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Presented by:

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Theme

Development of inventory and parts management module for CMMS

Publicly defended on 08 / 06 / 2026 in front of the jury composed

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2025-2026

Dedicate

With Allah's help, I was able to complete this work

Humble and simple, I dedicate this work to my dear

parents, my siblings, and everyone who contributed to

this success and

To myself.

Summary

Figure

Tables

Equations

Abstract:

This work examines the development of an inventory and spare parts management module as part of a computerized maintenance management system. This approach helps improve the efficiency of spare parts management by enabling the tracking of parts costs and identifying the most frequently used parts, which helps ensure timely availability of parts and reduces machine downtime.

I used the ABC analysis methodology to classify spare parts according to their importance and their success in improving maintenance and inventory turnover by 33.43%, as well as the average cost index to facilitate decision-making regarding inventory management. I applied this approach and sought to create a CMMS database that can be integrated into the CMMS system.

Keywords: CMMS, Spare parts management, Inventory, Maintenance, Stock movement, Cost.

Résume:

Dans ce travail, nous avons étudié le développement d'un module de gestion des stocks et des pièces de rechange dans le cadre d'un système de gestion de maintenance assistée par ordinateur. Cette méthode contribue à améliorer l'efficacité de la gestion des pièces de rechange en permettant de suivre les coûts des pièces et d'identifier celles qui sont les plus utilisées, ce qui facilite leur approvisionnement en temps opportun et réduit les temps d'arrêt des machines.

J'ai utilisé la méthode d'analyse ABC pour classer les pièces de rechange en fonction de leur importance et de leur efficacité à améliorer la maintenance et la rotation des stocks de 33,43 %, ainsi que l'indice de coût moyen pour faciliter la prise de décision en matière de gestion des stocks. J'ai appliqué cette approche et cherché à créer une base de données GMAO pouvant être intégrée au système GMAO.

Mots-clés : GMAO, Gestion des pièces de rechange, Stock, Maintenance, Mouvement de stock, Cout.

الملخص:

في هذا العمل، تمت دراسة تطوير وحدة إدارة المخزون وقطع الغيار كجزء من نظام إدارة الصيانة المحوسبة تسهم هذه الطريقة في تحسين كفاءة إدارة قطع الغيار بحيث يمكن تتبع تكاليف القطع ومعرفة القطع الأكثر استهلاكًا، مما يساعد في توفير القطع في الوقت المناسب وتقليل فترات تعطل الماكينة.

استخدمت منهجية تحليل ABC لتصنيف قطع الغيار حسب أهميتها ونجاحها في تحسين الصيانة ودوران المخزون بنسبة 33.43%، ومؤشر متوسط التكلفة لتسهيل اتخاذ القرار بشأن إدارة المخزون، وقمت بتطبيق هذا النهج وسعيت إلى إنشاء قاعدة بيانات CMMS يمكن دمجها في نظام .CMMS

الكلمات المفتاحية: إدارة قطع الغيار، المخزون، الصيانة، حركة المخزون, تسيير الصيانة باستخدام المحوسب, التكلفة.

General introduction:

Maintenance is defined as a set of technical, administrative, and organizational activities aimed at keeping machinery and equipment in good working order or restoring them to their normal condition after a breakdown, to ensure they perform at the required level of efficiency and at the lowest possible cost. Following the significant advancements in the industrial sector regarding production, machinery and equipment have become a cornerstone because of Computerized Maintenance Management Systems (CMMS) and their effectiveness in boosting production in both small and large organizations by organizing maintenance operations, tracking breakdowns, planning interventions, and ensuring timely and on-site maintenance, as well as optimizing the use of human and material resources

However, the success of any Computerized Maintenance Management System (CMMS) depends on effective management of inventory and spare parts, as inventory is the foundation of any organization, regardless of its function—particularly in production, where spare parts are critical. A shortage of spare parts hinders maintenance interventions, while overstocking leads to accumulation and subsequent spoilage of perishable items, both of which result in financial losses and high costs. This stems from a lack of demand forecasting and poor tracking of spare parts, particularly when relying on extensive paperwork and Excel spreadsheets, which make it difficult to achieve more accurate results in a shorter time

From this perspective, the following problem arises: How can the inventory and spare parts management module within the CMMS system be developed? To answer this question, I propose implementing the Economic Order Quantity (EOQ) method, which solves the problem of excess inventory and stockouts. I will use the Windev 10 environment, a branch of the WLanguage programming language.

Chapter I: Maintenance and Inventory Management in the Industrial Sector

Chapter I: Maintenance and Inventory Management in the Industrial Sector

I.1 Introduction:

Maintenance and inventory management are two essential pillars for sustainable production in modern industrial organizations. Maintenance is defined as a combination of technical and administrative activities aimed at keeping assets in optimal operating condition, while inventory management involves strategic planning to ensure the availability of necessary parts at the lowest possible cost. This highlights the importance of Computerized Maintenance Management Systems (CMMS) as strategic platforms that bridge these two areas; they are no longer merely a tool for recording data, but a means of improving operational efficiency and reducing total costs by ensuring the right part is available at the right time and place. The question is: what does each entail?

I.2 Definition of maintenance:

The British Standards Institution (BSI, 1984) defines maintenance as: "A combination of all technical and associated administrative activities required to keep an equipment, installations and other physical assets in the desired operating condition or restore them to this condition". [1]

I.3 Classification of maintenance:

a. **Breakdown maintenance (BM)**: "this is the maintenance strategy, whereby repair/restoration is initiated after the equipment failure/stoppage or upon occurrence of severe performance decline." [1]
b. **Corrective Maintenance (CM):**
Reactive maintenance is another name for corrective maintenance. Breakdown is seen or noticed, corrective maintenance is done. Of the time, corrective maintenance is done after a piece of equipment or machinery breaks down or when a problem with the equipment is found.do planned maintenance usually have to do corrective maintenance. [2]

CM can be put into the following groups.
Corrective repair: This type of repair is done after finding or seeing the problem in order to bring the equipment back to normal working order. How it works.
Basic overhaul: This type of repair is done to bring all of the equipment's parts back to their normal working condition, even if no specific failure has been found. [2]

c. **Preventive maintenance (PM):** "is a kind of physical check-up of the equipment to prevent equipment breakdown and prolong equipment service life. PM comprises of maintenance activities that are under taken after a specified period of time or amount of machine use.

During this phase, the maintenance function is established and time based maintenance (TBM) activities are generally accepted." [1]

a. Planned maintenance:

Planned maintenance is a part of preventive maintenance. It means scheduling the upkeep of buildings, machinery, equipment, and plants ahead of time to avoid breakdowns and unplanned stoppages. Most maintenance plans are set up for six months or a year. But the exact times for maintenance can be different and are usually set on a weekly, monthly, quarterly, or yearly basis, depending on how the machinery, equipment, or plants are built and how they are used. Most of the time, manufacturers' maintenance manuals give you the first ideas on how to set these regular maintenance intervals. Planned maintenance based on time makes sure that machines are put back into their original working condition, which lowers the chance of unexpected breakdowns. During this process, parts of the machinery or equipment are replaced according to how long they are expected to last. [2]

b. Predictive maintenance:

As the headings show, this kind of maintenance is all about using automated computer monitoring and assessment processes to figure out how likely it is that equipment will break down. Then it gives you a new way to keep things running that is meant to stop them from breaking down. [2]

I.4 The role of maintenance:

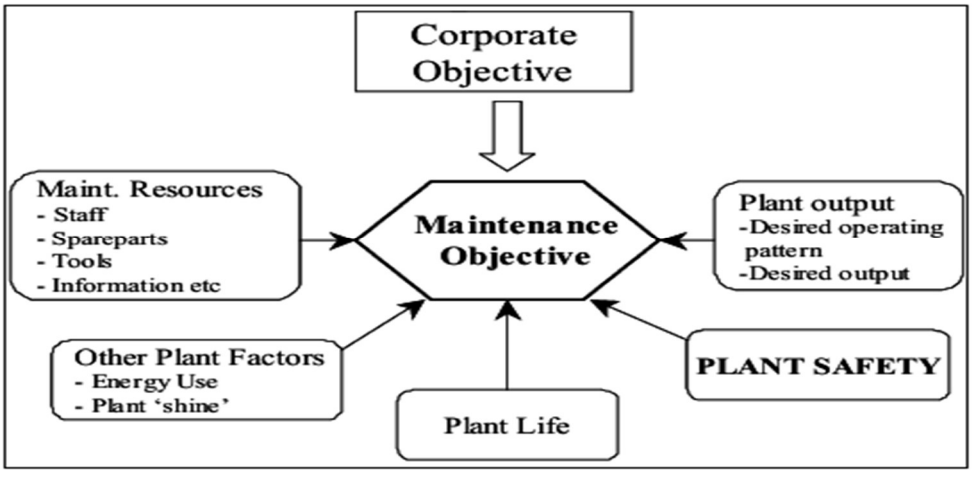

Figure 1Factors influencing the maintenance objectives [1]

Maintenance is very important for how well industries work. When a machine stops working, whether because of an unexpected breakdown or planned maintenance, it costs money. These costs could include the cost of labor and the materials needed for repairs, or they could go up a lot more if the downtime causes problems with the production process. [1]

Chapter I: Maintenance and Inventory Management in the Industrial Sector

I.5 Conception of CMMS:

Computerized Maintenance Management Systems (CMMSs) are very important for keeping track of all the tasks that need to be done to keep complex systems running smoothly, productively, and in good condition. Modern computer systems have made it possible for maintenance, for example, to be much more effective and efficient. Computerized maintenance management systems (CMMS) have been around for a long time, in one form or another. [3]

I.5 Role of CMMS:

The CMMS has developed into a strategic inventory management platform that connects supply chain and maintenance activities in the contemporary industrial setting, having started off as a straightforward maintenance logging tool. By guaranteeing that the appropriate part is available at the appropriate time and location, it directly lowers costs, boosts productivity, and improves customer. [4]

I.6 Advantages of CMMS:

- Cost-effectiveness
- Reduce downtime.
- Increased efficiency
- Management of inventory
- Extensive understanding [4]

I.7 Programming Languages:

Many programming languages can be used to realize a CMMS app or modules. We can find programming languages like PHP, C++, Delphi and Java and others witch use extern databases (Mysql, Postgres, MsAccess…). Other languages witch are kept with its databases, MsAccess, MsExcel and Windev witch each of these languages has its database. In this work we choose to use Windev language for its simplicity.

