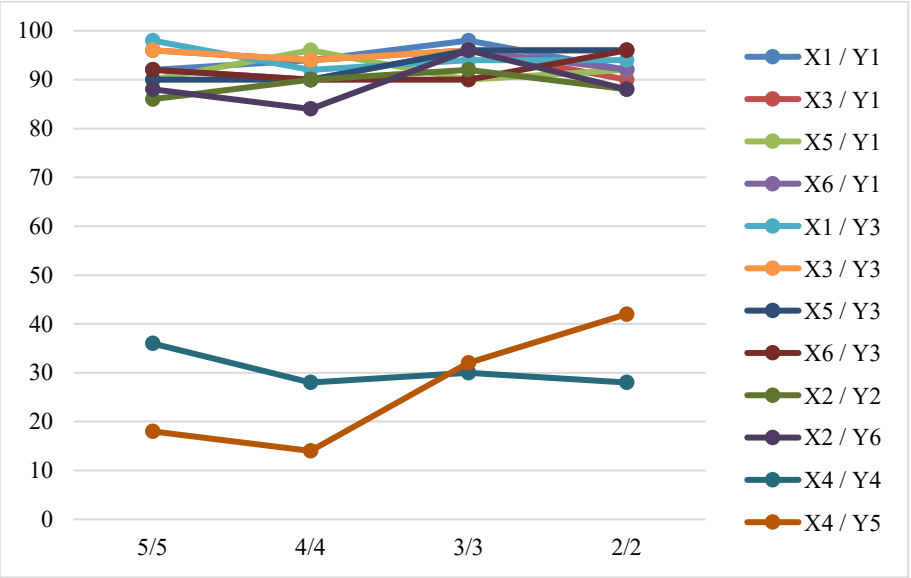

Fig.1. Distribution diagram of respondents' ratings.
Source: Compiled by the authors

Thus, the assessment showed that in terms of reducing resource intensity and achieving performance indicators, the goals of enterprises implementing Lean and Green management are convergent. This does not clearly indicate the identity of the tools, but indicates the uniformity of the synchronicity of changes, which indirectly confirms the hypothesis.

4 Discussion

The practice of implementing Lean and Green management confirms that achieving the goals of one direction automatically entails achieving the goals of the second. For example, a study conducted by scientists from the University of California showed that the implementation of Lean management can lead to a decrease in energy consumption and greenhouse gas emissions [19]. Another study conducted by scientists from the University of Michigan showed that companies that implement Green management manage to increase their efficiency and productivity, as well as reduce their costs [20].

However, despite the potential synergies between these two approaches, they can also have dissimilar goals that can lead to conflicts. For example, the implementation of Lean management can lead to increased productivity, but can also lead to an increase in energy consumption and greenhouse gas emissions. A study by the University of Cambridge showed that the implementation of Lean management can lead to an increase in greenhouse gas emissions and energy consumption in some industries [21]. Moreover, this effect is observed in organizations at the early stages of Lean management implementation, when there may be a bias towards increasing productivity at the expense of resource consumption..

Russian practice also generally demonstrates positive trends in the simultaneous implementation of lean manufacturing and environmental management standards. Thus, the Transneft Group began implementing a lean manufacturing system in 2012. The company's

goals included optimizing production processes, reducing energy consumption and waste. As a result, the company was able to reduce greenhouse gas emissions by 12%. In 2014, the company received an ISO 14001:2004 certificate for an environmental management system. A year later, Rosneft achieved a 10% reduction in this indicator and was also certified according to ISO 14001:2015. Similar dynamics are also demonstrated by Sibur (-12%) and Gazprom (-8%).

5 Conclusion

The conducted research showed that, despite the initial apparent disunity of the goals of Lean and Green management, in fact, at least two of the three stated goals coincide: 1) goals aimed at reducing resource consumption and 2) goals aimed at ensuring growth of the enterprise's performance indicators. The third group of goals aimed at forming a conscious "lean" attitude of personnel to work, equipment, the environment, apparently implies different understandings and interpretations. This may probably be due to the fact that Lean management operates more with material resources, and Green management is aimed at energy resources and the environment. Research in the area of convergence of measures implemented by industrial enterprises to achieve the goals of Lean and Green management deserves special attention. In particular, practical testing of the implementation of individual measures with measurements of changes in both directions is important..

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