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UTILIZATION OF LEAN PURCHASING TOOLS IN THE SUPPLY CHAIN IMPROVEMENT PROCESS

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Purpose: The rationale for writing this article is pragmatic. With the numerous challenges facing manufacturing companies and their purchasing departments, "tools" are needed to help them meet these challenges. Although Lean Management tools are very widely described in the scientific literature, the number of such publications on Lean Purchasing tools is insignificant.
Design/methodology/approach: The paper poses two research questions: 1) What management instruments can be used within the Lean Purchasing concept? and 2) What management instruments, recommended by Lean Purchasing, are most often used in procurement purchasing activities? It was decided to conduct a survey of a purposively selected research group. This group consisted of senior executives managing procurement purchasing in manufacturing companies (directors of the purchasing department) and owners, or presidents, of manufacturing companies. Such a choice of respondents involved conducting the survey on a smaller non-random sample, but made it possible to obtain representative results, thanks to the broad knowledge and professional experience, as well as knowledge of the specifics of the operation of manufacturing enterprises, of the survey participants. The survey covered a total of 120 enterprises.
Findings: An analysis of the results of the frequency of use of Lean Purchasing tools, as determined by all respondents, distinguishes the following tools, which are used by the majority (>50%) of the surveyed manufacturing companies: process and/or purchasing standardization, teamwork, team partnerships, learning by doing, supplier development, brainstorming, 5x why? and within the key process performance indicators: on-time delivery, or on-time and full-quantity delivery, material price index, number of defective parts per million units.
Research limitations/implications: The use of Lean Purchasing tools is still little known among micro, small and medium-sized enterprises. These companies took part in the survey conducted, however, due to the fact that the main research group in the study is large enterprises (63.3%), it was considered an insufficient research sample to be able to refer to this as a representative example to fill this research gap. The results included in the paper, however, can serve as a reference example for researchers wishing to address this issue in the future.
Originality/value: The article is an original proposal, based on the results of a survey on the use of management instruments recommended by Lean Purchasing.
Keywords: Lean manufacturing, Purchasing Strategies, Lean Purchasing.
Category of the paper: Research paper.

1. Introduction

Manufacturing companies, in order to remain profitable and continue to grow, must find new ways to deliver products on time and at the required quality, and at the same time face the ever-increasing costs of their operations. The amount of disruptions that have occurred and the increase in costs over the past few years have been particularly acute in the supply chain area of manufacturing companies. This has resulted in a number of challenges faced by the company in this area, such as the availability and increased cost of purchasing materials or semi-finished products necessary for order fulfillment, or the organization and cost of transportation. In their search for new sources of improvement, these companies can take advantage of proven management practices that are often even already in place in particular areas of their business. One such practice is Lean Management. This concept, in the form of Lean Manufacturing, is primarily used in production management, but can also be used in other areas of a company's operations, including the management of procurement purchases. These purchases, are responsible not only for ensuring that materials or semi-finished products are delivered on time, at a certain quality and price, but also for managing a significant area of the manufacturing company's supply chain. The use of Lean Management concepts in supply purchasing management is referred to as Lean Purchasing. Like Lean Management and Lean Manufacturing, Lean Purchasing is a concept focused on processes that add value for the customer, reducing activities that are necessary but do not add value, as well as systematically eliminating waste by getting rid of non-value-added activities. In effect, the aforementioned activities are aimed at improving supply chain performance.

The rationale for the article is pragmatic. In view of the numerous challenges faced by manufacturing companies and their purchasing departments, "tools" are needed to help them meet these challenges. Although Lean Management tools are very widely described in the scientific literature, the number of such publications on Lean Purchasing tools is insignificant. This situation prompted the authors of the article to attempt to answer the following research questions:

1) What management instruments can be used within the Lean Purchasing concept?
2) What management instruments, recommended by Lean Purchasing, are most commonly used in procurement purchasing activities?

In view of the research questions posed, the main purpose of the article is to present in cognitive terms the use of Lean Purchasing tools in the process of supply chain improvement. Such a broad purpose of the article required the preparation of the following specific objectives:

Cognitive Objectives:

1) Identify management instruments that can be used within the Lean Purchasing concept,
2) Categorization of Lean Purchasing tools and determination of the characteristics that a management instrument should meet if it is to be classified as a Lean Purchasing tool,

3) Identify the management instruments recommended by Lean Purchasing that are most commonly used in procurement purchasing activities.

The structure of the article is subordinated to the logical argument of the research proceedings. The research methodology section indicates the research methods used, such as the survey method and the documentary analysis method. For each research method, the following research techniques are specified:

1) For the survey method: a questionnaire survey in a purposively selected research group,
2) For the documentation analysis method: historical documentation analysis.

In doing so, it is also important to emphasize the function and value of the literature review and analysis, which allowed not only to identify research gaps, but also to find answers to cognitive research questions. A review of the literature relating to the theoretical basis of the lean purchasing concept was conducted. The purpose of the research sample was also indicated. The results of the survey were then presented. The conclusions focused on implications for further research in the area of using lean purchasing tools in the supply chain improvement process.

