IMPROVING LEAN-BASED ECONOMIC MECHANISMS FOR REDUCING PRODUCT COST IN INDUSTRIAL ENTERPRISES

Esheva Sarvinoz Axmatovna
Independent researcher, Tashkent State University of Economics
E-mail: sarvinozaripova22022022@gmail.com
DOI:https://doi.org/10.5281/zenodo.24181016

Abstract

The thesis examined a lean-based mechanism for reducing product cost in an industrial enterprise. Unit cost was expressed as the sum of material, energy, labour and overhead cost per unit, and a saving formula was built for each component. Allowable cost and the target-cost gap were calculated, together with an annual kaizen costing rate. According to the National Statistics Committee, industrial output in Uzbekistan grew by 13.7% in real terms in 2023-2025, while electricity supplied to industry rose by only 1.1%. In an illustrative enterprise, unit cost fell from UZS 429.6 thousand to UZS 399.3 thousand, and the gap of UZS 29.6 thousand was fully closed. Higher material yield delivered 42% of the saving. The results gave a practical basis for linking a waste map to the cost structure of a plant.

Keywords: lean production, product cost, target costing, kaizen costing, material yield, energy intensity, industrial enterprises.

Annotatsiya

Tezisda sanoat korxonasida mahsulot tannarxini tejamkorlik (lean) tamoyillari asosida pasaytirish mexanizmi ko‘rib chiqildi. Birlik tannarxi material, energiya, mehnat va ustama xarajatlar yig‘indisi sifatida ifodalandi, har bir tarkibiy qism uchun tejash dastagi formulasi tuzildi. Maqsadli tannarx bo‘yicha ruxsat etilgan xarajat va tannarx farqi, kaizen usulida yillik pasaytirish sur’ati hisoblandi. Milliy statistika qo‘mitasi ma’lumotlariga ko‘ra 2023-2025-yillarda sanoat ishlab chiqarishi real ifodada 13,7 foizga o‘sdi, sanoatga yetkazilgan elektr energiyasi esa 1,1 foizga ko‘paydi. Shartli korxona misolida birlik tannarxi 429,6 ming so‘mdan 399,3 ming so‘mga tushdi va 29,6 ming so‘mlik farq to‘liq yopildi. Tejamning 42 foizi material chiqishini oshirishdan olindi. Natijalar korxonalarda chiqindilar xaritasini tannarx tarkibi bilan bog‘lash uchun amaliy asos berdi.

Kalit so‘zlar: tejamkor ishlab chiqarish, mahsulot tannarxi, maqsadli tannarx, kaizen, material chiqishi, energiya sig‘imi, sanoat korxonalari.

Аннотация

В тезисе был рассмотрен механизм снижения себестоимости продукции промышленного предприятия на основе принципов бережливого производства. Себестоимость единицы была представлена как сумма материальных, энергетических, трудовых и накладных затрат, для каждой составляющей были построены формулы рычагов экономии. Были рассчитаны допустимые затраты и разрыв по целевой себестоимости, а также годовой темп снижения по методу кайдзен-костинга. По данным Национального комитета по статистике, в 2023-2025 гг. промышленное производство в реальном выражении выросло на 13,7%, а поставка электроэнергии в промышленность увеличилась на 1,1%. На условном примере предприятия себестоимость единицы снизилась с 429,6 до 399,3 тыс.

© 2026 London International Monthly Conference on Multidisciplinary Research and Innovation. All Rights Reserved.

сумов, и разрыв в 29,6 тыс. сумов был полностью закрыт. 42% экономии было получено за счет повышения выхода материала. Результаты дали практическую основу для увязки карты потерь со структурой себестоимости.

Ключевые слова: бережливое производство, себестоимость продукции, целевая себестоимость, кайдзен, выход материала, энергоемкость, промышленные предприятия.

INTRODUCTION

Every unit that leaves a factory carries the steel that was cut away as scrap, the kilowatt-hours used while a press stood idle, the minutes a worker spent looking for a tool and a share of a warehouse full of goods nobody has ordered yet. None of this adds value for the buyer, yet all of it ends up in the cost price. Lean thinking treats such load as waste and removes it step by step [1]. The economic question for a plant manager is narrower: which waste, removed by which tool, lowers which line of the cost sheet, and by how much?

The question matters for Uzbekistan because its industry is growing fast and becoming more manufacturing-oriented. Industrial output reached UZS 885.8 trillion in 2024 and UZS 1,101.1 trillion in 2025, with manufacturing accounting for 86.0% of the total in 2025 [2] [3]. State policy has long encouraged energy-saving technologies and energy management in industry [4]. As competition sharpens, margins are protected mainly by lower cost per unit, not by higher prices.

