**The North African Journal of Scientific Publishing (NAJSP)**
مجلة شمال إفريقيا للنشر العلمي (NAJSP)
EISSN: 2959-4820
Volume 1, Issue 4, October-December 2023, Page No: 117-130
Website: https://najsp.com/index.php/home/index
**SJIFactor 2023: 3.733** **0.63 :2023 (AIF) معامل التأثير العربي** **ISI 2023: 0.383**

# Integration of Materials Management with Maintenance planning and work orders Using Asset Management Operating System (AMOS): A Case Study

Aboubaker A. Mousstfa Aboubaker[1]*, Mustafa Ahmed Ben Hkoma [2], Mahmod Gomah [3], Abdussalam Ali Ahmed [4]
[1] Department of Mechanical & Industrial Engineering, Libyan Center for Engineering Research and Information Technology, Bani Walid, Libya
[2] Project Management Department, College of Technical Science, Misurata, Libya
[3,4] Mechanical and Industrial Engineering Department, Bani Waleed University, Bani Waleed, Libya

*Corresponding author: aboaltibabo@gmail.com

| Received: October 08, 2023 | Accepted: November 28, 2023 | Published: December 02, 2023 |
|---|---|---|

**Abstract:**
Inventory management is critical for most industrial companies, which has negative effects on the way inventory can be managed. Many oil companies face great challenges in managing inventory when they seek developments. This article is trying to integrate material management with maintenance planning and work order management using the Asset Management Operating System (AMOS).
To achieve the research goals an Oil Zelten Field, one of the Sirte Oil Company' fields was taken as a qualitative single-case study. Data collection is mainly through interviews with the top managers and other staff involved in inventory control operations. Some data were obtained from the actual readings given by the AMAOS Monitoring System and were compared with the actual availability of the spare parts in the Zelten field' warehouse.
The study concluded that ABC classification and different review periods could be set by each category's specific characteristics. Items have the priority to be reviewed as they account for 20% of the total amount of items, but with more than 50% of total dinar value, a more frequent review can help management to better control these items to minimize stock-out or excess stock occurrence, and EOQ model does not apply to this case because the necessary inputs are not available. Instead, the desired covering period approach is applied regarding order quantity determination.

**Keywords**: Material Management, Supply Chain Management, Integration, Maintenance Planning, Work Orders, Oil Zelten Field.

**Cite this article as:** A. A. Aboubaker, M. A. Ben Hkoma, M. Gomah, A. A. Ahmed, "Integration of Materials Management with Maintenance planning and work orders Using Asset Management Operating System (AMOS): Case Study," *The North African Journal of Scientific Publishing (NAJSP),* vol. 1, no. 4, pp. 117–130, October-December 2023



## تكامل إدارة المواد مع تخطيط الصيانة وأوامر العمل باستخدام نظام تشغيل إدارة الأصول (AMOS): دراسة حالة

أبو بكر الطيب أبو بكر [1*]، مصطفى أحمد بن حكومة [2]، محمود جمعة [3]، عبد السلام علي أحمد [4]
[1] قسم الهندسة الميكانيكية والصناعية، المركز الليبي للبحوث الهندسية وتقنية المعلومات، بني وليد، ليبيا
[2] قسم إدارة المشاريع، كلية العلوم التقنية، مصراتة، ليبيا
[3،4] قسم الهندسة الميكانيكية والصناعية جامعة بني وليد، بني وليد، ليبيا

**الملخص**

تعد إدارة المخزون أمر بالغ الأهمية بالنسبة لمعظم الشركات الصناعية، والتي لها آثار سلبية على الطريقة التي يمكن بها إدارة المخزون، وتواجه العديد من الشركات النفطية تحديات كبيرة في إدارة المخزون عندما تسعى إلى التطوير. تسعى هذه المقالة دمج إدارة المواد مع تخطيط الصيانة وإدارة أوامر العمل باستخدام نظام تشغيل إدارة الأصول (AMOS).

ومن أجل تحقيق أهداف البحث تم أخذ حقل زلتن النفطي باعتبار أحد حقول شركة سرت للنفط كدراسة حالة فردية نوعية؛ فقد تم جمع البيانات بشكل رئيسي من خلال المقابلات مع كبار المديرين وغيرهم من الموظفين المشاركين في عمليات مراقبة المخزون. تم الحصول على بعض البيانات من القراءات الفعلية التي قدمها نظام الرصد AMAOS وتمت مقارنتها بالتوافر الفعلي لقطع الغيار في مستودع حقل زلتن النفطي.

وخلصت الدراسة إلى أنه يمكن تحديد تصنيف ABC وفترات المراجعة المختلفة وفقا للخصائص المحددة لكل فئة. وتحظى الأصناف بالأولوية الأولى للمراجعة؛ حيث إنها تمثل 20% من إجمالي كمية المفردات ولكن بأكثر من 50% من إجمالي الأصناف بقيمة الدينار، وإن المراجعة الأكثر تكرارا يمكن أن تساعد الإدارة على التحكم بشكل أفضل في هذه العناصر لتقليل نفاذ المخزون أو حدوث فائض في المخزون، ولا ينطبق نموذج الكمية الاقتصادية على هذه الحالة نظرا لعدم توفر المدخلات اللازمة، وبدلا من ذلك، يتم تطبيق نهج فترة التغطية المطلوبة فيما يتعلق بتحديد كمية الطلب.

