



Developing Innovative and Attractive CVET programmes
in industrial shoe production

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Train-the-Trainer Manual Maintenance Management

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1 Introduction

1.1 Aims of the DIA-CVET Project

The aims of the Erasmus+ project «Developing Innovative and Attractive CVET programmes in industrial shoe production» are

- to develop, pilot and implement comprehensive courses for the Spheres of Activity (SoA) of foremen in industrial shoe production on European level; available in English (EN) as well as in DE, RO and PT,
- and to develop a sector qualification framework level 5 and 6 and to reference existing or newly drafted national qualifications from Germany, Portugal and Romania.

1.2 Manuals to Guide Tutors and Trainers

The purpose of the manuals is to prepare designated trainers for their role and to provide content and support. Due to the nature of the SoA of foremen, they do not include specific forms of training; but we suggest a blended approach. Successful Continuous Vocational Education and Training (CVET) programmes combine theoretical lessons with application of the acquired Knowledge, Skills and Competences (KSC) in real work environments. The tasks of a trainer are to

- impart SoA-specific KSC,
- demonstrate operations which the learners are expected to learn to perform,
- introduce the learners to each new task and supervise them during their first approaches,
- organise and supervise blended activities (i. e. projects),
- guide them towards an independent performance of the tasks of the respective SoA.

The manuals are not meant to replace a textbook. They are meant to provide support to the trainers to plan and execute their teaching. The trainers are invited to gather more information from other sources.

1.3 Refer your training to the business process of industrial shoe production

Industrial production is a complex process, where the Sphere of Activity, described in this manual, is embedded in the business process. Before you start the training on a specific SoA, please make sure that the learners are familiar with the other SoA of industrial foremen in shoe production.

For example, the learners should be introduced to the types of products the company manufactures and their intended use, the different customer segments, the distribution channels etc. They should be aware of the product creation and manufacturing processes, i.e. product design, pattern making, purchasing department, production planning, and all production departments to warehouse and logistics.

The production process (not part of DIA-CVET, for insights see: <http://icsas-project.eu/>) is in the core of the business process; the SoA of DIA-CVET play a preparatory, supporting or accompanying role (see Fig. 1).

