THE ANNALS OF "DUNĂREA DE JOS" UNIVERSITY OF GALAȚI
FASCICLE V, TECHNOLOGIES IN MACHINE BUILDING,
ISSN 2668-4829 (PRINT) 2668-4888 (ONLINE)
https://doi.org/10.35219/tmb.2024.1.06

OUTSOURCING STRATEGIES IN MANUFACURING PROCESSES OF BEARING RINGS

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ABSTRACT

In the last decades, the globalization of businesses has led to new approaches regarding the usage of resources. Identification of the optimum solution for resource planning and usage requires some market research. This is necessary to select, evaluate and qualify the suppliers. An important part of this feasibility evaluation process is the analysis of the supplier's capability to manufacture, control, and deliver products according to customer specifications. The integration of outsourced processes into company flow diagrams requires analysis and identification of product and process requirements. This paper proposes a new method that can be used to integrate the outsourced processes or phases into the manufacturing management system. A case study is presented to assess the feasibility of outsourcing as part of the manufacturing process for components used in bearings for the railway industry. The study was developed based on actual data collected from the industry.

KEYWORDS: outsourcing, manufacturing processes, strategies, flow diagram, hybrid production strategy.

1. INTRODUCTION

In the current economic environment, manufacturers are investing significant resources to identify the most suitable methods for cost optimization.

The make-or-buy decision is a strategic choice companies when deciding whether to manufacture a product in-house or purchase it from an external source, [1].

In some cases, decision regarding the implementation of a manufacturing process- whether to use internal resources or outsource all or part of the process- are made based on technological, financial, and logistical points of view.

Considering that manufacturing processes are the most important factor in resource management, manufacturers have identified and adopted a series of strategies.

In this context, the manufacturing and sale of products which satisfy the customer and legal requirements throughout their entire lifecycle give new opportunities. Manufacturers are beginning to redefine their management strategies in order to become more competitive in terms of cost and operational optimization.

The management and use of all types of resources in a sustainable manner become one of the most important factors in the planning of businesses [2].

Manufacturing all technological phases of a product at the same location is, in some cases, not optimal from an economic and technological point of view.

To become more competitive in a changing market, manufacturers are beginning to outsource a part of the manufacturing processes or phases to suppliers that can meet both legal and customer requirements. Sourcing plays a strategic role [3] in company strategies.

In today's economic environment, the management of the supply chain [4] is one of the most important factors for both company success and sustainability.

In today's global business landscape, outsourcing has become a crucial strategic decision that can allow organisations to develop and leverage the capabilities required to remain competitive [5].

Outsourcing provides organizations with the opportunity to focus their core competencies [6] on the

most feasible processes, both from technical and economical points of view.

Traditionally outsourcing decisions have been made by distinguishing between core and non-core competencies, with the latter being considered for outsourcing [3]

In the current dynamic business environment, outsourcing becomes one useful tool for decision-makers. Outsourcing is a very dynamic concept of management that covers many different areas of business activity, namely: production, logistics, accounting, human resource management, design, IT systems, and technologies [7].

A company will implement outsourcing decisions based on analyses aimed at reducing production and transaction costs [3]. The production cost parameter consists of the costs involved in the manufacturing phases (labor and infrastructure costs). The transaction costs refer to the expenses incurred during the supplier qualification phases such as: selection, initial evaluation, price quotation analysis, contract definition and analysis, qualification, and supplier performance monitoring.

Afteni et al. [8] conducted an analysis of the supplier qualification process, including its main phases as follows: evaluation, monitoring, and auditing of suppliers in supply chain management. Sourcing also depends on the type of industry, such as hospitality, manufacturing, textile, and automobile [9].

Shao et al. [10] propose two effective decision-making policies based on operating cost and product value to identify an optimal production strategy. Moreover, Kumar et al. [11] analyse the factors that are related to make-or-buy decisions, enhancing the understanding of how outsourcing and subcontracting can impact a company's business, operations, and profitability.

Previous studies [4] examine topics related to production strategies and the identification of simplified flow diagrams to illustrate make, buy, and hybrid production strategies. However, while these studies cover the main production strategies and their potential effects on company performance, the integration of hybrid production strategies in response to volatile demand – especially in the earing industry - has not been widely addressed.