**الكلمات المفتاحية:** إدارة المواد، إدارة سلسلة التوريد، تكامل، تخطيط الصيانة، أوامر العمل، حقل زلطن النفطي.

## Introduction

Inventory management is managing the parts or stocks of materials in any form inside the plant and stabilizing the flow of materials considering the variability in demand. It is very important that the inventory plans are structured in such a way that they accommodate variability in demand especially when the company deals with multiple products. Inventory management starts from the procurement of materials for manufacturing or processing until it reaches the customer as a finished product. Even stocked up finished goods are to be managed inside the facility along with the unprocessed materials. So, it becomes important to frame an overall plan that considers all materials to be stocked up inside the facility. Inventory management plans will lead to categorizing parts that comprise to a complete product and help in deciding the amount of inventory for each part that is stocked at any given time. Inventory management also facilitates a plant to decide the release and order intake dates of raw materials and finished parts considering the demand of the product and allotment of space for stocking materials inside the available facility [1].

During the 1990s, many manufacturers and service providers sought to collaborate with their suppliers and upgrade their purchasing and supply management functions from a clerical role to an integral part of a new phenomenon known as supply chain management. Since this aspect of supply chain management primarily focuses on the purchasing and supply management functions of industrial buyers, we have classified it elsewhere as the purchasing and supply perspective of supply chain management [2]. Correspondingly, many wholesalers and retailers have also integrated their physical distribution and logistics functions into the transportation and logistics perspective of supply chain management to enhance competitive advantage. Over the last 10 years, these two traditional supporting functions of corporate strategy evolved along separate paths and eventually merged into a holistic and strategic approach to operations, materials and logistics management commonly referred to as supply chain management (SCM) [3].

SCM has in recent years become an important way to enhance the company's competitive strength and therefore an important issue for most companies, a summary definition of the supply chain can be stated as: "All the activities involved in delivering a product from raw material through to the customer including sourcing raw materials and parts, manufacturing and assembly, warehousing and inventory tracking, order entry and order management, distribution across all channels, delivery to the customer and the information systems necessary to monitor all of these activities" [4].

Asset Monitoring & Optimization Solution (AMOS) System is effective software program that can help support the maintenance and planning crews to plan and prepare for turnaround scheduled maintenance. Some items and spare parts were shown available based on the given data on the AMOS Monitoring System. Indeed, the warehouse crews have usually made double checks to ensure the availability of the spare parts to be used in the scheduled/planning maintenance for any turbine or other equipment [5].

Damage to many stocks, nil stock, missing labelling, bad arrangements and unclassification of the spare parts in the warehouse appeared during the site visit of the planning and maintenance crew. The AMOS System was well programmed to issue a purchase order whenever the parts reached to a minimum certain level. Labelling of varieties of spare parts, the wrong way, which makes it difficult to find the

desired product, and sometimes making the issue an order to buy this new product which increases the accumulation of inventory in stock and increases investment in the wrong. Inventory stock-out often occurs despite the heavy investment in inventory. The lead time of some suppliers in Europe has been further extended from the previous three months to six months due to the production delay. To get a reliable forecast of the demand is not an easy task in the wholesaling industry. It is usually difficult to estimate the right quantity of demand during a specific period for each item [6].

**Material and methods**

In order to achieve the research goals a Sirte - Zelten Oil Field was taken as a qualitative single-case study. Data collection is mainly through interviews with the top managers and other staff involved in inventory control operations. Some data will be obtained from the actual readings given by the AMAOS Monitoring System and will be compared by the actual availability of the spare parts in the warehouse.
The Zelten Field lies in the Sirte Basin Eastern Libya. The Zelten oil field is an oil field located in the Zelten area of the Ghadames Basin in Libya. It is operated by the Sirte Oil Company, which is a Libyan national oil company involved in the exploration, production, and export of oil and natural gas. The Sirte Oil Company is one of the major national oil companies in Libya and operates several oil and gas fields in the country. Its primary focus is on developing and producing Libya's oil and gas resources.
The Zelten discovery well was located after only reconnaissance seismic lines had been run. It was completed on June 11, 1959 at the tested rate of 17,500 BPD [7].
Twenty-eight months later, in October 1961, after the construction of a field gathering system, a 175 kilometers pipeline and complete port facilities at Marsa Brega, the field was put on production. The reservoir consists of a carbonate complex of micritic and skeletal limestone and dolomite of Lower Eocene age. As of the year 1965, seventy-five wells had been drilled in the Zelten field of which fifty are productive and cumulative production to that date was 451,464,455 barrels [8].
Warehouse and Workshop are closed together in front of the offices; the Power Station built on two floors is the first installation noted coming from the road. The camp (living quarter) is just placed at 1 km from the production areas. The Remote Stations are accessible after crossing an average of 60 / 80 Km of desert route toward dunes, to reach those places with the car it has always been an attractive challenge [9].

**Figure 1.** Location of the Zelten oil field within Libya [10].

**AMOS - Material Management Impact**:

AMOS (Asset Management Operating System) is a computerized maintenance management system (CMMS) widely used in the maritime industry for effective asset management, maintenance planning, and material management. It offers comprehensive features and functionalities to streamline operations and optimize resources.
One of the key areas where AMOS has a significant impact is material management. Here are some additional details about the impact of AMOS on material management [5]:

1. Centralized Inventory Control: AMOS provides a centralized platform for managing inventory across multiple locations, vessels, or departments. It allows for real-time visibility of stock levels, locations, and movements. This ensures better control over materials, reduces the risk of stockouts, and minimizes excess inventory.