2. Literature review

2.1. The essence of Lean Purchasing

A lean manufacturing enterprise consists not only of lean production, but also of a lean supply chain. Collaboration between companies, within such a chain, is geared toward achieving three-factor goals: providing the best possible level of customer service, while delivering the highest level of quality, and creating new value at the minimum total cost of the product or service (Lamming, 1993). In the context of procurement management, the key features of such cooperation can be presented on the basis of Toyota and its cascading supplier management system:

1) A car manufacturer like Toyota is responsible for assembling parts supplied by first-tier suppliers.
2) First-tier suppliers (the first group of suppliers) are primarily responsible for the supply of whole components (partially assembled) or subassemblies, rather than component parts or materials for the production of components. These are trusted suppliers with a track record of cooperation confirmed by relevant results and length of cooperation. They have the largest order book and are characterized by advanced specialization.
3) Second-tier suppliers (the second group of suppliers) mainly supply first-tier suppliers. These are independent, specialized manufacturers whose implementation has been approved by Toyota.

4) Third-tier suppliers (the third group of suppliers), who cooperate, depending on the needs and complexity of the components, with suppliers of subsequent tiers. They are responsible, primarily, for supplying second-tier suppliers. They constitute the broadest group of suppliers.

This structure is pictorially shown in Figure 1. The number of suppliers in each group is approximate, hence it should be considered as an order of magnitude to show the illustrative structure of Toyota's supply network. A mid-range passenger car may consist of about 40,000 parts and components, hence it is worth noting the small number of first-tier suppliers Toyota directly works with. This structure of suppliers allows for a diversification of resources and competencies possessed by individual suppliers, allowing them, as they continue to work together, improve their processes and complete projects, to move into the group of higher-tier suppliers. Aspiring suppliers to join the first-tier supplier group, however, must prove that they have the right competencies, qualifications, knowledge, experience, while remaining competitive.

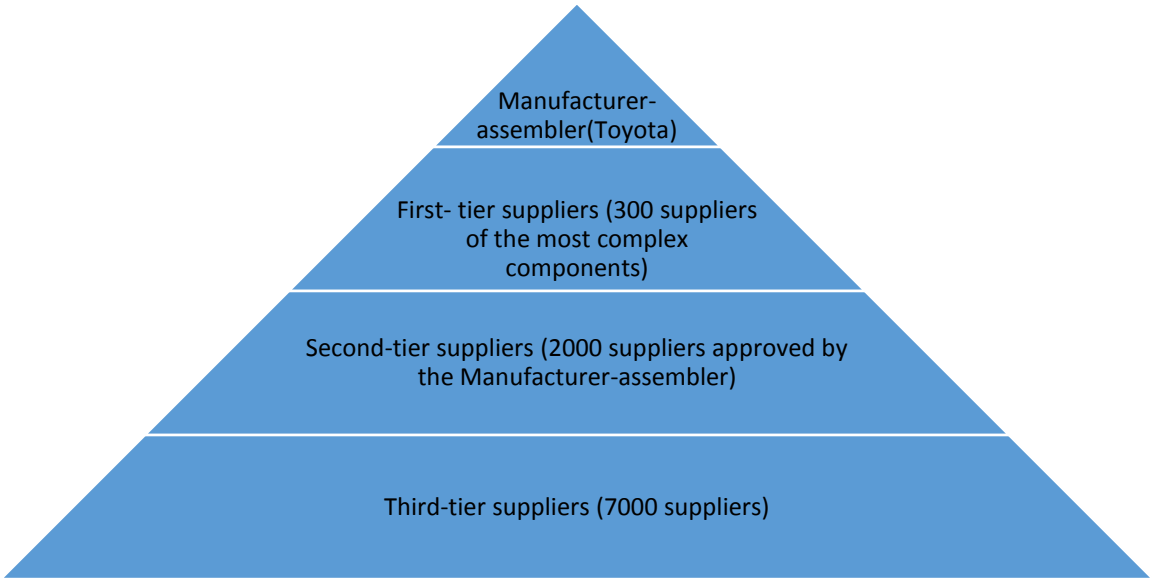

Figure 1. Toyota's hierarchical structure of suppliers.

Source: own compilation based on: (Liker, 2016; Lysons, 2004).

The essence of Toyota's supply chain is not only the flow of goods, services and information, but also the codification and sharing of knowledge among suppliers, and not only between suppliers and Toyota. This kind of knowledge sharing complements the collaborative partnership approach that is used at Toyota (not only towards employees, but also towards suppliers) (Witkowski, Baraniecka, 2018). Toyota understood that the essence of achieving a competitive advantage, is not only to implement the Toyota Production System in this company, but also to transfer these principles to its suppliers. Over many years of cooperation, Toyota has developed the following principles for effective partnerships with suppliers:

1) Collaborative process improvement, through sharing best practices with suppliers, supply chain integration, supplier associations, implementing a continuous improvement culture in supplier organizations, Kaizen employee referral programs, and more.
2) Communicate selectively to the supplier, through a precise and clearly defined information transfer procedure, regular meetings with suppliers or the use of databases and systems to facilitate and standardizing the exchange of data and information.
3) Technical-technological development of suppliers, by involving suppliers in challenging projects, fostering innovation and creativity, or supporting Toyota in solving problems.
4) Oversee the work of suppliers by involving senior managers in problem solving, meeting periodically with the supplier, providing feedback to suppliers, and reporting results periodically.
5) Maintain competitiveness and healthy rivalry between suppliers, through purchases of less complex components from different suppliers, compatibility of production between suppliers, and the establishment of joint ventures or Keiretsu with suppliers to ensure control and appropriate conditions for knowledge transfer.
6) Building business relationships and getting to know suppliers thoroughly by means of maintaining close, regular cooperation, periodic meetings, mutual respect or taking care of the continuous development of the company and suppliers.

