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THE ROLE OF QUALITY IN BUILDING RELATIONSHIPS WITH MRO (MAINTENANCE, REPAIR AND OPERATING) SUPPLIERS

Abstract: *Building relationships with MRO (Maintenance, Repair and Operating) suppliers by manufacturing companies is of particular importance to ensure continuous processes in the supply chain. For this reason, it is particularly important for the customer companies to ensure quality by MRO suppliers. The results of the empirical research clearly indicate that the quality of products plays a priority role as a criterion for selecting and building relationships with MRO suppliers. These suppliers are assessed in detail both in terms of the technical quality delivered through product quality control and organizational quality through periodic process audits. More and more often, companies that are buyers not only set requirements and assessment criteria, but also offer support programs to their suppliers. These programs focus on the possibilities of improving the technical quality of products as well as the quality of processes by improving their efficiency and effectiveness.*

Keywords: *MRO, Quality, Suppliers*

1. Introduction

In recent years, building long-term, partner relationships with suppliers has become increasingly important (Salamai, 2022; Woźniak et al., 2022). It is a truism to say that the efficient and effective functioning of supply chains is possible only when the links co-creating it cooperate in order to implement a coherent strategy (Zimon et al., 2019; Jurgilewicz et al., 2022). In the literature, quite a lot of space has been devoted to research on various aspects of cooperation within the supply chain. These studies covered various industries, countries and aspects of cooperation (Thi et al., 2022; Chauhan et al., 2022; Urbaniak and Zimon 2021). When reviewing the literature, it is

noted, however, that there are still not enough studies covering a specific group of suppliers made up of MRO (Maintenance, Repair and Operating Supply) providers. The role of MRO products in maintaining the smooth functioning of supply chains is usually underestimated and, for this reason, this issue is rarely addressed in the literature on the subject (Cardoso & Biazzin, 2020). This is incomprehensible, because MRO suppliers play an important role in maintaining the efficiency of machines and devices, and negligence in this area leads to disturbances in the smooth implementation of production processes in enterprises (Zhu et al., 2022). The important role of MRO suppliers in ensuring production continuity was highlighted by the Covid-19 pandemic, which forced many entrepreneurs to revise

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their existing business continuity strategies (Siponen et al., 2019; Tisdall et al., 2021). Uncertainty of supplies is a major threat to business, especially when it concerns the acquisition of critical spare parts (Arlinghaus & Knizkov, 2020). For this reason, MRO suppliers must work closely with other parties in the supply chain to ensure optimal product quality as part of a broader supply chain strategy (Fachrie, 2020). With the above considerations in mind, the article attempts to fill the gap that exists in the literature on the subject. The aim of the article will therefore be to highlight the importance of cooperation with MRO suppliers and to conduct empirical research in its scope covering the criteria for building partner relationships with these suppliers.

2. Literature review

For many industrial enterprises, building relationships with suppliers of MRO (Maintenance, Repair and Operating Supply) products is very important (Akbaba & Çetin, 2022). This can be seen especially in the case of manufacturers from sectors such as: automotive, chemical, electromechanical or aviation. This is conditioned by the specificity of MRO products, which include: consumables for maintenance and repair of equipment, machines and production systems, spare parts, protective equipment, and laboratory materials. These products are characterized by the need to ensure a very high level of quality due to their use in key operational processes (production, maintenance, logistics, quality control) and guarantee the continuity of supply chains. For these reasons, the determination of criteria for the assessment and selection of suppliers of MRO products should be indicated as particularly critical conditions in the functioning of enterprises. Therefore, building partnerships between customer companies and MRO suppliers can be very important for the effective functioning of supply chains. Customers often have to specify the requirements for this group of

products in quality specifications. These products can be purchased both standardized and customized versions (Gróf & Kamtsiuris, 2021). Both groups of products must ensure a high level of functional quality and safety. This quality is often confirmed by suppliers applying for certificates and approvals for products issued by specialized research and supervision institutions. Deliveries of standard MRO products are carried out in accordance with the make to stock concept. In the case of customized products, close cooperation between suppliers and customers is essential. These products often have to be precisely adapted to the conditions of operational processes carried out by customers through joint design work. Close cooperation in these cases ensures mutual trust and effective communication between partners. Such cooperation should ensure:

- ensuring high quality of products,
- maximizing the economic life of the machine park,
- maximization of production capacity,
- ensuring the continuity of operational processes,
- minimizing the costs of maintaining equipment in operational efficiency,
- ensuring safe conditions for infrastructure operation.

