applied sciences

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A Maintenance Maturity Model for Assessing Information Management Practices for Small and Medium Enterprises (M^3AIN4SME)

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Abstract: Maintenance management is assuming an increasingly important role and garnering increased attention in Small and Medium Enterprises (SMEs). However, the difficulty of collecting data and processing information is evident in such contexts. In the current literature, few maintenance maturity models focus on the maintenance information management practices field. Moreover, though the existing models allow for assessing the maturity level, they do not indicate or assist in identifying and defining actions to reach the highest level. Furthermore, these models are not suitable for any type of organisation, as the assessment areas defined are quite generic (high level). For this reason, this paper proposes an innovative model for assessing the maturity level of maintenance management information practices in Small and Medium Enterprises (SMEs). The model provides the organisation with the strengths and weaknesses of their maintenance information management practices. The proposed model allows a clear measure of the maturity of the maintenance information management practices in smaller industrial contexts and provides a customised improvement programme. The model proposed supports small and medium companies to improve the effectiveness and efficiency of their maintenance management information infrastructure. The maturity model developed, in addition to being an assessment tool, provides and supports knowledge on the behaviours and practices for achieving world-class results.

Keywords: industrial maintenance; maintenance management information systems (MMIS); Small and Medium Enterprises (SMEs)

Citation: Tortora, A.M.R.; Di Pasquale, V.; Iannone, R. A Maintenance Maturity Model for Assessing Information Management Practices for Small and Medium Enterprises (M^3AIN4SME). *Appl. Sci.* **2022**, *12*, 9282. https://doi.org/10.3390/app12189282

Academic Editor: Antonella Petrillo

Received: 26 July 2022
Accepted: 14 September 2022
Published: 16 September 2022

1. Introduction

The maintenance concept has suffered many transformations over the years and, today, it is considered as a complex management process that plays an important role in supporting organisations to reach their goals of productivity, profitability, sustainability and competitiveness, and in ensuring that their equipment operates effectively and efficiently [1]. The maintenance management process of an industrial plant involves handling a large amount of information that appears in organisations as a strategic resource of performance improvement, but may be difficult to identify, structure, analyse and reuse properly. Over the last decade, the amount of information that is created, stored and accessed within an organisation has risen exponentially and continues to rise for the development of more complex business processes. The use of the information and, consequently, the development of more effective strategies for its management are widely accepted as important issues for any organisation. For this reason, information management activity continues to be widely researched by both industry and academia.

Problem statement: Small and Medium Enterprises (SMEs) demonstrate relevant relationships between their characteristics and barriers, information technology, maintenance management practices and maturity models [2]. SMEs generally take an unsuccessful approach to information management, due to their specific characteristics and limited resources. Many SMEs hold insufficient in-house expertise for successful information system

adoption, and they need an up-to-date and well-managed database. Several surveys [3,4] demonstrated the existence of various conditions and barriers to Maintenance Management Information System (MMIS) adoption in SME companies (maturity level of the maintenance department and human, organisational and economic factors). Other studies [1,5–9] demonstrated the gap between the existing system functionalities and the SMEs' specific needs, causing an unsuccessful implementation of them. The existing maintenance maturity models [10–13] focus on generic assessment areas formulated from the literature, as maintenance management processes key measures that do not vary in importance depending on the business context; the information management assessment area is also not always deeply and properly considered.

Research questions: How is it possible to identify the status of the maintenance management practices and the level of the quality of the maintenance data collected and managed in an SME? How could it be improved with an effort appropriate to the company's expertise?

Objectives: This paper provides an innovative Maintenance Maturity Model for Assessing Information management practices for Small and Medium Enterprises (M^3AIN4SME). The approach allows an understanding of the strength and weakness points regarding maintenance information management practices (methodological, managerial, organisational and technological capabilities of the maintenance department) and to consequently identify the improvement and innovation actions to undertake.

The paper is organised as follow: Section 2 reports the literature results concerning the relationship between SMEs, Information Technology (IT) and maintenance, and different aspects of MMISs in the industrial organization; Section 2 also includes an overview of the maintenance maturity model in order to highlight the gaps and challenges and the novelty of the model proposed in this work. Section 3 describes the M^3AIN4SME model and all the steps performed to develop the model. Finally, the main conclusions and future developments are presented in Section 4.

2. Literature Overview

In the literature overview, different issues were addressed: The relationship between IT and the maintenance management practices used in SMEs were explored (Section 2.1). The trends and the main aspects of the MMIS were pointed out in order to understand the main characteristics of these systems and the limits of the existing systems for a specific type of organisation (Section 2.2). As the maturity of the maintenance department of the smaller industrial context seems to be the main reason for an unsuccessful introduction of MMIS, this topic was investigated to shed light on the methods developed to build a maturity model (Section 2.3).

2.1. IT and Maintenance Management in SMEs

In today's industries and organisations, the management of information is an important and necessary activity [14]. Information management aims to support all business functions, improving operating efficiency and organisational performance. For these reasons, information management is accepted by many organisations as an essential aspect that needs to be structured and better exploited. Moreover, recent technological advancements and the rapid growth of IT and computer networks are changing the way companies handle information. A growing stream of research since 1980 has examined the concept of IT as a powerful competitive factor for organisations [15]. Studies on the role of IT in competitiveness have been primarily focused on large organisations [16]. Few works have attempted to investigate the role of IT in SMEs, especially the role of IT in the maintenance management of SMEs context. SMEs rarely view maintenance as a strategic issue that will translate to a significant contribution to the company's profit margins [1]. Nevertheless, the growing importance of the maintenance process within enterprises, and the large amount of information to manage, have created the need to introduce systems better able to manage the maintenance information flow. Furthermore, the literature has outlined that SMEs generally have a poor approach to IT management and, consequently, fail in this field due

to different factors. SMEs are constrained in terms of their financial and human resources; the decision process is more intuitive and, based on experience, most of the activities are governed by informal rules and procedures, with a low degree of standardisation and formalisation. At the information systems level, other relevant features, identified in a literature review by [7], were pointed out: SMEs often lack the managerial expertise to plan, organise and direct the use of information resources, and many SMEs hold insufficient in-house expertise for successful information system adoption. The information system is still perceived in its first stage of evolution, mainly used to support the accounting function. Moreover, SMEs are reluctant to invest in IT to support the industrial process, especially in the IT for supporting the maintenance process. Small organisations seldom have a defined IT budget or an explicit IT plan or strategy [17,18]. The owner often drives investments in technology, rather than by any formal cost–benefit or strategic analysis. These reasons could cause a low success rate for MMISs supporting the maintenance process. Most SMEs rely on outdated technology and labour-intensive and traditional management practices. This, in many cases, has led to a lack of information and inadequate in-house expertise [19]. Most SMEs have simple systems and procedures that allow flexibility, immediate feedback, a short decision-making chain, better understanding and a quicker response to customer needs than larger organisations. Despite these supporting features, SMEs are under great pressure to sustain their competitiveness in domestic and global markets [8].

2.2. Maintenance Management Information Systems

Since a huge amount of maintenance data needs to be analysed quickly and efficiently to make better decisions [20,21], MMISs became necessary systems to improve the overall maintenance process. The literature highlights the growth in this field in recent years. Different positive and negative features have been discussed in many studies. Indeed, the scientific literature on this topic can be divided into different clusters related to the specific issues addressed regarding MMISs. Some studies focused on describing and/or improving the common features of an MMIS, since it can be considered as a set of functions that process data to develop indicators supporting maintenance activities. In addition, according to the literature, the main use of MMIS appears to be as a storehouse of maintenance information and data. Companies consume a significant amount of management and supervisory time compiling, interpreting and analysing the data captured within an MMIS. Based on these issues, the authors considered most of the existing off-the-shelf software packages, especially the Computerized Maintenance Management Systems (CMMS) and Enterprise Resource Planning (ERP) systems, as systems greedy for data input that seldom provide any output in terms of decision support. Despite the relevant benefits associated with MMIS as a support tool in maintenance management, different factors affect its implementation. Several surveys showed the existence of various barriers to MMIS implementation [3,4]. The most frequently indicated reasons are the maturity level of the maintenance department, high implementation costs, lack of knowledge of the system, unskilled and scarce workforces, and the difficulties in changing organisational culture [4]. Thus, if, on one hand, an MMIS is declared as a suitable tool to enhance maintenance activities, on the other hand, it yields low success due to the readiness level of the smaller industrial contexts that are still unaware of the key role played by the maintenance function.

