

DOKUZ EYLÜL UNIVERSITY
GRADUATE SCHOOL OF NATURAL AND APPLIED
SCIENCES

INVENTORY MANAGEMENT AND COST
ACCOUNTING SYSTEMS DEVELOPMENT

by
Mustafa BAKIR

April, 2007
İZMİR

INVENTORY MANAGEMENT AND COST ACCOUNTING SYSTEMS DEVELOPMENT

**A Thesis Submitted to the
Graduate School of Natural and Applied Sciences of Dokuz Eylül University
In Partial Fulfillment of the Requirements for the Degree of Master of
Science in Computer Engineering, Computer Engineering Orientation Program**

**by
Mustafa BAKIR**

**April, 2007
İZMİR**

M.Sc THESIS EXAMINATION RESULT FORM

We have read the thesis entitled “**INVENTORY MANAGEMENT AND COST ACCOUNTING SYSTEMS DEVELOPMENT**” completed by **MUSTAFA BAKIR** under supervision of **ASSOC. PROF. DR. YALÇIN ÇEBİ** and we certify that in our opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Science.

.....
Assoc. Prof. Dr. Yalçın ÇEBİ

Supervisor

.....
Asst. Prof. Dr. Gökhan DALKILIÇ

(Jury Member)

.....
Asst. Prof. Dr. Zafer DİCLE

(Jury Member)

.....
Prof. Dr. Cahit HELVACI

Director

Graduate School of Natural and Applied Sciences

ACKNOWLEDGEMENTS

I would like to thank to my supervisor, Assoc. Prof. Dr. Yalçın ÇEBİ who has reinforced me to complete the thesis.

I give my deepest gratitude to my family Gülsevım - Cemal BAKIR and Cem BAKIR for their endless support and encouragement.

Mustafa BAKIR

INVENTORY MANAGEMENT AND COST ACCOUNTING SYSTEMS DEVELOPMENT

ABSTRACT

Companies aim to drop their costs to minimum, because of raising competition level as a result of Global Economy. In this competition, inventory management and cost accounting systems are developed to use inventory efficiently and to drop inventory costs to minimum.

Inventory management and cost accounting systems are very important factors for companies to survive in such a hard competition. A good working inventory management system provides application comfort and also reduces inventory costs. So every company should organize their inventory level and also strengthen their cost accounting facilities.

Inventory Manager replies to inventory management needs of companies from all sectors. As a web-based inventory management system, Inventory Manager gains access to system from all over the world. Companies can control their inventory levels and they can also manage their inventories easily, both locally and abroad whenever they need. Inventory Manager's great reporting skills provide decision makers to access the datas in every format they want and it gives them great chance for making future plans on their activities easily.

Keywords: Inventory, Management, Cost, Accounting, JAVA, ORACLE.

STOK YÖNETİMİ VE MALİYET MUHASEBESİ SİSTEMLERİ GELİŞTİRİLMESİ

ÖZ

Günümüzde artan rekabet ile birlikte işletmeler maliyetlerini mümkün olduğunca düşük tutmaya çalışmaktadırlar. Mevcut rekabet ortamında, stokların etkin bir şekilde kullanılması ve stok maliyetlerinin en aza indirilmesi için stok yönetimi ve maliyet muhasebesi sistemleri geliştirilmiştir.

Stok yönetimi ve maliyet muhasebesi sistemleri, işletmelerin böylesi ağır bir rekabet ortamında ayakta kalabilmeleri için çok önemli faktörlerdir. İyi işleyen bir stok yönetim sistemi, uygulama kolaylığı sağlamasının yanında stok maliyetlerini de düşürmeye yardımcı olur. Bu sebeple bütün işletmeler stok seviyelerini kontrol altında tutmalı ve maliyet muhasebesi faaliyetlerini güçlendirmelidir.

Stok Yöneticisi, her sektörden işletmelerin stok yönetimi ihtiyacına cevap verir. İnternet tabanlı bir stok yönetim sistemi olduğundan, dünyanın her yerinden sisteme erişime olanak verir. Bu sayede işletmeler, yurt içinden ve yurt dışından her an, kolaylıkla stoklarının durumunu gözlemleyip, stoklarını istedikleri şekilde yönetebilirler. Stok Yöneticisinin üstün raporlama yetenekleri, karar vericilerin verilere istedikleri formatta ulaşmalarını sağlar ve gelecek planları yapmak için onlara önemli bir şans verir.