In the steps corresponding to the customer order analysis phase, the system must decide whether to accept or reject it [12], or whether to outsource certain production steps in order to obtain the products at a designed production cost, while ensuring the sustainability of the companies.

The analysis of each parameter of production cost sometimes leads to decision points based on two key factors: technological capability and economic impact.

This paper explores the possibility of integrating a hybrid production strategy into the workflow in case of a bearing components manufacturing company.

The steps involved in the production strategies were identified, and a hybrid flow diagram was developed to support decision-making. The criteria considered include product type, requested quantity, required homologation needed and tooling, quality requirements, delivery conditions, and other specific requirements.

The paper is structured in four sections. Following this introduction, Section II outlines the method for identifying decision steps and the applicable diagram for hybrid production strategy decisions. In Section III, a study is developed to identify the steps and controls required for implementing a hybrid production strategy. Finally, Section IV presents the paper's conclusions.

2. METHOD FOR THE PRODUCTION STRATEGIES IDENTIFICATION

The challenges associated with outsourcing decisions consist in the identification and qualification of the most suitable suppliers, considering: i) technical capability of the suppliers to manufacture products or provide services in the field of manufacturing processes; ii) logistical activities and associated costs; iii) quality control capability; iv) management system certifications, and v) actual competences and approvals for special processes.

According to the existing literature, the main reasons for outsourcing could be: i) bottle-neck identification in one or more production phases; ii) unavailable or lack of capacity in one or more production phases; iii) not enough know-how for process implementation in one or more production phases; iv) economic constraints related to one or more production phases; and v) organizational changes regarding supply chain and resources planning.

Identifying decision-level diagrams based on outsourcing reasons and challenges is one of the most important steps in a company's management strategy. A simplified diagram, comprising 3 different production strategies, was designed and is depicted in Figure 1.

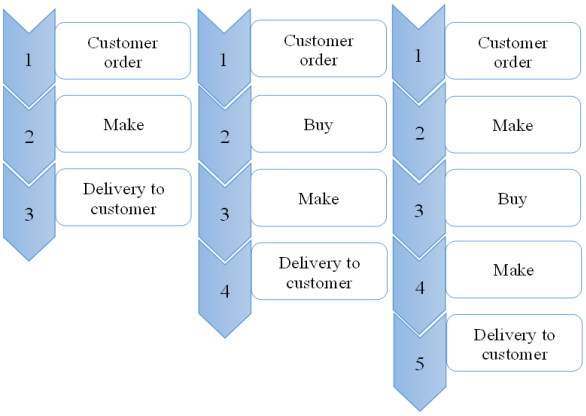

Fig. 1. *Simplified diagram of hybrid production strategies*

This section proposes a simplified flow diagram applicable to decision-making in the case of hybrid production strategy, along with a method for the

analysis of decision criteria, Figure 2.

The outsourcing decision depends on factors such as size, organizational structure, availability of skilled resources, internal know-how, availability of capacity, turnover, and experience of the organization.

Integration of suppliers into the company's management system presents a significant challenge for both designers and logistics personnel.