2. Spare Parts Management: AMOS enables efficient tracking of spare parts used for maintenance and repairs. It includes features for cataloguing spare parts, defining stock levels, setting reorder points, and managing supplier information. This helps ensure the availability of critical spare parts, reducing downtime, and optimizing inventory costs.
3. Procurement Optimization: AMOS streamlines the procurement process by automating various tasks, such as generating purchase orders, managing RFQs (Request for Quotations), and tracking supplier performance. It helps in standardizing procurement procedures, improving collaboration with suppliers, and ensuring timely procurement of materials at competitive prices.
4. Material Requisition and Approval: AMOS allows users to submit material requisitions electronically, which can be routed through approval workflows based on predefined rules. This ensures proper authorization and control over material requests, reducing the chances of unauthorized purchases or overspending.
5. Integration with Maintenance Planning: AMOS integrates material management with maintenance planning and work order management. When planning maintenance tasks, the system automatically checks for the availability of required materials and generates procurement requests if needed. This ensures that materials are procured in advance, minimizing delays in maintenance activities.
6. Cost Tracking and Analysis: AMOS provides comprehensive reporting and analysis capabilities for material costs. It allows for tracking expenses related to materials, analyzing spending patterns, and identifying cost-saving opportunities. This helps in optimizing budgets, negotiating favorable supplier contracts, and improving overall cost efficiency.

**Supply chain management (SCM):**

(SCM) refers to the coordination and management of all activities involved in the production and delivery of goods or services, from the sourcing of raw materials to the final delivery to the end customer. It encompasses the planning, execution, control, and monitoring of various processes to ensure that products or services are efficiently and effectively delivered to customers [11].

Key components of supply chain management include [12]:

1. Procurement: This involves sourcing and selecting suppliers, negotiating contracts, and managing relationships with suppliers to ensure the timely and cost-effective availability of materials and services.
2. Inventory Management: This includes managing and controlling inventory levels to meet customer demand while minimizing carrying costs and stockouts. It involves activities such as demand forecasting, order management, and optimizing inventory replenishment processes.
3. Logistics and Transportation: This entails managing the movement and flow of goods from suppliers to customers. It includes activities such as transportation planning, warehouse management, distribution network design, and order fulfilment.
4. Demand Planning and Forecasting: This involves analyzing historical data, market trends, and customer insights to forecast future demand accurately. It helps in aligning production, procurement, and inventory management with expected customer demand.
5. Supplier Relationship Management: This focuses on building strong relationships with suppliers, fostering collaboration, and managing performance. It includes activities such as supplier evaluation, development, and continuous improvement initiatives.
6. Risk Management: This entails identifying and mitigating risks that may affect the supply chain, such as disruptions in supply, natural disasters, or geopolitical events. It aims to develop strategies for risk prevention, contingency planning, and business continuity.

**Results and discussion**

**Inventory Control System:**

After several interviews with the manager and planning/maintenance crews in Zelten Oil Field, Sirte Oil Company (S.O.C) the researchers realized that there was not a formalized inventory control system. Normally, the manager and the staff working in the warehouse placed new orders from his intuition and experience, or when inventory happened to be found few lefts in the information system or as the result of a visual check by the staff working in the warehouse.

Such practice has two opposite results. The first one is stock-out, where the maintenance players have to wait for a period of time, shorter or longer if they do not cancel the order.

The second one is overstock, where unnecessary inventory accumulates and sits in the warehouse, costly but useless. Therefore, a formalized and standardized inventory control system should be established to solve the problems.

**ABC Analysis:**

At present, there have been a lot of different spare parts in Zelten Oil Field' Warehouse. If the manager and staffs allocate same time and effort on inventory control for each item, it would take them extra time and effort that would have been used otherwise, hence increasing labor costs. Based on the content in the theoretical framework, if we classify all the inventory items into several different level groups, then the different inventory groups can be treated differently. We believe this classification can save much time, effort and cost on the daily inventory operation. And it is a cost-efficient solution for the company, with improved management under limited resources.

According to Robert and Richard. (2019), classifying inventory items into A, B, C categories should follow several steps [14]:

1. Determine annual quantity usage of each item.
2. Multiply the annual quantity usage of each item by the cost of the item to obtain the total annual dollar usage of each item.
3. Add the total dollar usage of all items to get the aggregate annual dollar inventory expenditure.
4. Divide the total annual dollar usage of each item by the aggregate annual inventory expenditure to obtain the percentage of total usage for each item.
5. List the items in rank order by percentage of aggregate usage.
6. Review annual usage distribution and classify items as A, B, or C.