Thanks to the principles adopted, it was then possible to develop such mechanisms as: joint pricing, use of learning curves to reduce prices or prevent price increases, joint design of new products, building inter-organizational teams of skilled workers, supplying parts free of defects (the no-defect principle) and, most importantly, delivery just in time (*Just in Time*) (Lysons, 2004). It should be noted once again that the presented approach to lean supply chain management, using Toyota as an example, refers strictly to the cooperation between a manufacturing company and its suppliers in procurement purchases.

The Toyota Production System was the first more widely described example of the application of the lean management concept. Initially, the application of this concept was presented mainly in the context of Lean Manufacturing, but later the proven solutions began to be copied to other areas of business. One of them is procurement purchasing, thus - Lean Purchasing.

The idea behind *Lean Purchasing* is to design purchasing processes that minimize waste while detecting it early and optimizing each process within the purchasing scope of work as best as possible. Like Lean Management and Lean Manufacturing, it is a concept focused on processes that add value to the customer, reducing activities that are necessary but do not add value, and systematically eliminating waste by getting rid of non-value-added activities. The definition of ęe can be summarized by saying: "buy less, by buying better". The basic tenets of lean purchasing are delivery exactly on time, in the quantity needed (*Just in Time*) and free

of defects that disqualify its use (*Zero Defects*). Just in Time combined with Zero Defects affect both the quality and quantity of products purchased. In addition, a very important point consistent with the main purpose of purchasing activities is the elimination of waste in the cost aspect, primarily, by reducing the costs incurred. With regard to procurement purchasing, Just in Time (JiT) aims to provide the required materials and/or products at exactly the time they are actually needed and in the exact quantity required, so that added value is generated relative to the manufactured product, thus avoiding the generation of indirect costs.

Examples of JiT solutions include:

- Selection of preferred local suppliers.
- Focusing on total cost of ownership - the price of products is based on an open cost model.
- Long-term contracts that provide flexible delivery terms.
- The timing and specifics of delivery are predetermined. If necessary, order volumes are variable, and the size of the margins depends on the quantity of the delivered details.
- Control of samples at the stage of implementation, in the further stage of cooperation - abandonment of input control of delivered products.
- Invoices are sent and then billed on a monthly basis.

The higher frequency of deliveries and/or the smaller number of parts in deliveries creates the need to detect nonconformities as soon as possible (at the earliest possible stage of production). This need is the reason for conducting a Zero Defects Policy, i.e. shipping parts free of defects that make them unusable. As part of TPS and Lean Management, each employee is responsible for detecting and eliminating errors (which is also part of continuous improvement). This also applies to errors affecting the quality of manufactured parts or delivered services. If a Toyota production employee (or a Toyota supplier) notices that a part he received from a previous stage of production does not meet the requirements of the technical specification (e.g. in terms of assembly or surface quality), he will automatically notify the employee working in the previous production nest, so that the production of the erroneous parts can be quickly stopped and the problem can be solved. This approach contrasts with that adopted by many Western companies, where defective parts are set aside and the problem is handed over to the quality department, which must conduct an "investigation" and locate where the error originated (van Weele, Rozemeijer, 2022).

Both TPS and Lean Management, along with Lean Purchasing, place great emphasis on continuous employee development and training. Under these concepts, Teamwork, Employee partnerships, Learning by Doing, Job Enrichment, Mentoring, Yokoten, and Training are key elements for achieving expected performance. Therefore, in organizations that apply these management concepts, employee development values are usually firmly embedded in their corporate culture. The second element of the process is training and development of partners, which in Lean Purchasing are suppliers (supplier development). This takes place both between

the supplier and the customer, as well as between suppliers within the framework of so-called supplier associations (supplier associations). Supplier associations are usually made up of the company's most important suppliers, who cooperate with each other - to varying degrees, depending on the needs. The purpose of associations is to share and exchange best practices among suppliers (Hines, 1996). Another special type of cooperation is supplier integration, which goes beyond the traditional customer-supplier relationship and seeks mutual involvement, cooperation and information exchange. Supplier integration aims to build sustainable and strategic relationships with suppliers that benefit both parties. Supplier integration is based on a common business strategy and joint development of the customer and supplier, and is particularly applicable within Japanese supply chains.

The implementation of Lean Purchasing can be grouped into three main steps. The first step, and the most important element in the successful implementation of Lean Purchasing, concerns an organization's culture based on the pillars of the Toyota Way: continuous improvement, man at the center of the process, man as the best source of innovation, and respect for people. An organization that implements an organizational culture based on the Toyota Way will have a solid foundation to not only further implement Lean tools, but also to develop, engage and motivate suppliers to initiate the same actions on their side (and then also towards their sub-suppliers. The next step is to map purchasing processes and standardize them. It is important that the processes (and the procedures, instructions, and training created based on them) be as simple and transparent as possible - possible to implement sustainably and effectively. Only in the third stage of implementation does the organization focus on implementing the appropriate Lean Purchasing tools. Their selection should be the result of the previous steps and related work (Witkowski, Baraniecka, 2018; Hines, 1996).

By implementing Lean Management in the operation of procurement purchasing, companies can reap a number of benefits from doing so. These can be divided into three groups of benefits: in the area of management, use of technology and financial benefits. Benefits in the management area include:

- Standardization of purchasing processes, which makes communication and supply chain activities easier and faster.
- Elimination of unnecessary activities, within the framework of supplier-customer cooperation and directly at suppliers.
- Improve quality levels, reduce lead times and reduce inventory levels.
- A smaller supplier base that is easier to manage and involves fewer resources on the organization's side.
- There is less risk of losing a supplier (and, for the supplier, losing an important customer), thanks to more connections, and dependencies, between suppliers and the manufacturer.
- Less time required to acquire, change suppliers.