SMEs should be ready to adopt an MMIS. This requires a change in the recognition of the maintenance function as a key tool, not only for saving money by reducing the frequency of failures, but also for improving the availability of the plant (as equipment reliability increases) and the quality of the products being manufactured [22]. Furthermore, this trend highlights the importance of introducing an appropriate MMIS that reflects the readiness level of the specific industrial context. This satisfaction is dictated not by the features of the system, but by the culture of the maintenance department. One of the main issues in the development of an MMIS is to understand the maturity stage of the maintenance function.

2.3. Maintenance Maturity Models

The literature analysis conducted demonstrates that the recognition of the current maturity state of the maintenance process in the organisation is a mandatory step to determine the specific need in an industrial context and, consequently, a successful adoption of an MMIS; for this reason, an exploratory study on these systems was carried out.

The purpose of the Maintenance Maturity Models (MMM) analysis is to understand what the main aspects are for developing a maturity model for the maintenance information management domain. Maturity models have proliferated across a multitude of domains since the concept of measuring maturity was introduced with the Capability Maturity Model (CMM) from the Software Engineering Institute (SEI)—Carnegie Mellon [23]. Maturity models can be seen as a simple method that allow organisations to effectively measure the quality of their processes.

During the last two decades, the application fields for maturity models have widened. In the study of Wendler [10], who proposed the first systematic summary of the maturity model research, two points of view are underlined when developing a maturity model:

1. The life cycle perspective identifies those models having a well-defined 'final' stage of maturity that will be reached while evolving. Therefore, it may serve as a tool for management supporting the development of the examined objects. The idea is that an organisation evolves over time and, therefore, automatically must pass all the stages due to the improvements and learning effects. The user may decide if it is desirable to proceed to the next stage.
2. The potential performance perspective is principally used for the same purpose as above, but with a slight difference. These models show a development path, too, but the stages focus on the potential improvements that occur by moving along.

Maturity models, regardless of the perspective, describe and determine the state of perfection or completeness (maturity) of certain capabilities. The application of this concept is not limited to any domain. Therefore, maturity models define simplified maturity stages or levels that measure the completeness of the analysed objects via different sets of (multi-dimensional) criteria.

This explanation is reflected in the definition by Becker [24]: 'A maturity model consists of a sequence of maturity levels for a class of objects. It represents an anticipated, desired, or typical evolution path of these objects shaped as discrete stages. Typically, these objects are organisations or processes.' To summarise, two relevant issues must be considered during maturity models' development: the definition of maturity levels along which the examined object evolves and the criteria for measurement.

The identification and characterisation of maturity levels have been discussed in various knowledge areas, such as in project management, quality management and systems development, and the practical application of findings has led to the achievement of better results [11]. The first maturity model was introduced in the quality management area by Crosby and Free [25]. Maturity models allow an organisation to have its methods and processes evaluated by good management practices and with a set of external parameters. Typically, a maturity model consists of the following components [26]:

1. the number of maturity levels (ML),
2. a descriptor for each level, (e.g., uncertainty, certainty),
3. a description of the characteristics expected of an organisation at each level,
4. the number of dimensions,
5. a description of the elements/activities at each dimension,
6. a description of each activity as performed at each maturity level.

Over the past few decades, maturity models have been developed and applied in different areas encompassing product development, software management, patient safety culture, information management and risk management [24,27,28]. However, little of the published literature has reported on the development and application of maturity models in asset maintenance [11–13]. Many Capability Maturity Models (CMM) for asset main-

tenance are reported in unpublished literature sources, developed largely by consultants or individual companies as in-house maturity assessment tools. These models are mainly proprietary and contain limited information, especially regarding their development and use. Whilst several CMMs have been developed in the past few decades, the applicability of such models in asset maintenance is limited [10]. Moreover, all these models reviewed in the study of Olivera and Lopes [11] allow for assessing the maturity level, but do not indicate or assist in the identification and definition of the actions/activities that must be pursued to reach the highest level. Applying these models to different organisations may not be straightforward due to differences in several aspects, including the organisational structure and business context [12].

Moreover, in the maintenance maturity models available in the literature [11–13], the information maintenance management domain, if considered, often represents one of the measurement classes and is, therefore, not well detailed.

Methods for Maturity Assessment Development

Whilst maturity models are common and broad in application, few guidelines, procedures and methods are presented on how to develop a maturity model that is theoretically sound, rigorously tested and widely accepted for small and medium enterprises. The main models available in the literature [24,28–32] are reported in Table 1. These studies mainly proposed a method to develop a generic maturity model without considering the specific key elements related to the SME context. The models' features were analysed, for the purpose of this study, to apply the best practices in this field for the development of a model for the evaluation of information practices on maintenance management in the SME context, and to provide a more robust and rigorous model from a methodological point of view.

The general activities that these methods consider, at the first stage, are the problem identification, the identification of participants, and the scoping and planning of the goals. At the second stage, the activities establish the design strategy and architecture of the model. That is, they define the levels of capability and dimensions (some authors name these processes or focus areas) and establish the best practices expected for each dimension according to its capability level. At the third stage, an instrument to measure the maturity of the object of interest is built, and the procedures for its deployment and management are defined. In the last stage of development, the maturity model and assessment tool are validated. If the model is accepted, it enters a maintenance stage, where changes are managed and, if necessary, the model or instrument is updated.

2.4. Maturity Models & Maintenance Management: Gaps and Motivation of the Paper

The analysed MMMs propose the use of numerous subjective assessment criteria and, as such, may present applicability challenges when used for maintenance maturity measurement [10–12]. However, the MMMs discussed in the previous section ignore several important aspects for all types of companies, both SMEs and large enterprises, including:

1. no clear method/framework for deriving the assessment items,
2. the absence of a clear linkage between the maintenance process (especially executive) and assessment items,
3. no improvement programme that supports companies to reach a higher maturity level is included.

Moreover, in the existing models, the assessment areas defined are generic (high level), formulated from the literature as maintenance management process key measures, and do not vary in importance depending on the business context; this, potentially, could lead to ambiguous maturity results. This becomes particularly relevant for SMEs, which usually do not have a structured maintenance organisation; therefore, the measurement classes identified could be incoherent within their specific business context.

Table 1. Studies available in the literature for the maturity model development.

Title	Year	Scope	Development Phases
Understanding the Main Phases of Developing a Maturity Assessment Model [32]	2005	This paper proposes a methodology and outlines the main phases of generic model development. The paper applies the model proposed to two advanced maturity models in the domains of Business Process Management and Knowledge Management.	(1) Scope (2) Design (3) Populate (4) Test (5) Deploy (6) Maintain
Developing Maturity Models for IT Management—A Procedure Model and its Application [24]	2009	This paper proposes a procedure model for the development of maturity models. A case study shows the applicability of the model. The results of this paper are used as a manual for methodically well-founded designs and evaluations of maturity models.	(1) Problem definition (2) Comparison of existing maturity models (3) Determination of development strategy (4) Iterative maturity model development (5) Conception of transfer and evaluation
A method framework for engineering process capability models [30]	2009	This article introduces a Method Framework for Engineering Process Capability Models as an element of a methodology on a Process Capability Profile to drive Process Improvement.	(1) Initial decisions (2) Source analysis (3) Strategy for development (4) Model design (5) Draft model development (6) Draft model validation (7) Model consolidation
Assessing Organisational Capabilities: Reviewing and Guiding the Development of Maturity Grids [28]	2009	This paper presents both a reference point and guidance for developing maturity grids.	(1) Planning (2) Developing (3) Evaluation (4) Maintenance
The Design of Focus Area Maturity Models [29]	2010	This paper presents a generic method to develop a particular kind of maturity model: the focus area maturity model. The focus area maturity model is particularly well-suited to support incremental development of functional domains, as it departs from the concept of having a limited fixed number of generic maturity levels as used in CMM. Instead, it defines maturity levels, called 'capabilities', per focus area within the functional domain.	(1) Scoping (2) Design model (3) Instrument development (4) Implementation & exploitation
Development of Maturity Models: A Systematic Literature Review [31]	2012	In this paper, a systematic literature review was conducted to discover and analyse the existing methods and recommended practices for developing maturity models. The SLR results have served to propose a method for developing maturity models that are focused on product quality characteristics.	(1) Stating the problem (2) Establishing the goals (3) Developing a plan to perform a new maturity model.

For these reasons, this paper aims to develop a maturity model suitable to assess the maturity level of small and medium enterprises related to their maintenance management information practices. The maturity model is built on a well-designed and systematic approach and the proposed model provides, in the output, the strength and weakness points of the smaller industrial context. The objective of a customised improvement programme starting from the company's current maturity level is to provide the direction/indication for improving maintenance management information practices and reaching a higher maturity level. The aim is to support small and medium companies in introducing an appropriate maintenance management information infrastructure that reflects their current maturity level.