Anahtar Sözcükler: Stok, Yönetim, Maliyet, Muhasebe, JAVA, ORACLE.

CONTENTS

	Page
M.Sc THESIS EXAMINATION RESULT FORM	ii
ACKNOWLEDGEMENTS	iii
ABSTRACT	iv
ÖZ	v
CHAPTER ONE - INTRODUCTION	1
CHAPTER TWO - ESSENTIALS OF INVENTORY	3
2.1 Inventory.....	3
2.1.1 Inventory Costs	3
2.1.2 The Purpose of Inventory	3
2.1.2.1 Estimated Quantity	4
2.1.2.2 Unstable Demand	4
2.1.2.3 Relying on Supply	4
2.1.2.4 Price Protection	4
2.1.2.5 Lower Ordering Costs.....	4
2.1.3 Types of Inventory	5
2.1.3.1 Raw Materials.....	5
2.1.3.2 Work in Process.....	5
2.1.3.3 Finished Products	5
2.2 Demand and Types of Demand	6
2.2.1 Independent Demand.....	6
2.2.2 Dependent Demand	7
2.3 Inventory and Demand	7
CHAPTER THREE - FINANCIAL PART OF INVENTORY	8

3.1 Accounting for Inventories	8
3.2 Inventory's Valuation.....	8
3.2.1 First in - First out (FIFO).....	8
3.2.2 Last in – First out (LIFO)	9
3.2.3 Just in Time (JIT)	9
3.2.4 Average Cost Method.....	10
3.2.5 Standard Cost Method	10
3.3 Inventory on the Income Statement	10
3.3.1 Inventory Turnover Ratio	11
3.4 Carrying Cost and Purchasing	11
3.4.1 Reduction of Carrying Costs.....	12
CHAPTER FOUR - PRINCIPLES OF COST ACCOUNTING.....	13
4.1 Cost Accounting.....	13
4.2 Cost Accounting's Functions.....	13
4.2.1 External Reports.....	13
4.2.2 Internal Reports	14
4.2.3 Scorekeeping.....	14
4.2.4 Budgeting.....	14
4.2.5 Cost Reduction Analysis.....	15
4.2.6 Pricing.....	15
4.2.7 Cost-Benefit Analysis.....	16
4.3 Future Role of Cost Accounting	16
CHAPTER FIVE - INVENTORY MANAGER	17
5.1 Database Architecture	18

5.1.1 Definition of the Inventory Transaction	18
5.2 Data Model	27
5.2.1 TopLink Mappings for the Database Objects	27
5.2.2 TopLink Named Queries	29
5.2.3 TopLink Session.....	30
5.2.4 EJB Session Bean.....	31
5.2.5 ADF Data Controls.....	31
5.3 Page Flow Diagram.....	32
CHAPTER SIX - HOW TO USE INVENTORY MANAGER	34
6.1 Waybill	35
6.2 Invoice	39
6.3 Reports.....	42
CHAPTER SEVEN - CONCLUSION	50
REFERENCES	52

CHAPTER ONE

INTRODUCTION

Inventory management must be designed to meet the dictates of market place and support the company's strategic plan. The many changes in the market demand, new opportunities due to worldwide marketing, global sourcing of materials and new manufacturing technology means many companies need to change their inventory management approach and change the process for inventory control.

The inventory management system and the inventory control process provide information to efficiently manage the flow of materials, effectively utilize people and equipment, coordinate internal activities, and communicate with customers. Inventory management and the activities of inventory control do not make decisions or manage operations; they provide the information to managers who make more accurate and timely decisions to manage their operations (Wild, 1997).

Inventory is defined as the blocked working capital of an organization in the form of materials. Therefore, it should be zero, ideally. However, companies are maintaining inventory. This inventory is maintained to take care of fluctuations in demand and lead-time. In some cases it is maintained to take care of increasing price tendency of commodities or rebate in bulk buying (Muller, 2003).