- Work more effectively with suppliers through joint planning, information sharing and resource sharing based on mutual trust, transparency and long-term cooperation.
- Supplier loyalty, which in addition to the high value of generated turnover, can translate into greater attentiveness of suppliers to the continuous improvement of supply chain operations, development of new products, ongoing cooperation, as well as prioritization of tasks especially in the event of crises or potential disruptions, which promotes the implementation of the company's strategy and building resilient and efficient supply chains.

Technological benefits, on the other hand, include:

- Greater willingness, openness of partners to share knowledge, experience and use of modern technology to achieve competitive advantage.
- Greater involvement of partners in the design of new products (under Early Supplier Involvement), from the conceptual phase, product design, to its commercialization and implementation in the market.
- Involving suppliers who are specialists in their field avoids many design errors or quality problems, and enables a new product to be launched more quickly.

On the other hand, financial benefits include:

- Cost optimization, by eliminating waste, reducing unnecessary processes and better inventory management, a company can significantly reduce purchasing costs.
- Sharing business risks, through various forms of cooperation with partners. In financial terms, this can translate into reducing risks associated with new investments, developing new technologies, conducting research, or adapting to changing trends and market conditions.
- Ability to better control price levels through close cooperation, transparency, and joint influence on emerging market changes (Benton, 2020; Taghipour, Phuong, Xue, 2020). In addition to the benefits that flow, as well as the opportunities that arise through it, the implementation of the Lean Purchasing concept, brings with it some challenges that companies must face. Among the most important of these are:
- The need to change the organizational culture of companies in accordance with the Toyota Way - the implementation of Lean Purchasing requires a change in the organizational culture of the company as well as its suppliers.
- Top management support for change - implementing change takes time (for example: it took Toyota about 15 years to fully implement the Kanban system) and commitment of resources. With this in mind, top management should initiate and support change within the organization, as well as change at suppliers.
- Lack of knowledge and experience - as indicated above, the implementation of Lean Purchasing is a long process of continuous learning (also by making mistakes) and continuous improvement. It requires building awareness and a sense of responsibility

among employees or standardizing the solutions developed. In the absence of knowledge and experience in implementing Lean concepts, an organization may need more time and/or more resources necessary to develop best practices.

- Supply chain complexity - implementing Lean Purchasing can be difficult in the case of a complex supply chain in which many companies are involved in providing products or services.
- Lack of cooperation from the supplier's side - implementing Lean Purchasing requires cooperation, willingness and commitment from the supplier's side, which can be difficult if the supplier is not prepared to make changes.
- Dependence on suppliers can also be a risk - deeper cooperation can bring a number of benefits to both partners. On the other hand, too much dependence on the other party involves certain risks, such as the phenomenon of domination or supplier bankruptcy.
- Costs of change, implementation costs - the implementation of changes may involve implementation costs, such as training of employees, suppliers or implementation of management systems, or the involvement of consulting companies to support the implementation.
- Reducing costs in one part of the supply chain may stimulate their occurrence in another part of the chain, for example - reducing minimum order sizes may help reduce the size of a company's inventory, but at the same time may result in the need for more frequent deliveries, thus increasing transportation costs. In the same way, too much reduction in inventory levels throughout the supply chain can cause downtime or delays, resulting in the company facing financial penalties for delays or even lost orders, in addition to downtime costs.

Despite the challenges faced by companies in implementing Lean Purchasing, the benefits of implementing the concept significantly outweigh the potential risks. It is important, however, that companies, being aware of their occurrence, take proactive measures to minimize their appearance (as well as the resulting consequences) and have an action plan in place should they occur.

2.2. Lean Purchasing in the face of contemporary trends in the development of procurement purchasing

The development of Industry 5.0 is forcing changes within both supply chain management and procurement purchasing management. These changes, will at the same time cause Lean Purchasing, along with Lean Management, to also have to evolve. The form and possible areas of use of Lean Purchasing tools will certainly change. The range of available tools that can be used within the concept will also increase. Some of them may also cease to be widely used. In the authors' opinion, what will change are the underpinnings of this Lean concept, framed by the Toyota Way, such as continuous improvement, man at the center of the process or respect - for people and the environment. On the one hand, they are universal, simple, logical and

confirmed by many years of practice, validity and success of organizations that have adopted the Japanese culture of conduct. On the other hand, these principles are in line with industry development trends, which the author would describe as its level of maturity to provide products and services in a responsible and sustainable manner. Of course, this is a long-term process that, despite much faster technological advances, will take years, but from an ethical point of view, this is the right direction for development, and the Toyota Way can help in its consistent implementation.