**Table 1a.** presents data collected based on the AMOS Monitoring System.

| No | Item No. | Description | In Use | In Stock | The Actual In store |
|---|---|---|---|---|---|
| **1.** | 300666604 | valve, non-return SV52FB 3-10 | 1 | 3 | 0 |
| **2.** | 300666611 | valve, check type MK | 1 | 3 | 1 |
| **3.** | 300667328 | gasket and seat ring set 30-RK-45-TT-Dn80-INSTR.49 | 1 | 1 | 2 |
| **4.** | 300667419 | shackle | 1 | 4 | 2 |
| **5.** | 485901928 | pressure control valve, 2" | 1 | 1 | 0 |
| **6.** | 485901929 | valve, safety - 931 NM.80 | 1 | 1 | 0 |
| **7.** | 485901951 | card dis-trasm- AGC-DTM.7 | 1 | 2 | 1 |
| **8.** | 485901952 | stepper motor -AGC-DTM.78 | 1 | 2 | 0 |
| **9.** | 485901953 | unit rvdt -AGC-EDEW.76.01 | 1 | 2 | 0 |
| **10.** | 485902510 | E.L Motor for fan intake system WAD 12mm | 1 | 1 | 0 |
| **11.** | 485902512 | gasket foe bypass flap type | 4 | 5 | 6 |
| **12.** | 485902514 | repair kit K0380(Goyen) | 10 | 11 | 4 |
| **13.** | 485902516 | diaphragm repair kit 4516(Goyen | 26 | 54 | 24 |
| **14.** | 485902518 | solenoid valve control box | 1 | 1 | 9 |
| **15.** | 485902520 | solenoid valve control box | 2 | 2 | 12 |
| **16.** | 485902522 | supervision print type 118 | 1 | 1 | 30 |
| **17.** | 487901102 | switch pressure -Y-110 MOD 358 (PS-471) | 1 | 1 | 2 |
| **18.** | 487901301 | switch temperature -C.110A MDD 102(TS-480) | 1 | 1 | 2 |
| **19.** | 487901502 | switch limit -14. CE -101-1 | 1 | 2 | 1 |
| **20.** | 732432903 | 2.5 mm | 1 | 503 | 96 |

**Table 1b.** presents data collected based on the AMOS Monitoring System.

| No. | stock maxi-mum | stock min-mum | Reorder level | Reorder Quantity | Price /Unit | Total cost |
|---|---|---|---|---|---|---|
| 1. | 0 | 0 | 2.99 | 2 | 2661.25 | 5322.5 |
| 2. | 0 | 0 | 1.99 | 2 | 196.15 | 392.3 |
| 3. | 0 | 0 | 0.99 | 2 | 19.92 | 39.84 |
| 4. | 0 | 0 | 3.99 | 4 | 89.15 | 356.6 |
| 5. | 0 | 0 | 0.99 | 1 | 10827.97 | 10827.97 |
| 6. | 0 | 0 | 0.99 | 1 | 1519.65 | 1519.65 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 7. | 0 | 0 | 1.99 | 1 | 1350.05 | 1350.05 |
| 8. | 0 | 0 | 0.99 | 2 | 6661.24 | 13322.48 |
| 9. | 0 | 0 | 0.99 | 2 | 2303.72 | 4607.44 |
| 10 | 0 | 0 | 0.99 | 1 | 4467.14 | 4467.14 |
| 11 | 0 | 0 | 1.99 | 4 | 260.13 | 1040.52 |
| 12 | 0 | 0 | 3.99 | 10 | 76.33 | 763.3 |
| 13 | 60 | 0 | 30 | 30 | 183.4 | 5502 |
| 14 | 0 | 0 | 0.99 | 1 | 1093.57 | 1093.57 |
| 15 | 0 | 0 | 0.99 | 2 | 1217.37 | 2434.74 |
| 16 | 0 | 0 | 0.99 | 1 | 1506.24 | 1506.24 |
| 17 | 0 | 0 | 0.99 | 1 | 246.65 | 246.65 |
| 18 | 0 | 0 | 0.99 | 1 | 73.09 | 73.09 |
| 19 | 0 | 0 | 1.99 | 2 | 230.14 | 460.28 |
| 20 | 0 | o | 9.99 | 288 | 1.05 | 302.4 |
| **Total Cost** | | | | | | **55629** |

According to Table 2, we can get the list of these items in rank order by percentage of Libyan dinar usage and classify them into A, B or C., the classification is using a model of 10-40-50 percentages of the items. This percentage is the approximate number and will vary from company to company. By the real situation of the sampled twenty items in Zelten Oil Field, we established 20-40-40 as the appropriate percentage of the items for the classification as shown in Table 2.