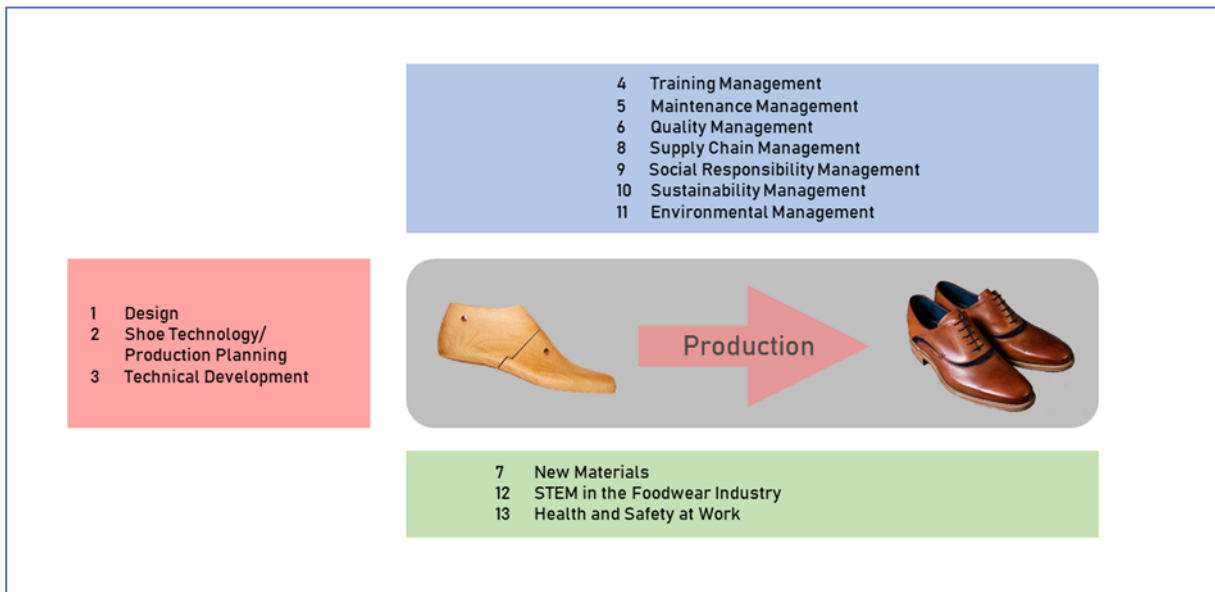


Fig. 1 Spheres of Activity of DIA-CVET and their relation to the production process.

2 Maintenance Management

2.1 Introduction

Society and markets are increasingly competitive, global and evolving, forcing industry to strengthen its competitiveness, the quality of its products or services, the flexibility of its processes, technological evolution, qualification of its human resources and to assume maintenance as a fundamental area of intervention.

Maintenance is *“a combination of technical and economic management actions applied to a company's assets to optimise their life cycle”*.

Maintenance, driven by technological and scientific evolution over recent years, promotes the development of management processes and strategies that greatly contribute to productivity, greater safety, better environmental impact and improved quality of products or services, at optimised costs.

Nowadays, industrial Maintenance Management is based on structural systems, methodologies and adequate strategies and on the use of several management tools aimed at optimising the cost/efficiency ratio. The highlights are Total Productive Maintenance (TPM) and Reliability Centred Maintenance (RCM), CAM – Computer Aided Maintenance; PBS – Performance Based on Specifications; RBI – Risk Based Inspection.

It is essential to create a structural system that makes it possible to: ensure the company's operational activity, guarantee effective maintenance of facilities and equipment, boost efficiency, productivity and quality gains, diagnose risks and prevent problems, assess costs and contribute to a circular economy.

The maintenance management of assets, installations and equipment is an essential component in the management and operational activity of the footwear company.

2.2 Maintenance Definition

There are a large number of definitions of Maintenance, but they are similarly characterised as the set of actions aimed at ensuring the proper functioning of machinery and facilities, guaranteeing good operating conditions, productivity and optimised global cost, considering an effective intervention, avoiding breakdowns and low performance.

This intervention, compatible with the company's intervention in a combination of technical, economic, administrative and management actions in order to ensure the production cycles of products, goods or services. Intervention to support better organisational goals.

Maintenance allows to:

- Reduce costs;
- Avoid stoppages which will result in production losses;
- Reduce the number of breakdowns;
- Reduce intervention times, through good work preparation policies;
- Increase equipment lifetime, preserving its capacities for as long as possible;
- Improve production quality;
- Increase service safety.

2.3 Maintenance Function

Maintenance requires human and material resources, governed by a determined maintenance policy, with which it acts on equipment in order to optimise its life cycles.

The Maintenance Manager is responsible for managing these means in order to achieve certain objectives, through the implementation of various actions (Pinto, 1999):

- To target resources to ensure their effectiveness and efficiency;
- To plan and schedule maintenance activities and interventions;
- To coordinate the execution of planned, scheduled and curative interventions within the foreseen time frame and with the required quality;
- To control the costs involved and check their conformity with the budgeted forecasts;
- To motivate and promote the training of human resources with the aim of achieving high levels of individual and team productivity.

The activities of the Maintenance Function can be grouped into two functional areas: primary functions and secondary functions (Cabrita and Silva, 2002):

The primary functions are related to the daily work carried out by the Maintenance Department:

- Maintenance of company equipment: carrying out the necessary repairs to production equipment as quickly and economically as possible, trying to anticipate these repairs, using a maintenance programme appropriate to each situation;
- Building and grounds maintenance: repairs to buildings and to a company's external infrastructure (roads, drainage systems, water collection and supply to factory premises);
- Operation of energy production/supply facilities: if the company's manufacturing facilities generate their own energy source (whatever it may be), this activity is taken over by the Maintenance Department.
- Installation of new equipment, participation in the design and construction of equipment and/or buildings; Inspection, lubrication and cleaning of company equipment.