What, in turn, will have to change, within the Lean concept, is the "focus" of the concept and the way it has been perceived, which up to now has been primarily placed on maximizing results using the minimum number of resources[1] . Initially this was due to the post-war socio-economic conditions in which Japan found itself, then the described "anatomy" of Toyota's success was widely disseminated both in the world of science and business, which adapted it in a similar form to the original. If, on the other hand, as a result of the increasingly frequent disruptions to supply chains and the changes that are to take place as part of the progress of civilization, greater emphasis is to be placed on the flexibility and resilience of supply chains, then the aforementioned "focus" of the concept will have to shift toward achieving both goals. This may mean, a change in the interpretation of certain phenomena, within Lean Management. For example, maintaining an adequate level of inventory of materials or semi-finished goods, ensuring the required resilience, may no longer be treated as a waste, but as a necessity within "Lean Purchasing 5.0". With such adaptation, Lean Management and Lean Purchasing, particularly for the preferred conditions of their application, will be able to continue to be successfully used in business practice. Specifically, since some of the attributes of Supply Chain Management in Industry 5.0, such as transparency, standardization, strong network connections, fast delivery or quick response, innovation or even compliance with ESG assumptions, overlap with the attributes of Lean Purchasing, hence the concept will be able to have further practical application within Industry 5.0. The assumptions of the concept, as well as the tools used within it, can actively support ESG (Environmental, Social and Governance) assumptions, through: using sustainable materials, minimizing the use of materials, using recycled raw materials, selecting suppliers that provide decent working conditions for their employees, including following the model of Japanese supply chains - local suppliers, and much more. Despite the evolution of the industry, companies will have to continue to constantly compete with each other, hence the emphasis on eliminating waste and focusing on adding value for the customer will continue to be an important source of ensuring competitive advantage. Another guiding element of the next industrial revolution is the digitization, autonomization and automation of processes. As part of technological advances, a number of modern instruments can be applied to lean purchasing management. Among the most important of these are:

[1] Such a definition of Lean is consistent with the definition of optimization, but such a comparison is a gross oversimplification, since Lean Management, Lean Purchasing are primarily based on the process of continuous improvement, which is a broader concept than optimization.

1) Internet technologies and connected solutions:
   - Internet of Things (IoT). IoT solutions can include, among others, Vending Machines, Real-time tracking systems (Real-time device location system) and Chatbots.
2) Technologies and analytical tools:
   - Big Data (processing of digital datasets of very large size),
   - Artificial Intelligence (AI), including: Machine Learning (Machine Learning), Big Data Analytics (Big Data Analytics) and Chatbots,
   - Cloud computing (cloud computing, cloud computing), for example: cloud software (Dropbox, Office 365), cloud storage (Google Drive, iCloud), cloud analytics and business solutions (Power BI).
3) Purchasing Systems:
   - Supplier Relationship Management (SRM), E-Sourcing, E-Purchasing, E-Procurment, supported by Electronic Data Interchange (EDI).
4) Technologies related to identification and integration of processes and equipment:
   - Radio-Frequency Identification (RFID - remote identification of objects using radio waves),
   - Cyber-Physical Systems (CPS - the integration of physical devices, their software with a digital network).
5) Technologies related to automation and robotization of equipment and processes:
   - Autonomous Vehicles,
   - Robotic Process Automation (RPA).
6) Technologies related to security and information management:
   - Blockchain and Smart Contracts.
7) Technologies related to the creation of virtual reality:
   - Digital Twin (Digital Twin),
   - Virtual Reality (VR),
   - Augmented Reality (AR).
8) Enterprise resource planning (ERP) business systems (Jaouhari, Arif, Kumar, Jain, Agrawal, 2023).

Technological instruments may have the greatest impact in the future on the further development of procurement purchasing management, and at the same time - Lean Management and Lean Purchasing due to the fact that in modern industry, competitive advantages will be built by modern technologies. As part of the continuous improvement of the aforementioned instruments, both from the point of view of the user and their author (manufacturer), the already well-known Lean tools such as Standardization or Value Stream Mapping can be used.

3. Methodology

3.1. Lean Purchasing tools in theoretical terms

Lean Purchasing tools can be presented as management instruments supporting the implementation of the Lean Purchasing concept within the framework of procurement purchasing management and supply chain operations. The variety of Lean Purchasing tools means that, like Lean Management tools, they should be classified as management instruments used within the Lean Purchasing concept. The overriding goal of using Lean Purchasing tools should be to maximize the added value for the customer created by purchasing processes by eliminating or maximally reducing anything that does not bring this value. Given the unchanging priorities of purchasing operations, it is understood that there is a strong synergy between Lean Management (and Lean tools) and procurement purchasing management. This fact means that a significant number of Lean Management tools can be categorized as Lean Purchasing tools. In order to systematize them, the authors propose the following division, according to the area of their implementation:

1) Lean Purchasing tools used within the operation of the company's purchasing department (***internal tools***).
2) Lean Purchasing tools used within supply chain flows (***indirect tools***).
3) Lean Purchasing tools used in the implementation of Lean Management directly at the supplier (***external tools***).

Internal tools will be concerned with improving the operation of purchasing processes within the company, i.e., for example: Standardization, 5S, Kaizen Employee Referral System, Value Stream Mapping. Indirect tools, on the other hand, are concerned with activities at the "points of contact" between suppliers and the company, i.e. the links between them within the supply chain operation. These can include such tools as Kanban, Just in Time, Just in Sequence, Milk Run and others. On the other hand, external tools, implemented directly within the operation of the supplier's enterprise, qualify the same tools that are used within the internal tools of Lean Purchasing. In addition, also any other Lean Management tools that will be implemented in cooperation between the customer and the supplier, such as knowledge and/or technology transfer, also in the area of the supplier's production process, so One Piece Flow, Jidoka, Andon, SMED or TPM. As with Lean Management tools, the proposed division is not the only one by which Lean Purchasing tools can be categorized. Another division proposed by the authors differentiates Lean Purchasing tools due to the following five criteria**:**

1) Continuous improvement.
2) The man at the center of the process.
3) Cooperation with suppliers.
4) Problem solving and data analysis.
5) Process monitoring.