Customized products are usually delivered according to the engineer to order concept. This concept includes design, prototype construction, manufacturing and installation of the product at the customer's site.

The factor determining the correct relations with MRO suppliers is their adaptation to the technological progress of customers (Uhlmann et al., 2013).

The development of new products, on the other hand, requires greater involvement of suppliers. In addition, wider product differentiation puts more pressure on manufacturing processes and inventory management.

Supplier selection is considered a very important step in the purchasing and supply management process in order to maintain and strengthen a competitive advantage (Abdollahi et al., 2015). MRO suppliers are assessed in detail both in terms of the technical quality delivered. This assessment includes both product quality control and organizational quality control through periodic process audits (Zhu et al., 2022).

The criteria determining the selection of a MRO supplier include: technical quality of products, purchase price, certificates and qualification certificates held, references from MRO recipients, market opinion, and the breadth of the product range. In addition, the conditions determining the choice of a supplier of spare parts include the guarantees and post-warranty service, terms and dates of delivery and payment.

In addition, the experience in cooperation with clients is important, as well as the effectiveness of information exchange and the prospect of long-term cooperation. Such mutual relations are usually bound by long-term contracts and commercial agreements. Often, however, these documents contain exclusivity clauses for the delivery or collection of a specific type of assortment. This, in turn, is related to the lack of risk diversification when working with one client. The occurrence of undesirable events disrupting the cyclicity, quality or quantity of supplies may adversely affect good partnership relations (Zhu et al., 2022).

These premises require the MRO supplier to improve in terms of quality management requirements according to international management standards. At a later stage, this involves the acceptance and readiness of the supplier of spare parts and consumables to conduct regular and formalized audits of specific processes. The audit is part of supplier quality management SQA (Supplier Quality Assurance). The purpose of audits is to assess potential suppliers according to the criteria set by the recipient and to determine whether they are able to meet all the

requirements specified by the production company in specifications and contracts. The audit studies also identifies possible disruptions, including the stability and capacity of the supplier in the context of planned procurement (Dinis et al., 2019). Periodic evaluation of the supplier by the buyer allows to obtain reliable and up-to-date information about a given partner. Satisfaction from cooperation with the MRO supplier also depends on timeliness, quality and price, including discounts and discounts. It can also be observed that not every MRO supplier is willing to subject their organization to the rigors of such an audit. In addition to the MRO supplier audit, thorough and regular supplier due diligence is essential to assess their financial and legal background.

Conducting periodic audits and observing their economic development allows us to obtain information on the implementation of new technologies and technical solutions by suppliers. Monitoring legal regulations, including environmental regulations, allows both customers and MRO suppliers to adjust requirements as part of information exchange and improve mutual relations. Current information in partnerships can mitigate the effects of adverse events that may occur (Albakkoush et al., 2021). The ability to react quickly to emerging risks is one of the determinants of cooperation between a manufacturing company and a partner in MRO supplies. Close cooperation between MRO suppliers allows customers to successfully implement both Total Productive Maintenance (TPM), Lean Management and Business Continuity Management concepts (Korchagin et al., 2020). The implementation of TPM allows customers to maximize the use of all equipment by eliminating losses resulting from failures, maximizing the efficiency of equipment operation and building a comprehensive preventive maintenance system. In turn, the implementation of the Business Continuity Management concept allows customers to prepare process

recovery plans in the event of supply disruptions.

Close cooperation between MRO suppliers and customers should be based on a jointly developed inventory management concept (Rolinck et al. 2021). This concept should focus on:

- minimizing inventory and related costs in the production process and in the supply chain,
- immediate response to demand and delivery of necessary products and elements to customers in the shortest possible time,
- achieving continuity of production flow to meet the emerging demand without delays and losses,
- ensuring full reliability of deliveries of the necessary elements and materials at the right time.