The thesis pursues two aims. The first is to give a cost-reduction decomposition model that ties each lean saving lever to one component of unit cost. The second is to link that model to target costing and kaizen costing, so that a plant knows how large the cost gap is and how fast it should close it. The mechanism uses only data an enterprise already keeps in its cost accounts.

LITERATURE REVIEW

Lean production grew out of the Toyota system and was generalised by Womack and Jones into five principles: specify value, map the value stream, create flow, let the customer pull, and pursue perfection [1]. The classical list of seven wastes (overproduction, waiting, transport, over-processing, inventory, motion and defects) gives the shop floor a common language for spotting non-value-adding activity. Shah and Ward showed on a large sample of US plants that lean practices work best as bundles and that these bundles are associated with better operational performance [5]. Bhamu and Sangwan found cost reduction among the most often reported lean outcomes, though its financial side is often measured loosely [6].

Management accounting supplies the missing financial link. Target costing starts from the price the market will accept, subtracts the required profit and treats the remainder as the cost the product is allowed to have [7]. Ansari, Bell and Okano described it as a market-driven system that manages cost before production begins [8]. Kaizen costing extends the same logic to products already in production: small, continuous reductions are planned period by period and checked against actual results. Modarress, Ansari and Lockwood showed in a case study how kaizen costing turned lean improvements into measurable cost targets [9]. For overhead, time-driven activity-based costing helps assign indirect cost by the capacity each product actually uses [10].

A third stream connects lean with resource saving. King and Lenox found that lean plants also tended to reduce waste generation and emissions, since scrap and excess inputs are both a cost and an environmental burden [11]. Allwood and co-authors argued that material efficiency, making the same goods with less material, is a large and under-used reserve in manufacturing [12]. Worrell and colleagues showed that energy-efficiency measures in industry are often cost-effective but remain unexploited because

© 2026 London International Monthly Conference on Multidisciplinary Research and Innovation. All Rights Reserved.

energy use is poorly measured at the process level [13]. What is rarely offered is one simple formula set that runs from a waste type to a cost line and then to a target gap.

METHODOLOGY

The national context uses official data of the statistics body: industrial output and its structure [2] [3], the quarterly cumulative industrial growth index [14] and electricity supplied to the industrial sector [15]. Electricity use per unit of real output is the author's calculation. The enterprise part is an illustrative (hypothetical) example computed in Python, because published enterprise-level cost data are not available. The core of the method is a cost-reduction decomposition model:

$$C=c_M+c_E+c_L+c_O=\frac{p_M m}{\eta}+p_E\varepsilon+wh+\frac{F}{Q} \qquad (1)$$

where C is unit cost, thousand UZS; c_M, c_E, c_L and c_O are material, energy, labour and overhead cost per unit; p_M is the price of material per kg; m is the net material content of one unit, kg; η is material yield (net input divided by gross input); p_E is the price of energy per kWh-equivalent; ε is energy intensity, kWh-equivalent per unit; w is the hourly labour cost including social tax; h is labour hours per unit; F is annual fixed overhead; Q is annual output in units. In plain words, each cost line is written through one physical driver that the shop floor can influence.

The saving from each lever is the difference between the baseline state (index 0) and the lean state (index 1):

$$\Delta c_M=p_M m\left(\frac{1}{\eta_0}-\frac{1}{\eta_1}\right), \qquad \Delta c_E=p_E(\varepsilon_0-\varepsilon_1) \quad (2)$$

where Δc_M and Δc_E are the savings per unit in material and energy; η_0 and η_1 are material yield before and after the measures; ε_0 and ε_1 are energy intensity before and after. Put simply, material saving comes from less scrap and energy saving from fewer kilowatt-hours per unit.

$$\Delta c_L=wh_0\left(1-\frac{1}{1+g}\right), \qquad \Delta c_O=\frac{F}{Q_0}\left(1-\frac{Q_0}{Q_1}\right) \quad (3)$$

where Δc_L and Δc_O are the savings per unit in labour and overhead; h_0 is baseline labour hours per unit; g is the gain in labour productivity as a share; Q_0 and Q_1 are annual output before and after. Labour saving comes from fewer hours per unit, and overhead saving from spreading the same fixed cost over more units sold.

