

The Multidisciplinary Solution to the Maintenance Contracts Management Problem

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Abstract. In the context in which more and more industrial companies choose to resort to outsourced maintenance services, through contracting with specialized third-party entities, there is a need to know how to manage all maintenance contracts that are either to be concluded, in existence or about to expire, in order to ensure the desired result. Since the diversity of maintenance services is large and maintenance plays an extremely important role in maintaining production lines within appropriate parameters, it is recommended to adopt a system that facilitates the management of maintenance contracts. The paper aims to propose a maintenance contracts management model, given the lack of such a tool. To this end, through an analysis of the specialized literature, contracts management models from related fields were identified, namely: the contracts performance model, the contracts maturity model, the smart contracts model and the contracts optimization model. These models were analyzed comparatively and in regard to the main management functions. Through the focus group research method, the dimensions extracted from the models identified in the literature were investigated in order to select the dimensions and sub-dimensions relevant to maintenance contracts management. In this way, the paper develops a maintenance contracts management model based on the following dimensions: start-up management, team, communication and relationships, execution, smart component, performance monitoring and reporting, integration and completion.

Keywords: Services, Outsourcing, Models, Dimensions, Tool.

Introduction

Maintenance is a complex activity, namely a set of technical activities that involve both economic and managerial resources, which aims to maintain a system in a specified operating state, determined by the technical characteristics of the system or by parameters established by the owning company (Verzea, 2015).

Considering that all manufacturing companies define their business strategies and competitive priorities based on a series of factors such as flexibility, productivity and quality, maintenance plays an extremely important role in guaranteeing the availability and reliability of the production facility. Moreover, in the modern and globalized world, industry and production systems have a crucial impact on resource consumption, both at the environmental and societal levels, so in recent years the concept of sustainable development has been developed, which

involves 100% recyclable products in which the production process has no impact on the environment.

Maintenance policies have become a major lever for sustainable production because they provide companies with the ability to maintain their efficient production systems and products at a high-quality level, sustainability being a goal of manufacturing companies (Herghiligu et al, 2023). Also, maintenance activity is essential for the respective equipment/system/installation because it helps extend its lifespan, while also guaranteeing quality requirements.

In the field of maintenance, maintenance procedures and policies have evolved over time: historically, the first to be applied was the corrective or reactive one, which was driven by the logic of „*run-to fail*“. Later, the approach of preventing failures instead of correcting them was implemented, leading to the implementation of preventive maintenance, this category including both scheduled maintenance and condition-based maintenance. Recently, more proactive maintenance concepts have begun to be included, using management tools and strategies based on information and communication technologies that offer the possibility of adapting activities to dynamic environmental changes and aligning them with business strategies and requirements arising throughout the life of the system. The most modern maintenance policies are represented by: "proactive maintenance" based on the analysis of the causes of failure and not on symptoms (Fusko et al, 2018) in which proactive actions are taken as a result of monitoring, diagnosis and prognosis and the use of decision-making algorithms for data analysis; "tele-maintenance" or remote maintenance which is fully supported by technologies such as virtual reality (Boessenkool et al, 2013) and augmented reality (Palmarini et al, 2017); "own maintenance" (Dinardo et al, 2018) by using autonomous robot. Also, Di Bona et al (2018) considers that from the nine technological pillars, IoT (Internet of Things) and system integration are the ones that can have the most applications in maintenance management processes, while additive manufacturing and autonomous robots are at the opposite pole, with the fewest applications in maintenance management processes.

The maintenance service can be performed either within the company by an internal structure or by a third-party entity specialized in this field, in which case the beneficiary company will search for and choose a service provider that will be able to carry out the maintenance process, the relationship between them being established through a maintenance contract. In the latter case, the advantages are closely linked to the emergence of competent entities in the field of maintenance that have specific knowledge, modern technologies, technical capabilities and qualified personnel, thus optimizing the performance of maintenance in industrial companies. Regarding the disadvantages of outsourcing, there is the possibility that by adopting an outsourced maintenance policy, knowledge regarding internalized maintenance will be reduced, the company becoming dependent on the maintenance provider. From a certain perspective, it can be said that when maintenance activity is contracted for all types of maintenance, the contractual period actually represents the lifetime of the system/equipment, but on the other hand, maintenance providers can change, multiple contracts with different contractual periods can be concluded.