3. The M^{3}AIN4SME Model

The elements characterising the maturity models presented in Section 2.3 and the steps for their development (Table 1) have been taken as a reference and integrated in an innovative way in the development of the M^{3}AIN4SME. The proposed approach (Figure 1), composed of three steps, aims to measure and improve the effectiveness of the maintenance information management practices in SMEs.

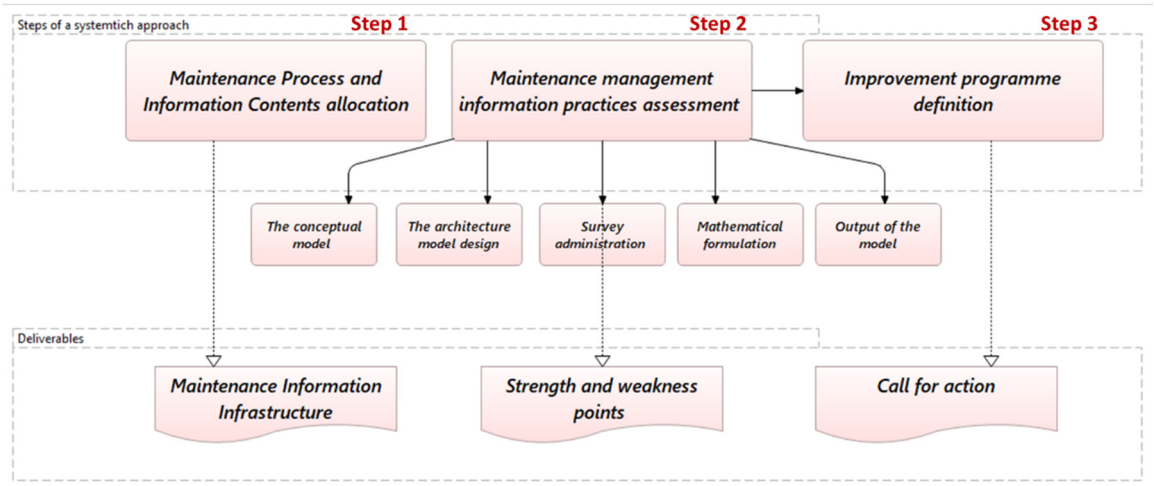

Figure 1. The M^{3}AIN4SME model.

Step 1 consists of a proper allocation of information contents to the maintenance process. The output is the identification of the maintenance information infrastructure, including the most significant information databases, essential for the proper maintenance process execution.

The assessment of the maturity level (ML) of the maintenance management information practices is performed through a well-organised and standardised approach (Step 2). The measurement of the ML allows the identification of the areas where improvements can be made.

To achieve the highest ML, the improvement programmes (Step 3) are defined, so that the company is driven by a strategic roadmap based on the selection of the maintenance management best practices.

3.1. STEP 1: Maintenance Process and Information Contents Allocation

The generic maintenance process has been investigated to identify all the possible information contents. In many studies, a representation of a maintenance process was presented [33–36], and, using the analysis of the European Standard EN—17007 [37], all the information contents moving into the maintenance process were identified. Regardless of the type of maintenance request (professional, autonomous or emergency) and the item to be maintained, a generic maintenance process can be divided into four subprocesses:

the planning and scheduling, performing, work closeout and monitoring and continuous improvement. To correctly perform the activities included in each subprocess, several pieces of the information contents should be readily available. Each subprocess is based on access to a specific information repository to make proper decisions. Figure 2 describes the complex information infrastructure behind the maintenance process through the Archi modelling tool [5,6].

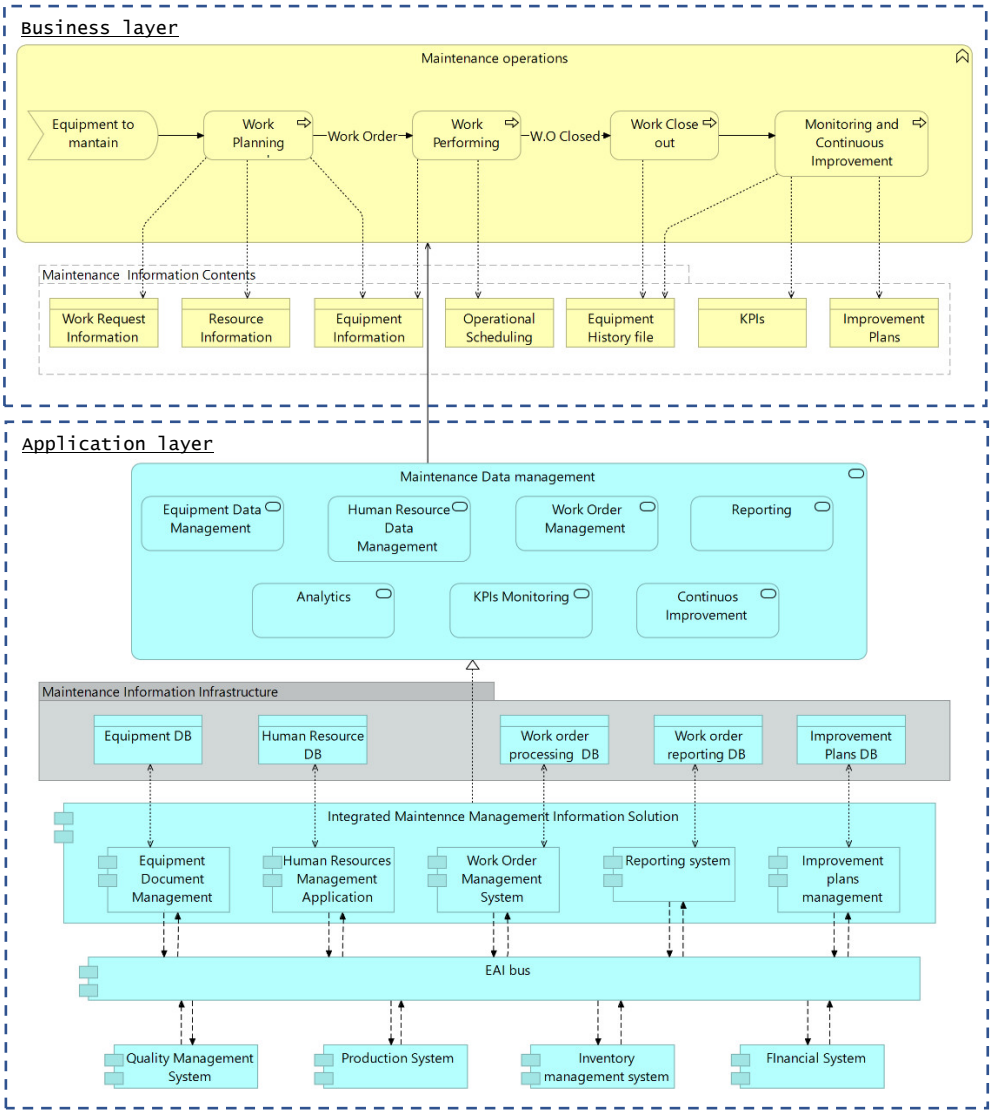

Figure 2. Maintenance process architecture.

The high-level architecture modelling highlights the relevant interaction between the maintenance business process and the application portfolio (seen as a set of databases) that any organisation should have to be competitive.

Figure 2 illustrates the business (yellow boxes) and application (light blue boxes) core layers to demonstrate how meaningful and valuable the data and information management support for decision-making and improvement functions are.

At the business layer, a wide variety of business objects (repositories of information) were used to represent all the data and information that is relevant to execute each subprocess. Considering the maintenance operations, the planner needs the details on the equipment to be worked on, the human and material resources and all relevant information enclosed in the equipment, resource and work-request databases, respectively. Maintenance scheduling requires information such as the maintenance technicians/maintainers, equip-

ment, materials required and reasons for the work. This is the stage where the work request becomes a work order (WO). All the data recorded during the execution stage (concerning what happened on the equipment and what was performed) are processed and organised in the equipment history file. The monitoring of the Key Performance Indicators (KPI) and trend analysis allows the definition of maintenance best practices and the identification of all the improvement plans.