**Table 2.** Ranking of items, using a 20-40-40% ABC classification.

| No | Item No. | Description | Reorder Quantity | Price/ unit | Total cost | Percent of value | Cumulative value | Price /Unit | Total cost |
|---|---|---|---|---|---|---|---|---|---|
| 8 | 485901952 | steppermtor -AGC-DTM.78 | 2 | 6661.24 | 13322.48 | 23.948 | 23.948 | 2661.25 | 5322.5 |
| 5 | 485901 | pressure | 1 | 10827. | 10827. | 19.46 | 43.413 | 196.15 | 392.3 |
| 13 | 485902516 | diaphragm repair kit 4516(Goyen | 30 | 183.4 | 5502 | 9.890 | 53.304 | 19.92 | 39.84 |
| 1 | 300666604 | valve, non-return SV52FB 3-10 | 2 | 2661.25 | 5322.5 | 9.567 | 62.872 | 89.15 | 356.6 |
| 9 | 485901 | unit rvdt - | 2 | 2303.7 | 4607.4 | 8.282 | 71.154 | 10827. | 10827. |
| 10 | 485902 | E.L Motor | 1 | 4467.1 | 4467.1 | 8.030 | 79.18 | 1519.6 | 1519.6 |
| 15 | 485902520 | solenoid valve control box | 2 | 1217.37 | 2434.74 | 4.376 | 83.561 | 1350.05 | 1350.05 |
| 6 | 485901929 | valve, safety - 931 NM.80 | 1 | 1519.65 | 1519.65 | 2.731 | 86.293 | 6661.24 | 13322.48 |
| 16 | 485902522 | supervision print type 118 | 1 | 1506.24 | 1506.24 | 2.707 | 89.001 | 2303.72 | 4607.44 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 7 | 485901951 | card dis-trasm-AGC-DTM.7 | 1 | 1350.05 | 1350.05 | 2.426 | 91.427 | 4467.14 | 4467.14 |
| 14 | 485902518 | solenoid valve control box | 1 | 1093.57 | 1093.57 | 1.965 | 93.393 | 260.13 | 1040.52 |
| 11 | 485902512 | gasket foe bypass flap type | 4 | 260.13 | 1040.52 | 1.870 | 95.264 | 76.33 | 763.3 |
| 12 | 485902514 | repair kit K0380(Goyen) | 10 | 76.33 | 763.3 | 1.372 | 96.636 | 183.4 | 5502 |
| 19 | 487901502 | switch limit -14. CE -101-1 | 2 | 230.14 | 460.28 | 0.827 | 97.463 | 1093.57 | 1093.57 |
| 2 | 300666611 | valve, check type MK | 2 | 196.15 | 392.3 | 0.705 | 98.168 | 1217.37 | 2434.74 |
| 4 | 300667419 | shackle | 4 | 89.15 | 356.6 | 0.641 | 98.810 | 1506.24 | 1506.24 |
| 20 | 732432903 | 2.5 mm | 288 | 1.05 | 302.4 | 0.543 | 99.353 | 246.65 | 246.65 |
| 17 | 487901102 | switch pressure -Y-110 MOD 358 | 1 | 246.65 | 246.65 | 0.443 | 99.796 | 73.09 | 73.09 |
| 18 | 487901301 | switch temperature -C.110A MDD 102(TS-480) | 1 | 73.09 | 73.09 | 0.131 | 99.928 | 230.14 | 460.28 |
| 3 | 300667328 | gasket and seat ring set 30-RK-45-TT-Dn80-INSTR.49 | 2 | 19.92 | 39.84 | 0.071 | 100 | 1.05 | 302.4 |
| **Total Cost** | | | | | | | | | **55629** |

ABC analysis is a type of technique, which provides the means for identifying those items that make the largest impact on a company's overall inventory cost performance. Following the ranking from the analysis, we can place different controls on items A, B and C to improve the total inventory performance. From Table 2, we can conclude that the first four items (Item No. 485901952, 485901928, 485902516 and 300666604) are the high-priority A items. They should be controlled more closely on inventory records, and they need more frequent reviews in terms of forecasting, demand inquiry and order quantity determination. The next eight items (Item No. 485901953, 485902510, 485902520, 485901929, 485902522, 485901951, 485902518 and 485902512) are the medium priority B items. They should have less control compared to A items and be reviewed less frequently. The last eight items (Item No. 485902514, 487901502, 300666611, 300667419, 732432903, 3487901102, 487901301 and 300667328) belong to the lowest priority C items. They should have the least control

and be reviewed over a long time, at the same time C items can be ordered in large quantities and have more safety stocks.

**Warehouse:**
Form the empirical findings, we got to know that AMOS - Maintenance Management uses one warehouses for their inventory storage. Warehouse visibility is very important to improve the efficiency on warehousing operations. There are several ways to strengthen the visibility inside the warehouse:

a. **Location labeling on the warehouse floor:**
Distinct floor mark in warehouse can help forklift drivers to find the correct zones, regions or aisles easily. Usually, the bright yellow will be used for the floor mark color. At the same time, the grid of columns is one popular way for workers to identify the areas. The grid location labels can be affixed on all sides of columns. Figure (1) shows the example of column grid labeling. Compare with this example, we can observe from Figure (2) that Zelten warehouse is lack of this kind of identification labels.


**Figure 1**. The example of column grid label.

**Figure 2.** Zelten Field' Warehouse.

**b. Zone identification:**
According to the authors' experience, one common solution for zone identification is to hang a "name card" above every specific zone. Maybe the flat "name card" can't be seen from every direction, especially in the large rooms. Then we can use the triangular signs above the racks. This kind of shingle is visible from all directions. Unfortunately, we didn't find these zone identification signs in the Zelten warehouse.

**c. Rack identification:**
Rack identification is the most useful and effective method for identifying locations in pallet racks by three coordinates for the aisle, column within the aisle, and level within the column.
When the authors visited Zelten Oil Field Warehouse, we encountered some problems with the rack identification.
There is no item location guide. Some items' number was shown on the label, like Figure. (3) on the side of the rack, but some items can't be found in the appointed rack, show us one suitable item location guide board on the side of the racks.


**Figure 3.** The example of shingle of zone.

- Location addressing is inconsistent or not adequately displayed. From the Figure. (4). We can see the label on the rack shows the item number is 512005, but after checking the goods on the pallet, it is not Item 512005. Figure (5.7) shows that most racks still did not have any kind of location address.


**Figure 4.** Incorrect rack label.

**Figure 5.** There is no rack label for the item location.

**d. Warehouse Management System (WMS):**

Base on the practical situation of Zelten Field' Warehouse, which store approximate 1000 thousand different kinds of items, author surprising why they did not use the barcode scanning system which can make the inventory control operation efficiently and accurately?

It is hard for them to consolidate them into one barcode label. Even the same item in one wooden box but they are in different colors. Figure (6) shows the same size of rubber plates in one big wooden box, but usually they are in different colors. If every independent small box has one barcode label, it takes time for workers to scan all of them. Nowadays, they input these data according to the packing list from suppliers with the shipment.

**Figure 7.** There is no rack label for item location.

**Information System:**

To evaluate the information system 'Navision'[1], we had to focus on its performance in inventory management for Oil Zelten Field. The biggest aid 'Navision' is providing the management to update the inventory records for all the items every day, so that they can capture the right data to support their decisions regarding inventory. Without the support from 'Navision', the management will face great difficulty in managing inventory effectively and efficiently.