The target-cost gap shows how much of the saving is actually required:

$$C_A=P_T-\pi_T, \qquad G=C_0-C_A \qquad (4)$$

where C_A is allowable cost per unit; P_T is the target price that the market accepts; π_T is the target profit margin per unit; G is the cost gap; C_0 is current unit cost. A positive gap means the product earns less than the plant planned, so the gap becomes the cost-reduction assignment.

$$k=1-\left(\frac{C_A}{C_0}\right)^{1/T}, \qquad s_j=\frac{\Delta c_j}{G}\cdot 100 \qquad (5)$$

where k is the annual kaizen costing rate; T is the number of years allowed to close the gap; s_j is the share of the gap closed by lever j, %. In plain words, the first formula turns the gap into a steady yearly target and the second shows which lever does most of the work.

ANALYSIS AND RESULTS

Industrial context in Uzbekistan

Table 1 brings together the national indicators that frame cost management in industry.

Table 1

© 2026 London International Monthly Conference on Multidisciplinary Research and Innovation. All Rights Reserved.

Industrial output and electricity use in Uzbekistan, 2023-2025[1]

Indicator	2023	2024	2025
Industrial output, current prices, UZS trillion	-	885.8	1,101.1
Industrial production index, % of previous year	106.3	106.5	106.8
Real industrial output, 2023 = 100	100.0	106.5	113.7
Share of manufacturing in output, %	-	85.1	86.0
Electricity supplied to industry, million kWh	17,838.2	19,432.6	18,026.8
Electricity per unit of real output, 2023 = 100	100.0	102.3	88.8
Operating industrial enterprises at year end, thousand	-	55.6	59.8

Real industrial output rose by 13.7% over 2023-2025, while electricity supplied to industry grew by only 1.1%. As a result, electricity use per unit of real output fell by about 11% in two years, from 100.0 to 88.8. Part of this change reflects a shift in the mix towards manufacturing, whose share rose from 85.1% to 86.0%, and part reflects energy-saving measures at plant level. For an enterprise the message is clear: growth now rewards plants that produce more with the same inputs, which is the aim of lean cost management.

Illustrative enterprise and target-cost gap

The example describes a hypothetical plant that makes steel panel radiators. The assumptions are: net steel content m of 16 kg per unit at UZS 12.5 thousand per kg, yield of 0.86; energy use of 30 kWh-equivalent per unit at UZS 1.1 thousand; 2.4 labour hours per unit at UZS 35 thousand per hour; fixed overhead of UZS 9.6 billion a year and output of 120 thousand units. The target price is UZS 500 thousand with a 20% target margin, so allowable cost is UZS 400 thousand by equation (4). All figures are assumed and do not describe a real company. The lean state assumes that one improvement programme brings these results: yield rises to 0.91 through quality at source, energy intensity falls by 12% through metering and shut-down rules, labour productivity rises by 10% through 5S and cell layout, and pull planning frees capacity that is sold, raising output to 129.6 thousand units.

Table 2

Cost decomposition and saving levers in the illustrative enterprise, thousand UZS per unit[2]

Component	Lever: baseline → lean	Baseline	Lean	Saving	Share of gap, %
Material	yield 0.86 → 0.91	232.6	219.8	12.8	43.2
Energy	30.0 → 26.4 kWh-eq. per unit	33.0	29.0	4.0	13.4
Labour	2.40 → 2.18 hours per unit	84.0	76.4	7.6	25.8

[1] Source: Statistics Agency under the President of the Republic of Uzbekistan [2]; National Statistics Committee of the Republic of Uzbekistan [3] [14] [15]; author's calculation. The 2024 index is the revised value in [14]; the preliminary release gave 106.8%. Electricity per unit of real output = electricity supplied to industry divided by the real output index. A dash means the value was not used.

[2] Source: author's calculation in Python by equations (1)–(5); illustrative (hypothetical) example, all inputs assumed. Shares may not add up because of rounding.

© 2026 London International Monthly Conference on Multidisciplinary Research and Innovation. All Rights Reserved.

Component	Lever: baseline → lean	Baseline	Lean	Saving	Share of gap, %
Overhead	120.0 → 129.6 thousand units	80.0	74.1	5.9	20.0
Unit cost	sum of components	429.6	399.3	30.3	102.5
Allowable cost	price 500, margin 20%	400.0	400.0	-	-
Gap	current minus allowable cost	29.6	−0.7	-	-

Current unit cost is UZS 429.6 thousand, so the gap against allowable cost is UZS 29.6 thousand, or 6.9% of cost. The four levers together save UZS 30.3 thousand per unit, which covers 102.5% of the gap and lifts the margin from 14.1% to 20.1% of the target price. Material cost makes up 54.1% of baseline cost, and yield improvement alone closes 43.2% of the gap. Energy is only 7.7% of cost, yet a 12% cut still closes 13.4% of the gap. At the new volume the annual saving reaches about UZS 3.9 billion.

