

Mechanics, material science, industrial engineering and management
Mechanika, medžiagų inžinerija, pramonės inžinerija ir vadyba

RESEARCH AND IMPROVEMENT OF SUPPLY CHAIN IN
THE METALLURGICAL INDUSTRY

Pablo VILLANUEVA FREGOSO*

Vilnius Gediminas Technical University, Vilnius, Lithuania

Received 08 December 2018; accepted 11 December 2018

Abstract. As the recent industrial situation is characterized by a growing global competition, decreasing product life cycles and increased levels of global outsourcing, among other challenges, the importance of supply chain integration between companies and its suppliers has become a critical factor for their survival in the international market. The way on how they arrange their supply networks to accomplish a flexible supply chain will define the future of modern enterprises. This article aims to explore Supply Chain Management in the Lithuanian metallurgical industry. More precisely, it will be focused on determining its supply chain and describing actual situation and relationships that affect it. Additionally, this paper looks to analyze the possible improvements that could be made in order to make it more efficient. In addition, to get an overview of the present supply chain in the metallurgical sector, a survey has been sent to a selection of metal-manufacturing companies inside Lithuania. The conducted survey-questionnaire represents the empirical research base for this study.

Keywords: Supply Chain Management, metallurgical industry, Supply Chain integration, Lithuanian metallurgical sector, strategic collaboration, and manufacturing.

Introduction

All companies must meet a series of procedures in order to offer to a final consumer, not only the end product or service but also the satisfaction they wish to obtain. Customer demand is getting stricter, however, more companies work side by side with others through a very complicated logistic process in order to give the consumers everything they need within range.

The metallurgical industry encompasses a great variety of activities that go from iron melting (foundry) to transformation and welding, or surface heat treatment. There can be divided into two main production operations: primary and secondary metallurgy. The first one aims at the production of metal through ore minerals both ferrous and nonferrous by extraction (mining). Secondary refers to the production of metal using ingots and recovery of metal from scrap and salvage.

Nowadays the biggest producer of iron and steel is China, which in 2015 had an accumulated production of 691.415,00 thousand tones (World Steel Association, 2017). Due to its geography, Lithuania is not considered as an ore metal producer, but the metal recovery industry is present by companies who recycle these materials. Ob-

taining raw materials from recycling scrap metal is one of the most important activities in the industry; only in 2016, it is estimated that 600 million tons were recycled worldwide (World Steel Association, 2017).

As can be seen, the metallurgical sector is a very wide and complicated one, for this reason, this study will only focus on the supply of structural steel and general engineering steel, which is the most common and used type of steel that construction industry, automotive industry, heavy machinery industry, etc. consume for their specific purposes.

1. Supply Chain Management and Supply Chain integration background

The correct managing of supply chains is a topic that has been drawing a lot of interest in recent years. Its origins come from pure logistics, but it has rapidly converted into an integrative vision of processes, direct and indirect. Overall, SCM can be defined as a process of integrating a chain of entities (such as suppliers, manufacturers, warehouses, and retailers) in a way which guarantees the production and distribution of goods in the right quantities and at the right time, while minimizing costs and satisfying

*Corresponding author. E-mail: pablovifre@gmail.com

customers (Maqsood, Petri, & Yohanes, 2013).

The reason for this interest lies because of the advantages it offers to companies that have a proper management of all involved links in a supply chain, it can improve the competitiveness of companies and give them a crucial advantage to resist the constant changes in the industrial world. Between these challenges, the next could be emphasized:

- Competition and globalization of markets.
- Availability and constant increasing offer of products and brands.
- Customer demand on a more personalized management of their requirements and problems.
- Increasing sensibility from society towards social responsibility and environmental protection policies to companies.

Although the interest in this topic originates in the mid-1990s as companies started to become more aware of the importance of integrating their suppliers in the process of new product development (Feng, Linyan, & Zhang, 2010) the study of the effects of the integration of suppliers and customers about the capacity of companies to generate greater value and improve its business results are still developing. Supplier involvement in new product development (NPD) is essential, therefore, because suppliers have specific product and process capabilities, which are critical as products are becoming more and more complex (Johnsen, 2009). On the one hand, the dimensions that make up the concept of SCI (Flynn, Huo, & Zhao, 2010). On the other, the shortage of a terminology common and shared about concept meaning such as integration, collaboration, cooperation, and alliances has led to the lack of congruence between studies that analyze the relationship between integration and results business (Kim, 2013).