At the application layer, to support and automate the process, an integrated MMIS solution is proposed. The solution consists of different components that perform specific functionalities (e.g., equipment data management, human resource data management, analytics, reporting), thanks to a well-organised and structured database (DB) comprising the equipment, human resource, work order, work order reporting and improvement plans. To reach a complete integration, the maintenance information solution should communicate with all business functions through an enterprise application integration. Nevertheless, just maintaining the quality, reliability and integrity of the data and information is considered a critical point for SMEs. For this reason, SMEs need a procedure to create, organise and process their databases properly.

3.2. STEP 2: Maintenance Management Information Practices Assessment

Step 1 shown in Figure 1 allows the definition of a typical maintenance information infrastructure. The output of Step 1 is used in the development of the maturity model (Step 2). The maintenance information file proved by the first analysis provided inspiration and support for the definition of the maturity model architecture. In the following subsection, all the phases for the development of the maturity model are described.

3.2.1. The Conceptual Model Development

The approach proposed by Becker et al. [24] has been applied to develop an assessment/readiness model on the maintenance management information practices in the SME context. In the following subsection, all the phases (Figure 3) are described.

Figure 3. Phases for the development of maturity models proposed by Becker et al. (2009) [24].

Problem definition: 'The prospective application domain of the maturity model, as well as the conditions for its application and the intended benefits, must be determined before design' [24].

The use of information and, consequently, the development of more effective strategies for its management are widely accepted as being important issues for any organisation, especially for SMEs.

Information is central to strategic planning, management, control, tactical planning and daily operation. The objective of a more effective information management strategy is to efficiently support these activities to ensure that the value of the information is identified and exploited to its fullest extent. Since the 1980s, considerable advances have been made in information communication and technology (ICT) and in handling electronic information. Consequently, the development and application of techniques and tools, computer-based for a given process or activity, has progressed. For the maintenance process, many information systems have been developed. As widely indicated in the literature analysis, these systems are not successfully implemented by SMEs due to their inherent characteristics; the main cause is related to the maturity level of the maintenance department. Maintenance management information practices measurement aims at providing a comprehensive representation of an SME's information infrastructure state. The identification of the present shortcomings and future fields for action using a maturity model was broadly justified by

the available literature studies discussed in the first section. The assessment of the existing situation is a mandatory step to support smaller enterprises in adopting an appropriate maintenance information system.

Comparison of existing maturity models: 'The need for the development of a new maturity model must be substantiated by a comparison with existing models. The new model may also just be an improvement of an already existing one' [24].

Maturity models that explicitly address information maintenance management practices are lacking in the literature. Instead, different maturity models have been identified that view information maintenance management as a subdomain in the maturity assessment of the maintenance process. These maturity models generally disregard the importance of the data collection and the quality of information collected for well-managed databases. There are, however, separate maturity models for IT management, and alignment of functional information systems, but these are not specifically related to the maintenance field. Moreover, it is argued that this fundamental understanding of the existing information infrastructure is critical for the effective specification and implementation of additional elements of the infrastructure to improve information management; it is also a prerequisite for the effective long-term management and development of the IS infrastructure. This issue is not well-evaluated by the existing maturity models since the scope is different.

Determination of the development strategy: 'The most important basic strategies that can be discerned are the completely new model design, or the enhancement of an existing model (CMM); the combination of several models into a new one (CMMI); as well as the transfer of the structures (DPMM, eMM) or contents (ACMM, IS/ICT CMF) from existing models to new application domains' [24].

The comparison of the existing maturity models with the problem definition suggests a design strategy that results in a new model development. The identified maturity models are used as a starting point for the design process since they cover some of the aspects of information maintenance management.

On one hand, their tiered structure, the definition of maturity levels and the suggestion concerning the calculation of the maturity level inspired the structuring of the maturity model; all these parts were expediently transferred to our problem area. On the other hand, all the contents, the definition of the evaluation criteria, the description and the definition of the maturity levels are new contributions.

Iterative maturity model development: 'The central phase of the procedure model is the iterative maturity model development. The sub-steps of this phase, selecting the design level, selecting the approach, designing the model section, and testing the results will be iterated' [24].

The maturity model design was carried out through five stages. In the first iteration, a primary architecture was drafted that included the identification of the main informative databases. Based on extensive research of the literature, the main contents of each model design, their attributes and evaluation criteria were defined during the second iteration. At this stage, the five degrees of maturity, ranging from the identification of a chaotic condition (0) to the best in class (4), were included and described. In the third stage, a structural survey was conducted, and a mathematical formulation of the model was developed in order to measure the maturity level. Furthermore, a consolidated spreadsheet-assisted maturity evaluation was created. In the fourth stage, semi-structured interviews with maintenance experts were conducted in order to confirm the completeness and feasibility of the model. The strong orientation towards the operative aspects of the maintenance management information practices was largely approved, as well as the great precision and details of the contents, whereas some technical aspects were criticised. Following the improvement suggestions, the modified architecture, carried out in the fifth and last stage, led to a revised version of the maturity model that received good feedback from the domain experts.

The concept of transfer and evaluation: 'The different forms of result transfer for the academic and the user communities need to be determined' [24].

Besides academic publications, the current concept of transfer and evaluation includes the administration of the survey to regional SMEs to understand the current situation and to give companies a measure of their maturity. This is meant to expand the empirical basis, create a consistent dataset and validate the model, so far consisting only of the evaluation from the expert interviews. The survey results should allow a statistical survey of the distribution of the degrees of maturity in individual companies to support the definition and creation of an evolution/improvement path.

3.2.2. The Architecture Model Design

The architecture of the maintenance execution process, performed through the ArchiMate, allowed the definition of the maintenance management information infrastructure, composed of a set of databases (DB) (Figure 4):

(1) The equipment DB includes all the documents and information files associated with the equipment and relevant for carrying out the proper maintenance interventions. All the types of documents should be consulted, both to plan a maintenance intervention and to perform the work order. The information files associated with the equipment include the physical and technical documents, failure documents, maintenance documents, and improvement plans.
(2) The maintenance personnel DB includes all the documents and systems associated with the maintenance personnel and are relevant for planning and choosing the correct operator for carrying out the intervention. The systems associated with the maintenance personnel include the systems for education and training, and for reward and recognition, in order to monitor the performance and improve the competencies with a specific training programme.
(3) The maintenance work order system is composed of two parts: a maintenance work order request and a maintenance work order. The maintenance work request represents the completion (paper, telephone or computer) of a form that contains all the information useful to the planner or the maintenance coordinator in order to schedule the maintenance operation. The request can be made by any person in the organisation. The maintenance work order represents the completion (paper, telephone or computer) of a form containing all the information useful to the maintenance and/or production operator in order to carry out the maintenance work (whether it is an inspection, a preventive or replacement intervention or an emergency). In this way, the request, once planned and scheduled, becomes operational.
(4) The maintenance reports system includes elements (data) collected previously for the objects: the equipment, maintenance personnel and work orders.

The aim is to understand what information exists to define the indicators and to monitor the progress of the maintenance process. The scope is to assess the maturity of each DB, considering several criteria: what and how many documents (information files) linked to each DB are currently available and ready to be consulted; the level of accessibility by users and the quality of each document (HOW); the upgrade period (WHEN); the support tool used for their maintenance and management (WHICH); and if, for each one, there is a specific employee who takes care of its correct management (WHO).

Not all the criteria are significant for each DB; therefore, for the maintenance work order only, the criteria HOW and WHEN are evaluated. Regarding the aspects included in a work order request and work order, the other criteria (WHEN and WHO) are not significant.

However, the model developed, to date, covers four DBs: the equipment, maintenance personnel, maintenance work order and maintenance report; therefore, a systematic approach is used to assess the maturity level of each (Figure 4).