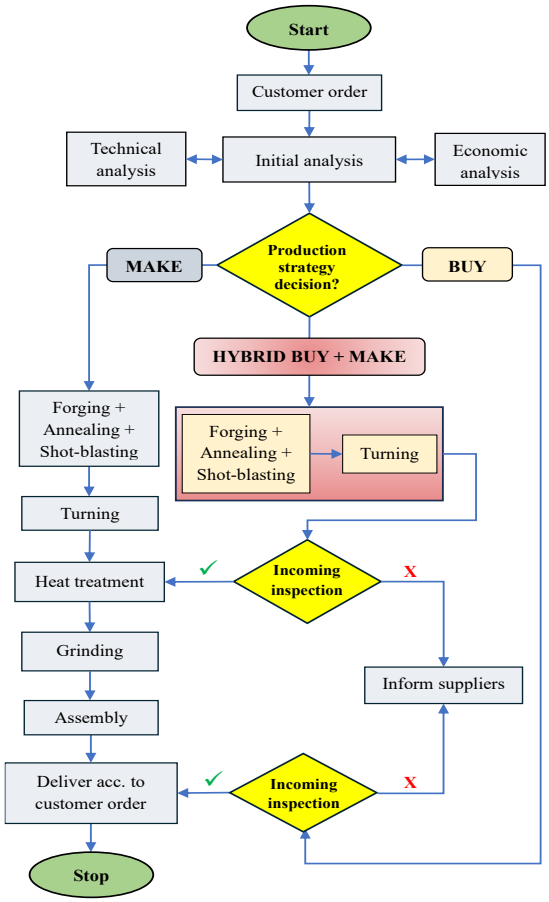

Fig. 2. *Flow diagram for integrating the hybrid production strategy*

Using qualified suppliers to outsource part of the manufacturing process requires both technical and economic analysis. A complete analysis of the premises for an outsourcing strategy must consider the applicable rules in terms of suppliers' management. The feasibility of buy decisions is assessed by comparing the price levels quoted by suppliers with the internal production costs. Manufacturers are always focusing on consolidating their presence in markets that are considered mature, while aiming to increase their market share in emerging market [13].

3. CASE STUDY

To ensure business sustainability, companies have started to analyze the possibilities of outsourcing either entire manufacturing processes or specific production phases.

This paper presents a case study developed to identify the necessary steps and controls required to implement a hybrid production strategy, buy + make.

Based on the steps followed by the company team in response to a customer's request for a quotation an integrated matrix was identified, as depicted in table 1.

The proposed method and flow diagram were tested using bearings intended for railway applications, Figure 3. Bearings are one of the most important components in a railway vehicle, especially in terms of safety, [14]. Knowing that a bearing consists [15] of an outer ring, an inner ring, cages, and rollers or balls, for this study, the outer ring of a cylindrical bearing used in railway applications was selected. Therefore, an order of 500.000 outer rings was considered.

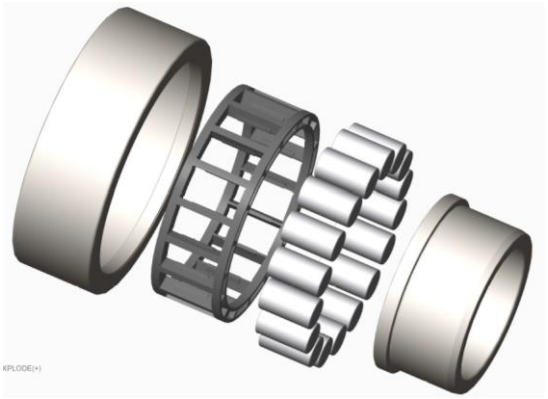

Fig. 3. *Railway bearing components*

For this quantity, an operation plan was designed, and the production cost was estimated.

Based on this production cost, the final price was determined. Quotations for the same product were also requested from two different suppliers. The input data used in the evaluation are summarized in Table 2.

In the analyzed case, the company implemented both the *buy strategy* and the *in-house strategy* over the past two years, 2022 and 2023, according to the annual reports.

The results of the afore-mentioned strategies, in terms of produced or outsourced quantities (in tons), are depicted in Figure 4. The outsourcing strategy led to an increase of about 24% in 2023 versus 2022.

At the same time, the in-house production registered a decrease of about 10%.