At the same time, industrial companies enter into various contractual relationships more often, given the multitude of needs they cover but also their accessibility and as a result, they have become indispensable to the activities of companies because some contracts are crucial for ensuring the production process (purchase contracts, maintenance contracts). As businesses grow and develop, contracts management has gained more interest, becoming a point of reference in company management. Given that contract management intervenes throughout the contract, from the first stages to its end, contract management covers the contract life-cycle and so, from a managerial perspective, a contract must be viewed from three major stages: pre-contractual,

contractual, post-contractual. In the pre-contractual stage, there are a series of specific activities that are carried out such as: contracting offer, negotiations, contract drafting. The contractual stage is viewed from the following perspectives: contract approval; contract execution, obligations management, review, contract audit and reporting. The last stage is the post-contractual stage that occurs after the termination of the contract, the parties being able to opt for the renewal of the agreement, in which case they can use the information collected as a result of the execution of the previous contract and can include those aspects in a new contract.

Literature review

Although maintenance management and contracts management have been extremely widespread topics, being the subject of numerous specialized studies, maintenance contracts management has not enjoyed such attention from specialists despite the real needs of companies and the growing interest in this topic.

Given that management is the process of planning, decision-making, organizing, leading and controlling an organization's resources, maintenance contracts management combines legal knowledge, managerial knowledge and specific knowledge in the field of maintenance. When a contract is poorly drafted, an organization could lose considerable amounts of money due to a simple technical issue that was not previously identified. Effective contract management can ultimately create a strong business relationship and pave the way for greater long-term profitability, but only when managed correctly (Clarke, 2021). In Khan's opinion (2018), At the company level, a multidisciplinary team is needed to help the manager manage the activity, as the contract includes legal, commercial, technical and financial aspects. Thus, good contracts management will reduce risk, increase certainty and enhance the reputation of a company, because the existence of a department that ensures contracts management determines an added value in the choice of contractor.

The role of maintenance contracts management is to ensure the continuous coordination of the contractual relationship between the beneficiary company and the maintenance provider, the monitoring and control of the activities and results obtained by the provider, as well as the coordination, monitoring and control of all activities and resources involved at the beneficiary company level during the contract period.

Thus, the most appropriate thing for carrying out an efficient outsourced maintenance activity would be the existence of some benchmarks that would support the managers of the beneficiary companies in the maintenance contracts segment, namely the existence of a maintenance contracts management model. Since at the moment there are no specialized works that address the issue of maintenance contracts management and propose relevant models in this field, the paper sought to identify contracts maintenance models from related fields, which can serve as a reference in applying the focus group research method.

Identified models

A first contracts management model was identified in the field of construction contracts, the authors being Gunduz & Elsherbeny (2020). They proposed a multidimensional operational model for measuring construction contracts management performance based on eleven factors. The study revealed that although all of these factors influence construction contracts management performance, the factors related to communication and relationships, performance monitoring and reporting, and documents and records are the most significant.

The second contracts management model was identified in the field of procurement where Garrett & Rendon (2005) introduced a contracts management maturity model through which they wanted to provide an evolutionary roadmap for the organization to follow in order to improve the capacity of the contracts management process from an ad-hoc (immature) to an optimized (mature) process. Optimized contracts management processes provide organizational capabilities that can consistently produce successful results for procurement managers. The procurement contracts management maturity model is based on five maturity levels, referred to as ascending, depending on the stage of development of contract management within a company.

Thus, it starts with an ad-hoc level (first level) where although the existence of contracts management processes practiced by other companies is known, there are no basic contracts management processes at the company level and organizational managers and contracts management personnel are not held accountable for compliance or non-compliance with the established processes. This continues with a basic process capability (second level) where basic contracts management processes and standards are established but only for complex, critical or high-visibility contracts. The third level is determined by a fully structured and institutionalized process capability where there is formal documentation developed for these contracts management processes and standards. The fourth level is characterized by processes integrated with other organizational processes that result in benefits across the company, and the fifth level assumes that the optimized processes have focused on continuous improvement and the adoption of lessons learned and best practices.

Procurement contracts management maturity levels are inspired by TRLs (technology readiness levels) that measure the maturity level of a technology as it progresses through its research, development and implementation phase and represent an effective way for companies to assess their level of capability and effectiveness for the critical contracts management process.

The third contracts management model, called the smart model, represents the intelligent way of managing contracts through the use of smart contracts or software platforms through which contract management is achieved throughout their life cycle, namely creation, collaboration, execution, tracking and renewal, offering an optimized and integrated solution that ensures increased productivity and efficiency within the contracted services.