Among the factors that may affect the management of spare parts stocks are the product assortment structure, delivery frequency, order fulfillment time, stock price, storage conditions, criticality for maintaining production continuity, quantity and customer demand volatility.

In the event of problems at MRO suppliers, customers should maintain a safe level of buffer stock to ensure safety or protection against a threat to the continuity of production in the event of a failure. Therefore, the maintenance departments of purchasing companies must maintain a stock of critical spare parts on an ongoing basis in case of emergencies. This can bring benefits to buyers such as reducing downtime by improving response times, preventing losses and reducing risks associated with production line downtime. This is especially true when customers deliver just-in-time. The risk elements in the MRO supplier's assessment include, among others:

- the ability to ensure continuity of supply,
- technological competence and leadership,
- financial situation,

- price competitiveness,
- location and method of transport,
- competitive factors,
- external and internal factors affecting suppliers,
- long-term use of production capacity,
- product life cycle (Jeeva, 2016).

For this reason risk mitigation in relations with MRO suppliers can be important for the functioning of supply chains (Luo et al, 2021).

3. Methodology of research and results

The purpose of the empirical studies was to determine the importance of the selection criteria for MRO suppliers used by customers and the criteria determining the building of partnership relations with these suppliers. The study was conducted using a survey questionnaire with 100 deliberately selected MRO suppliers registered in the supplier database of Lotos Service Orlen Capital Group. The criteria were rated by respondents on a five-point Likert scale, from the most important (5) to the least important (1). Most of the respondents were small enterprises employing up to 49 employees. The results of the conducted tests are presented in the tables below. Table 1 presents the results of the research covering the criteria determining the selection of the MRO supplier.

The results of the studies clearly indicated that all surveyed enterprises considered the technical quality of the products offered to be the most important criterion for selecting MRO suppliers. Criteria such as terms and timeliness of deliveries and MRO certificates held by suppliers are also very important references and market opinions. In the opinion of MRO suppliers, the possibility of long-term cooperation is also important for customers, price, warranty conditions as well as the effectiveness of information exchange.

All of the assessed MRO supplier selection criteria were of greater importance in the opinion of medium and large-sized enterprises (employing at least 50 employees) than in the case of small

organizations. Table 2 contains the results of the studies relating to the criteria determining the building of partner relations with MRO suppliers.

Table 1. Criteria for choosing an MRO supplier (general results and a comparison between the segments depending on the number of employees, average)

Criteria for choosing an MRO supplier	<i>M</i> N=100	<i>M</i> N=100	Number of employees		
			1-9 N=40	10-49 N=32	50- N=28
Technical quality of products	100	4.78	4.80	4.71	4.82
Terms and timeliness of deliveries	97	4.60	4.63	4.55	4.63
Certificates/references/market opinion	92	4.49	4.53	4.23	4.71
The prospect of long-term cooperation	87	4.34	4.10	4.29	4.64
Price	87	4.33	4.38	4.16	4.46
Warranty conditions	88	4.28	4.15	4.23	4.47
Efficiency of information exchange	87	4.27	4.33	4.13	4.36
The breadth of the product range	84	4.17	4.10	4.19	4.21

Table 2. Criteria for building partnerships with MRO suppliers (general results and a comparison between the segments depending on the number of employees, average)

Variables	<i>M</i> N=100	Number of employees		
		1-9 N=40	10-49 N=32	50- N=28
Customer satisfaction with the quality delivered by the supplier	4.76	4.72	4.73	4.84
Durability of cooperation	4.61	4.50	4.69	4.63
Opportunity to obtain attractive commercial terms	4.51	4.58	4.39	4.56
Flexibility of cooperation in terms of the possibility of changing the delivery date, volume, assortment	4.42	4.33	4.46	4.47
Joint pursuit of process improvement	4.40	4.25	4.38	4.58
Management of relations with buyers on the basis of mutual partnership	4.39	4.36	4.35	4.47
Supplier's market opinion/references and certificates	4.32	4.33	4.06	4.57
Shortening the delivery time by the supplier	4.32	4.45	4.10	4.40
Suggestion and willingness of the supplier to introduce product and/or process innovations	4.22	4.20	4.23	4.22
Securing stock levels by the supplier for the fulfillment of buyers' orders	4.19	4.08	4.38	4.1
Reducing the cost of delivering the product to the buyer	4.18	4.08	4.04	4.41
Application of quality management requirements defined in international management standards by the supplier	3.97	3.95	3.68	4.28
Periodic supplier assessment performed by the buyer	3.28	3.11	3.31	3.42