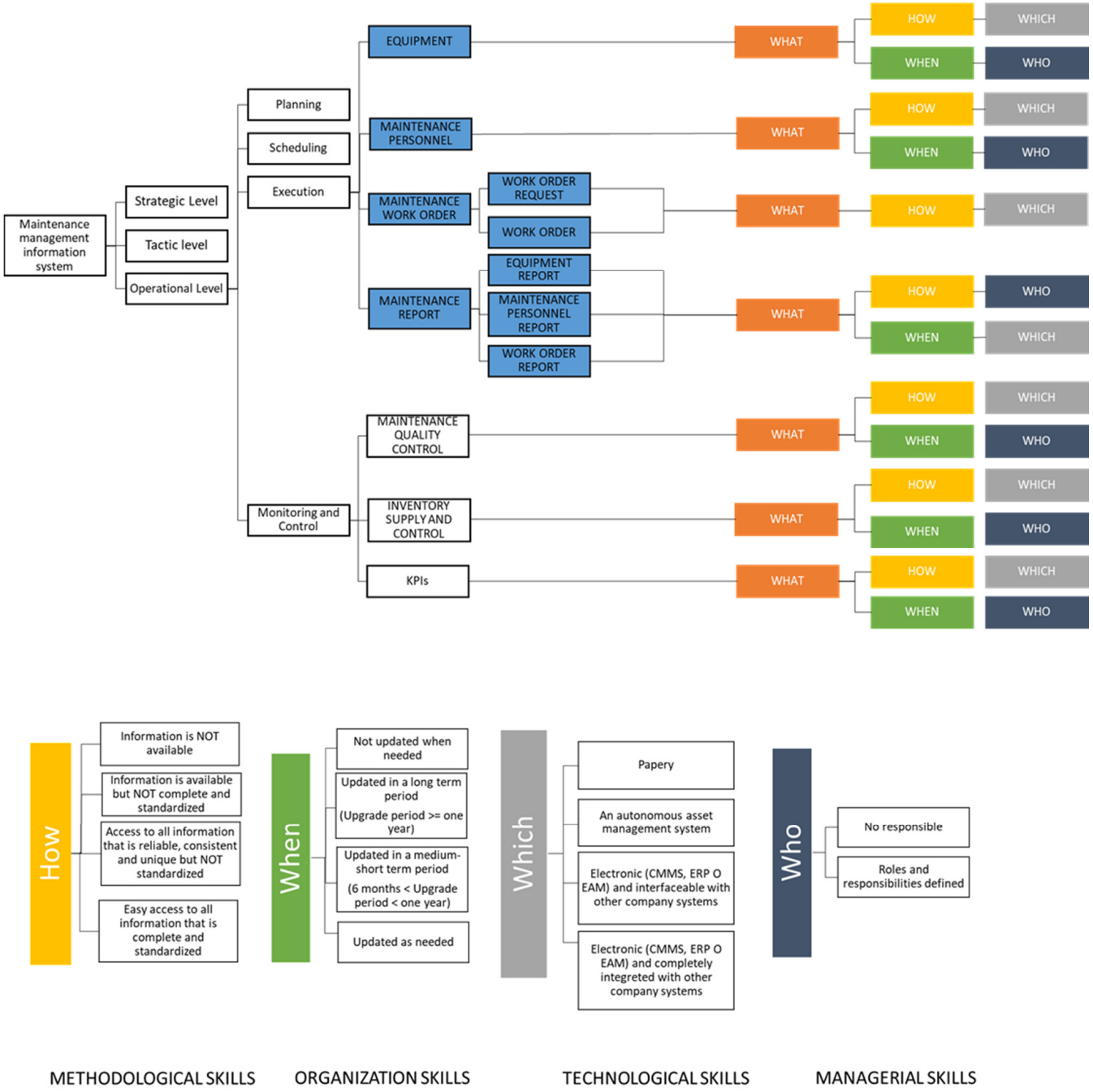

Figure 4. The M[3]AIN4SME architecture.

3.2.3. Survey Administration

A survey was carried out using a well-designed questionnaire to assess the maturity level of the information management practices adopted. The objective was to understand and have a quantitative measure of the maintenance information infrastructure adopted by small companies and to identify their maturity level.

The structured, web-based survey was devised and deployed for the data collection through an open-source platform called LimeSurvey. LimeSurvey is an open-source web application that allows the simple and effective creation of questionnaires and online surveys in which an unlimited number of users can participate. The sampling frame was collected from the lists of companies belonging to regional trade associations. Figure 5 shows the logical structure of the survey, including the main question groups.

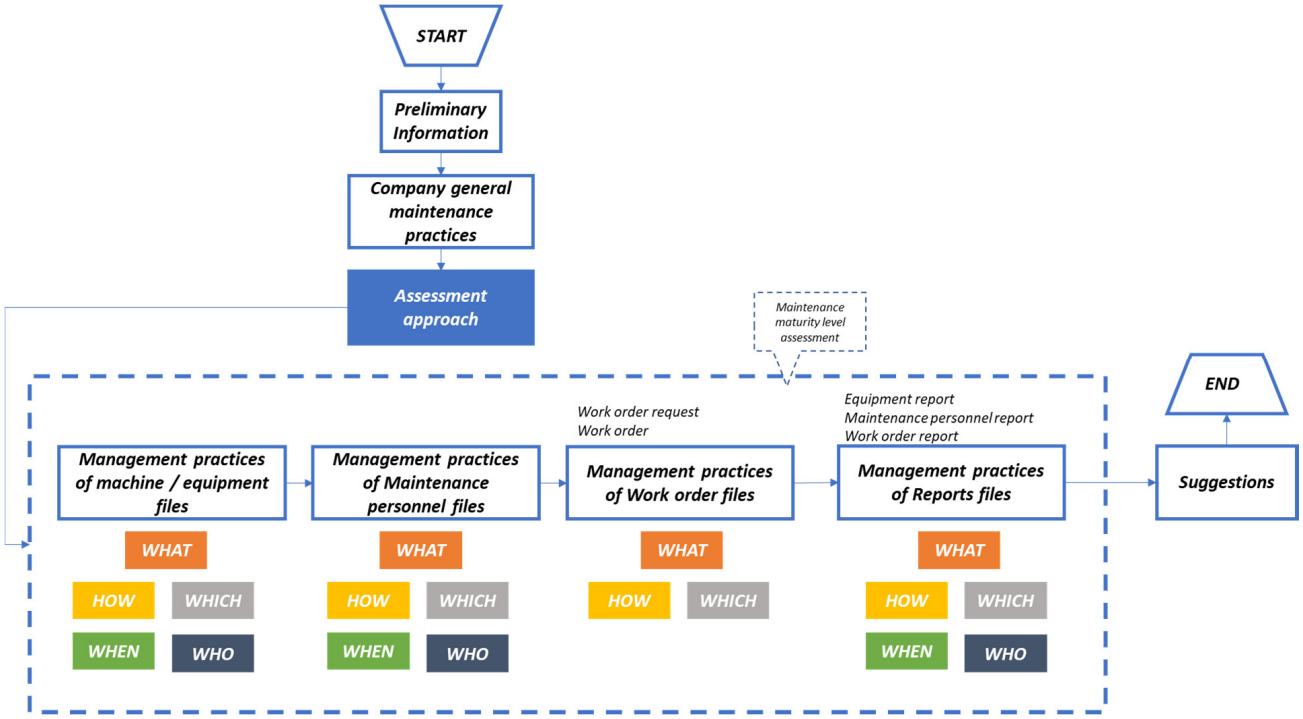

Figure 5. Survey Structure.

The preliminary information contains a set of questions related to the company (size, sector and operational headquarters) and the interview (professional role). A set of questions concerning general maintenance practices was included to understand the strategy and the approach adopted by the companies for their maintenance operations. Based on the fundamental structure of the model, a section for each DB containing questions for every evaluation criterion was performed. The answers are ranked, according to a description, ranging from the initial/basic practice to good/best practice. The highest ML is assigned if the existing management practices operate according to best practices; the lowest ML is assigned when the practices are either weakly available or not performed at all. For a better understanding, a practical example is provided in Figure 6.

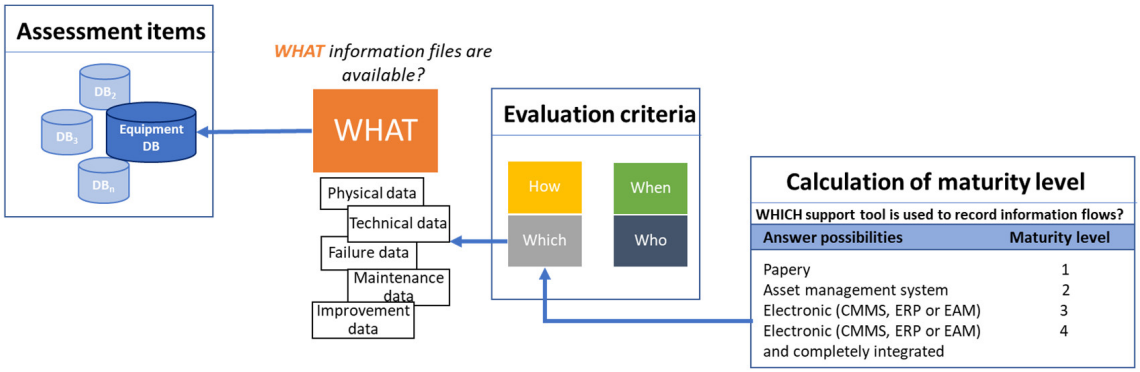

Figure 6. Example of a survey question.