In the field of construction, Hunhevis et al. (2020) propose a smart contracts model that uses digital twins and blockchain technologies to enhance contractual performance. The concept of digital twins requires three parts: the physical product, the virtual replica, and the connection between them. The connection is made using the Internet, which describes the concept of devices (things) with embedded electronics and software that collect and exchange data over the Internet. In the digital twin concept, smart devices collect data that they then transmit to the virtual representation and then vice versa, in order to optimize the physical state of the product based on the analyses performed on the virtual model.

The fourth contracts management model identified in the literature represents a solution for optimizing maintenance contracts by using mechanism design theory (Hong et al, 2016). In mechanism design theory, the beneficiary tries to design a mechanism (contract) that will allow him to achieve his goal in a game (maintenance actions) with the help of a provider. Mechanism design theory is also called reverse game theory, because the outcome of the game (actions, costs, profit) is designed by the mechanism and is not just the consequence of an existing game.

Comparative analysis

Given that the models identified in the specialized literature present differences depending on the purpose pursued, they will be analyzed comparatively by reporting them to the main functions of management (Dalota & Baragan, 2020) respectively: planning, organizing, leading and controlling.

Table 1. Comparative analysis of contracts management models

Basic management functions	Model 1 Gunduz & Elsherbeny (2020)	Model 2 Garrett & Rendon (2005)	Model 3 Hunhevis et al (2020)	Model 4 Horn et al (2016)
Planning	Start-up governance and management; Team management.	Procurement planning; Sourcing planning; Sourcing; Source selection.	Establishing activity; Establishing user addresses; Roles; Sensor and digital twin IDs.	Creating contract templates for different providers.
Organizing	Communication and relationship management; Quality and acceptance management; Document and records management; Financial management.	Contract administration.	Configuring the smart contract.	Contract selection by the provider.
Leading	Change and change control management; Complaints resolution management.	-	-	Incentives compatible mechanism.
Controlling	Performance monitoring and reporting management; Contract risk management; Contract termination management.	Contract termination.	Permissions Check; Performance Levels Check; Workflow Logic Execution.	Monitoring the provider's objectives and actions.

Source: Authors' own research results.

It can be seen that the models are quite balanced, although in some cases the emphasis is placed more on the planning or controlling function to the detriment of the leading function. In the case of the maturity model proposed by Garrett & Rendon (2005), it focuses on very good planning and administration, which are essential in order to reach the highest possible level of maturity, while in the case of the smart contract proposed by Hunhevis et al (2020), the leading function is completely missing due to the lack of the human factor in this management process, the designed system being the one that checks user permissions, verifies the fulfillment of performance levels and automatically executes the workflow. Regarding the optimization model (Hong et al, 2016), the motivation of the provider to fulfill the obligations assumed is also achieved through incentives. The contracts performance model proposed by Gunduz & Elsherbeny (2020) pays attention to all management functions although it approaches the organizing function from a more complex perspective.

Methodology

The focus group discussion was designed both to gather information from experts relevant in the field of the paper and to clarify certain aspects regarding the development of a maintenance contracts management model, which will also facilitate the compilation of the questionnaire for future quantitative research. This was a qualitative study that used the focus group to explore the

knowledge and experience of people in different roles and hierarchical positions within the university and companies. The focus group provided the participants with the opportunity to reflect on their experiences, revealing other approaches previously unidentified by the researchers. The positions of the participants of the focus-group were: a lawyer, a university professor with extensive experience in the legal field, a university professor with extensive experience in the management field, a manager of a company, an engineer. The focus-group research was structured in three stages.

In the first stage, before the actual discussion began, the participants were presented with the topic of the discussion, then the rules of the debate were explained to them. There were no right or wrong answers, it was desirable that the participants speak in turn and all participate in the discussion. The participants were asked general questions regarding what maintenance contracts management means in their opinion and how should maintenance contracts be efficiently managed in a company. Subsequently, it was presented that, following an exploratory study of the specialized literature in the field, it was identified theoretical elements that compose and define a conceptual framework, regarding maintenance contracts management. Through the group interview, the aim was to capture perceptions, opinions and knowledge from professional and personal experience regarding the dimensions that can form the basis for the development of a maintenance contracts management model as they were identified from the literature. Thus, the dimensions and sub-dimensions identified in the literature of the four contracts management models were presented.