A one-point test shows where attention pays best: one point of yield (0.86 to 0.87) saves UZS 2.67 thousand per unit, against 0.83 for 1% more labour productivity, 0.79 for 1% more volume and 0.33 for 1% less energy. In material-heavy production the scrap bin is the first place to look. Closing the gap over three years needs a kaizen rate of 2.35% a year by equation (5): 429.6, 419.5, 409.6 and 400.0 thousand UZS.

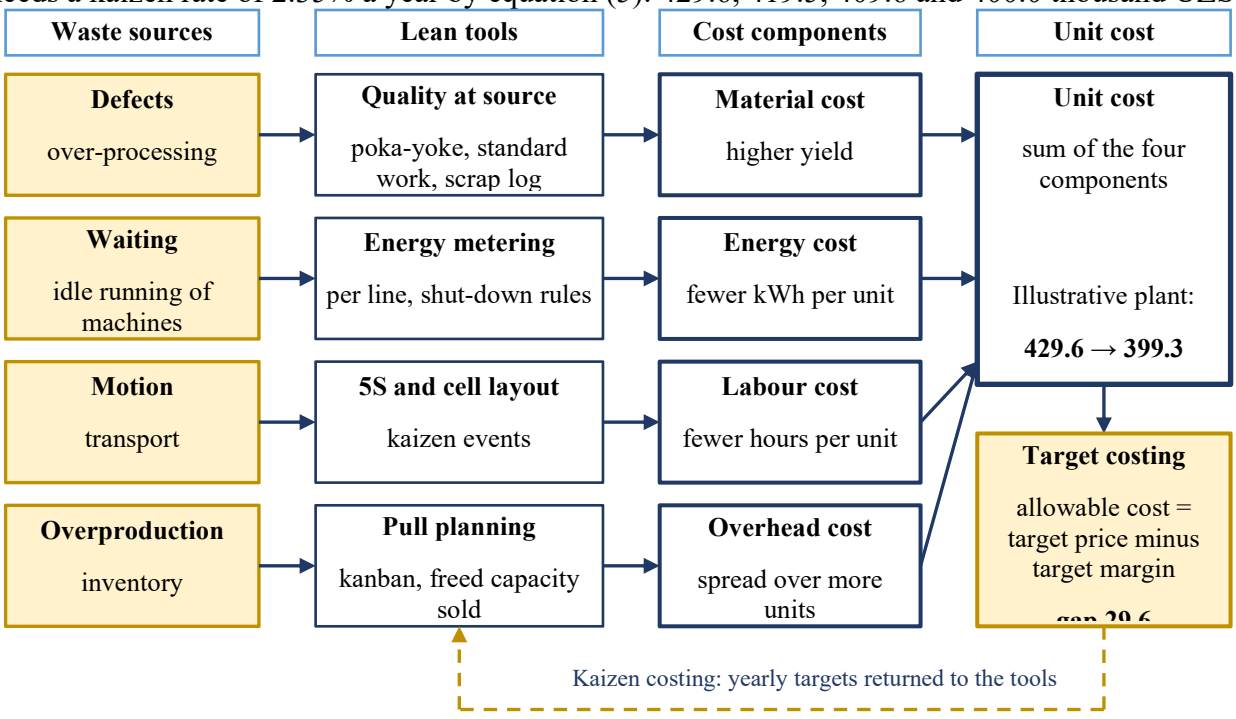


Figure 1. Lean-based mechanism of product cost reduction[3]

[3] Source: author's development based on [1]; [7]; [9]; figures from Table 2.

© 2026 London International Monthly Conference on Multidisciplinary Research and Innovation. All Rights Reserved.

Figure 1 summarises the mechanism. Each pair of related wastes is assigned to one lean tool and one cost line, so the plant can see which project moves which number. Target costing sets the size of the task, and kaizen costing breaks it into yearly portions fed back to the teams, which turns one-off projects into a repeatable mechanism.

CONCLUSION AND SUGGESTIONS

The thesis showed that lean thrift becomes an economic mechanism once each waste is tied to a physical cost driver and each driver to a line of unit cost. The decomposition in equations (1)-(3) makes savings additive and easy to audit, and the target-cost gap in equations (4)-(5) tells the plant how much saving it needs and how fast. Uzbekistan's industry has already shown that output can grow faster than electricity use, and the same logic inside each plant turns that trend into higher margins.