The final section, 'suggestions', contains questions for collecting feedback and recommendations for the survey from the experts who compiled it. A simple algorithm, implemented in Excel, returned an aggregate maturity index and the specific maturity level for each DB, as well as the evaluation criteria to identify the strength and weakness points of each one. As of now, the survey has been submitted and the responses are being collected.

3.2.4. Mathematical Formulation

The proposed model quantifies the level of maturity for each of the four databases considered as a weighted average of the level of maturity of the single information content of that specific database. Similarly, the level of maturity of the single information content is calculated as a weighted average of the levels of the four domains (HOW, WHICH, WHEN and WHO) for each piece of information content. In particular, in the proposed mathematical formulation, the variable i = 1, . . . , n represents the detailed information contents (WHAT) related to each DB. For example, the drawings, files from the manufacturer and engineering, the equipment registry (equipment code, location, cost, etc.), bill of materials, technical specifications (operating parameters), failure mode and effect critical analysis, maintenance best practice (repair methods, maintenance standard procedure), equipment history file (failure and inspection) and the equipment improvement management programme are the information contents within the equipment DB.

The score for WHAT depends on how many pieces of the information contents in each DB are maintained by an organisation; if information content is available, the variable 'z' is equal to 1, either z is equal to 0. Based on the value assigned for each piece of information content, the maturity level of WHAT varies from 1 to 4.

The variable j = 1, . . . , 4 represents the different domains related to each piece of information content (HOW, WHICH, WHEN and WHO). These domains are standardised and not equally important; b_1, b_2 . . . b_4 are the relative weight of these m domains.

The variable S_{ij} is the level of practice used (initial practice = level 1, best practice = level 4) in the j-th domain for the flow i-th.

Then, the maturity level for i-th information content can be calculated as:

$$ML_i = \sum_j b_j S_{ij} \qquad \sum b_j = 1; \forall\, j = 1, \ldots, 4; 1 \leq S_{ij} \leq 4 \tag{1}$$

Moreover, assuming that the information flows are not of equal importance, and w_i is the relative weight reflecting its importance to the maintenance system, a measure of the MLDB of k-th DB (k = 1, . . . , 4) can be obtained using the composite scores principle:

$$MLDB_k = \sum_i w_i * ML_i \qquad \sum w_i = 1; \{1 \leq ML_i \leq 4\ \forall z \neq 0\}; \{ML = 0\ \forall z = 0\}; \forall\, i = 1, \ldots, n \tag{2}$$

The maturity level of each domain MLD_j is measured as a mean of the levels of practice used for all the information contents:

$$MLD_j = 1/n * \sum i\, S_{ij} \qquad \forall\, j = 1, \ldots, 4; \forall\, i = 1, \ldots, n \tag{3}$$

The maturity level highlights the strengths and weaknesses of the current maintenance information management practices. Different graphics (e.g., bar chart and radar chart) with the maturity level for each database and of each domain are displayed as the result of the assessment process described above. Figure 7 reports the results obtained from an example case used to test the model. The areas with the lowest ML are candidates for improvement programmes. Considering the weaknesses of each domain, a strategic roadmap will emerge. The maintenance improvement programmes will provide a growing path made by steps supporting the company to reach the highest maturity level. To reach the next step on the roadmap, the organisation must complete the previous one. This will enable the company to achieve a higher maintenance effectiveness standard and a continuous improvement process will be activated.

3.2.5. Output of the Model

The output of the proposed model provides a description and the meaning of the maturity level reached for each criterion, as shown in the tables included in Appendix A.

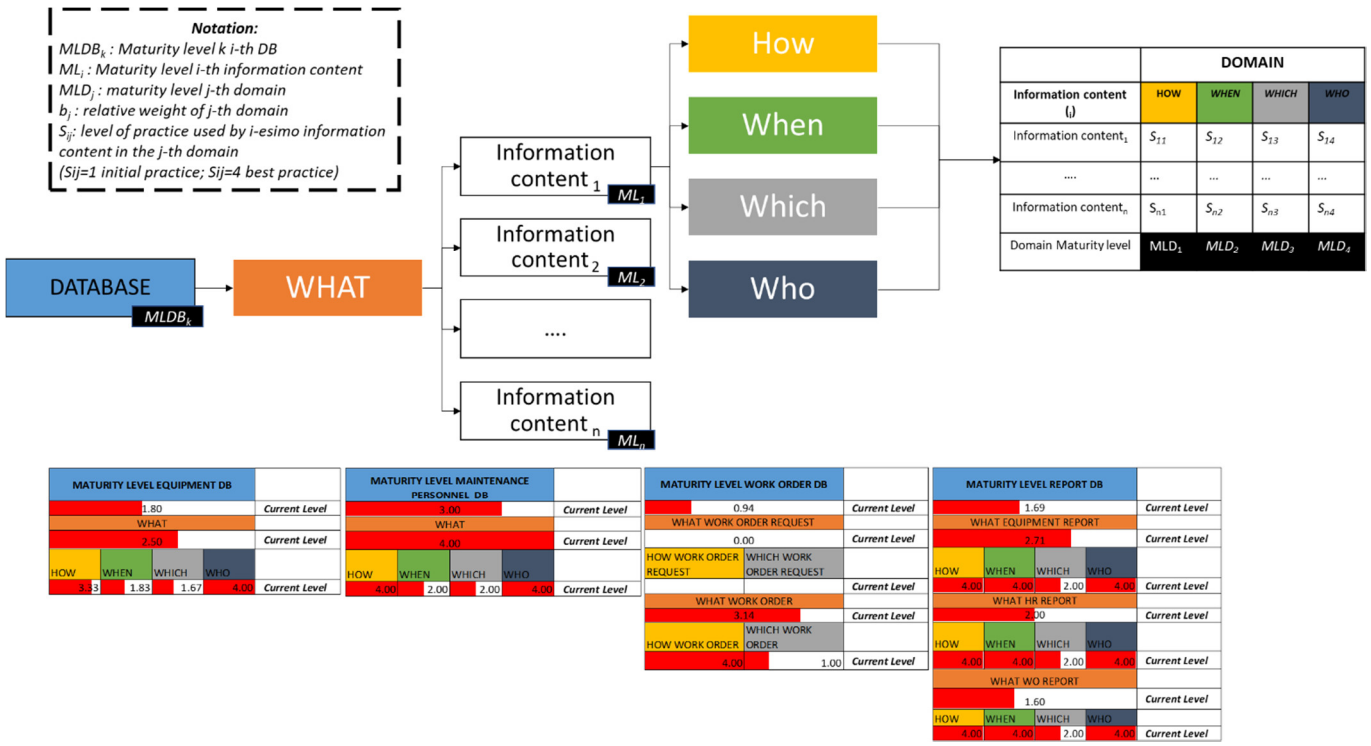

Figure 7. Mathematical formulation and results.

3.3. STEP 3: Improvement Programme Definition

Very few studies attempting to develop a maturity model have proposed an improvement programme to reach the highest level. For this reason, contrary to the maturity model, the methods for defining an improvement programme are not yet present in the literature. Therefore, we propose in this paper the preliminary idea for how to build an improvement programme that will be detailed in future research works.

The improvement programme (Step 3) will be designed based on the assessment model developed. It will be based on setting targets and related to the specific weakness measured during the assessment; a roadmap with the selection of which actions to follow for reaching the highest ML will be suggested. The roadmap could be considered as a beginning step for improving or for introducing maintenance management information practices with maintenance processes. It can be used for different purposes: for an organisation pursuing the transfer of information management best practices to its maintenance department or for other organisations beginning the adoption of a maintenance management information infrastructure for the maintenance department. The roadmap will be flexible in order to allow adjustments according to any maintenance strategy. The improvements can be pursued along horizontal (by increasing the information contents/systems to the actual information infrastructure) or vertical (by improving the method for handling information infrastructure) dimensions. This enables the company to achieve a high maintenance effectiveness standard more than once; as a result, a continuous improvement process will be activated, always maintaining the goal of a higher maturity level.

The aim is to define a growing path of sequential steps for improving the management of each DB by the definition of best practices for each one.

The improvement programme will be based on the principle of the total productive maintenance, identifying the best practices, techniques and methodologies that can be introduced to improve the maintenance management information practices. Nonetheless, when talking about information, a connection with currently available technologies is advisable. Therefore, an identification of the available technologies supporting maintenance management practices will be performed.

Starting from the maturity level of the WHAT criteria (the most important, since it defines the information infrastructure of each database) for each level, different actions for reaching progressive maturity levels will be defined. The completeness of each level is gained only if all other evaluation criteria (HOW, WHEN, WHICH and WHO) have reached the highest level.