The results of the studies clearly indicated, that for the surveyed enterprises the most important criterion for building partnership relations with MRO suppliers is the buyer's satisfaction with the delivered product quality. Durability of cooperation with suppliers and the possibility of obtaining attractive commercial terms are also very important criteria. The surveyed organizations also included the following as important criteria for building partnership relations with MRO suppliers:

- flexibility of cooperation in terms of the possibility of changing the delivery date, volume, assortment;
- joint efforts to improve processes;
- management of relations with buyers on the basis of mutual partnership;
- market opinion of the supplier/references and certificates and also
- striving to shorten the delivery time by the supplier.
- slightly less important in the opinion of MRO suppliers, are the following criteria:
- proposing and willingness to introduce product and/or process innovations.
- securing inventory (components, raw materials) for the implementation of buyers' orders.
- reducing the cost of the process of delivering the product to the buyer.

4. Discussion

The results of the conducted studies clearly indicated that all the surveyed enterprises indicated the technical quality of the products offered as the most important criterion for the selection of MRO suppliers used by customers. Criteria such as terms and timeliness of deliveries as well as MRO certificates held by suppliers were also very important, references and market opinion. The results of the conducted studies also

clearly indicated that for enterprises, the most important criterion for building partnerships with MRO suppliers is the satisfaction of the buyer with the quality of the product supplied. Durability of cooperation with suppliers and the possibility of obtaining attractive commercial terms are also very important criteria. Building relationships between customer companies and MRO suppliers is essential to the process of supply chain management and ensuring its continuity. Cooperation in MRO deliveries also has a decisive impact on ensuring product quality, risk diversification and innovation.

The obtained research results indicate this, that both manufacturing companies and their suppliers must strive to meet high quality standards. As rightly noted by Li et al. (2022) ensuring optimal product quality is in the interest of the entire supply chain and is important not only for its development but also for its survival. Research results also confirm, that the key to ensuring optimal product quality is cooperation between the supplier and the recipient. The obtained results are confirmed in the literature on the subject in studies conducted, among others, by Hoque and Maalouf (2021) or Zimon and Madzik (2020). The particular importance of the quality and timeliness of MRO deliveries is emphasized by Zhu and co-authors (2022) in their research.

The basis for building relationships with MRO suppliers is mutual trust and effective communication. These elements allow partners to develop long-term relationships, based on win-win principles (Krivokapić & Stefanović, 2020). Building lasting relationships with MRO suppliers requires companies to take actions aimed at their sustainable development. More and more customer companies are offering supplier development programs to their partners. MRO suppliers are also covered by these programs. These programs focus on activities aimed at ensuring and improving the quality of products as well as ensuring the quality of processes (Mishra & Patel,

2010). Often these programs also include joint research and development projects on new products. Most often, these programs are aimed at improving the efficiency and effectiveness of processes at suppliers by implementing the Toyota Production System and Lean Management concepts (Sánchez & Sunmola, 2017; Arlinghaus & Knizkov, 2020, Zimon et al., 2022). This is to create disruption-resistant supply chains by efficiently managing the stock of purchased products and responding effectively in the event of a failure. These programs are implemented through specialized training, mentoring and work of interdisciplinary teams of employees cooperating with clients and suppliers. Increasingly, these programs are aimed at implementing the concept of sustainability at suppliers to improve safety and reduce the negative impact of products on the environment, as well as supplier processes (Uhlmann et al., 2013; Wits et al., 2016).