2. SCM in the metallurgical sector: theoretical framework

Nowadays the metallurgical industry faces various challenges such as variable economies, uncertainty in oil and gas prices, green production dilemmas, shrinkage in the global market, etc. that directly affect the way the supply chain behaves from the producer of raw materials until the product reaches end customer.

As mentioned before, Lithuania is not considered as a raw material producer in this sector, instead, the country imports raw materials to transform them into new products such as pre-fabricated structural components for building or civil engineering, aluminum frames and thresholds for doors and windows, wire of iron or non-alloy steel, chassis components for automotive industry etc. (Statistics Lithuania, 2018) Only in 2015, Lithuanian Railways reported that 20.61 million tonnes of imported freight were transported, and from those imported goods 10% were ferrous metals (Lithuanian Railways, 2017). In the whole European Union, also in 2015, a total of 544,712 thousand tonnes of ferrous and non-ferrous goods were transported (EUROSTAT, 2018).

It is important to realize that in order to maintain a competitive domestic manufacturing industry, it is necessary to rely on a healthy and vigorous supply chain. Is no secret that global market conditions are not at their best right now with constant variation of gas prices and market uncertainty. These problems demand the current SCM to improve and become a key component for the continuance or prosperity of the industry and all business and job positions that depend on it.

By analyzing which strategies are being used within the current supply chain, such as: Buy to order, Make to order, Assemble to order, Make to stock, Ship to stock (Naylor, Mohamed, & Berry, 1999). We can then define the proper supply chain model for the manufacturing industry or re-engineer the current one. Furthermore, no model would work if the industry lacks agility to read the market information and adapt to the current problems of the global trade. It is necessary that manufacturers stop looking at each involved operations of their products as a seclusion process, but instead they must look every operation as part of the supply chain. A recent example of miss adaptation to the market is the South Korean Hanjin Shipping Company which now faces bankruptcy and their cargo is stranded all over the world with more than 5 million tonnes of cargo that is not going to reach their final customers on time, or at all (Stewart, 2016). This tragedy started after the world 2008 financial crisis which at the time slowed down trade and decreased freight rates. Hence, this example shows the importance of looking at every step of the supply chain and being aware of the situations of all industries involved in the process.

Other issues affecting the links of the metallurgical supply chain are global environmental problems. Although the most efficient steel companies have reduced their energy consumption per ton of steel produced by 60% since 1960 (World Steel Association, 2017), it is still one of the major industries with the most energy consumption in the world. The most notorious way to look how this affects it is through the automotive industry. As the world aims to be less reliant on fossil fuels, this forces the automakers to look for innovative new materials that are both lightweight and resistant. Hence, the thickness of metal sheets for automobile parts is being reduced; furthermore, competing materials like aluminum alloys and plastics are replacing the steel components (Seetharaman, 2005). In addition to this, there are more risks that could affect the current metallurgical supply chain (Wicher, Lenort, & Krausová, 2012), such as:

- Globalization.
- Outsourcing.
- Lean processes.
- Centralization.
- IT dependence.
- Complex product and service.
- Deficit of information.
- Specialized factories.
- Volatility of demand.
- Technological innovations.

3. Research methodology

A computer-based questionnaire was used in order to get the most quantity of responses as possible since it offers several advantages such as rapid collection, simple to use (allows a quick selection of multiple answers), inexpensive to administer or free and high reliability. A total of 29 questions were included in four different sections (in English and Lithuanian language): basic information; supplier and customer relationship; performance, metrics and improvement methodologies; and future perspectives (Figure 1). The questionnaire was sent to a series of manufacturing companies in which metals (ferrous and non-ferrous) are used as raw materials in some part of their processes.

4. Analysis of empirical research

Nowadays markets follow the globalization trend which involves an increasing need to outsource many processes in order to cut operational costs, as well as merging of big companies to gain more presence in the markets around the world, all this has put a lot of pressure on supply chain systems since customer demand patterns have become increasingly complex and very dynamic. This survey tries to highlight the problematic signs or risk that exist within the metallurgical industry and its supply chain links.

With regards of outsourcing, companies must make the decision whether to integrate partners into their supply chain from a strategic point of view that would involve long-term production for entire production lines or by

tactical decision using only mid-term agreements of sub-contracting only a few processes. It can be observed that Lithuanian companies are also following the outsourcing trend since 67.7% answered that they do outsource at least one of their processes (Figure 2).