As illustrated in the model, there are four levels, but there is also a starting level, called 'Level 0', that cannot be measured; it identifies a preliminary situation for those companies that would like to start an initial improvement process but are completely unaware of the status of their maintenance information infrastructure:

- Lev 0: Chaos/Improvisation: The first level is characterised by a chaotic condition in which the question of what information to be collected is evident. The stakeholders are not aware of the importance and relevance of the information. No consistent understanding of the maintenance information needed to improve maintenance management practices exists in the company. Call for action: There is much to do. First, a clear definition of the maintenance process, especially in terms of the information and data needed for effective maintenance management, must be provided to instil in the company the importance of collecting the data and information.
- Lev 1: Orientation: The second level is characterised by an awareness of the importance of the maintenance data as an improvement source for the company's operational performance. The company recognises the added value of the information, but the data are collected in a fragmented and irregular way. Call for action: The data must be ordered and classified.
- Lev 2: Definition: In the third level, all the data and information are sorted, but not defined. Call for action: A detailed and precise map of what type of documents and data to be collected is undertaken, with the definition of all possible techniques, methodologies and instruments available for better definition and collection.
- Lev 3: Maintain: The fourth level may be the stage in which the aim of information and data, as well as the method for collecting them, are understood. At this stage, a high level has already been attained. Call for action: How to use this information must be clarified; an important issue is to transform the information into knowledge, to maintain and deploy the information and data efficiently and effectively to improve the overall maintenance performance.
- Lev 4: Best in class: The fifth level is the highest one. The company has a well-managed and organised database, and its information infrastructure is strong and effective. It is ready to introduce a suitable maintenance management information system, completely integrated to guarantee the interoperability between inter-/intra-enterprise information systems for the seamless integration of the internal departments along the supply chain.

4. Conclusions

Information management is the most critical issue amongst the maintenance management activities of a manufacturing organisation. The research outcomes show that SMEs take an unsuccessful approach to maintenance information management because of their inherent characteristics and several barriers. Since the most critical aim is the maturity of the maintenance department, SMEs should be ready to introduce maintenance management information practices of a higher quality. The research proposal suggested in this paper, which is the first phase of a bigger project, aims to define a standardised procedure for evaluating the current maturity level of maintenance information management practices. Starting from these results, the objective is to draw a strategic roadmap that allows small companies to reach higher maturity levels through driven paths.

4.1. Practical and Managerial Implications

In addition to being an assessment tool, the maturity model proposed will provide and support the knowledge on the behaviours and practices for achieving world-class results.

The innovative model M^{3}AIN4SME, suggested in this paper, aims to provide a simple procedure that allows small companies to overcome their constraints and reach progressive maturity levels, starting from their current maturity situation. The companies will be supported in introducing a well-organised and managed maintenance information infrastructure, with the aim of adopting a maintenance system suitable to their maturity and organisation. Knowing the strengths and weaknesses of maintenance information systems can allow companies to become aware of their current state and define intervention plans to improve it. Having a clear vision of the level of maturity can also allow the definition of strategic roadmaps and intervention priorities.

4.2. Limitations and Future Development

The maintenance information management architecture defined presents some limitations; the validation of the model will be carried out as soon as the dataset of responses becomes consistent. First of all, the model is general and not customised to specific industrial sectors; this would require additional evaluation criteria and, above all, different weights for the identified criteria. Furthermore, the current weights are equally distributed; an Analytic Hierarchy Process (AHP) approach, based on the expert opinions, will be used to set the weights expressed in the mathematical formulation of the method proposed for future development.

The proposed model supports small companies in improving the effectiveness and efficiency of their MMIS through a well-defined and organised database. The improvement programme will consist of a growing path of sequential steps for improving the management of each DB by the definition of the best practices for each one; therefore, a well-defined approach will be structured in the future development. The automatization and cost–benefit analysis of the improvement path drawn could be a future step. The future development will include a pilot test of the assessment survey to validate the approach proposed.

Author Contributions: Conceptualization, A.M.R.T., V.D.P. and R.I.; Investigation, A.M.R.T.; Methodology, V.D.P.; Supervision, V.D.P. and R.I.; Validation, R.I.; Writing—original draft, A.M.R.T.; Writing—review & editing, V.D.P. and R.I. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Data Availability Statement: The data presented in this study are available on request from the corresponding author.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

	Lev. 0–1	Lev. 1–2	Lev. 2–3	Lev. 3–4
WHAT EQUIPMENT	Some files regarding the physical and technical condition of the machines are available within the organisation. The information management practices regarding the equipment are really basic.	Some files regarding the physical and technical condition of the machines and some machine failure data are available within the organisation. The information management practices regarding the equipment are really basic.	Some files regarding the physical and technical condition of the machines and some machine failure and maintenance data are available within the organisation. The information management practices regarding the equipment are increasing.	All files regarding the physical and technical condition of the machines and all machine failure and maintenance data are available within the organisation. An improvement programme is prepared by the company. The information management practices regarding the equipment are the best in class.

	Lev. 0–1	Lev. 1–2	Lev. 2–3	Lev. 3–4
HOW EQUIPMENT	Most machine maintenance equipment files and document are not readily available. The methodological skills of the company are low.	Most machine maintenance equipment files and document are available but not complete and standardised. The methodological skills of the company are low.	Most equipment maintenance files are unique, consistent and reliable, regardless of the storage period or the frequency of access. The information available is not redundant.	Most equipment maintenance files are complete, standardised and well organised for access and retrieval. The information available is significant and correctly managed.
WHICH EQUIPMENT	The support used for the collection of most data is papery. This approach demonstrates poor company technological capabilities, which leads to the waste of resources and many inefficiencies in data and information management.	The support used for the collection of most maintenance files is an autonomous system for maintenance management that is not integrated with other systems. It is a stand-alone application for the management of only maintenance interventions. The company's technological skills appear to be in an initial phase.	The support used for the collection of most maintenance files is an electronic software that can be interfaced with other company systems (for example, Enterprise Asset Management [EAM], CMMS or ERP). The software includes more features than an autonomous management system and this demonstrates the increase of company technological capabilities with a reduction in waste and inefficiencies towards an integration, albeit initial, between different functions.	The support used for the collection of most maintenance files is electronic (CMMS, ERP or EAM) and completely integrated with other company systems. It is a maintenance application system that is completely integrated with all the company's systems. There is a complete exchanging of data/information between all company systems. This allows the company to have perfectly synchronised processes and achieve excellent performance. High degree of automation.
WHEN EQUIPMENT	Most machine maintenance files and documents are not updated when needed. Outdated information compromises the integrity and reliability of the database itself.	Most machine maintenance files and documents are updated in a long-term period, within an upgrade period greater than one year.	Most machine maintenance files and documents are updated in a medium-short term period, within an upgrade period between one year and six months.	Most machine maintenance files and documents are updated as needed.
WHO EQUIPMENT	There isn't a specific employee who takes care of equipment maintenance files' correct management.			There is a specific employee who takes care of equipment maintenance files' correct management.
WHAT MAINTENANCE PERSONNEL	Very few documents and/or systems interested with the management of 'maintenance personnel' are available within the organisation. The information management practices regarding the equipment are really basic.	Not many documents and/or systems interested with the management of 'maintenance personnel' are available within the organization. The information management practices regarding the equipment are really basic.	Most documents and/or systems interested with the management of 'maintenance personnel' are available within the organisation. The information management practices regarding the equipment are increasing.	All the documents and/or systems interested with the management of 'maintenance personnel' are available within the organisation. The information management practices regarding the equipment are the best in class.