In the second stage of the focus-group, after the introductory stage of presenting the list of dimensions and sub-dimensions, the analysis and discussion stage between the focus group participants followed, as a result of which the following were concluded: consensus on the understanding of the notion of maintenance contracts management, accepted as a system that governs the entire outsourced maintenance activity of a company, from the moment of creating contracts until they have achieved their purpose (either by performing the contracted activity or by reaching the deadline), having a continuous and comprehensive approach that involves not only careful planning, diligent reviews, strict compliance, but also strategic decision-making in order to optimize the maintenance activity; consensus on the importance of each dimension and sub-dimension exposed at the beginning of the group discussion, which contributes to the development of an maintenance contracts management model; consideration of the dimensions on which there was a consensus of at least 4 out of 5 opinions of the experts participating in the focus group; eliminating dimensions on which there was no consensus of at least 4 out of 5 opinions regarding their relevance and importance; eliminating incorrectly defined or inconclusive dimensions.

In the third stage, following the focus group and careful analysis of the discussions held by the participants, a series of significant aspects were noted and summarized.

The focus group discussions were based on the dimensions extracted from the specialized literature, grouped within the four basic management functions. Thus, specifically for the planning function, the following dimensions were considered: Governance and start-up management; Team management; Procurement planning; Sourcing planning; Sourcing; Source selection. Activity establishment; User address establishment; Roles; Sensor and digital twin IDs; Creation of contract models for different providers. For the organization function, the following dimensions were analyzed: Communication and relationship management; Quality and acceptance management; Document and records management; Financial management; Contract administration; Smart contract configuration; Contract selection by the provider. Regarding the leading function, the following dimensions were taken into account: Change and change control management;

Complaints resolution management; Incentive-compatible mechanism. Finally, specific to the controlling function, the following dimensions were analyzed: Performance monitoring and reporting management; Contract risk management; Contract termination management; Contract termination; Permission verification; Performance level verification; Logical execution of the workflow; Monitoring of the provider's objectives and actions.

Results and discussions

Following the discussions within the focus group, it was considered that in order to properly manage maintenance contracts, it is necessary to plan a start-up management very carefully and to have a dedicated and competent team to supervise and manage all maintenance contracts. At the same time, in order to streamline maintenance activities and avoid operational blockages, it is recommended to establish a communication system between the contracting parties, for this purpose the communication and relations dimension being relevant. Given that maintenance activities are the subject of managed contracts, ensuring the consistent execution of maintenance is crucial, with beneficiary companies having to develop a system that ensures periodic checks are carried out. The increasing development of technology is a factor to consider when managing maintenance contracts, with the competent team truly benefiting from the use of available digital tools. Also, the participants agreed that in order to optimize outsourced maintenance activity, it is important to verify compliance with maintenance requirements, the reliability and maintainability of the system/machinery/equipment subject to maintenance, as well as to prepare regular progress reports. Following the discussions within the focus group, it was revealed that interdepartmental collaboration is necessary (between maintenance contract management and the technical, financial, accounting, procurement, research, operations departments) in order to ensure efficient management. It is also necessary that at the end of the contractual period, the beneficiary company reviews the provider's activity in a timely manner and considers the possibility of contractual renewal. All of the participants considered that it is not relevant for maintenance contracts management: procurement planning, creating contract templates for different providers and contract selection by the provider.

Thus, the following dimensions were established as relevant in the issue of maintenance contracts management: start-up management, team, communication and relationships, execution, smart component, performance monitoring and reporting, integration and completion.

Table 2. Dimensions and sub-dimensions of the maintenance contract management model

Dimensions	Sub-dimensions
Start-up management	Establishing a process to determine the maintenance object and the type of maintenance to be contracted; Establishing the maintenance policy; Conducting market research to identify the latest maintenance services; Selecting the contract type (one-time execution or successive execution) of the contractual terms and conditions; Establishing the price and supplements; Conducting a pre-award survey of the potential provider to verify its technical capacity.
Team	Designation of a competent maintenance contract management team; Designation of roles and responsibilities; Conducting training programs.
Communication and relationships	Establishing a communication system; The need for the parties to agree on any changes; Scheduling regular meetings; Managing operational issues in a timely manner; Assigning responsibility for contract risk; Organizing a meeting to ensure that all providers understand the technical and contractual requirements of maintenance.
Execution	Adopting a system for verifying timely maintenance for preventive maintenance or verifying complete maintenance performance in the case of corrective maintenance; Carrying out periodic checks to verify the compliance of the maintenance performed; Notifying providers in the event