5. Conclusions

The conducted research process made it possible to partially fill the gap that exists in the literature on the subject and to formulate

the following conclusions:

- the technical quality of purchased products as well as buyers' satisfaction with the products offered is a key factor that must be met by the MRO supplier.
- it's worth pointing out, that the implementation of quality management systems by suppliers is not an important factor influencing cooperation.
- according to the respondents, punctuality of deliveries is another important requirement that customers set for MRO suppliers.
- the breadth of the product range is the least significant criterion for MRO suppliers. Recipients therefore prefer a narrower range of products that meet high quality standards.
- the size of the surveyed organizations does not affect the hierarchy of requirements towards suppliers.

Finally, it is worth noting, that the way to effective management of the supply chain is long-term and close cooperation of its links, which should be the foundation and starting point for implementing the adopted strategy.

References:

- Abdollahi, M., Arvan, M., & Razmi, J. (2015). An integrated approach for supplier portfolio selection: Lean or agile?. *Expert Systems with Applications*, 42(1), 679-690.
- Akbaba, M. M., & Çetin, O. (2022). Supplier Performance Evaluation Using Cluster Analysis and Artificial Neural Networks in a MRO Business in Aviation Sector. In *Corporate Governance, Sustainability, and Information Systems in the Aviation Sector*, Volume I (pp. 177-192). Springer, Singapore.
- Albakkoush, S., Pagone, E., & Saloniitis, K. (2021). An approach to airline MRO operators planning and scheduling during aircraft line maintenance checks using discrete event simulation. *Procedia Manufacturing*, 54, 160-165.
- Arlinghaus, J. C., & Knizkov, S. (2020). Lean Maintenance and Repair Implementation-A Cross-Case Study of Seven Automotive Service Suppliers. *Procedia CIRP*, 93, 955-964.
- Arlinghaus, J. C., & Knizkov, S. (2020). Lean Maintenance and Repair Implementation-A Cross-Case Study of Seven Automotive Service Suppliers. *Procedia CIRP*, 93, 955-964.

- Cardoso, A. L., & Biazzin, C. (2020). What is the value of e-procurement for suppliers? The drivers, barriers and opportunities for engaging MRO suppliers. *International Journal of Procurement Management*, 13(2), 278-297.
- Chauhan, C., Kaur, P., Arrawatia, R., Ractham, P., & Dhir, A. (2022). Supply chain collaboration and sustainable development goals (SDGs). Teamwork makes achieving SDGs dream work. *Journal of Business Research*, 147, 290-307.
- Dinis, D., Barbosa-Póvoa, A., & Teixeira, Â. P. (2019). A supporting framework for maintenance capacity planning and scheduling: Development and application in the aircraft MRO industry. *International Journal of Production Economics*, 218, 1-15.
- Fachrie, Y. (2020). Supplier evaluation in industrial power services: a case study in gas-turbine maintenance, repair, and overhaul. In *E3S Web of Conferences* (Vol. 202, p. 13002). EDP Sciences.
- Gróf, C., & Kamtsiuris, A. (2021). Ontology-based Process Reengineering To Support Digitalization of MRO Operations: Application To An Aviation Industry Case. *Procedia CIRP*, 104, 1322-1327.
- Hoque, I., & Maalouf, M. M. (2022). Quality intervention, supplier performance and buyer–supplier relationships: evidence from the garment industry. *Benchmarking: An International Journal*, 29(8), 2337-2358.
- Jeeva, A., Supplier Intelligence in MRO procurement. *International Journal of Computer Applications*, 135(12), 2016, 21-29.
- Jurgilewicz, M., Kozicki, B., Piwowarski, J., & Grabowska, S. (2022). Contemporary challenges for the economic security of enterprises in Poland. *Journal of Security and Sustainability Issues*, 12(1).
- Korchagin, A., Deniskin, Y., Pocebneva, I., & Vasilyeva, O. (2022). Lean Maintenance 4.0: Implementation for aviation industry. *Transportation Research Procedia*, 63, 1521-1533.
- Krivokapić, Z., & Stefanović, M. (2020). Role of responsibility in the quality management system. *International Journal for Quality Research*, 14(3), 805-816.
- Li, Y., Lin, X., Zhou, X., & Jiang, M. (2022). Supply Chain Quality Decisions with Reference Effect under Supplier Competition Environment. *Sustainability*, 14(22), 14939.
- Luo, S., Ahiska, S. S., Fang, S. C., King, R. E., Warsing Jr, D. P., & Wu, S. (2021). An analysis of optimal ordering policies for a two-supplier system with disruption risk. *Omega*, 105, 102517.
- Mishra, R., & Patel, G. (2010). Supplier development strategies: a data envelopment analysis approach. *Business Intelligence Journal*, 3(1), 99-110
- Rolinck, M., Gellrich, S., Bode, C., Mennenga, M., Cerdas, F., Friedrichs, J., & Herrmann, C. (2021). A Concept for Blockchain-Based LCA and its Application in the Context of Aircraft MRO. *Procedia CIRP*, 98, 394-399.
- Salamai, A. A. (2022). A review of collaboration and secure information-sharing for supply chain management. *Journal of Information & Knowledge Management*, 21(04), 2250047.
- Sánchez, A., & Sunmola, F. (2017, April). Factors influencing effectiveness of lean maintenance repair and overhaul in aviation. In *International symposium on industrial engineering and operations Management* (pp. 855-863).
- Siponen, M., Haapasalo, H., & Harkonen, J. (2019). Maintenance, repair, and operations inventory reduction and operational development. *International Journal of Industrial and Systems Engineering*, 32(1), 1-31.