As a part of Global Economy, companies have to minimize their costs. Inventory management and cost accounting systems are invaluable factors for companies to reduce their costs in present hard competition.

In order to provide effective and user-friendly web-based Inventory Management System, the development of Inventory Manager is started. Inventory Manager meets companies' requirements on minimizing their inventory costs and managing their inventories, from all sectors. Since it is a web-based inventory management system, users can access to system from everywhere, and companies can also manage their inventories whenever they need to. This study is organized as follows.

In chapter two, essentials of inventory are mentioned. Inventory's definition, purpose of inventory and types of inventory are also mentioned in chapter two. The main purpose of this chapter is to introduce inventory and its bases.

Chapter two also defines demand and types of demand. The relationship between demand and inventory is also defined in this chapter in order to show their connection.

Chapter three contains inventory's financial part. Inventory valuation methods and their definitions are also mentioned in this chapter. Inventory turnover ratio is defined. This chapter also includes its formulae to show how to calculate this ratio. It is also defined carrying and purchasing costs of companies and how to reduce them.

In chapter four, bases of cost accounting are defined with the types of reports which are used by cost accountant in order to assist companies' authorized departments. This chapter also includes the future role of cost accounting in the global competition environment.

Chapter five contains the definition of Inventory Manager. The database structure and model of Inventory Manager are mentioned with its figures. The main bases of Inventory Manager's working process are also shown in this chapter.

Chapter six shows how to use the Inventory Manager. Inventory Manager's functions and their usages are shown by figures. So users can easily work with Inventory Manager. With easy usage of Inventory Manager, companies can manage their inventories by Oracle's functional database organization and Jdeveloper's versatility.

CHAPTER TWO

ESSENTIALS OF INVENTORY

2.1 Inventory

Inventory contains the raw materials, work-in-process goods and finished products as parts of itself. Inventory plays a very important role for companies. In order to avoid insufficient product for sale, inventory must be managed properly.

Inventory can be anything that a company uses in manufacturing process. Such as raw materials in the beginning of manufacturing; work in process goods as a part of manufacturing process, supplies used in operations in order to complete the manufacturing, and finished goods as a result of the manufacturing process.

2.1.1 Inventory Costs

There are some costs that come with inventory. These costs are the results of ordering and holding inventory. Such as: purchasing cost, space available, labor cost, and possibility of deterioration and risk of theft (Muller, 2003).

Main costs of inventory are ordering and holding costs. The biggest costs on holding inventory are storage costs. This needs stock keeping employees, warehouse and also costs taxes to the company.

2.1.2 The Purpose of Inventory

Inventory could be considered as a waste by a company that uses a just in time manufacturing process. But, in some sectors, companies have to keep inventory to complete their manufacturing processes. There are many reasons that companies to require inventory in their manufacturing processes. Most important reasons to keep inventory are:

2.1.2.1 Estimated Quantity

Companies have to control their manufacturing process and need to know that how much raw materials and subassemblies they will require in this process. This is needed by companies' planning department. Inventory can be a buffer on manufacturing process to complete it by the given time.

2.1.2.2 Unstable Demand

Demand is changeable. Companies can not know when will be maximum or minimum demand on their products. These fluctuations in demand force companies to keep inventory in order to complete their manufacturing process by the given time.

2.1.2.3 Relying on Supply

Supply chains play very important role for companies. Unreliable suppliers cost very much to the companies such as penalties for nonperformance, cancellation of long term relationships. In order to prevent this, companies have to find an alternate way such as keeping inventory.

2.1.2.4 Price Protection

According to Muller (2003), "Buying quantities of inventory at appropriate times helps to avoid the impact of cost inflation." So companies can manage their costs by protecting price level.

2.1.2.5 Lower Ordering Costs

Companies can drop their ordering costs by ordering larger quantities, less frequently from their regular orders. As a result of this, it costs less to companies on transportation and they can have discounts on buying items.

2.1.3 Types of Inventory

The three main types of inventory are; raw materials, finished goods, and work in process. These are very important parts of manufacturing process.