However, 'Navision' cannot make right decisions about inventory for the management. Data are kept in the information system. But how to use and analyze data to establish an effective and efficient inventory control system is still placed on the management. If they are unable to do it in the right way, the information system will reap fewer benefits. 'Navision' now has a disadvantage.

The historical inventory record is replaced by new updates and cannot be retrieved any longer. We suggest these historical inventory records of each day should be kept in the database, which will be used to draw a graph for each item over the course of a whole year. The graph becomes a vivid measurement to demonstrate the inventory management performance. The management can easily identify whether there are overstock and stock-out for specific item, the occurrence frequency and degree.

Through the reviews the management will get more experience about the inventory control system, hence further improve inventory management for the near future.

**Component/ Equipment Technical Data:**

This part of study will focus on AMOS Monitoring System. This program has password if you desire to access the data, few employees have an access to this system, and one of them is the research because he works a maintenance planner. The Supply chain management is illustrated as following.

If we speak mainly on the preventive maintenance, all the equipment was programmed in a certain date for maintenance works. All kind of spare parts, unskilled manpower, skilled manpower, technicians, experts, commissioners which usually hired from the manufacturer, Etc.

The AMOS Monitoring System helps the planner to know all the details regarding the spare parts/items which available in the Field Warehouse. The researchers have accessed to the AMOS Monitoring System during the writing the practical part of the research while he was working on preparations of

[1] Microsoft Navision or Microsoft Dynamics NAV is an ERP (Enterprise Resource Planning) solution built by Microsoft to aid business management.

one of the equipment that has to be maintained based on scheduled program. The following Figures were printout by the researcher's named component called A-100- Maintenance – (Components -0007- Sulzer Type (7). The equipment is a Gas Turbine Machine for power station located at Oil Zelten Field (A-100). Figure (8) indicates the detailed data of the equipment (GT IN-0007). All data needed such as: Type, Type No., Stock Items, Serial No., Machine Code, Status, Function No., and Function Description.

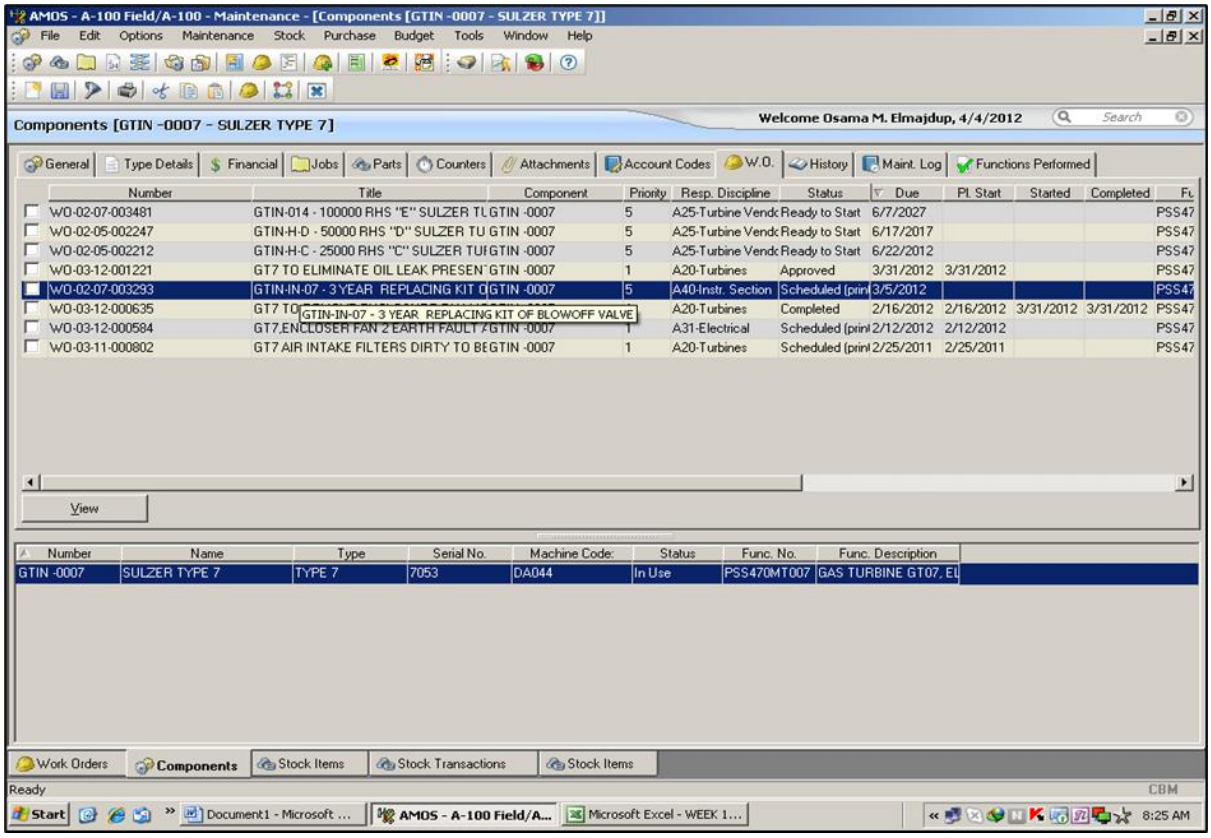


**Figure 8**. Printout of GTIN-0007Technical Data using AMOS Monitoring System.

**Work Order:**

The work order is one of the major problems that face the maintenance activities, if the work order system or chain is not followed and performed properly, later will have a negative impact on SCM. Usually, the work order is issued traditionally by operation crews who notice or observed any problems. The operator or the assigned person has to handwrite the work order in case of any corrective maintenance.