I.7.1 Definition:

"WLanguage is an integrated language. The WLanguage functions allow you to create processes for each project, window, page and control. These processes are entered in a dedicated source**".** [5]

I.7.2 WLanguage's tools:

Three main tools or versions make up the WinDev development environment, which enables developers to use the WLanguage programming language to create and manage projects:

1. WinDev: This development tool is used to create knowledge management (Windows) applications and their components, as well as Windows programs.

2. WebDev: This is necessary for website administration. Two kinds of code can be utilized with it:

Server Code: The server runs this code.

Browser Code: This sort of WLanguage code is automatically translated to JavaScript and runs within the user's browser.

3. WinDev Mobile: This program focuses on creating apps for mobile devices, such as the following gadgets:

- Android
- IOS (iPad/iPhone)
- Windows Mobile and Pocket PCs

These three classes share a common language called WLanguage, which also facilitates object-oriented programming right from the start. [5]

I.8 inventory management:

I.8.1 Definition:

A specialized area of corporate management, inventory management entails the strategic planning and management of inventories with the goal of maintaining the optimal stock levels for particular goods. [6]

Maintaining a careful balance between overstocking and running out of product is a major difficulty in inventory management. Achieving efficient inventory control is crucial since it has a direct impact on an organization's financial objectives, customer happiness, and operational effectiveness. Inventory management gets more complicated when supply chains get more complicated by adding more stages. Specifically, inventory management in a multi-echelon supply chain is far more difficult than in a single-echelon system. [6]

I.8.2 The Function of Inventory Control:

By guaranteeing the seamless flow of supplies and minimizing disruptions, inventory management is essential to improving supply chain efficiency. It functions as a strategic financial tool that reduces storage-related operating expenses and maximizes cash flow. It directly increases consumer happiness and cultivates long-term loyalty by ensuring product availability and prompt

order fulfillment. In the end, a company's competitive edge and total profitability are greatly enhanced by efficient inventory management.

I.8.3 Inventory management techniques (strategies):

Techniques such as FIFO, JIT, EOQ, ABC analysis and regular auditing are some of the effective inventory management techniques that can help improve inventory levels, reduce storage costs, prevent stockouts and increase profitability. Key techniques include using real-time data to forecast demand and using vendor-managed inventory (VMI) safety stock to manage demand fluctuations. Here are the principal inventory management strategies: [7]

Just-In-Time (JIT) system: products are received only when needed for production or sale, which reduces storage costs and waste.

Economic Order Quantity (EOQ): A formula that determines the optimal order quantity to minimize total storage and ordering costs.

ABC Analysis: Inventory is classified into three categories (A-high value, B- medium value, C-low value) to prioritize management efforts on high-value items.

First-In-Out (FIFO) and Last-In-First-Out (LIFO): FIFO sells the oldest stock first, ideal for perishable goods, while LIFO sells the newest stock first.

Safety Stock: Extra inventory is kept to prevent stockouts caused by unexpected demand spikes or supply chain disruptions.

Vendor-Managed Inventory (VMI): The supplier manages the customer's inventory, monitoring levels and restocking as needed.

Cycle Counting: (Regular Auditing) A method to ensure inventory accuracy by periodically checking a sample of stock instead of conducting a full annual count.

Demand Forecasting: Uses historical data and market analysis to predict future demand and adjust purchasing accordingly.

Material Requirements Planning (MRP): A system that ensures materials are available for production and products are ready for delivery.

Barcode/RFID Tracking: Technology used for real-time tracking, ensuring data accuracy, and reducing material errors.

These methods ensure improved cash flow, reduced overall costs, and increased customer satisfaction through product availability. [8]

I.8.4 Organization and management of spare parts inventory in maintenance:

The organization and management of maintenance spare parts inventory are mainly handled by the Stock Module of a Computerized Maintenance Management System (CMMS). "It's a cohesive approach that ensures the right parts are on hand at the right time, while optimizing costs and operational efficiency.
According to the sources, the key aspects of this management system are:

I.8.4.1 Primary Objectives

The main objectives of inventory and procurement management are:
Ensure that sufficient quantities of the required products are available to avoid stoppages of production.

Lower inventory management costs and avoid overstocking. Shorten delivery lead times and eliminate stockouts. [9]

I.8.4.2 Important Data & Files

To build an effective inventory system the following initial information has to be collected and recorded:
Bill of Material (BOM): A file containing all consumables for each machine, including manufacturer references.
Supplier Files: Detailed contact information and terms for various suppliers.
Replenishment Parameters: Auto replenishment file on minimum stock levels, reorder points and quantities to order.
Movement Records: Tracing through Materials Requisition Slips (MRS) and Materials Receipt Slips (MRR) [9]

I.8.4.3 Classification of articles in stock

Maintenance store materials are classified according to their nature and strategic importance as follows:
Of Nature:
Consumables: Things such as fuses, seals, screws and oils.
Spare Parts Sensors, motors, belts, bearings etc.
Traditional Tools: Standard tools used by maintenance agents and measurement instruments.
Special Tools: Specialized equipment such as lifting gear, thermal cameras and vibration analyzers.

By Strategic Importance:
Spare parts essentials the critical items that affect production risks, safety and quality
Necessary Spare Parts: Held in stock to cover supplier lead times, warranty periods and rates of consumption. [9]

I.8.5 Administrative Procedures and Work flow

The management cycle involves several automated and manual steps:

Usage Tracking: Documenting actual consumption through "Warehouse Release Orders".

Inventory Monitoring: Continuously auditing available stock against minimum levels to trigger **automated alerts**.

Purchasing Management: Automating the creation of purchase requisitions and orders to maintain necessary stock levels.

Reporting: Generating detailed lists regarding part values and consumption data per specific machine or sector. [9]

I.8.6 Role of the Maintenance Technical Office (MTO)

The Maintenance Technical Office (**MTO**) acts as the **central coordinator** for maintenance and inventory activities. Its roles include:

Analyzing equipment breakdowns and defining the appropriate maintenance policies. Managing spare parts to ensure they align with both the **overall budget** and the technical requirements of the facility.

Managing spare parts to ensure they align with both the **overall budget** and the technical requirements of the facility.

Using a **CMMS** to automate these processes, allowing the system to notify users when parts exceed their usage life or when stock replenishment is required, thus boosting production effectiveness. [9]

I.9 Relationship between inventory management and CMMS

This section highlights the **advantages of accurate forecasting** when inventory management is integrated with a CMMS:

Optimal Stock Levels: It helps determine the right balance to avoid both overstocking and costly stock shortages.

Cost Reduction: Balanced inventory minimizes carrying costs and optimizes the use of the company's working capital.

Supply Chain Efficiency: Reliable forecasting fosters better collaboration with suppliers, leading to reduced costs and better responsiveness to market demands.

Improved Turnover: Accurate alignment with demand results in faster inventory turnover, which improves cash flow and cuts storage-related expenses. [6]

Chapter II: Literature Review and research

Chapter II: Literature Review and research

II.1 Introduction

This chapter presents an analysis of the literature and studies related to inventory and spare parts management in the field of computerized maintenance management systems (CMMS). This chapter aims to develop an understanding of the theoretical and empirical framework upon which this study is based, through four main axes: first, the importance of computerized maintenance management systems and their role in facilitating the performance of maintenance operations; second, advanced research and algorithms used in predictive planning and maintenance; third, methodologies for developing inventory management systems with a focus on the Waterfall model; fourth, innovative tools and techniques. This chapter also highlights the research conducted in this field and contributes to identifying the gap that this study seeks to address.

II.2 Detailed literature review structure with citation of studies

II.2.1 Section: The Importance of CMMS Systems in Manufacturing and Maintenance Services

1. The Strategic Role of Computerized Maintenance Management Systems

The study by Shankar and al (2024) conducted on a motorcycle manufacturing company in India, demonstrated that implementing a CMMS system led to tangible improvements in maintenance performance. The system contributed to:

Improving inventory control from approximately 64% to 12% over five years.

Enhancing asset management and reducing the annual failure rate from 66% to 10%.

These results confirm the importance of CMMS in improving the operational efficiency of industrial companies.

2. Challenges in Traditional Inventory Management

The study by Lau & Rozanawati (2025) on developing an inventory management system for an auto workshop (Thompson Auto Service Centre) revealed fundamental problems in traditional systems:

- Reliance on paper records and Excel spreadsheets.

- Inaccuracy in tracking inventory and parts.

- Unnecessary costs resulting from overstocking or stockouts.

These challenges confirm the urgent need for computerized inventory management systems.

II.2.2 Section: Advanced Mathematical Models and Algorithms in Predictive Maintenance and Inventory Management.

1 Integrated Modeling of Maintenance and Inventory

The study by Chang & al. (2025) presented an integrated mathematical model for predictive maintenance and inventory management with reliability constraints. The model integrates:

- Opportunistic Maintenance (OM) and Routine Maintenance (RM).