On the other hand, the secondary functions of the Maintenance Function are:

- Parts warehouse control;
- Organisation and Management of Industrial Maintenance;
- Collection and treatment of industrial waste: due to current environmental regulations and the technologies used (compactors, wastewater treatment plants, etc.);
- Pollution source control: bearing in mind that the various components of the production process liable to emit pollutants are subject to periodic checks and adjustments;
- Other activities: licensing of equipment and facilities, studies and projects.

In summary, the function of Maintenance is not only linked to guaranteeing the operation of the equipment, it must guarantee the level of operation of the equipment for the required availability and quality, minimising costs and downtimes, but it also has a close relationship with Quality, a fundamental contribution to the quality of the goods produced.

The maintenance function is fundamental in an organisation for the following reasons:

- It is decisive to guarantee the availability of the equipment used in the production process, influencing the level of product quality and production costs.
- It is fundamental for the optimisation of the production process, considering the scientific and technological revolution.

Maintenance is an area that interacts with all the other constituent areas of an organisation/company.

2.4 Maintenance Types

Maintenance can be developed in a reactive or proactive way. Reactive: resolutive, curative or corrective maintenance after an occurrence/failure. Proactive: maintenance occurs before failure.

Thus, we have the following types of maintenance:

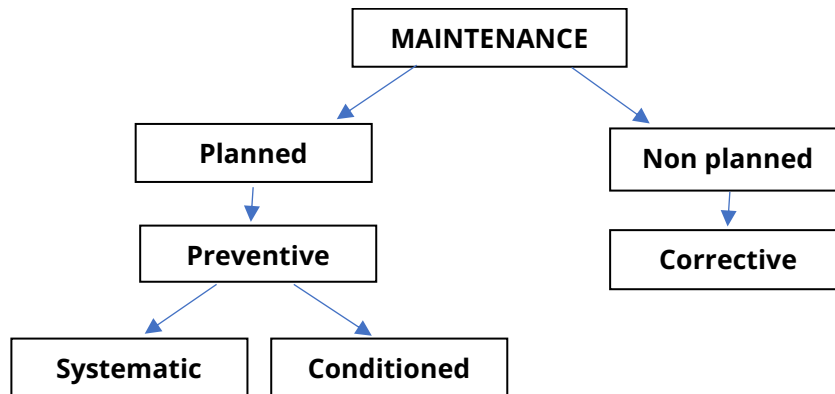


Fig. 2: The maintenance types

2.4.1 Preventive Maintenance

Maintenance is inseparable from all industrial processes. Thus, it is primordial to emphasise the strategic function by enhancing maintenance measures. It is characterised by interventions carried out at certain intervals, resulting from risk assessment.

Preventive maintenance should try to ensure a continuous production flow, which is not interrupted by fortuitous maintenance actions or as a result of poor quality due to malfunctioning equipment, contributing to the achievement of high availability values. A breakdown results in a loss of production or unpredictable downtime costs, so maintenance minimises downtime to achieve high levels of productivity. Considering that equipment breakdowns follow a statistical pattern, this type of maintenance considers the knowledge of the average equipment lifetime and the planning of preventive actions. Two forms of preventive maintenance are defined:

- **Systematic preventive maintenance** - replacements are planned, done at a pre-established interval of time.
- **Conditional preventive maintenance** - replacements are based on the analysis of the level of degradation of the operating parameters of the equipment.

2.4.2 Corrective Maintenance

Preventive maintenance is an intervention arising from the occurrence of an anomaly or malfunction and aims at correcting the problem situation. This is a non-pre-planned intervention, initiated after the occurrence of the malfunction.

Corrective maintenance is a methodology that entails numerous consequences as it is not possible to determine how long the equipment will be unavailable, due to the cost of repairs or spare parts, irregular workload.