On the other hand, making sure you have a consistent supply of the right products in the right place, at the right time is a challenge for any company. This is because each supplier has their own way of doing business, for this reason, is very important to make good and clear agreements that could work for both sides since the goal is to rely on suppliers to drive down costs, improve profit margins and enhance product quality and flow. With this said, we can observe that two main points that are being problematic for companies in Lithuania when dealing with their suppliers: Cost and delivery times (Figure 3).

One possible reason why there are these problematic issues between companies and their suppliers might be because 66% of the respondents answered that they don't have a feedback program between them and their suppliers (Figure 4). This can be a key solution for optimizing the performance of your existing suppliers and ensuring successful on-going receipt of the services purchased.

The ability to generate competitiveness is derived from the way in which companies perform their multiple and diverse processes and activities. Process outsourcing, the internationalization or adjusted production are, among others, some of the business strategies that drive

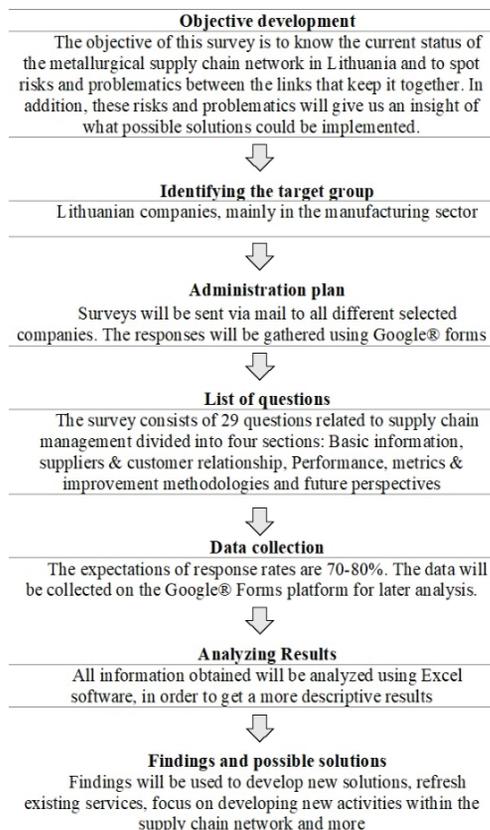


Figure 1. Methodology stages (source: prepared by the author)

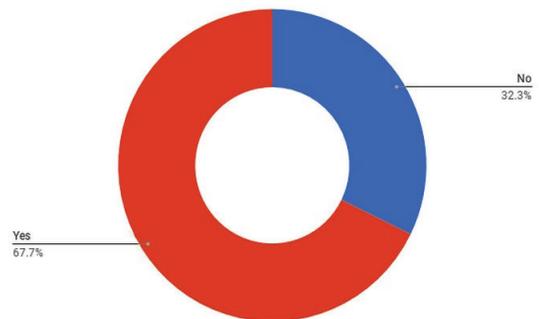


Figure 2. Percentage of companies that outsourcing methods (source: prepared by the author)

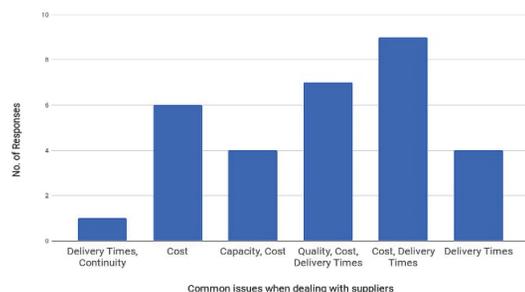


Figure 3. Common problems that companies face with their suppliers (source: prepared by the author)

companies towards greater dependence on its suppliers and customers. Hence, some manufacturers have built close partnerships with their suppliers to gain a competitive advantage. Specifically, lean manufacturers have succeeded in reducing production costs through cooperation with their suppliers (Lida, 2012). Among the priorities for local companies which seek a better advantage over its competitors is to be able to reduce operating costs and improve the quality of their products/services (Figure 5).

The importance of having quality checks along the entire production process is something that cannot be undervalued since by implementing these measures companies can guarantee that their products and/or services are being delivered according to specifications. Therefore, quality control (QC) becomes an essential part of a successful SCM by measuring factors such as product quality, delivery times, information quality, customer satisfaction, leadership, etc. (Jraisat & Sawalha, 2013). Knowing this, local companies show that they also have implemented QC along its SC, since 75% of them answered that QC is built inside their system (Figure 6).