This proposal for the division of Lean Purchasing tools follows from the main principles of the Toyota Way and the criteria for their division in the context of their use in procurement management. This division was considered superior to further research work, due to the fact that it does not cause a dilemma to which group, the division criterion, a given tool should be assigned (for example: external tools can be the same instruments that the supplier's customer has implemented, in the form of internal tools). Based on a review of the literature, the authors identified thirty-eight key Lean Purchasing tools, which were categorized according to the above five criteria:

- *Continuous improvement of people and* processes, within which the most important tools are: Value Stream Mapping (VSM), **Waste Analysis** (Waste Analysis), **Standardization** (Standardization of processes and/or purchases), **5S** (Selection, Systematics, Cleaning, Standardization, Self-Discipline), Visual Management, **Kaizen employee suggestion system**, Kaizen **process**, **Kaizen flow**, **Kaikaku** (Breakthrough Kaizen - implementation of innovations), **Hansei (**reflection) - Lessons Learnt, **PDCA** (Deming Cycle).
- *Man at the center of the process,* so tools relating to cooperation between employees of enterprises and their development: Teamwork, **Employee** partnerships, Learning by **Doing, Job Enrichment**, **Mentoring, Yokoten, and** Sharing best practices.
- *Supplier collaboration,* which includes: **Supplier development** (Rozwój dostawcy), **Supplier integration** (Integracja dostawców), **Supplier association** (Stowarzyszenia dostawców), **Heijunka** (Balansowanie pracy w ramach zamówień do dostawców, planowania produkcji i in.), **Kanban**, **Vendor Managed Inventory** (VMI), **Consignment Stock** (Zapas Konsygnacyjny), **Just in Time** (Dokładnie na czas), **Just in Sequence** (Dokładnie w kolejności), **Milk Run** (Dostawy w ramach „kursu mleczarza").
- *Problem solving* and data analysis, which include: **Genchi Genbutsu** (Go and See), **Ishikawa Diagram** (Fishbone Diagram), **5 Why?** (5x Why?), Brain Storming, **Poka Yoke** (Mistake proofing, Error proofing), **Pareto principle** (Pareto principle - 80/20), **ABC** analysis, Failure **mode** and effect analysis (FMEA analysis), **A3** Report, Total Cost **of** Ownership analysis (TCO analysis).
- *Monitor processes* using Key Performance **Indicators** (KPIs), in terms of monitoring costs, investments, deliveries, quality and ongoing procurement projects.

It should be noted that these are not all the tools (management instruments) that can be categorized as Lean Purchasing tools. This collection is a recommendation against the instruments that can be used within the Lean Purchasing concept. Due to the dynamic progress in the exchange of best practices, the widespread access to knowledge, whether through academic literature, as well as conferences, industry forums, training courses or based on visits to other companies or in the development of one's own enterprise, there may be more and more proposals to qualify the proposed management instruments as Lean Purchasing tools.

This can cause dilemmas as to whether the instrument can actually be qualified as a Lean Purchasing tool. Therefore, the authors have prepared a summary of the key eight characteristics that a management instrument should meet if it is to qualify as a Lean Purchasing tool:

- It focuses on added value for the customer.
- It enables the elimination of waste by removing non-value-added activities and reducing business value added.
- It is part of a continuous improvement process.
- It is intuitive and relatively easy to implement and use.
- It is integrable and scalable within the supply chain.
- It meets all necessary safety standards and social and environmental standards and environmental standards.
- It was implemented as part of the culture and values of the Toyota Way.
- The implementation area must include procurement purchases (Purchasing).

The above summary of characteristics can be helpful not only in categorizing Lean Purchasing tools, but also in "slimming down" already implemented, functioning tools in the organization. It is worth noting that this "slimming down" should be understood as a greater focus on customer value, by eliminating non-value-added activities and reducing business value added. This is a very important aspect of Lean Purchasing, so as to avoid a situation where "slimming down" one process, creates 3M (Muda, Mura, Muri) in another area of the supply chain. Equally important is the implementation of tools in "lean organizations" that function in accordance with the culture and values of the Toyota Way (hence, first the organization should implement the culture, values and principles on which the concept of Lean Management and Lean Purchasing are based, and only then focus on Lean Purchasing tools). An integral part of Lean Purchasing is the process of improvement and continuous improvement. This improvement should be interpreted as a unit improvement, an improvement of a solution (e.g., by solving a problem), which can be part of a continuous improvement process. At the same time, since the decisions made by the purchasing department of an enterprise, will have a direct impact on the functioning of the supply chain (which is due to the broader scope of their functions than the term "procurement purchasing" itself may suggest), the use of the Lean Purchasing tool in the process of improving the supply chain (and not just procurement purchasing) has been referred to.

The application of Lean Purchasing tools can bring a number of benefits to companies, which include: reducing/reducing purchasing costs while improving product and service quality, streamlining the procurement process and flow, reducing delivery times and elimination of waste, increased efficiency and responsiveness of suppliers, strengthening the strategic and partnership approach in the development of procurement purchasing and above all - greater focus on value-added activities for the customer and the company.