This maintenance is present in the majority of companies, either due to the unpredictability of some malfunctions occurring, and therefore difficult to avoid, or due to the lack of implementation of good practices and methodologies for analysing the history of failures that do not allow taking advantage of preventive maintenance.

3 Maintenance Management – Strategies, Policies and Models

Maintenance management is defined as the set of management activities that establish the objectives, strategy and responsibilities of maintenance, and implement them through planning, control and supervision of maintenance and continual improvement of the organisation's methods including economic factors.

Industrial maintenance management considers the management of all maintenance processes of machinery, equipment and production instruments in industries, aiming to keep them running and increase their useful life. Besides the main objective, which is to maintain the performance of machinery and equipment, the management of industrial maintenance also has as objectives:

- To ensure that production is carried out at the lowest possible cost, with the desired quality and within the required safety standards;
- To identify costs in maintenance processes and where possible reduce them;
- To draw up records of maintenance actions applied;
- To optimise the resources available for maintenance, both human and material;
- To minimise energy consumption;
- To minimise the stock of consumables.

Industrial maintenance management is strategic for an organisation, ensuring the safety of the operation and the proper pace, preferably without delays or waste that could affect the company's profit. Likewise, maintenance management also contributes to the implementation of Quality Standards.

Thus, the objectives and strategies of maintenance management meet the objectives of the organisation, and in this way, they should be combined in order to obtain the best results.

3.1 Maintenance Strategies and Policies

Maintenance must have an internal organisation that provides it with the human and material resources necessary to its activity. Maintenance is no longer characterised as "a necessary evil", but is a fundamental function in an organisation, being an area of intervention for profitability and quality. Considering the technological evolution, and using new technologies and software, new methodologies and strategies have been created.

Aspects to consider when designing policy and strategies:

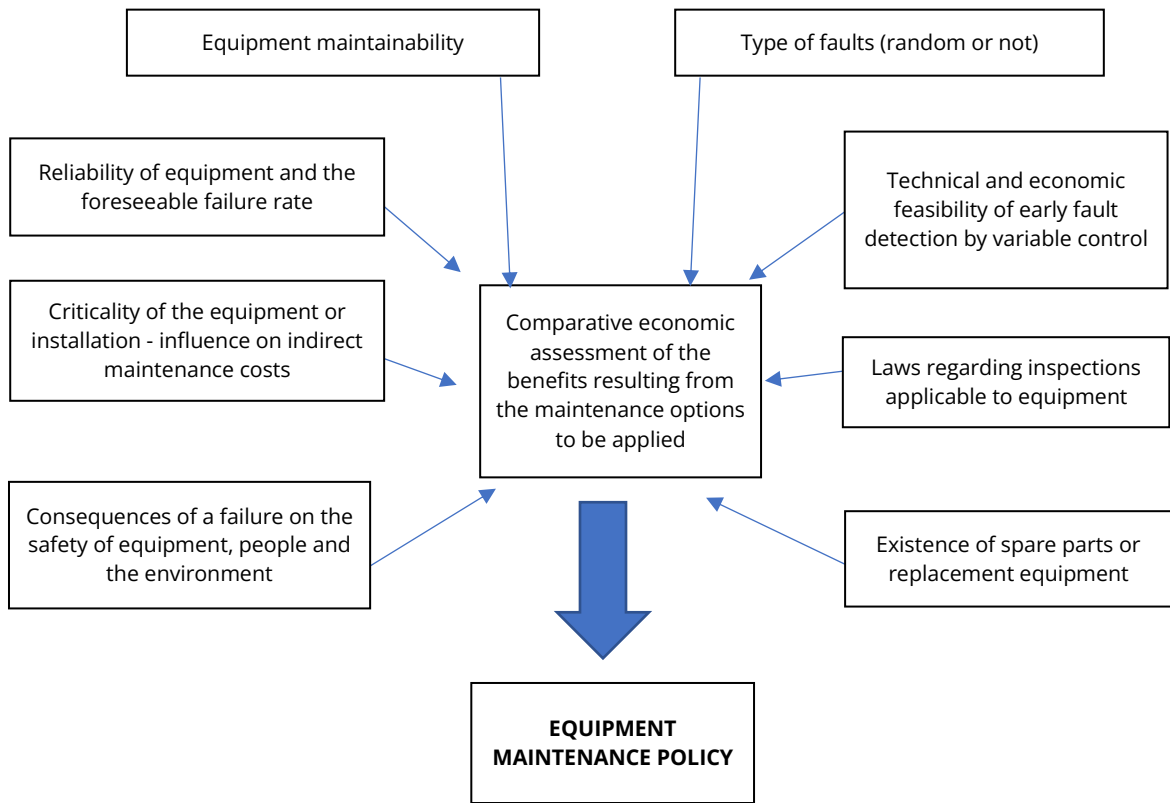


Fig. 3: Aspects to consider when designing the maintenance policy

According to the production characteristics and considering the aforementioned factors, the maintenance policies to be implemented should be clearly explained. These should be proactive, always relegating corrective maintenance as far as possible to second place.

The following figure illustrates the summary of maintenance policies used currently.

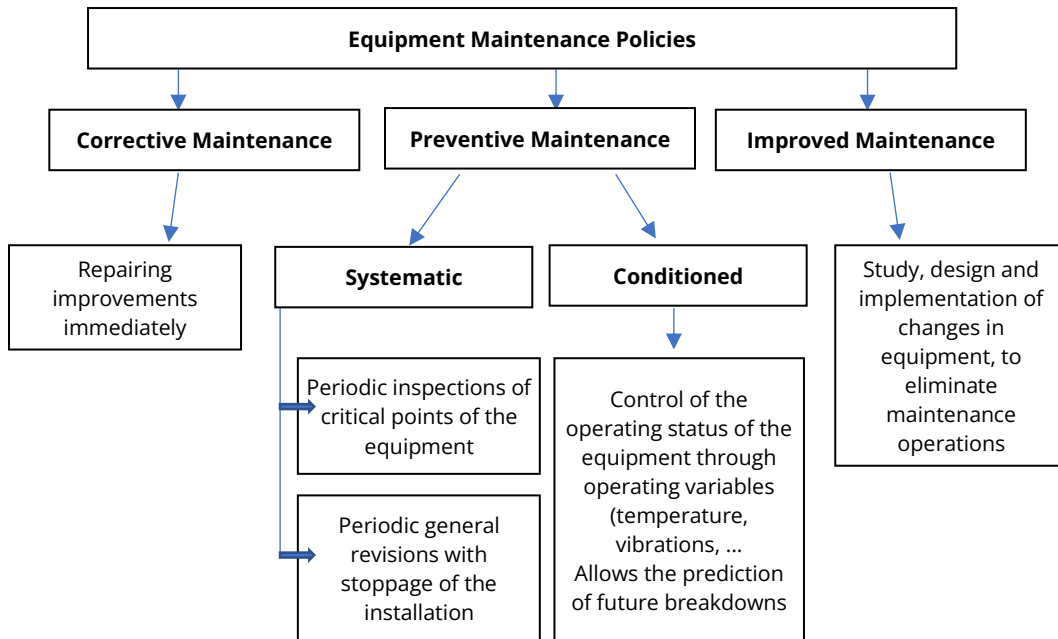


Fig. 4: Equipment Maintenance Policies

3.2 Management models

The selection of the management model has an influence on production costs and quality and, consequently, on the cost of the final product or service.

Regardless of the model, maintenance must be articulated with the other functions of the company – production, procurement, personnel, finance. It must correspond to the needs of the company.

Maintenance requires prior planning in order to maximise the use of resources and minimise the inconvenience arising from the stoppage of production equipment, based on preventive maintenance.