Four practical steps follow from the analysis. First, enterprises should keep a monthly cost sheet in physical drivers (yield, kWh per unit, hours per unit, units produced) next to the money figures. Second, yield should be the first target in material-intensive branches, since one point of yield is worth several points of the other levers. Third, energy metering at line level should be standard practice, in line with national energy-efficiency policy. Fourth, the target-cost gap should be split into annual kaizen targets and assigned to named teams. Testing the model on real cost data of enterprises in metalworking, building materials and textiles is the natural next step of this research.

REFERENCES

1. Womack, J. P., & Jones, D. T. (1997). Lean thinking: Banish waste and create wealth in your corporation. Journal of the Operational Research Society, 48(11), 1148. https://doi.org/10.1038/sj.jors.2600967
2. Statistics Agency under the President of the Republic of Uzbekistan. (2025). Socio-economic situation of the Republic of Uzbekistan (January-December 2024). https://stat.uz/img/talil-2024-jil-yanvar-dekabr-english-_p25689.pdf
3. National Statistics Committee of the Republic of Uzbekistan. (2026). Socio-economic situation of the Republic of Uzbekistan (January-December 2025). https://stat.uz/img/news/talil-2025-jil-yanvar-dekabr-angl-_p61855.pdf
4. Resolution of the President of the Republic of Uzbekistan No. PP-4422 of 22 August 2019 on accelerated measures to improve the energy efficiency of economic sectors and the social sphere, introduce energy-saving technologies and develop renewable energy sources. https://lex.uz/docs/4486125
5. Shah, R., & Ward, P. T. (2003). Lean manufacturing: Context, practice bundles, and performance. Journal of Operations Management, 21(2), 129-149. https://doi.org/10.1016/S0272-6963(02)00108-0
6. Bhamu, J., & Sangwan, K. S. (2014). Lean manufacturing: Literature review and research issues. International Journal of Operations & Production Management, 34(7), 876-940. https://doi.org/10.1108/IJOPM-08-2012-0315
7. Cooper, R., & Slagmulder, R. (1999). Develop profitable new products with target costing. Sloan Management Review, 40(4), 23-33. https://sloanreview.mit.edu/article/develop-profitable-new-products-with-target-costing/
8. Ansari, S., Bell, J., & Okano, H. (2006). Target costing: Uncharted research territory. In C. S. Chapman, A. G. Hopwood, & M. D. Shields (Eds.), Handbooks of Management Accounting Research (Vol. 2, pp. 507-530). Elsevier. https://doi.org/10.1016/S1751-3243(06)02002-5

© 2026 London International Monthly Conference on Multidisciplinary Research and Innovation. All Rights Reserved.

9. Modarress, B., Ansari, A., & Lockwood, D. L. (2005). Kaizen costing for lean manufacturing: A case study. International Journal of Production Research, 43(9), 1751-1760. https://doi.org/10.1080/00207540500034174
10. Kaplan, R. S., & Anderson, S. R. (2004). Time-driven activity-based costing. Harvard Business Review, 82(11), 131-138. https://hbr.org/2004/11/time-driven-activity-based-costing
11. King, A. A., & Lenox, M. J. (2001). Lean and green? An empirical examination of the relationship between lean production and environmental performance. Production and Operations Management, 10(3), 244-256. https://doi.org/10.1111/j.1937-5956.2001.tb00373.x
12. Allwood, J. M., Ashby, M. F., Gutowski, T. G., & Worrell, E. (2011). Material efficiency: A white paper. Resources, Conservation and Recycling, 55(3), 362-381. https://doi.org/10.1016/j.resconrec.2010.11.002
13. Worrell, E., Bernstein, L., Roy, J., Price, L., & Harnisch, J. (2009). Industrial energy efficiency and climate change mitigation. Energy Efficiency, 2(2), 109-123. https://doi.org/10.1007/s12053-008-9032-8
14. National Statistics Committee of the Republic of Uzbekistan. (2026). Growth rates of industry, quarterly (SIAT indicator 1871). https://api.siat.stat.uz/media/uploads/sdmx/sdmx_data_1871.pdf
15. National Statistics Committee of the Republic of Uzbekistan. (2026). Volume of electricity supply in the industrial sector (SIAT indicator 3169). https://api.siat.stat.uz/media/uploads/sdmx/sdmx_data_3169.pdf

© 2026 London International Monthly Conference on Multidisciplinary Research and Innovation. All Rights Reserved.