In the section for future perspectives, one of the main challenging points for supply chains in the future will be the lack of qualified labor. This is a real issue in Lithuania since it's losing highly skilled workers every year due to emigration. Only in 2016, Eurostat reported that 50,333 men and women in total, left the country. But also another challenge worrying the local metal manufacturers is the bigger pressure from global competition (Figure 7). Lithu-

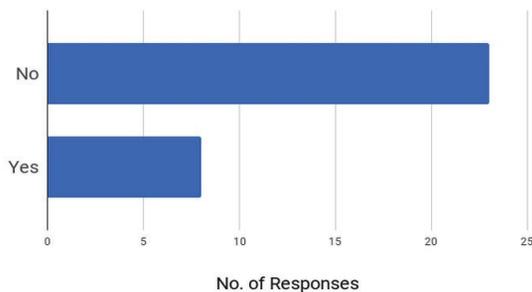


Figure 4. Percentage of companies that use a feedback program between them and their suppliers (source: prepared by the author)

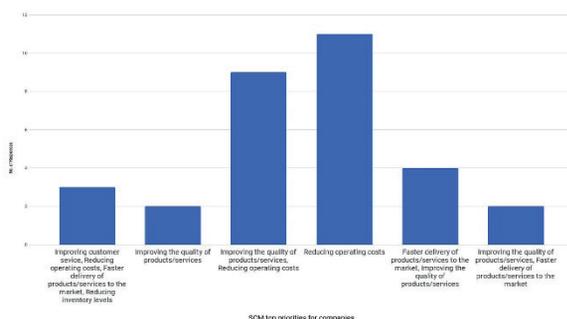


Figure 5. Top priorities of SCM for companies (source: prepared by the author)

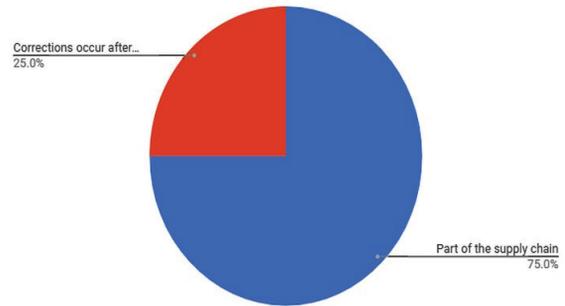


Figure 6. Percentage of companies who have implemented QC within its supply chain processes (source: prepared by the author)

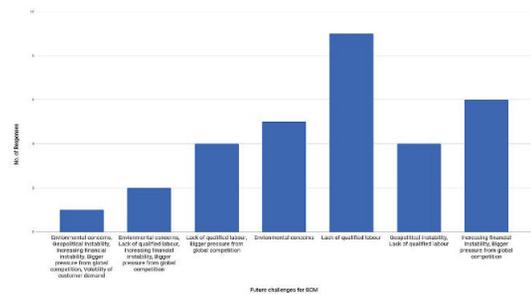


Figure 7. Major future challenges concerning companies (source: prepared by the author)

anian metal-manufacturers are faced with a challenge of becoming more competitive in order to offer their products in other markets worldwide, this is due to the limited market that it exists locally.

5. Pending solutions and suggestions

– Coordination and collaboration in SCM

As mentioned before, SC involves all enterprises that participate in the production, handling, storage, transportation, distribution and commercialization of a product and their components. Within SC we have many participants such as suppliers, manufacturers, wholesalers, distributors, transporters, clients, and consumers. Given that synchronization is key to define the chain's costs and its capacity to deliver products and services with a differential value to its customers, collaboration between the many participants in SC is one of the most critical strategies for the success of it as a whole.

Whenever we think on coordination and collaboration, nowadays the first thing that comes to our minds is a link through Information Technologies (IT), because the software and technology have been improving rapidly throughout recent years. If we can make systems to “talk to each other”, then all companies would be connected and could easily collaborate in order to get mutual benefits and thus, add more value for their customers (Figure 8). This might sound like the perfect strategy, but without the human touch and the adequate organizational link between partner companies (customer-supplier), it will be

difficult to achieve positive results for improving the current SC. Supply chain collaboration, such as information sharing, collaborative forecasting, and joint new product development can be a source of strategic advantage (Wen Guang & Zhiyong, 2015).

Technology here plays an important role in SC integration, but the most important part is played by human interaction from both sides. Basically sharing knowledge and information between participants in the field of:

- Innovation-New product development.
- Special promotions for consumers.
- Future demand forecasts.
- Inventory status (finished goods and/or components).
- Capacity plans and-or production programs.
- Forecast-Production estimates.
- Share installations-warehouse- transportation- etc.