3.2.1 Reliability Centred Maintenance – RCM

Reliability Centred Maintenance (RCM) is the maintenance philosophy used to determine which procedures to develop in order to guarantee that any physical asset continues to fulfil its functions in the operational context in which it is inserted, diagnosing the various factors that contribute to its unreliability, as well as the measures to be taken to implement it.

The RCM model is based on the following principles:

- The function and context of the system or equipment is the most important factor;
- Some equipment presents more than one type of failure, which may or may not cause problems of greater or lesser severity;
- Preventive maintenance must be prioritised.

The RCM model promotes the application of maintenance policies based on complete knowledge of the function of each piece of equipment in the context of its operation, as well as knowledge of its types of faults and their consequences, considering the following aspects:

- Function of the equipment and its standard requirements;
- Analysis of its functional failures and their types and effects;
- Consequences of breakdowns on safety, the environment and production;
- Definition of the appropriate maintenance policy, using the following actions:
 - Preventive maintenance;
 - Corrective maintenance and changes.

We conclude that RCM is an organisational strategy in the maintenance area, which encourages knowledge at all hierarchical levels, leading to a continuous improvement in the performance of the facilities, through the participation of the whole organisation. This provides greater availability, reliability and therefore optimised operating costs, as well as including environmental and safety aspects.

3.2.2 Total Productive Maintenance – TPM

The main characteristic of TPM is the involvement of the human resources of Production in the Maintenance operations, considering that the Operator is the one who knows the machine best, being able to create the best conditions for preventing failures. As a result, synergies are generated between all the company's organisational functions, more specifically between Production and

Maintenance, in order to continuously improve the quality of the products manufactured, increase the operational availability of the equipment and improve operators' safety conditions.

This model is characterised by the following principles:

- Involvement and participation of all staff, from the top of the hierarchy to the bottom, with the aim of continuously improving overall efficiency by looking for the most significant causes of loss;
- Involvement of the whole structure in the process, particularly the departments with the greatest participation in the life cycle of the equipment;
- Establishment of preventive maintenance plans, covering the equipment's life cycle, promoting improvements in equipment;
- Promotion of the study and analysis of breakdowns and the search for solutions to avoid them, through autonomous activity groups;
- Promotion of the execution of maintenance and cleaning operations, not only by more qualified managers or technicians, but also by the equipment operators, promoting training for all staff.

This method aims for organisations to achieve the highest possible availability of equipment by reducing or eliminating losses arising from: Breakdowns; Changes and adjustments in production lines for product changes; Reduction in the cadence of equipment in relation to its nominal value; Losses resulting from start-up periods.

Through TPM, tangible and intangible results are expected. Tangible results: Approaching zero faults; Machine reliability; Reduction of equipment stoppage times; Increase in productivity, both of installations and of personnel; Reduction of work accidents; Reduction of resources needed for production, such as energy. Intangible results: increased motivation of employees, the creation of a better working environment as well as the improvement of the company's image.

4 Conclusion

Regardless of the maintenance management model to be adopted within a structure, the following tasks should be carried out:

- Survey of all factory equipment:
 - Identifying all the machines in the production sector;
 - Collecting all machine documentation, e.g. machine catalogues;
- Creating individual equipment records;
 - Scheduling of preventive maintenance;
 - Registering malfunctions;
 - Registering interventions made to improve functioning;
 - Identifying wear and tear parts.
 - Identifying Hygiene and Safety cares when handling the equipment.
- Specific training in the handling of equipment during its preventive maintenance;
- Creating "checklists" to verify the state of the equipment.
- Creating preventive maintenance sheets for the operator.

Nowadays, we can already find in the market a vast list of maintenance management software, which allows, in an agile way, to register information directly through a Smartphone, Tablet or laptop. Thus, it decreases the number of stakeholders in maintenance management, facilitating the consultation of files anywhere, namely in the preparation of technical interventions.

Maintenance Management must always be in harmony with the production, quality and safety sectors, so that its intervention does not affect production, guarantees the best quality of the product and the safety of those involved.

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