- Shock-degradation dependence between hard and soft failure modes.

- A multi-supplier inventory policy with a choice between OEM and aftermarket spare parts vendors.

3. Advanced Optimization Algorithms

The researchers developed the SASK E-Jaya algorithm, which combines:

- Surrogate modeling using Stochastic Kriging.

- Quantile techniques to handle reliability constraints.

- An adaptive self-penalty mechanism for solving constrained problems.

Results showed the superiority of this algorithm over Jaya and GA in finding optimal solutions.

II.2.3 Section: Methodologies for Developing Inventory Management Systems: The Waterfall Model.

1 Applying the Waterfall Methodology in Development

The study by Lau & Rozanawati (2025) applied the Waterfall model in developing an inventory management system for an auto workshop, including the following phases:

1. Planning Phase: Stakeholder interviews, requirement identification.

2. Analysis Phase: Design of DFD and ERD diagrams.

3. Design Phase: User interface and database design.

4. Implementation Phase: Coding using Visual Studio Code.

5. Testing Phase: Functional testing and user acceptance testing.

2 Comparison with Other Methodologies

The study indicated that the Waterfall model is suitable for projects with clear and stable requirements, aligning with the nature of inventory management systems.

II.2.4 Section: Design of Inventory System Modules: Applied Case Studies

1 Core Modules of Inventory Management Systems

The study by Lau & Rozanawati (2025) identified six core modules:

2 Role-Based User Interface Design

The same study presented customized interface designs for each role:

- Manager Interface: Full permissions (add, modify, delate, reports).

- Clerk Interface: Purchase orders and their follow-up.

- Mechanic Interface: Withdrawing parts from inventory.

II.2.5 Section: Tools and Techniques for Improving Inventory Management Efficiency

1 Application of Lean Manufacturing Principles

The study by Tisza-Vargas (2025) on small and medium-sized textile enterprises in Peru demonstrated the effectiveness of Lean tools in improving inventory management:

- Just-In-Time (JIT)

- Kanban System: Reduced inventory levels by 35%.

- Production Leveling (Heijunka): Reduced work-in-process inventory by 40%.

- RFID Technology: Improved inventory-tracking accuracy.

2 Quantitative Results of Improvement

The study achieved tangible improvements:

- Reduction in overproduction rate: from 29% to 3% (an 89.66% improvement).

- Reduction in incorrect delivery rate: from 24% to 6% (a 75% improvement).

II.2.6 Section: Research Gap and Expected Contribution of the Current Study

Chapter II: Literature Review and research

1 Summary of Current Research Coverage

Previous studies adequately cover the following aspects:

Module	Function	Target User
Login & User Management	Authentication and account management	All Users
Inventory Management (CRUD)	Add/Modify/Delete Products	Manager, Clerk, Mechanic
Purchase Orders	Restocking requests and approvals	Manager, Clerk
Search Function	Product search by key	All Users
Reports	Monthly sales reports	Manager
Notifications/Alerts	Low stock level notifications	All Users

Table 1 Gap Analysis - Basic Functions Covered in Previous Studies

1. The strategic importance of CMMS. [10]
2. Advanced mathematical modeling. [11]
3. Software development methodologies. [12]
4. Efficiency improvement tools. [13]

2 The Identified Research Gap

Despite the comprehensiveness of previous studies, they do not specifically focus on managing spare parts in field industrial, which are characterized by:

1. Intermittent and irregular demand.
2. High variety of types and models.
3. High cost of critical parts.
4. Direct impact on machines downtime.

5 Expected Contribution of the Current Study

This study will contribute to bridging this gap through:

Developing a specialized module for managing spare parts within a CMMS.

Integrating custom predictive algorithms for spare parts demand.

Designing tailored interfaces for warehouse managers.

An optimized cost model that considers the specifics of spare parts

II.3 Proposed research

This research proposes the development of a module for inventory and spare parts management that can be integrated into a Computerized Maintenance Management System (CMMS) or used independently using the WinDev development environment.

This module aims to improve inventory and spare parts management within industrial organizations and maintenance workshops by providing a simple and practical computerized tool that helps inventory managers track inventory and make appropriate decisions more quickly and accurately.

This work addresses the gap between complex theoretical models of inventory optimization and the practical realities of industrial settings. Many studies rely on mathematical models and simulations, which are time-consuming—and mathematical expertise to perform, given the maintenance engineer's limited time, their practical application in the field is often challenging.

Therefore, this study focuses on developing an easy-to-use tool designed and adapted by the maintenance engineer to meet the institution's needs, while it is actually used by the inventory manager to monitor inventory movement and efficiency.

The proposed module provides a range of basic and analytical functions, including:

Management of spare parts, inventory, and supplier data.

Tracking of spare parts receipts and issuances.

Calculation of annual spare parts consumption rates.

Calculating the percentage of consumption for each part relative to total consumption.

Calculating the average cost of consumption.

Classifying spare parts using ABC analysis to identify the parts that are most important and have the greatest impact on inventory costs.

These analytical indicators also enable improved inventory monitoring and support decision-making regarding supply priorities and tracking of high-consumption parts, while helping to reduce waste and improve inventory management.

The proposed module is highly flexible, as it can be operated as a standalone unit for inventory and spare parts management, or integrated later into a comprehensive computerized maintenance management system, making it scalable and adaptable to the organization's needs.

II.4 Conclusion

The literature review shows that the research field is mature from both theoretical and practical perspectives. However, there is a valuable opportunity for specialization in spare parts management. The four presented studies form a solid foundation upon which a specialized and effective module within a CMMS can be developed.

Chapter III: inventory management Module

III.1 Introduction

This chapter presents four steps which are collection data, unit design, unit development and results & discussion. With focus to create a data bases from the industrial field which can create a unit help too much in maintenance exactly in availability of spare parts in time to complete maintenance operations, I used economic order equation (EOQ) method and ABC analysis in WinDev environment.

III.2 Data Collection

Data were collected through interviews conducted with a store clerk, IT engineer, maintenance and studies staff at Senelgaz Company in Adrar.

III.2.1 Presentation of company:

Sonelgaz is the national electricity and gas company in Algeria, established in 1969 to succeed the French company EGA. The Adrar power plant is a production unit that relies on gas turbines powered by natural gas (as the primary source) coming from the SBAA dehydration station (SONATRACH) arrived at pressure of 60 bar and diesel –fuel oil–(as an emergency source) storage capacity of 6,400 m3 guaranteeing autonomy of 15 days with groups at full load.

Location and Area: The electricity production plant is located in the industrial zone 5Km north of city center Adrar -national road No 06- Province and occupies a total area of 15 hectares. Its current capacity is 200 MW, distributed across several types of turbines (such as Nuovo Pignone and ASEA).

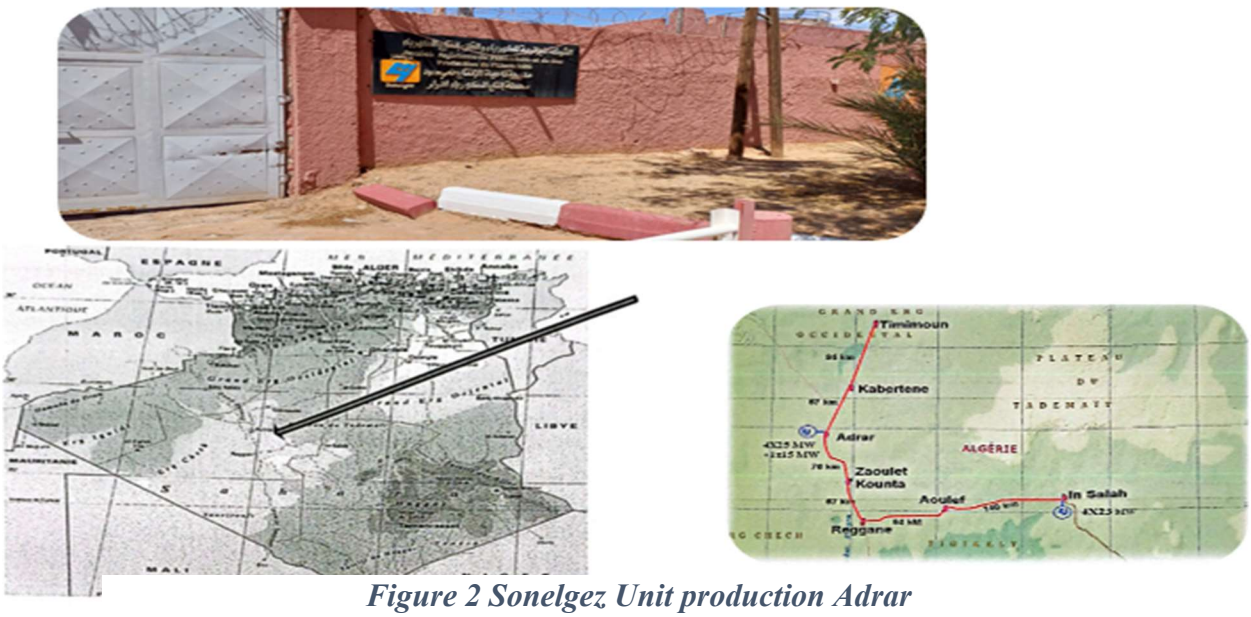

Figure 2 Sonelgez Unit production Adrar

III.2.2 Interviews

I conducted interviews with the maintenance department (a mechanical technician and a maintenance engineer), during which I learned how spare parts requests are linked to maintenance work order and inventory operations.

III.2.2.1 Observation of the Existing system

During the internship at Sonelgaz in Adrar, a field study was conducted to understand the operations of the maintenance department and the inventory management unit. The company relies on several types of warehouses, including warehouses for maintenance spare parts and office supplies. Inventory management is carried out through a set of internal procedures that include ordering spare parts, verifying their availability, purchasing, and recording inventory movements.