	Lev. 0–1	Lev. 1–2	Lev. 2–3	Lev. 3–4
HOW MAINTENANCE PERSONNEL	Most of maintenance personnel documents and/or most of systems are not readily available. The methodological skills of the company are low.	Most of maintenance personnel documents and/or most of the systems are available but not complete and standardised. The methodological skills of the company are low.	Most of maintenance personnel documents and/or most of systems are unique, consistent and reliable, regardless of the storage period or the frequency of access. The information available is not redundant.	Most of maintenance personnel documents and/or most of systems are complete, standardised and well-organised for access and retrieval. The information available is significant and correctly managed.
WHICH MAINTENANCE PERSONNEL	The support used for the collection of most of the data is papery. This approach demonstrates poor company technological capabilities, which leads to the waste of resources and many inefficiencies in data and information management.	The support used for the collection of most of the maintenance personnel documents is an autonomous system for maintenance management that is not integrated with other systems. It is a stand-alone application for the management of only maintenance interventions. The company's technological skills appear to be in an initial phase.	The support used for the collection of most the of maintenance personnel documents is an electronic software that can be interfaced with other company systems (for example Enterprise Asset Management [EAM], CMMS or ERP). The software includes more features than an autonomous management system and this demonstrates the increase of company technological capabilities with a reduction in waste and inefficiencies towards an integration, albeit initial, between different functions.	The support used for the collection of most of the maintenance personnel documents is electronic (CMMS, ERP or EAM) and completely integrated with other company systems. It is a maintenance application system that is completely integrated with all the company's systems. There is a complete exchange of data/information among all company systems. This allows the company to have perfectly synchronised processes and achieve excellent performance. High degree of automation.
WHEN MAINTENANCE PERSONNEL	Most of maintenance personnel documents are not updated when needed and maintenance personnel systems are not scheduled when needed. Outdated information compromises the integrity and reliability of the database itself.	Most of maintenance personnel documents are updated in a long-term period, within an upgrade period greater than one year, and the maintenance personnel systems are scheduled on an optional basis.	Most of maintenance personnel documents are updated in a medium-short term period, within an upgrade period between six months and one year and the maintenance personnel systems are scheduled on a rare or irregular basis.	Most of maintenance personnel documents are updated as needed, i.e constantly, and the maintenance personnel systems are scheduled as needed.
WHO MAINTENANCE PERSONNEL	There isn't a specific employee who takes care of some/all maintenance personnel files' correct management.			There is a specific employee who takes care of some/all maintenance personnel files' correct management.

	Lev. 0–1	Lev. 1–2	Lev. 2–3	Lev. 3–4
WHAT WORK ORDER DB work order request	The company does not have an efficient and effective maintenance work order management system. The company uses a work order request that provides little useful information to the planner. The organisation has poor methodological capabilities.	The company does not have an efficient and effective maintenance work order management system. The company uses a work order request that does not provide all the useful information to the planner. The organisation has poor methodological capabilities.	The company has an efficient and effective maintenance work order management system. The company uses a work order request that provides almost all useful information to the planner. The organisation has good methodological capabilities.	The company has an efficient and effective maintenance work order management system. The company uses a work order request that provides all useful information to the planner. The organisation has the best methodological capabilities.
WHAT WORK ORDER DB work order	The company does not have an efficient and effective maintenance work order management system. It uses a work order that provides little useful information to the maintenance technician to perform the maintenance intervention properly. The organisation has poor methodological capabilities.	The company does not have an efficient and effective maintenance work order management system. It uses a work order that does not provide all useful information to the maintenance technician to perform the maintenance intervention properly. The organisation has poor methodological capabilities.	The company has an efficient and effective maintenance work order management system. It uses a work order that provides almost all useful information to the maintenance technician to perform the maintenance intervention properly. The organisation has good methodological capabilities.	The company has an efficient and effective maintenance work order management system. It uses a work order that provides all useful information to the maintenance technician to perform the maintenance intervention properly. The organisation has the best methodological capabilities.
WHICH work order management	The support used for the management of work order and/or work order request is mainly papery. This approach demonstrates poor company technological capabilities, which leads to waste of resources and many inefficiencies in data and information management.	The support used for the collection of work orders and/or work order request data is mainly an autonomous system for maintenance management that is not integrated with other systems. It is a stand-alone application for the management of only maintenance interventions. The company's technological skills appear to be in an initial phase.	The support used for the collection of work orders and/or work request data is mainly an electronic software that can be interfaced with other company systems (for example Enterprise Asset Management [EAM], CMMS or ERP). The software includes more features than an autonomous management system and this demonstrates the increase of company technological capabilities with a reduction in waste and inefficiencies towards an integration, albeit initial, among different functions.	The support used for the collection of work orders and/or work request data is mainly electronic (CMMS, ERP or EAM) and completely integrated with other company systems. It is a maintenance application system that is completely integrated with all company's system. There is a complete exchange of data/information between all company systems. This allows the company to have perfectly synchronised processes and achieve excellent performance. High degree of automation.
HOW work order management	A standard has not been established for the management of maintenance work orders.			A standard has been established for the management of maintenance work orders.

	Lev. 0–1	Lev. 1–2	Lev. 2–3	Lev. 3–4
WHAT EQUIPMENT REPORT	The company does not have an efficient and effective reporting management system. It creates very few reports related to the equipment that records and monitors little data. This does not allow for the creation of meaningful statistics that can support the decision-making process. The organisation has poor methodological capabilities.	The company does not have an efficient and effective reporting management system. It does not create all reports related to the equipment that records and monitors little data. This does not allow for the creation of meaningful statistics that can support the decision-making process. The organisation has poor methodological capabilities.	The company has an efficient and effective reporting management system. It creates almost all reports related to the equipment that records and monitors much data. This allows for the creation of meaningful statistics that can support the decision-making process. The organisation has good methodological capabilities.	The company has an efficient and effective reporting management system. It creates all reports related to the equipment that records and monitors all data. This allows for the creation of meaningful statistics that can support the decision-making process. The organisation has the best methodological capabilities.
WHAT MAINTENANCE PERSONNEL REPORT	The company does not have an efficient and effective reporting management system. It creates very few reports related to the maintenance personnel who record and monitor little data. This does not allow for the creation of meaningful statistics that can support the decision-making process. The organisation has poor methodological capabilities.	The company does not have an efficient and effective reporting management system. It does not create all reports related to the maintenance personnel who record and monitor little data. This does not allow for the creation of meaningful statistics that can support the decision-making process. The organisation has poor methodological capabilities.	The company has an efficient and effective reporting management system. It creates almost all reports related to the maintenance personnel who record and monitor much data. This allows for the creation of meaningful statistics that can support the decision-making process. The organisation has good methodological capabilities.	The company has an efficient and effective reporting management system. It creates all reports related to the maintenance personnel who record and monitor all data. This allows for the creation of meaningful statistics that can support the decision-making process. The organisation has the best methodological capabilities.
WHAT WORK ORDER REPORT	The company does not have an efficient and effective reporting management system. It creates very few reports related to the maintenance work order that records and monitors little data. This does not allow for the creation of meaningful statistics that can improve the work order management process. The organisation has poor methodological capabilities.	The company does not have an efficient and effective reporting management system. It does not create all reports related to the maintenance work order that records and monitors little data. This does not allow for the creation of meaningful statistics that can improve the work order management process. The organisation has poor methodological capabilities.	The company has an efficient and effective reporting management system. It creates almost all reports related to the maintenance work order that records and monitors much data. This allows for the creation of meaningful statistics that can improve the work order process. The organisation has good methodological capabilities.	The company has an efficient and effective reporting management system. It creates all reports related to the maintenance work order that records and monitors all data. This allows for the creation of meaningful statistics that can improve the work order process. The organisation has the best methodological capabilities.
HOW REPORTS	A standard has not been established for the management of maintenance reports.			A standard has been established for the management of maintenance reports.

	Lev. 0–1	Lev. 1–2	Lev. 2–3	Lev. 3–4
WHICH REPORTS	The support used for the collection of reports is mainly papery. This approach demonstrates poor company technological capabilities, which leads to waste of resources and many inefficiencies in data and information management.	The support used for the collection of reports is mainly an autonomous system for maintenance management that is not integrated with other systems. It is a stand-alone application for the management of only maintenance interventions. The company's technological skills appear to be in an initial phase.	The support used for the collection of reports is mainly an electronic software that can be interfaced with other company systems (for example Enterprise Asset Management [EAM], CMMS or ERP). The software includes more features than an autonomous management system and this demonstrates the increase of company technological capabilities with a reduction in waste and inefficiencies towards an integration, albeit initial, between different functions.	The support used for the collection of reports is mainly electronic (CMMS, ERP or EAM) and completely integrated with other company systems. It is a maintenance application system that is completely integrated with all company's system. There is a complete exchange of data/information among all company systems. This allows the company to have perfectly synchronised processes and achieve excellent performance. High degree of automation.
WHEN REPORTS	Most of the maintenance reports are not analysed when needed. Outdated information compromises the integrity and reliability of the database itself.	Most of the maintenance reports are analysed in a long-term period, within an analysis period greater than one year.	Most of the maintenance reports are analysed in a medium-short term period, within an analysis period between six months and one year.	The maintenance reports are analysed as needed.
WHO REPORTS	There isn't a specific employee who takes care of maintenance reports' correct management.			There is a specific employee who takes care of maintenance reports' correct management.

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