Since sharing valuable information is a sensitive issue for many companies, uncertainty is important when trying to implement a collaborative SC scenario. This sensitive information might be used for some companies to get better deals or to exploit its partners' weaknesses in order to gain a better position in the market. Anticipating that supply chain partners may behave opportunistically by exploding their relationship-specific investments and their strategic information, firms will be indisposed to make relationship-specific investments on supply chain collaboration and share strategic information with their supply chain partners (Wen Guang & Zhiyong, 2015)

- Increase customer satisfaction

Nowadays in all markets due to globalization, there are some fundamental factors for success within the organizations and the quality of products or services they offer. There are tendencies worldwide, in which customer become more demanding with quality, price, delivery times etc. and this has to be present in all organizations in order to boost continuous improvement so that they can achieve the client's satisfaction and in return, the organizations get a better profit from their sales. Customer satisfaction can be achieved by obtaining the necessary quality certifications for the products and/or services they offer, also with feedback programs in order to get detailed information of the client's expectative, continuous auditing, etc.

- Application of newest Information Technologies

Organizations have invested a lot of resources in terms of money, people and time in order to automate their processes through the implementation of different information systems. Internet, as a global network, presents a great opportunity for automation of supply chain processes and providing real-time information across different supply network nodes. Internet also provides room for cost reduction and increased productivity by identifying places for process improvement (Samson, 2011).

SCM is one of the main consumers of IT software programs and internet since the trend is to automate all planning and distribution processes as well as getting information about the products and their status in real time.

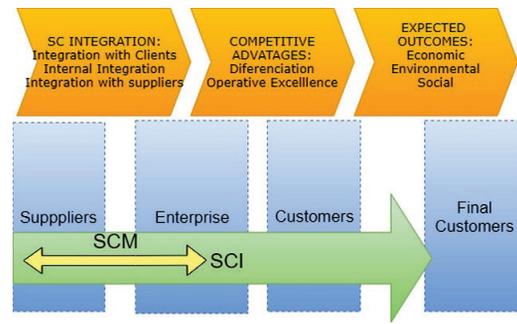


Figure 8. New SCI Model (source: prepared by the author)

Conclusions

It is important to mention that during the process of writing this paper there were some limitations when conducting this empirical research. The main issue was that most companies are still hesitant to participate in these types of studies. Also, there is a limited amount of information available on the subject. Lithuanian companies, however, seem to rely on contractual manufacturing but are slowly moving towards internationalization.

As mentioned in the beginning, the main objective of this paper was to analyze the current scenario for supply chain network in the local metallurgical sector. In order to reach this goal, first of all, an analysis of the current SC situation was made to understand the role of SC in the creation of value added to metal-manufactured products. Also, it was necessary to know the level of SC integration within the manufacturers and its suppliers.

Given the enormous amount of competition that companies face and all of the complex problems that this globalized world has. It is necessary to realize that an adequate SCM system within a company could save it from disappearing. In addition to this, local firms need to:

- Find the best way to integrate their suppliers and other associates in order to gain a substantial competitive advantage.
- Demolish all walls or barriers within companies, as well as making commercial agreements throughout the chain and have a closer relationship with suppliers and customers by working together and sharing data and information.
- Offer or use multiple channels to relate with customers for procurements, support or any kind of help the customer is trying to accomplish with that particular company
- In a social point of view, Lithuania is losing its workforce due to the growing emigration of young men and women. The lack of a well-skilled labor force limits the true growth potential for companies and businesses despite their sector. That is why a possible solution to tackle this problem would be to implement a vocational education and training (VET) program for undergraduate students, which plays an important role for preparing young people for work,

developing the skills of adults and responding to the labor-market needs of the economy (Organisation for Economic Co-operation and Development (OECD), 2010). Countries like Germany or Denmark have successfully implemented this system.

Further empirical work is essential on how dynamic relationships between upstream and downstream chain participants have evolved and the critical aspects that will guarantee an effective SCI among the chain members. This study, therefore, reinforces the importance of building long-term relationships with suppliers. This suggests that the integration of supply chain partners is multi-faceted, and that many competencies act complementary to achieve a higher level of performance.