The observation phase also provided insight into the relationship between maintenance activities and inventory management, as spare parts are ordered based on maintenance work orders, and inventory movements are recorded according to the type of transaction (incoming, outgoing, or transfer). These procedures highlighted the importance of spare parts availability in ensuring the continuity of maintenance operations and preventing equipment downtime.

III.2.2.2 Interviews with Staff

Information was gathered through interviews with a number of employees, including a maintenance engineer, a mechanical technician, a warehouse clerk, and an IT engineer. These interviews provided practical insights into how maintenance and inventory operations are managed within the organization.

The interviews also helped clarify how work orders are created and how spare parts requests are processed and approved prior to maintenance operations. Additionally, the methods used for recording spare parts, tracking inventory movements, and organizing warehouse data were identified.

Furthermore, the IT engineer provided explanations regarding the IT tools currently in use within the organization, as well as some shortcomings related to the adopted inventory management methods.

III.2.2.3 Identified Problems

Based on field observations and interviews, a number of issues related to inventory and spare parts management were identified. One of the most significant of these issues is the unavailability of certain spare parts during maintenance operations, which can lead to equipment downtime and delays in maintenance. It also became clear to me that inventory tracking relies heavily on traditional procedures without sufficient analytical indicators to aid decision-making. Additionally,

the lack of automated tools for classifying spare parts and analyzing consumption makes it difficult to identify the most critical parts and improve inventory management.

These issues have highlighted the need to develop a computerized system specifically for inventory and spare parts management, which will help improve

III.2.3 Transfer the document to data module:

The most important documents examined and relied upon as the primary source of information for understanding how spare parts and transactions are managed in the inventory and maintenance departments were: the “Goods Receipt” (Bon de Réception) and the “Spare Parts Issue Request / Issue Slip” (Bon de Sortie).

سونلغاز
sonelgaz

الشركة الجزائرية للكهرباء و الغاز - إنتاج الكهرباء
Société Algérienne de l'Electricité et du Gaz – Production de l'Electricité

Unité production d'Adrar
Division Maintenance d'ADRAR
Section G.D.S
Magasin : ADRAR

BON DE RECEPTION N°02 / /

Facture n° : F-2025.....
Fournisseur :
Imputation :
Montant : 000 000 000.00 DA

Item	Désignation	Qte (FUT)			Nouv Stock	Qte Entré	Prix Fournisseur	Frais Répartie	Valeur Total
		Ann onn	Reçue	Accep					
01	Huile MOBIL JET 254	75	75	75	84	75			
02	Huile SULLUBE	01	01	01	02	01			
03	Huile JET OIL II	20	20	20	20	20			
TOTAL									

VISA DU S. STOCK **VISA SECTION APPROVISIONNEMENT**

VISA CHEF DIVISION MAINTENANCE

Figure 3 Goods Receipt annex

Imprimé le: 07/04/2026

سونلغاز sonelgaz	Bon de sortie	SPE / ADR / Code : Version: 1.0 Date document: N° de référence . Date Mouvement:

Dénomination FR: Magasin Unité adrar **N°:** **Centre charge:**

Type de stock 1: Utilisable

Ordre travail: **Date de l'OT:**

N° demande: **Date demande:**

Liste des Articles

N°	Gr	Code	Ancien code	Article	U.M	Emp.	Ref.Four	Quantite demandée	Stock à nouveau	Quantité sortie	Prix unitaire	Total
1	12				FUT							

Montant DZD

EMETTEUR **VISA RESPONSABLE** **MAGASINIER** **UTILISATEUR** **FICHISTE**

Page 1 /1

Figure 4 Spare Parts Issue Request annex

Data Extraction

by analyzing these documents, the essential information that must be stored in the system was identified:

Document number. Transaction date.

Supplier. Part code.

Part name. Quantity received or issued.

Unit price. Total value.

Warehouse. Storage location.

Recipient or work order. Converting Documents to a Database

After studying the content of these forms, the entities and their relationships were extracted, leading to the creation of the following tables:

Warehouse

Spare Parts

Suppliers

Category

Inventory Details

Stock Movement

Work Order

Demand

Reception voucher

Exit voucher

Example

From figure 3 "goods receipt" information on the supplier, parts, and quantities received was extracted, leading to the creation of the following tables:

Supplier Spare Parts Stock Movement

From figure 4 "spare parts" information on the parts issued and work orders was extracted, which helped create:

Work Order Stock Movement demand.

The study of the actual documents used within the organization allowed for an understanding of the flow of inventory information and the conversion of this paper-based data into a relational database model that ensures the storage, organization, and retrieval of information in a computerized and efficient manner.

III.3 Module design

Part 1: Initial setup and database design

III.3.1.1 Detailed Requirement Analysis for the Module

Before starting the actual database design, the functions that the Inventory and Parts Management Module must perform were analyzed. Based on the theoretical study of CMMS systems and common needs in maintenance management, the following functional requirements were identified:

Core Functions of the Module:

- Add, modify, and delete spare parts data
- Track the current quantity of each part in inventory
- Define a minimum stock level for each part (Min Quantity)
- Link spare parts to Work Orders
- Generate automatic alerts when stock falls below the minimum level" Identifying Required Data (warehouse, Parts, Suppliers, Work Orders...)

III.3.1.2 Database design using analysis file

In this section, the **tables designed** along with explanations.

III.3.1.3 Identifying required data

To achieve the functional requirements mentioned above, the database was designed to include the following tables:

PK= primary key; FK= Foreign Key; Varchar: Text

Warehouse table:

Field	Type	Description
IDWarehouse	Integer(PK)	Unique identifier of the warehouse
IDinventory	Integer(FK)	Key foreign of inventory details
Name	Text	Name the warehouse

Table 2 Ware hause table

Figure 5 warehouse

Spare Part Table:

Field	Type	Description
IDPart	Integer (Auto)	Primary Key
Code	Varchar	Part code
Part	Varchar	Part name
IDMouvement	Integer(FK)	Number of stock mouvment
IDCategory	Integer(FK)	Category the part belongs to
Unit	Varchar	Unit of measurement (piece, kg, liter)
Min Quantity	Numeric	Minimum allowed stock level
IDLocation	Integer(FK)	Part Location in which warehouse
IDSupplier	Integer	ID Supplier (Foreign Key)
Unit Price	Currency	Unit price
Reorder quantity	Numeric	Reorder quantity
Total Quantity	Numeric	Global quantity
Percentage	Numeric	Percentage of annual consumption
Cumulate percentage	Numeric	Cumulate percentage
Type	Combo	Case of Parts
Annual con	Numeric	Consumption Cost

Table 3 Spare Parts

SpareParts

Nombre de rubriques : 17 Taille en octets : 122 Afficher dans l'ordre physiqu

Clé	Nom	Libellé	Type	Taille
	IDPart	N spare	Id. automatique	4
	code	Cod	Texte	20
	IDSupplier	N supplier	Numérique	4
	IDCategory	N category	Numérique	4
	IDMovement	N mouvement	Numérique	4
	IDlocation	N loc	Numérique	4
	pname	Part	Texte	20
	typspr	Types	Sélecteur,Liste,Combo	2
	unit	Unit	Texte	10
	loca	Location	Texte	8
	miniquantity	Miniquantity	Numérique	4
	reorquantity	Reorder quantity	Numérique	4
	totalquantity	Total quantity	Numérique	4
	unitprice	Unitprice	Numérique	4
	annual_con	Cost	Numérique	4
	percentage	Percentage	Numérique	4
	cumlper	Cumul per	Numérique	4

Figure 6 Spare parts

Stock Movements Table

Field	Type	Description
IDMovement	Integer (Auto)	Primary Key
IDWarehouse	Integer (FK)	warehouse
IDPart	Integer(FK)	ID Part (FK)
Type	Combo box	List of Movement type
Quantity	Numeric	Quantity demand
Date	Date	Movement date
Reference	Varchar	Reference (Work Order or Purchase Order number)
IDUser	Integer(FK)	ID of the user who performed the movement
Obs	Varchar	Observation about parts
Time	Time	Hour

Table 4 Stock mouvements

Figure 7 Stock mouvements

Suppliers Table

Field	Type	Description
ID_Supplier	Integer (Auto)	Unique identifier of the supplier
Name	Varchar	Supplier Name
Phone	Varchar	Phone number
Email	Varchar	Email address
Address	Varchar	Address of supplier

Table 5 Supplier

Figure 8 Supplier

Work order

Field	Type	Description
IDWorkOrder	Integer (Auto)	Code of work order
IDMouvement	Integer(FK)	Number of movement
IDPart	Integer(FK)	Number of spare part
IDUser	Integer(FK)	Number of user
IDService	Integer(FK)	Number of service
IDLoc recep	Integer(FK)	Number of location reception
Date	Date	Date of the order
PH N	Varchar	Phone of service chef