Dimensions	Sub-dimensions
	of non-performance/delayed or non-compliant performance of maintenance activities; Adopting a system for making payments on agreed deadlines.
Smart component	Storing contracts in the cloud; Using smart contracts; Making payments through digital instruments; Using A.I. technology; Using electronic signature.
Performance monitoring and reporting	Monitoring the performance of service providers to ensure the fulfillment of contractual obligations; Managing and controlling contract changes regarding costs, activities and performance requirements; Reporting major problems that occurred both in the contractual relationship with service providers and in the maintenance activity; Existence of a periodic control for non-compliance of the maintenance performed; Preparation of regular progress reports; Notification of the service providers for delay in execution or non-execution; Monitoring service provider resources; Verification of materials used.
Integration	Collaboration of the maintenance contracts management department with other departments in the company (technical, financial accounting, procurement, research, operations) in order to ensure integrated management; Use of an inter-departmental integration software platform; If necessary, spare parts or tools can be provided within the company.
Completion	Establish a contract termination system (termination, maintenance performed); Early review of closure documentation; Verification of physical completion of maintenance work; Documentation of lessons learned and best practices; Possibility of contract renewal.

Source: Authors' own contribution.

In this way, maintenance contract management involves a complex approach that tracks maintenance contracts in a company throughout their lifecycle, including in the event of renewal.

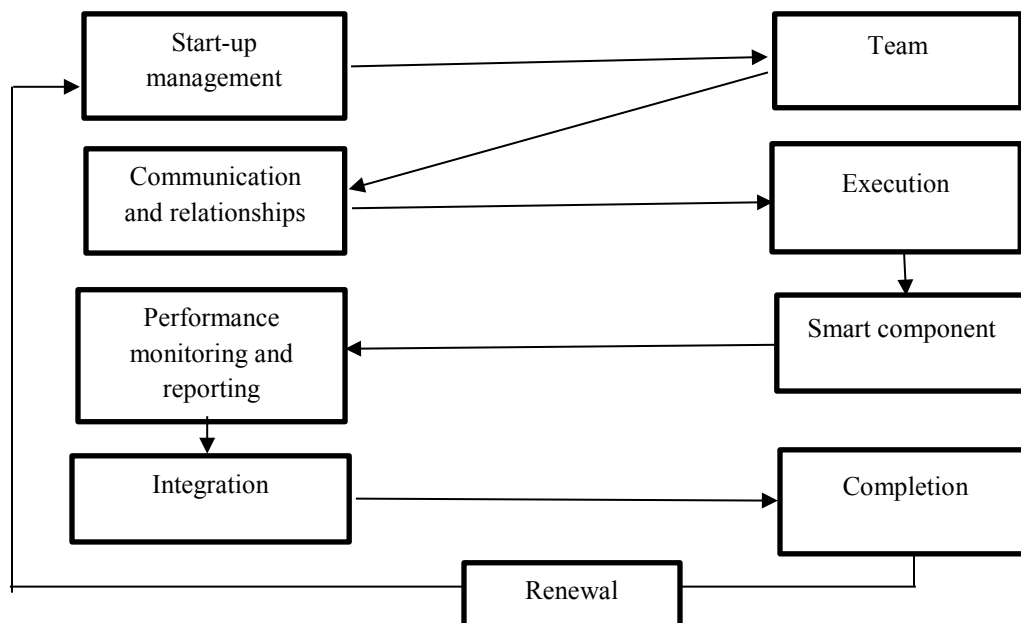


Figure 1. Maintenance contracts management model

Source: Authors' own contribution.

The maintenance contracts management model is thus proposed, which follows the eight dimensions identified as the most relevant, namely: start-up management, team, communication and relationship, execution, smart component, performance monitoring and reporting, integration and completion. Through these dimensions, timely management of ongoing maintenance contracts at a company level can be carried out, an instrument made available by this paper with a comprehensive and efficient approach to the issue of maintenance contracts management.

Conclusion

Given that management is the process of planning, decision-making, organizing, leading and controlling the resources of an organization, maintenance contracts management combines legal knowledge, managerial knowledge and specific knowledge in the field of maintenance. Given the complexity with which this issue must be approached, the most appropriate would be the existence of a maintenance contracts management model that can support the managers of industrial companies.

Since there are currently no specialized works that address the issue of maintenance contracts management, the paper identified four contracts management models from related fields on which a comparative analysis was conducted in order to extract relevant dimensions and sub-dimensions that would form the basis of focus group research aimed at establishing the dimensions and sub-dimensions that contribute to the development of a maintenance contracts management model.

Following the focus group research, consensus was reached on the dimensions that will underpin the proposed maintenance contracts management model, which are: start-up management, team, communication and relationships, execution, smart component, performance monitoring and reporting, integration and completion.

In the future, the authors will focus on quantitative research of the topic addressed through a statistical analysis of the responses provided by specialists in the field in order to validate the results obtained through this paper.

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