References

- EUROSTAT. (2018). *Statistical classification of economic activities in the European Community*. Retrieved from <http://ec.europa.eu/eurostat/web/europe-2020-indicators/statistics-illustrated>
- Feng, T., Linyan, S., & Zhang, Y. (2010). The effects of customer and supplier involvement on competitive advantage: An empirical study in China. *Industrial Marketing Management*, 39, 1384-1394. <https://doi.org/10.1016/j.indmarman.2010.04.006>
- Johnsen, T. (2009). Supplier involvement in new product development and innovation: Taking stock and looking to the future. *Journal of Purchasing & Supply Management*, 15, 187-197. <https://doi.org/10.1016/j.pursup.2009.03.008>
- Jraisat, L. E., & Sawalha, I. H. (2013). Quality control and supply chain management: a contextual perspective and a case study. *Supply Chain Management: an International Journal*, 18(2), 194-207. <https://doi.org/10.1108/13598541311318827>
- Lida, T. (2012). Coordination of cooperative cost-reduction efforts in a supply chain partnership. *European Journal of Operational Research*, 222, 180-190. <https://doi.org/10.1016/j.ejor.2012.03.029>
- Lithuanian Railways. (2017). Retrieved from <http://www.litrail.lt>
- Maqsood, A. S., Petri, H., & Yohanes, K. (2013). Steel supply chain management by simulation modelling. *Benchmarking: an International Journal*, 20(1), 45-61. <https://doi.org/10.1108/14635771311299489>
- Naylor, B. J., Mohamed, N. M., & Berry, D. (1999). Leagility: Integrating the lean and agile manufacturing paradigms in the total supply chain. *International Journal of Production Economics*, 62, 107-118. [https://doi.org/10.1016/S0925-5273\(98\)00223-0](https://doi.org/10.1016/S0925-5273(98)00223-0)
- Organisation for Economic Co-operation and Development (OECD). (2010). *Learning for jobs*. OECD Reviews of Vocational Education and Training. Retrieved from <http://www.oecd.org/education/skills-beyond-school/Learning%20for%20Jobs%20book.pdf>
- Samson, M. R. (2011). *Supply-Chain Management: theories, activities/functions and problems*. New York: Nova Science Publishers, Inc.
- Seetharaman, S. (2005). *Fundamentals of metallurgy*. Cambridge, England: Woodhead Publishing Limited.
- Statistics Lithuania. (2018). Retrieved from <http://www.stat.gov.lt>
- Stewart, K. (2016). Hanjin shipping – the first domino to fall? *AUSMARINE*, 10.
- Wen Guang, Q., & Zhiyong, Y. (2015). The effect of uncertainty avoidance and social trust on supply chain collaboration. *Journal of Business Research*, 68, 911-918. <https://doi.org/10.1016/j.jbusres.2014.09.017>
- Wicher, P., Lenort, R., & Krausová, E. (2012, 23-25 May). Possible applications of resilience concept in metallurgical supply. In *Proceedings of Metal Conference*. Brno, Czech Republic.
- World Steel Association. (2017). Retrieved from <http://www.worldsteel.org>

TIEKIMO GRANDINĖS TOBULINIMO GALIMYBIŲ TYRIMAS METALURGIJOS PRAMONĖJE

P. Villanueva Fregoso

Santrauka

Augant pasaulinei konkurencijai, mažėjant produktų gyvavimo ciklams ir didėjant užsakomųjų paslaugų mastams gamybos pramonėje, tiekimo grandinės integracija tarp įmonių ir jos tiekėjų tampa vienu iš lemiamų veiksnių, įmonėms siekiant išlikti tarptautinėje rinkoje. Tai, kaip įmonės organizuoja savo tiekimo tinklus, siekdamos turėti lanksčią tiekimo grandinę, lems šiuolaikinių įmonių ateitį. Straipsnyje apžvelgiamas tiekimo grandinės valdymas Lietuvos metalurgijos pramonėje. Tiksliau, analizuojama dabartinė tiekimo grandinė ir jai įtakos turintys santykiai. Aptariami galimi patobulinimai, kurie galėtų pagerinti tiekimo grandinės efektyvumą. Dabartinei situacijai tiekimo grandinėje nustatyti buvo atlikta pasirinktų metalo apdirbimo įmonių Lietuvoje apklausa, kuri yra empirinio tyrimo pagrindas.

Reikšminiai žodžiai: tiekimo grandinės valdymas, metalurgijos pramonė, tiekimo grandinės integracija, Lietuvos metalo pramonės sektorius, strateginis bendradarbiavimas ir gamyba.