Table 6 work order

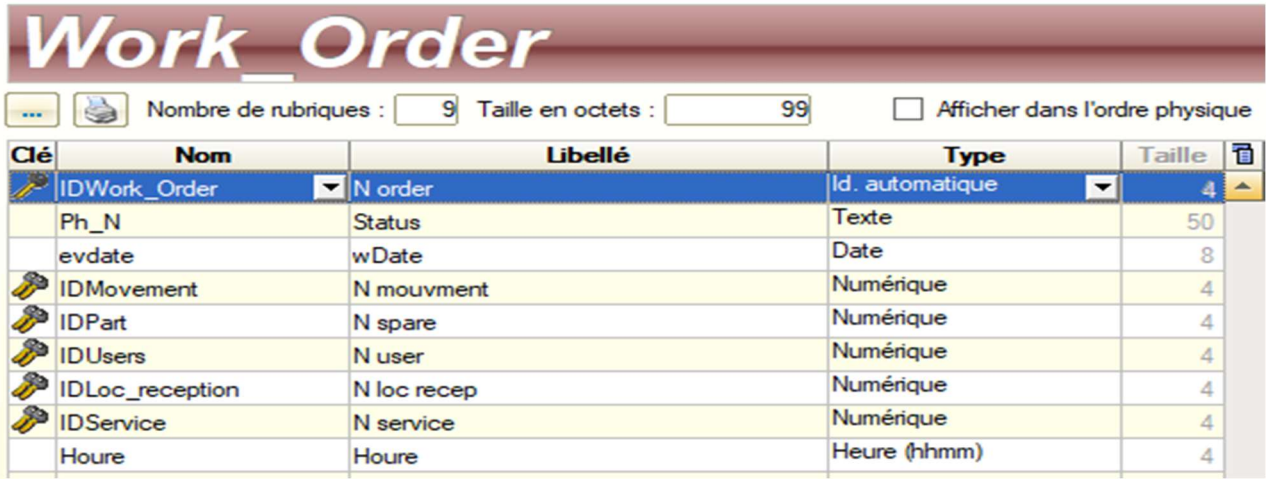

Figure 9 work order

Inventory details table

Field	Type	Description
IDInventory	Integer (Auto)	Identifying code inventory
IDPart	Integer(FK)	Identifying code parts
IDWarehouse	Integer(FK)	Identifying code ware house
Quantity	Numeric	Quantity in ware house
Last Update	Date	Last date

Table 7 inventory details

Figure 10 Inventory details

Category table

Field	Type	Description
IDCategory	Integer auto	Cod of category
Name	Varchar	Category of parts

Table 8 category

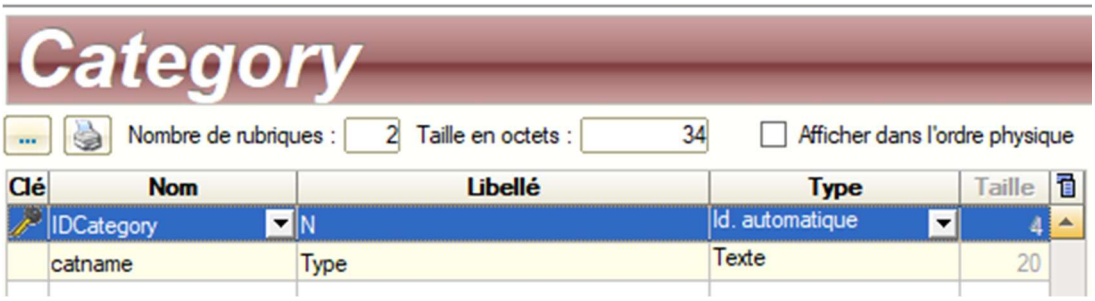

Figure 11 Category

User table:

Field name	Data type	Description
IDuser	Integer(PK)	ID user
Username	Vachar	Family name
Fist N	Vachar	First name
Position	Vachar	Position of user
Ph N	Numeric	Phone number
Email	Vachar	User email

Table 9 User

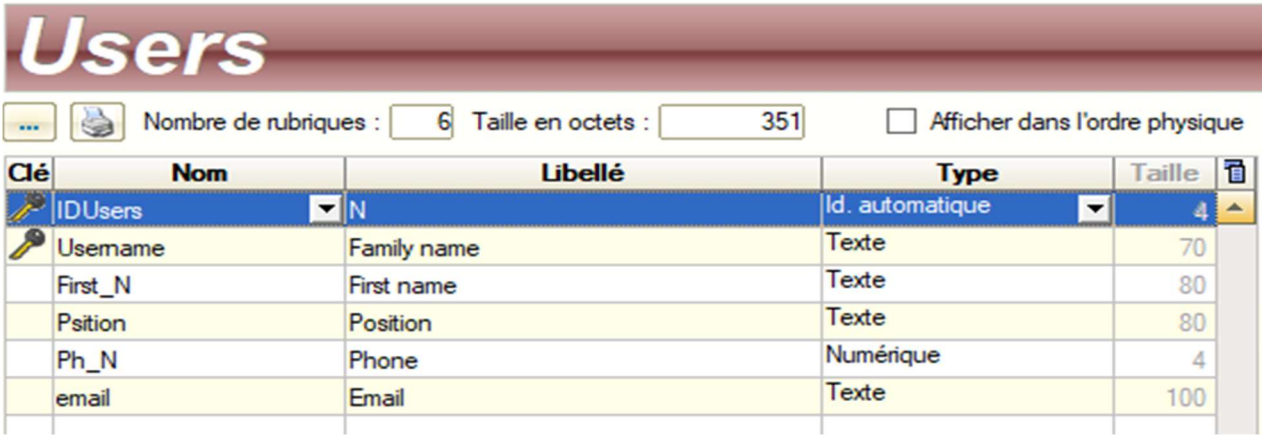

Figure 12 User

Demand table

Field	Type	Description
IDdemand	Auto	Number of demand
IDPart	Integer	Spare arts
IDwork order	Integer	Number of work order
IDExit voucher	Integer	Number of voucher
Date	Date	Date of demand
Qte	Numeric	quantity

Table 10 Demand table

Figure 13 Demand

1.2.2 Defining Relationships between Data

After defining the tables and fields, the following relationships were established to ensure data integrity:

Relationship between Spare Parts and Suppliers:

SpareParts. SupplierID ← Suppliers.ID_Supplier

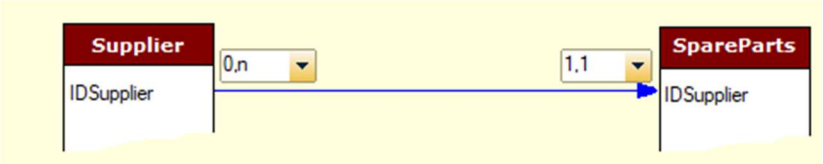

Figure 14 supplier and spare part relation

(Each spare part is supplied by one supplier, and one supplier supplies many parts)

Supplier → Spare Parts:

Each supplier can supply one or more spare parts → Yes

Each supplier must supply at least one spare part → No

Spare Parts → Supplier:

Each spare part can be supplied by one or more supplier → Yes

Each spare part must be supplied by at least one supplier → Yes

Relationship between Stock Movements and Spare Parts:

Stock Movements Spare Part ID ← Spare Parts ID Spare Part

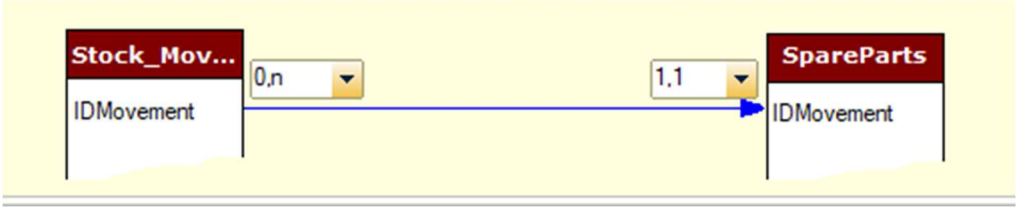

Figure 15 Stock Mouvement and spare parts Relation

(Each movement belongs to one part, and one part has many movements)

Inventory Transactions → Spare Parts:

Each inventory transaction can involve only one spare part → 1

Each inventory transaction must involve at least one spare part → 1

Spare Parts → Stock Movements:

Each spare part can have multiple stock movement → n

Each spare part mustn't have at least one stock movement → 0

Result: Stock Movements → Spare Parts: (1, 1)

Spare Parts → Stock Movements: (0, n)

Relationship between Work Orders and Stock Movements:

Stock Movements Reference can contain ID Work Order to link part consumption to maintenance orders

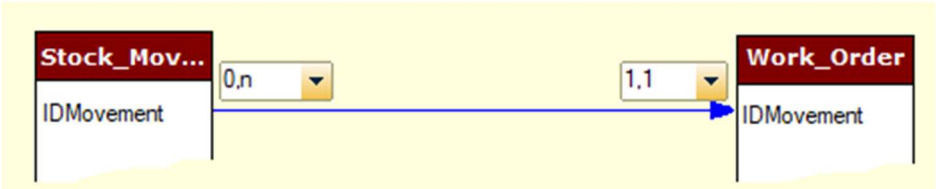

Figure 16 Stock Mouvement and Work Order Relation

Work Orders → Requests:

Each work order can have multiple part requests → n

Each work order mustn't have at least one part request → 0

Requests → Work Orders:

Each request can belong to only one work order → 1

Each request must belong to at least one work order → 1

Result: Work orders → Requests: (0, n) and Requests → Work orders: (1, 1)

Relationship type: One-to-Many (1, n)

Conceptual document model:

Windev handles 40% of the work—that is, it generates a simple template based on the data you enter to lighten the engineer's workload—while the remaining 60% consists of programming, modifications, and other tasks that I handle.