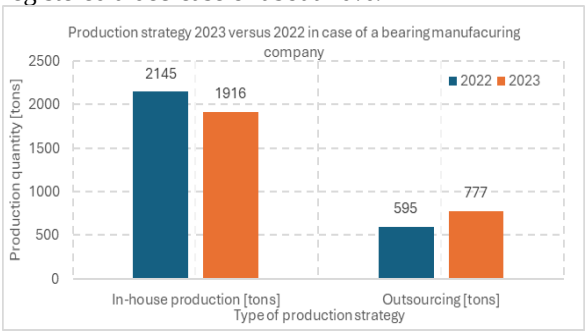

Fig. 4. The *implemented production strategies (year 2023 vs. year 2022)*

Table 1. *The integrated matrix in case of a customer request for quotation*

Flow diagram steps / Decision criteria	Raw material	Forging	Annealing	Turning	Secondary heat treatment	Grinding	Assembly + marking	Delivery condition
Product type	Type of raw material	Machine and process type	Furnace and process type	Machine availability	Furnace and process type	Machines availability	Imposed marking rule	Packing specification
Requested quantity	Stock analysis	Machine and process type	Furnace and process type	Process type	Furnace and process type	Process type	Machine availability	Packaging materials
Homologation needed + tooling	Customer tools Specific tools for handling	Machine and process type	Machine and process type	Machine and process type	Furnace and process type	Machine and process type	Specific tools	Specific tools for handling and loading
Requested quality	Imposed incoming inspections Traceability	Traceability ntrol of process parameter ntrol of product parameter	Traceability ntrol of process parameter ntrol of product parameter	Traceability ntrol of process parameter ntrol of product parameter	Traceability Control of process parameters Control of product parameters	Traceability Control of process parameters Control of product parameters	Traceability Control of process parameters Control of product parameters	Traceability
Delivery conditions	Traceability	Traceability	Traceability	Traceability	Traceability	Traceability	Traceability	Type and transport rules
Other specific requirements	Imposed suppliers	Imposed controls	Imposed controls	Imposed controls	Imposed controls	Imposed controls	Imposed controls	Imposed controls

Table 2. *The input data of the evaluation*

Flow diagram steps / Decision criteria	Request for supplier	Quotations results		
		Own computation	Supplier 1	Supplier 2
Product type	Outer ring for railway bearing	ok	ok	ok
Process steps	Forging +heat treatment + shot-blasting + turning	ok	ok	ok
Requested quantity	500.000pcs	ok	ok	ok
Homologation needed + tooling	Supplier tools Homologation files	ok	ok	ok
Requested quality	good	ok	ok	ok
Delivery conditions	At customer site	ok	ok	ok
Other specific requirements	Raw material with 3.1. certificate from approved suppliers	ok	ok	ok
Price level	No price target	118.37	99.06	164.66

The main reason considered for replacing the in-house production strategy with outsourcing strategy was the impact of economic factors on company expenses, as well as challenges in securing raw materials due to military conflicts on one side, and the high level of production capacity utilization on the other side.

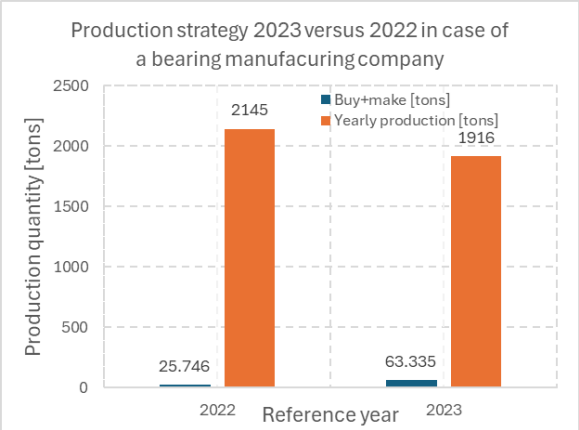

Fig. 5. *The implemented buy+make production strategies (year 2023 vs. year 2022)*

The analysis of the collected data regarding the hybrid production strategy, buy + make, shows that, in 2023, the company increased the level of outsourced manufacturing from 25 tons in 2022 to 63 tons in 2023, Figure 5.

4. CONCLUSIONS

This paper presents a study regarding management strategies that can be addressed by companies when considering the outsourcing of part or all of their manufacturing processes.

In the above context, a flow diagram for integration of hybrid production strategies into the company's existing process was designed and tested.

Based on the performed analysis of quotations received from different suppliers, the proposed method and flow diagram showed good results and can be applied to other products or manufacturing processes.

The implementation of hybrid production strategy could help manufacturer to produce and deliver customized products with optimized lead times and production costs.

The hybrid strategy could be composed by 2 or 3 stages, such as: buy + make or make + buy + make.

As an effective approach, the hybrid strategy enables companies to deliver the ordered products within shorter lead times and obtain economic efficiency.

By using the hybrid production strategy, both the customer company and the supplier could improve their management systems to better meet end-customer requirements in terms of product quality, price, and logistics.

The proposed method and flow diagram were tested in the case of bearings used in railway applications and demonstrated that the usage of the proposed method could be successfully applied in today's business environment.

ACKNOWLEDGEMENTS

The authors acknowledge the support from Rulmenti SA Barlad, Romania for providing the data used in this study.

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