3.2. Survey methodology

It was decided to conduct a survey of a purposively selected research group. This group consisted of senior executives managing procurement purchasing in manufacturing companies (directors of the purchasing department) and owners, or presidents of manufacturing companies. This made it possible to target respondents who should have knowledge of Lean Purchasing and Lean Purchasing tools. Such a selection of respondents involved conducting the survey on a smaller non-random sample, but made it possible to obtain representative results, thanks to the broad knowledge and professional experience, as well as knowledge of the specific operation of manufacturing enterprises, of the survey participants. The survey covered a total of 120 enterprises. The larger survey sample exceeded the research capacity due to the fact that only senior executives were selected for the survey. Respondents represented a global supply chain company that manufactures medical equipment, their direct suppliers and second-tier suppliers (vendor suppliers), and equally micro, small, medium, or large enterprises. The inclusion of companies of varying sizes in the survey made it possible to capture different perspectives on their use of Lean Purchasing tools. The companies in the study were located in Europe, North America, or East Asia and had diverse manufacturing operations in the industrial sector. Due to the wide diversity of the companies' business profiles, the results cannot refer to any other type of business than manufacturing activities in the industrial sector. The survey was conducted in April 2023. The survey questionnaire was prepared in electronic form. It was sent out to the enterprises comprising the survey sample via Internet mail. The distribution of the questionnaire was preceded by a direct email or telephone contact to present the purpose and scope of the survey, how it was conducted and the relevance of the research area. At the same time, technical instruction was also provided. Respondents were assured of anonymity. The survey used the CAWI (Computer-Assisted Web Interview) method, in which the participant is asked to complete the survey electronically. The survey used Lean Purchasing tools, categorized according to 5 criteria based on the key tenets of the Toyota Way. The survey focused on the quantitative aspect of the use of Lean Purchasing tools in business practice (which tools and how often they are used by respondents), so it captures, first of all, the percentage of respondents using the tools (N) and the frequency distribution ($\%^K$). The survey did not take into account the qualitative aspect of the use of these tools (for example, assessing the effectiveness of the use of Lean Purchasing tools), so it does not exhaust the issue of the use of Lean Purchasing tools in business practice and is a prerequisite for further analysis of this research area.

4. Survey results - analysis of respondents' answers

The survey verified the practical use of individual Lean Purchasing tools, according to their systematization, according to the following criteria: continuous improvement, people at the center of the process, cooperation with suppliers, problem solving and data analysis, and process monitoring. In addition, the survey took into account such factors as the size of the company, the location of the production facility and the declared desire to implement the tools in the near future. Managing an enterprise according to the Lean Management concept was a common practice in the sample, with the vast majority of respondents identifying with it. Only one in four respondents declared that their enterprise was not a "lean organization". 10% of the survey sample were respondents who could not clearly indicate whether their enterprise was managed in accordance with the Lean Management concept.

Respondents were asked about the use of Lean Purchasing concepts in purchasing management - two-thirds of them used Lean Purchasing in their company for this purpose. A quarter of respondents did not use Lean Purchasing in purchasing management. There was also a small group in the survey that was unable to clearly state whether they were using Lean Purchasing in their procurement management.

In the next stage, respondents answered questions about the use of selected Lean Purchasing tools in the enterprise they represented, systematized into 5 categories. For this purpose, multiple-choice questions were used, which allowed respondents to select more than one answer - in this case, respondents could select all the tools they used from a given category, or not select any of them, in case their enterprise did not use any of the listed tools. First, it was decided to look at Lean Purchasing tools from the *continuous improvement* category. A fairly wide range of tools related to continuous improvement are used in enterprises, but the popularity of each of them varies quite a bit. Based on the results, it can be concluded that certain continuous improvement tools are used more often than others. From the indications of respondents, it appears that standardization of processes and/or purchasing is most often used in companies. Of relatively high popularity can be said for 5S and the Deming Cycle, which are used in a third of enterprises. At the same time, it is also possible to distinguish such tools, which are used by enterprises far less frequently: visual management, reflection (hansei) and kaizen flow.

Table 1.
Use of Lean Purchasing tools from the continuous improvement category

	N	%K
value stream mapping	36	8,7%
waste analysis	38	9,2%
Standardization of processes and/or purchasing	83	20,1%
5S	55	13,3%
visual management	32	7,8%
kaizen employee suggestion system	44	10,7%
process kaizen	33	8,0%
kaizen flow	15	3,6%
hansei (reflection)	27	6,6%
Deming cycle	49	11,9%

Source: own elaboration.

A slightly different perspective on the use of Lean Purchasing tools is presented by the set of *human-centered* tools. A narrower repertoire of instruments can be observed in this group of tools than in the continuous improvement category, but the popularity of their use is much more comparable to each other, as captured by the summary in Table 2.

Table 2.
Use of Lean Purchasing tools from the human-centered process category

	N	%K
teamwork	94	23,6%
partnerships in teams	81	20,3%
learning by doing	83	20,8%
Employee development through challenging tasks	40	10,0%
mentoring	55	13,8%
yokoten (sharing of good practices)	46	11,5%

Source: own elaboration.

Based on the above information, it can be concluded that teamwork is widely used in the surveyed companies. No less important are team partnerships and learning by doing. It can be noted that the least surveyed companies rely on sharing best practices (yokoten) and developing employees by assigning challenging tasks.

The next Lean Purchasing category analyzed is *supplier-based* tools. It can be seen that a fairly diverse range of supplier-oriented instruments are used in the surveyed companies. Their summary is presented in Table 3.

Table 3.
Use of Lean Purchasing tools from the supplier collaboration category

	N	%K
supplier development	79	22,0%
supplier integration	39	10,9%
supplier associations	21	5,8%
consignment stock	42	11,7%
heijunka (balancing work)	18	5,0%
kanban	47	13,1%
supplier-managed inventory	44	12,3%
just in time	40	11,1%
exactly in the (expected) order	12	3,3%
deliveries under the "milkman's course"	17	4,7%

Source: own elaboration.