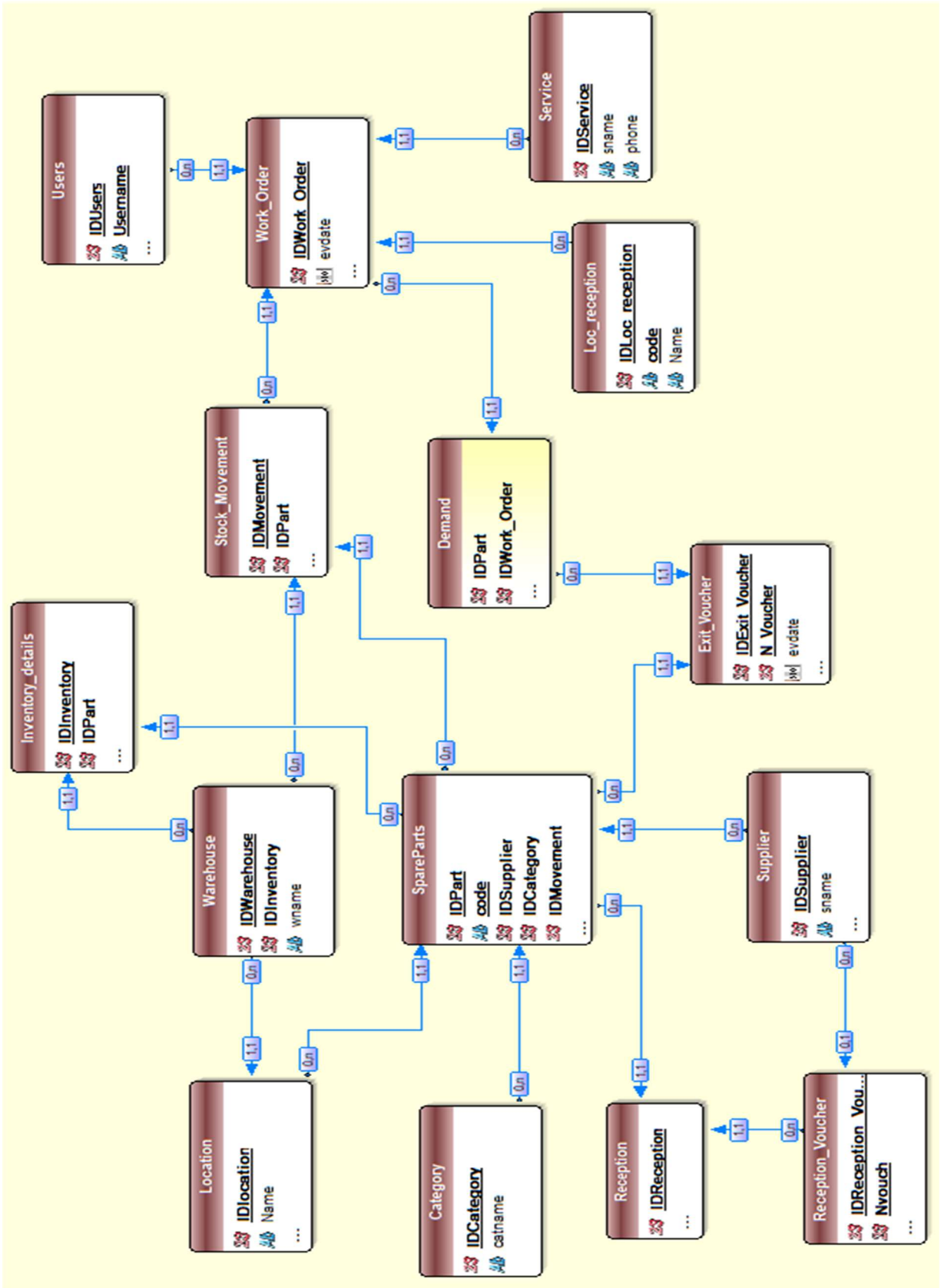

Figure 17 Data base

Part 2: Development

III.2.1 ABC analysis

Classification of Spare Parts (ABC Analysis)

To apply the Pareto principle to the supply chain, the ABC method is used to analyze inventory. This helps identify effective opportunities to optimize inventory levels, thereby reducing working capital and lowering storage costs. The Pareto principle, also known as the 80/20 rule, states that 80 percent of a company's revenue comes from only 20 percent of its product portfolio; these are the profitable assets that should be prioritized

Category A contributes 70% of the profit margin

Category B contributes 20%

Category C contributes 10%

To calculate ABC class:

Number of spare parts

$$Annual\ consumption\ =\ (total\ quantity)\ \times\ (Unit\ price)$$

Equation 1 Annual consumption

The average cost serves as an indicator of annual or monthly expenses

To programmed this function this is the following cod I used

annual_con..Valeur=totalquantity..Valeur*unitprice..Valeur

Note that the same code must be entered in the "Unit Price" and "Total Quantity" fields in the spare parts table.

$$Mean\ cost\ =\ \frac{annual\ consumption}{Number\ of\ parts}$$

Equation 2 Mean cost

Mean cost is an analytic indicator helps inventory manager to understanding of overall inventory consumption behavior and identifying whether consumption costs are high or stable.

In addition, this indicator supports decision-making by simplified information about overall inventory performance. It can also monitor the evolution of consumption costs over time.

$$percentage = \left(\frac{annual\ consumption}{Number\ of\ parts}\right) * 100$$

Equation 3 ppercentage

Percentage of annual consumption (cost)

$$Cumul\ percentage\ = percentage + cumul\ percentage$$

Equation 4 cumuli percentage

Cumuli Percentage of annual consumption (cost)

III.2.2 Discussion of the Results

A main interface for the project and a spare parts management interface were designed to facilitate parts monitoring.

Ability to integrate the unit with a computerized maintenance management system (CMMS)

Ability to export tables to Excel, where analytical charts can be created.

Analytical indicators:

- Consumption indicator
- ABC analysis (class)

Consumption indicator was used to determine the average cost of consumption as well as total costs.

An ABC analysis was conducted to identify where costs are concentrated, whether on an annual basis or over a specific period,

Based on previous studies, the ABC classification method has achieved significant success, estimated at 33.43% in increase in inventory turnover and a 19.95% reduction in total logistics costs at small and medium-sized enterprises [14]. As such, it yields greater benefits for large companies, reduces financial losses, and minimizes machine downtime.