Nowadays, computer systems play an important role in programming the maintenance activities. The work order will be issued automatically whenever there is a need for maintenance, this kind of programming is a combined network that links the operation, maintenance and warehouse together.

In the Equipment (GTIN-0007) case, was scheduled and planned for preventive maintenance 2020, May 13. But indeed, this was delayed due to many problems such as: lack of foreigner manpower which supposed to be contracted, lack of spare parts which have to be ordered in early date. But due to Libya is facing problems (i.e. previous war, exiting of all foreign contractors, specialized companies, sanctions, etc.). Figure (9) shows a printout of the work order page using the AMOS Monitoring System.

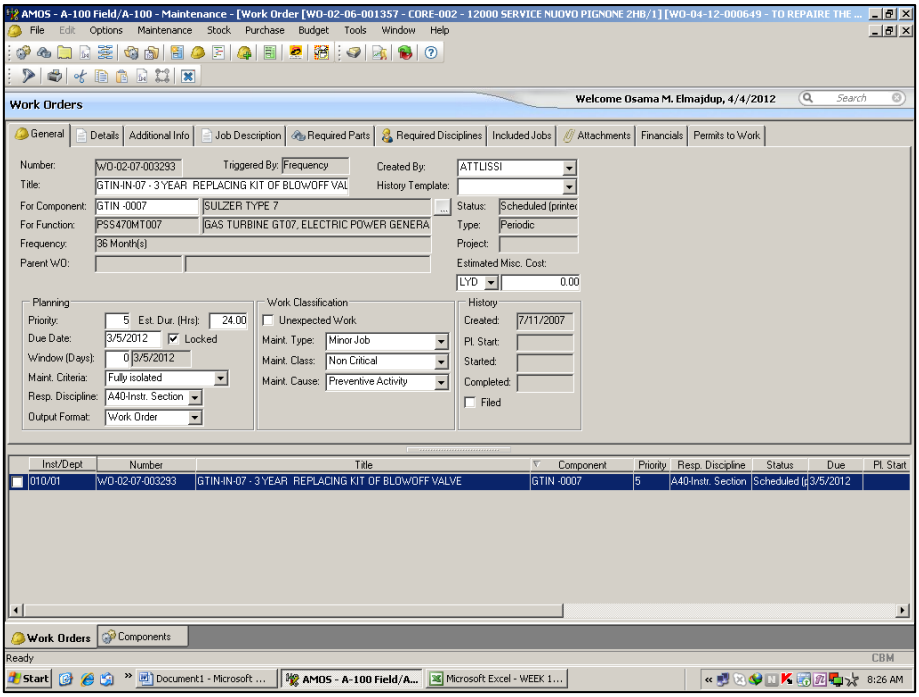


**Figure 9**. printout of work order page using AMOS Monitoring System.

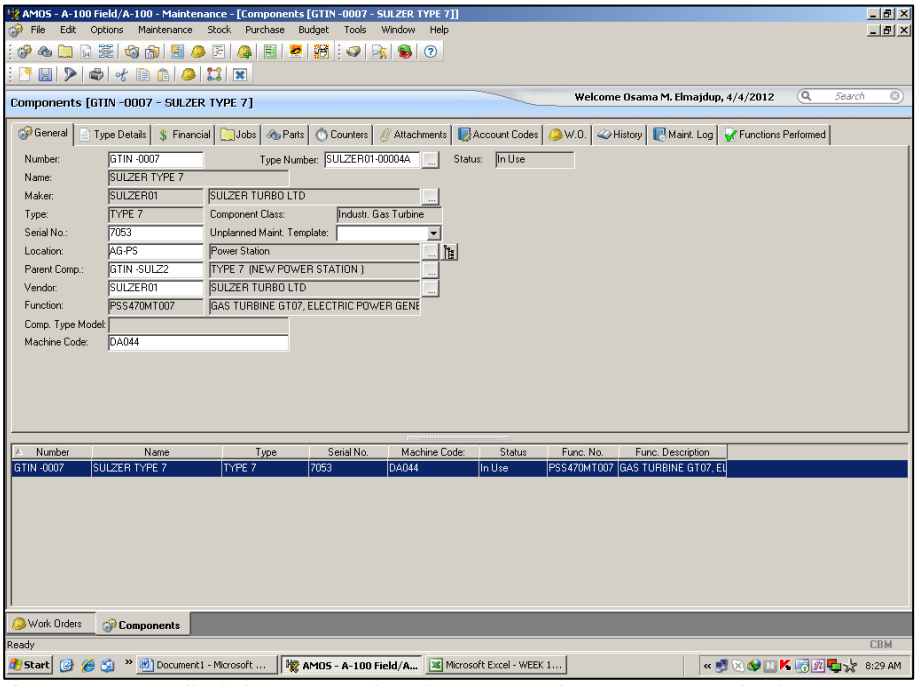


**Figure 10.** Detailed data on work order page using AMOS Monitoring System.

## Conclusion

Inventory management is critical for most companies, which have negative effects on the way inventory can be managed. Many companies face great challenges in managing inventory when they seek developments. This article is trying to connect theories with a real case and propose managerial solutions that Oil Zelten Field, can implement to improve its inventory management.