For this category of tools, their popularity varies quite a bit - some tools are used more readily than others. A relatively large number of companies used kanban, supplier-managed inventory and consignment stock. The surveyed companies relatively rarely decided to implement just-in-time delivery, a surprising result relative to expectations. The fewest respondents marked deliveries exactly on (expected) time and deliveries as part of the "milkman's course".

The survey also included a group of tools oriented toward *conducting analysis and solving problems*, which can not only lead to an in-depth analysis of the root cause of problems, but also allow this problem to be solved. Included in this group of tools was a wide "array" of instruments, listed in Table 4, the popularity of which varies widely among the surveyed companies.

Table 4.
Use of Lean Purchasing tools from the problem solving category and conducting analysis

	N	**%K**
genchi genbutsu (go and see)	24	5,6%
fishbone diagram	38	8,8%
5x why?	67	15,6%
brainstorming	82	19,1%
poka yoke (error prevention)	33	7,7%
Pareto principle (80/20)	56	13,0%
ABC analysis	47	10,9%
Analysis of the causes and consequences of failure - FMEA analysis	34	7,9%
A3 report	7	1,6%
Total Cost of Ownership analysis	42	9,8%

Source: own elaboration.

Based on respondents' indications, it can be concluded that companies are most likely to use brainstorming. The second most commonly used tool is 5x why? which involves asking the question "why?" five times to provide a clear answer that solves the right problem. Also in common use is the Pareto principle (80/20), which states that 20% of causes cause 80% of effects. Relatively few companies use error prevention (poka yoke). Few managers also declare that, if necessary, they personally verify the necessary information (genchi genbutsu). Somewhat contrary to its simplicity and effectiveness, the A3 report is also not very popular in the surveyed organizations.

Lean Purchasing's "toolbox" (i.e., the surveyed toolbox) also had to include tools for monitoring processes using Key Performance Indicators, which are presented in Table 5. Within this category, differentiated indicators were identified that focus on key aspects of procurement purchasing activities, which include monitoring: costs, investments, deliveries, quality and ongoing procurement projects.

Table 5.
Use of Lean Purchasing tools from the process monitoring category

	N	%K
return on investment	51	6,6%
material price index	69	9,0%
supplier price index	23	3,0%
life cycle cost	21	2,7%
coverage by supplier contracts	29	3,8%
deliveries on time and in full quantity	60	7,8%
on-time delivery	82	10,7%
average order processing time	40	5,2%
inventory turnover ratio	54	7,0%
stock size indicator	18	2,3%
open orders value index	24	3,1%
quality indicator of supplies / suppliers	42	5,5%
Number of defective parts per million units	63	8,2%
getting it right the first time	38	4,9%
cost of low quality	18	2,3%
8D report	55	7,2%
scrapping rate	36	4,7%
project implementation time	24	3,1%
Scheduled project hours vs. time spent on project implementation	8	1,0%
deviation of the project budget	14	1,8%

Source: own elaboration.

The popularity of the use of indicators in the surveyed companies is characterized by clear variation. The largest number of companies focus on monitoring just-in-time deliveries (while at the same time exactly one in two companies, instead of just-in-time deliveries, monitor just-in-time deliveries and in full quantity). For two out of three companies surveyed, the key performance indicator for the supply chain is also the material price index. Slightly more than half of the companies in the survey are aware of the value of monitoring the number of defective parts created per million units produced. A large percentage of respondents also marked the performance of 8D reports. Interestingly, both quality indicators were selected more often in the survey than the supplier/supplier quality indicator. At the same time, some tools are used far less often. For example, only one in ten companies monitors the deviation of the project's financial budget, which can signal budget overruns, but also the possibility of allocating free financial resources. Only single companies verify the difference between the planned number of hours allocated to a project and the time actually spent on it.

5. Conclusions

An analysis of the results of the frequency of use of Lean Purchasing tools, as determined by all survey respondents, makes it possible to distinguish the following tools, which are used by the majority (>50%) of the surveyed manufacturing companies: process and/or purchasing standardization, teamwork, team partnerships, learning by doing, supplier development,

brainstorming, 5x why? and within the key process performance indicators: on-time delivery, or delivery on time and in full quantity, material price index, number of defective parts per million units. These ratios relate to three basic aspects of procurement management: on-time and complete deliveries, prices of purchased products, and their quality. There were slight differences in the tools used between companies in different geographic regions of the world, which may be a result of globalization and universal access to knowledge and information. There was greater variation in the tools used by company size - large and medium-sized companies used a wider range of Lean Purchasing tools than small or micro companies. This may be due to factors such as the scale of the companies' operations, their resources and capabilities, organizational structures or market competition.

The above aspects mean that further work on Lean Purchasing, both in practical and theoretical terms, is still necessary, especially in the area of Lean Purchasing auditing, which could help companies identify directions for further development of this concept in the organization, as well as the tools implemented within its framework. The survey conducted within the framework of the study dealt with the use of Lean Purchasing tools in business practice, but did not include a qualitative aspect concerning the evaluation of the level of effectiveness of the implemented tools, which could also be the subject of further research on Lean Purchasing tools. The use of Lean Purchasing tools is still little known among micro, small and medium-sized enterprises. These enterprises took part in the survey conducted, however, due to the fact that the main research group in the study is large enterprises (63.3%), it was considered an insufficient research sample to be able to refer to this as a representative example to fill this research gap. The results included in the paper, however, can serve as a reference example for researchers wishing to address this issue in the future.

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