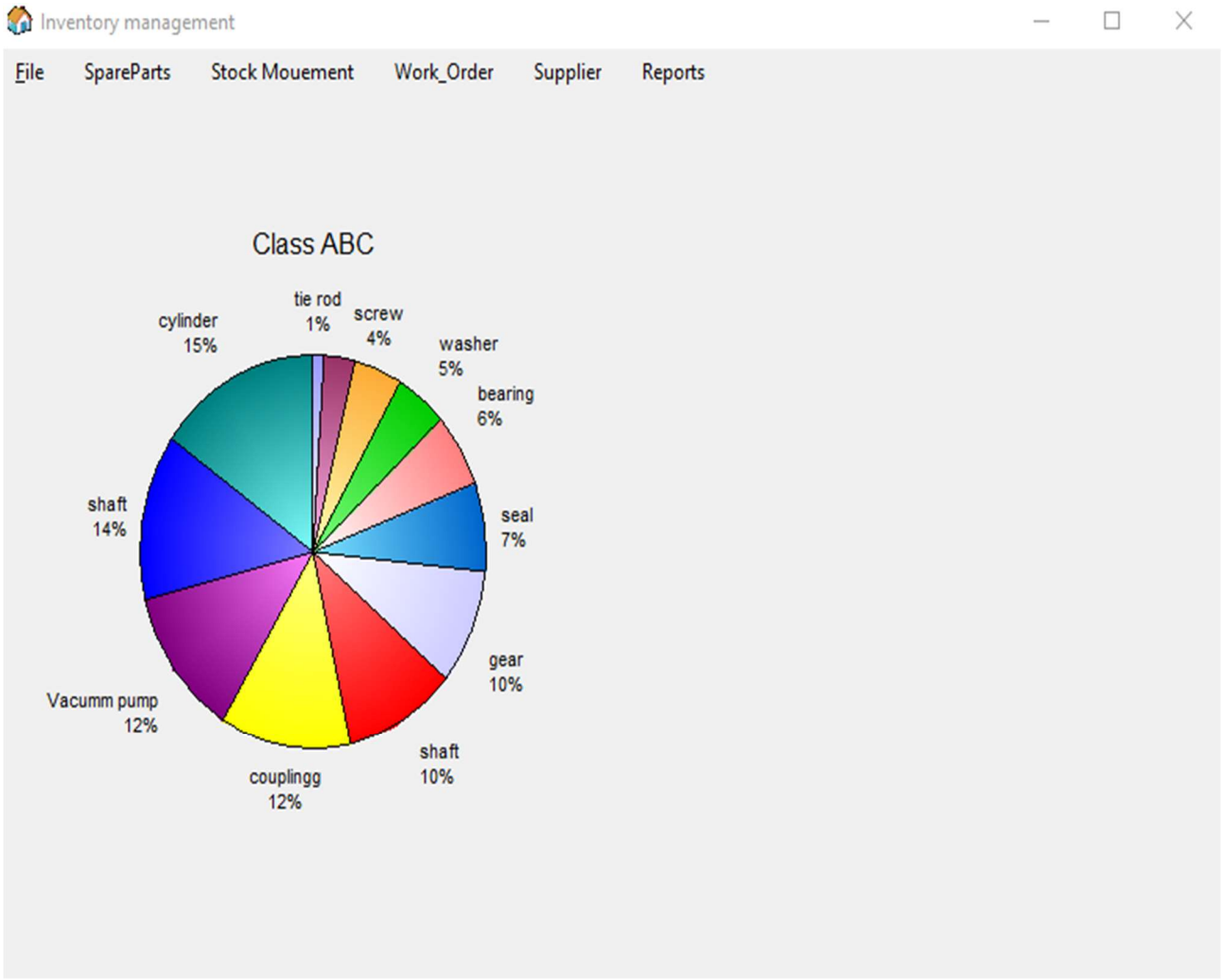

Figure 18 interface

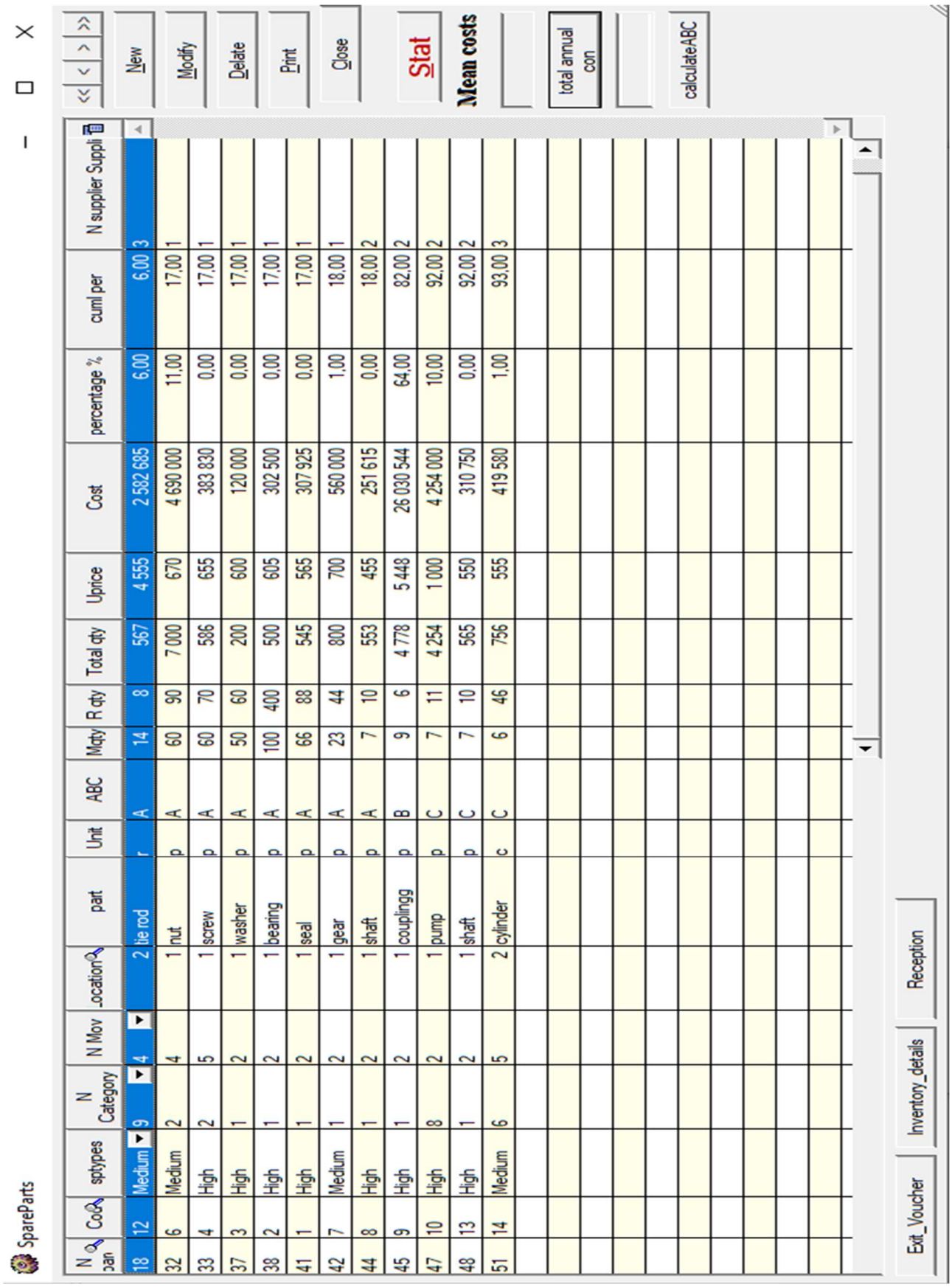

Figure 19 windew of spare part table

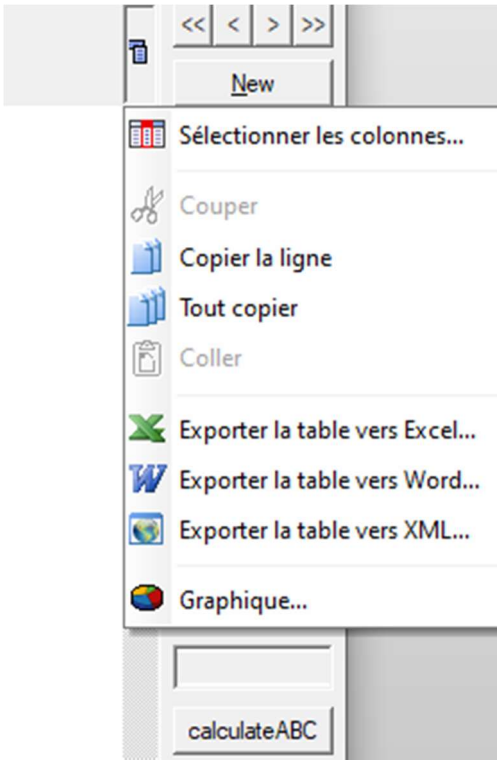

Figure 21 Settings of spare part window

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	
1	N spare	Cod	sptypes	N Category	N Mov	N loc	part	Unit	ABC	Mqty	R qty	Total qty	Uprice	Cost	percentage %	cuml per	N sup
2	18	12	Medium	9	4		tie rod	r	A	14	8	565	100	45200	0	0	3
3	32	6	Medium	2	4		nut	p	B	60	90	7000	670	4690000	71	71	1
4	33	4	High	2	5		screw	p	B	60	70	586	655	383830	5	76	1
5	37	3	High	1	2		washer	p	B	50	60	200	600	120000	1	77	1
6	38	2	High	1	2		bearing	p	B	100	400	500	605	302500	4	81	1
7	41	1	High	1	2		seal	p	B	66	88	545	565	307925	4	85	1
8	42	7	Medium	1	2		gear	p	C	23	44	800	700	560000	8	93	1
9	44	8	High	1	2		shaft	p	C	7	10	553	5	4475	0	93	2
10	45	9	High	1	2		couplingg	p	C	9	6	4778	9	43002	0	93	2
11	47	10	High	8	2		pump	p	C	7	11	4254	9	38286	0	93	2
12	48	13	High	1	2		shaft	p	C	7	10	565	55	31075	0	93	2
13	51	14	Medium	6	5		cylinder	c	C	6	46	46	555	25530	0	93	3
14																	