- Thi, B. N., & Thu, H. N. T. (2022). Effects of supply chain collaboration on customer loyalty for household electronic appliances in Vietnam. *Journal of Asian Business and Economic Studies*, 29(4), 280-298.
- Tisdall, L., Zhang, Y., & Zhang, A. (2021). COVID-19 impacts on general aviation—comparative experiences, governmental responses and policy imperatives. *Transport Policy*, 110, 273-280.
- Uhlmann, E., Bilz, M., & Baumgarten, J. (2013). MRO—challenge and chance for sustainable enterprises. *Procedia Cirp*, 11, 239-244.
- Urbaniak, M., & Zimon, D. (2021). Implementation of standardized management systems and the requirements of production companies towards suppliers. *International Journal for Quality Research*, 15(4), 1081.
- Wits, W. W., García, J. R. R., & Becker, J. M. J. (2016). How additive manufacturing enables more sustainable end-user maintenance, repair and overhaul (MRO) strategies. *Procedia Cirp*, 40, 693-698.
- Woźniak, J., Budzik, G., Przeszłowski, Ł., Fudali, P., Dziubek, T., & Paszkiewicz, A. (2022). Analysis of the quality of products manufactured with the application of additive manufacturing technologies with the possibility of applying the industry 4.0 conception.
- Zhu, Y., Xia, T., Chen, Z., Pan, E., & Xi, L. (2022). Optimal maintenance service strategy for OEM entering competitive MRO market under opposite patterns. *Reliability Engineering & System Safety*, 217, 108060.
- Zhu, Y., Xia, T., Hong, G., Chen, Z., Pan, E., & Xi, L. (2022). Collaborative maintenance service and component sales under coopetition patterns for OEMs challenged by booming used-component sales. *Reliability Engineering & System Safety*, 226, 108712.
- Zhu, Y., Xia, T., Hong, G., Chen, Z., Pan, E., & Xi, L. (2022). Collaborative maintenance service and component sales under coopetition patterns for OEMs challenged by booming used-component sales. *Reliability Engineering & System Safety*, 226, 108712.
- Zimon, D., & Madzík, P. (2020). Standardized management systems and risk management in the supply chain. *International Journal of Quality & Reliability Management*, 37(2), 305-327.
- Zimon, D., Madzík, P., Dellana, S., Sroufe, R., Ikram, M., & Lysenko-Ryba, K. (2022). Environmental effects of ISO 9001 and ISO 14001 management system implementation in SSCM. *The TQM Journal*, 34(3), 418-447.
- Zimon, D., Tyan, J., & Sroufe, R. (2019). Implementing sustainable supply chain management: Reactive, cooperative, and dynamic models. *Sustainability*, 11(24), 7227.

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