**Theoretical Conclusions:**

The theories about SCM, inventory management and IT included in theoretical framework are interrelated implicitly when they are applied to the case study in this dissertation. In other words, the option of an efficient inventory control system is affected by all of them, in different perspectives, and to different extent.

We also find that even though inventory management is critical businesses, the related theory on managing inventory facing rapidly fluctuating demands is sparse. And most studies about various

inventory control techniques did not provide prerequisites and constraints in terms of their application. However, we do get inspiration from previous research and construct the suitable theoretical framework for this case study as following:

1. In order to allocate time and money on inventory in rationalization, ABC analysis model has been used to classify various items.
2. Periodic review policy is selected to help management to determine when they should place new orders for inventory replenishment.
3. The 'desired covering period' approach is chosen to determine the order quantity.
4. The logic why specific theories have been selected and the way in which they were applied to this case study may be seen as a little contribution to the theory evolution.

**6.2 Practical Conclusions:**

The data in 2020 gathered from the main AMOS Monitoring System of twenty items reveal that demand variability is big in fact. After ABC classification, treatments become different for different category items. For instance, more attention needs to be paid to items and less review on C items. It is an efficient approach to saving costs, time and efforts for management.

Following ABC classification, different review periods could be set in accordance with each category's specific characteristic. Items have the first priority to be reviewed as they account for 20% of total amount of items, but with more than 50% of total dinar value.

More frequent review can help management to better control these items to minimize stock-out or excess stock occurrence.

It is concluded the EOQ model is not applicable to this case because the necessary inputs are not available. Instead, the desired covering period approach is applied regarding order quantity determination. We suggest that order quantity can vary for single replenishment based on the historical demand records, and the desired covering period is exactly the same as each item's review period.

**Recommendations:**

1. For the organization to be sure of the safety of its stock and for proper accountability, a good character, honest and trustworthy Personnel well verse with the principles of effective store control should be recruited and employed.
2. The use of shelves as a storage facility by organizations is appropriate but this is not enough. Other storage facilities such racks and pallets should be employed in the stores. The use of these facilities will ensure maximum security against deterioration and breakages. For other heavy materials like these used in large electrical installations, stock yield should be provided with adequate pallets and fenced to facilitate control and security. The gates should be well constructed and lockable and a provision of fire prevention in case of any unforeseen contingencies.
3. Stock levels should be fixed for items and materials purchased and held in stores in order to help provisioning. These levels, (maximum, minimum and re-order levels) could be fixed based on the previous purchasing order and the result adjusted in the light of what is likely to occur in the future.
4. Supplier's delivery date and time should be fixed for organization's suppliers. They should also be aware of the days and time during which they are expected to make deliveries and when facilities will be available to accept such deliveries. This will curb the system of suppliers delivering materials at will, reduce the burden of store officers and avoid unnecessary delays, stock out and costs.
5. Employees other than stores officers should not be allowed into the stores unless it is strictly on business. The habit of employees using the store area for their lunch break should be discouraged by organizations.
6. Stores ledger comprising all items of stock held in various stores located from the physical stock itself should be kept.
7. For easy identification of materials in the stores and to reduce fatigue, appropriate coding system should be employed. This can be done by using letters, Figures or a combination of both. The system could be based upon the nature of the stores items, the purpose for which items are bought, or on any other basis regarded as suitable for the business.
8. The Storekeeper in charge of the main store should be empowered to receive all in-coming materials irrespective of the sub-store they belong. He should always be informed of what he is expected to receive and when it is likely to arrive by giving him a copy of the order form. The exercise should be supervised by a Senior Officer at supervisory level with knowledge of effective store control. These materials can be dispatched to sub-stores which they belong and

to be received by the stores keepers in charge. If this is applied, it will reduce time wasting in receive materials as well as unnecessary delays of suppliers in the absence of a store Officer.

**References**


[1] Tony Wild, (2020). Best Practice in Inventory Management, 4th edition, John Wiley & sons, Inc, Canada.

[2] Suresh P. et. al (2019). Inventory and Supply Chain Management with Forecast Updates. University of Texas, Business Media, Inc, pp104-105.

[3] Lam, J., & Postle, R. (2006). Textile and apparel supply chain management in Hong Kong. International Journal of Clothing Science and Technology, 18(4), 265-277.

[4] Blackstone, J. H., Jr., & Cox, J. F. (2018). Inventory Management Techniques. Journal of Small Business Management, 4(1), 27-33.

[5] Toomey, J. Wong. (2017). Asset Monitoring & Optimization Solution (AMOS): Principles, Concepts and Techniques. Norwell: Kluwer Academic Publishers, York, USA.

[6] Davis, C. H., Raafat, F., & Safizadeh, M. H. (2018). Production and Inventory Information Processing: Material Requirements Planning. Journal of Small Business Management, 12(3), 24-37.

[7] Baric, G., Geochemical characterization of source rocks in NC-157 Block (Zelten Platform), Sirt Basin, (Ibid), p. 541-553.

[8] The Libyan National Oil Corporation (NOC).
website: http://www.noc.ly/.

[9] Energy Information Administration (EIA): https://www.eia.gov/

[10] Oil & Gas Journal: https://www.ogj.com/

[11] The Council of Supply Chain Management Professionals (CSCMP): https://cscmp.org/

[12] Supply Chain Management Review: https://www.scmr.com/

[13] Robert F. Jacobs and Richard B. Chase, (2019). Operations and Supply Chain Management: The Core, John Wiley & sons, Inc, Mechigan, USA.