Figure 20 spare part table in excel

Algorithm

Flowchart for calculate annual consumption

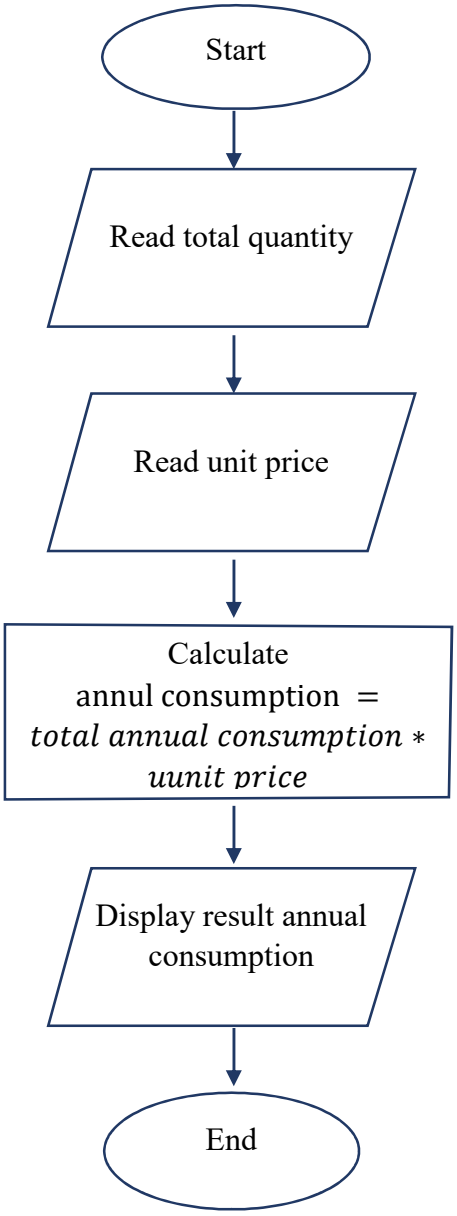

Figure 22 annual consumption Algorithm

Flowchart for calculate mean cost

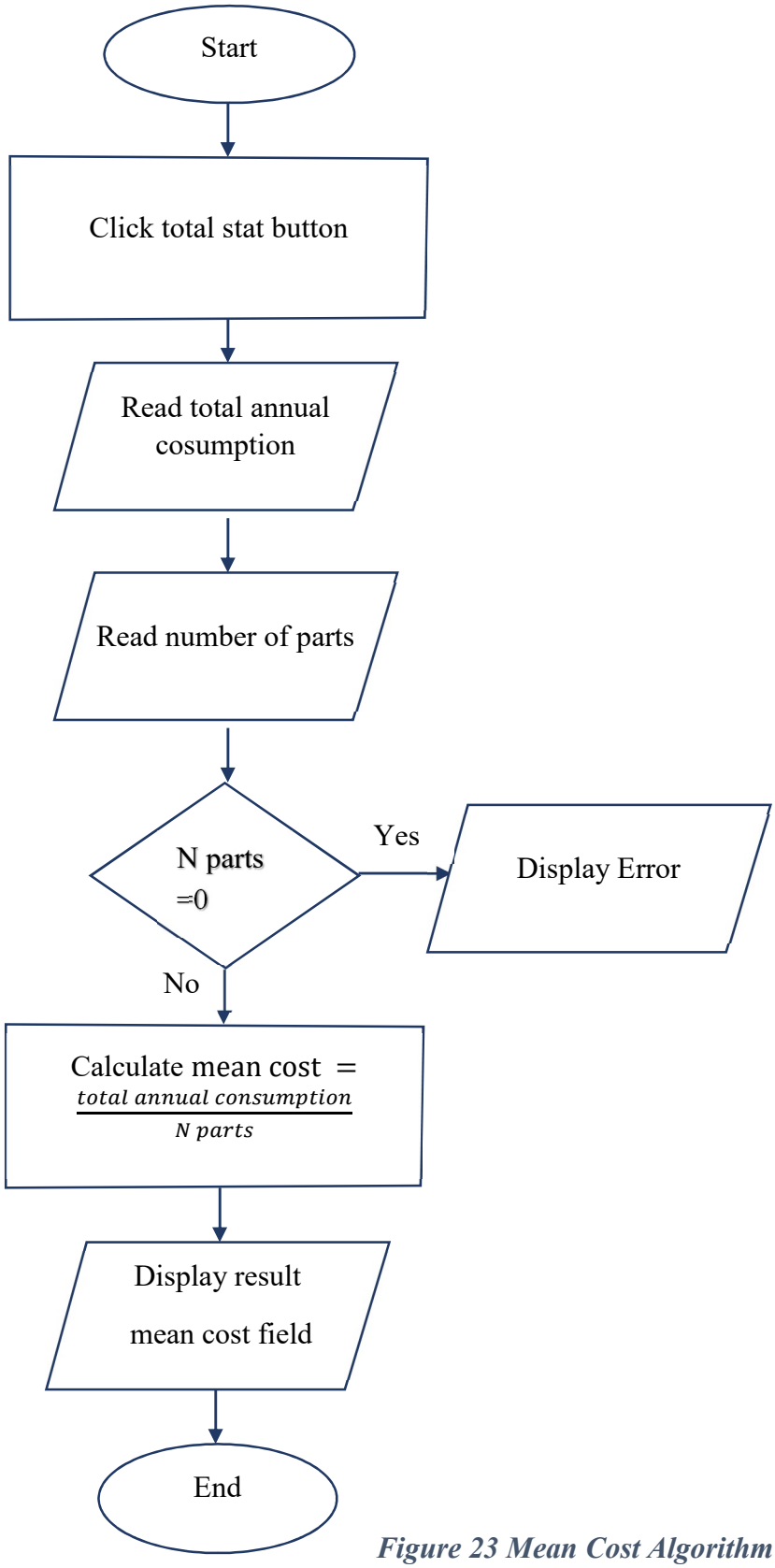

Figure 23 Mean Cost Algorithm

Flowchart for calculate ABC

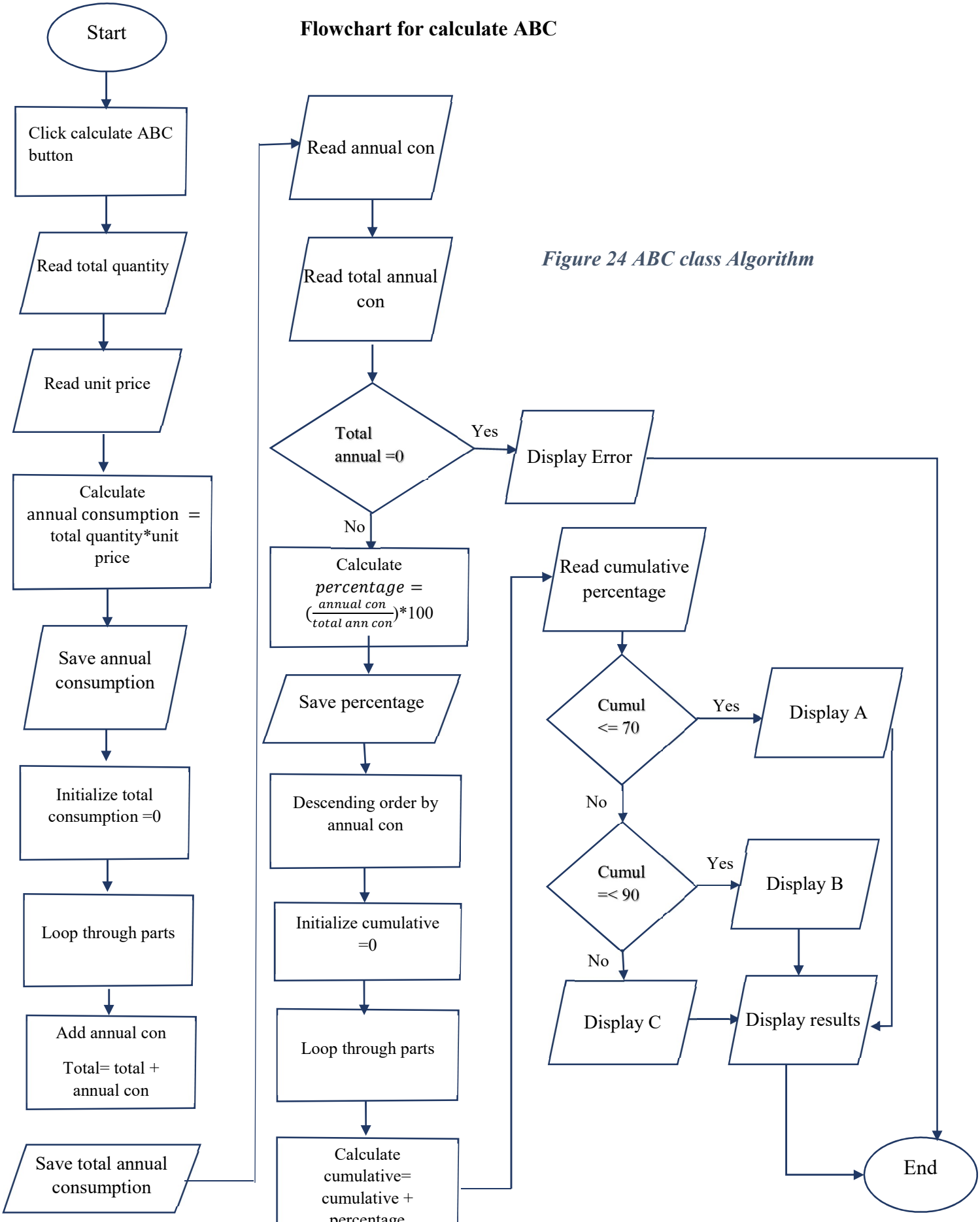

Figure 24 ABC class Algorithm

III.2.3 Recommendations:

Although the goal of this research is to bridge the gap and find solutions for developing the inventory and spare parts management unit, there is still room for further development and improvements by using

- The Economic Order Quantity method
- Designing a web portal to leverage all digital tools
- On-screen dashboard: tailored to each employee's role

Conclusion

In conclusion, inventory management plays an important role in improving maintenance operations by reducing downtime (zero downtime), ensuring spare part availability, and improving traceability.

This study focused on developing a module for inventory and spare parts management using the WinDev environment, which can operate independently or be integrated into a CMMS system. This reinforces the applications of computerized maintenance and its importance in the industrial sector, the developed module allows for the management of spare parts and inventory movements while incorporating analytical indicators such as annual consumption, percentage analysis, average consumption cost, cumulative percentage, and ABC classification.

These features help improve inventory monitoring, support decision-making, and track parts;

The results obtained demonstrated the effectiveness of ABC analysis in identifying critical spare parts and improving inventory organization. Finally, this project can be improved in the future by incorporating additional features such as EOQ calculations, automatic alerts, and forecasting techniques.

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Annexes:

سونلغاز
sonelgaz

الشركة الجزائرية للكهرباء و الغاز - إنتاج الكهرباء
Société Algérienne de l'Electricité et du Gaz – Production de l'Electricité

Unité production d'Adrar
Division Maintenance d'ADRAR
Section G.D.S
Magasin : ADRAR

BON DE RECEPTION N°02 / /

Facture n° : F-2025.....
Fournisseur :
Imputation :
Montant : 000 000 000.00 DA

Item	Désignation	Qte (FUT)			Nouv Stock	Qte Entré	Prix Fournisseur	Frais Répartie	Valeur Total
		Annon	Reçue	Accep					
01	Huile MOBIL JET 254	75	75	75	84	75			
02	Huile SULLUBE	01	01	01	02	01			
03	Huile JET OIL II	20	20	20	20	20			
TOTAL									

VISA DU S. STOCK **VISA SECTION APPROVISIONNEMENT**

VISA CHEF DIVISION MAINTENANCE

Sonelgaz - Production de l'Electricité, société par actions au Capital Social de 35 000 000 000 DA -
RC Alger 16/00 - 0965448 B04
Direction Région production Sud / Unité d'Adrar, Zone industrielle Adrar, BP 149 – Adrar
Tél : 049 36 37 60 – Fax : 049 36 37 61
Société du Groupe Sonelgaz

Imprimé le: 07/04/2026

سونلغاز sonelgaz	Bon de sortie	SPE / ADR / Code : Version: 1.0 Date document: N° de référence . Date Mouvement:

Dénomination FR: Magasin Unité adrar **N°:** **Centre charge:**

Type de stock 1: Utilisable

Ordre travail: **Date de l'OT:**

N° demande: **Date demande:**

Liste des Articles

N°	Gr	Code	Ancien code	Article	U.M	Emp.	Ref.Four	Quantite demandée	Stock à nouveau	Quantité sortie	Prix unitaire	Total
1	12				FUT							

Montant DZD

EMETTEUR **VISA RESPONSABLE** **MAGASINIER** **UTILISATEUR** **FICHISTE**