2.1.3.1 Raw Materials

Raw materials are used to produce partial products or completed goods. These items are the first step of manufacturing process.

Every sector uses different raw materials in their manufacturing process. This can integrate a company into another even if it is from different sector. Because, one raw material can be another's work in process or final product. For example; screw is a raw material for an electronic equipment manufacturing company, but at the same time it is a final product of a company which manufactures screws.

2.1.3.2 Work in Process

Work in processes are the items that between raw materials and finished products. Partial products and subassemblies can be considered as work in process.

These items should not be at large quantities and it is better to keep them at minimum. Work in process constitutes the main factor of manufacturing process. So if a company has large quantities of them, this shows the company is not performing well in the manufacturing process.

2.1.3.3 Finished Products

Finished products are the items which are ready for customer sales. These are the final products of companies.

Finished products are the last ring of the manufacturing chain. They are the main purpose of companies on manufacturing process. Company that manufactures them, survive by selling them and some other companies use them as raw materials.

All departments of the companies work on these final products. Marketing department works on to sell them as the company's needs. Planning department decides on how to organize the manufacturing process.

Finally, the finished products are the artery of a company. All activities of the companies aim to build them. All manufacturing processes are made for them to come.

2.2 Demand and Types of Demand

Demand takes the main part for every sector. It plays the most important role for companies on their manufacturing or distribution process. In every sector, companies operate their organizations basing on the demand of their products or services.

There are two types of demand that concern companies no matter which sector they include. These are called independent and dependent demands (Wild, 1997).

2.2.1 Independent Demand

This type of demand is affected by global market situations. Companies do not play any role on this. They have no effect on the demand. Their products are not dependent with each other.

Companies must have the appropriate amount of inventory. So they can be prepared for any conditions in this environment. They have to decide the very inventory level they need, in their situation.

2.2.2 Dependent Demand

This type of demand takes effect with another item. This means; one product is used with another because of its nature. Razor blades would be a good example to that. When a customer buys a razor, he will need a razor blade in order to shave. This means one is useless without the other. Because of that, the demand on razor would be dependent on the demand on razor blade.

Unlike the independent demand, dependent demand is integrated into the product's relationship with other products. So this necessitates being careful on decision making over a product. Because, the decision which to be given on one of the products, effects another one.

2.3 Inventory and Demand

Inventory is connected with the demand on the product. Companies have to decide their inventory level for their manufacturing or distributing period. They must determine the appropriate level of inventory in order to avoid inventory waste or insufficient quantity of inventory. So they have to set their inventory level depending on the demand on their products.

Demand plays the key role in this process. Companies's planning department should consider past demand levels on their products and their sales of those products in the last years. This would help companies on determining on the appropriate level of inventory (Donath, Mazel, & Dubin, 2002).

CHAPTER THREE

FINANCIAL PART OF INVENTORY

3.1 Accounting for Inventories

- *Raw Materials*
- *Work in Process*
- *Finished Goods*

Most inventories fit into one of these three types, but it changes from companies to their specifics on their sectors. Different sectors, such as manufacturing and distribution, show differences on types of inventory. While distribution sector mostly uses finished goods, manufacturing companies to have more raw materials and subassemblies than finished products.

3.2 Inventory's Valuation

In order to assign a cost value to inventory, companies have to make some assumptions about the inventory on hand. A company can only make these assumptions once per fiscal year (Muller, 2003).

Companies may occasionally change their inventory methods basing on their financial condition and performance targets. The main inventory valuation methods are:

3.2.1 First in - First out (FIFO)

First in - First out inventory valuation means; the first goods purchased must be used or sold first. This method aims to use the goods before their expiration date come.

First in - First out method can be chosen for tax minimization by companies. In order to avoid remaining and most recently purchased inventory ratio raise, companies want to get rid of the firstly in inventory instead of recently in inventory.

3.2.2 Last in – First out (LIFO)

Last in – First out inventory valuation means; the most recently purchased goods must be used or sold first, before their expiration date come.

This method aims to use inventory before its incoming cost pass its sale price. When the sale price of an inventory falls under its cost to the company, it would be a capital loss for the company. But if it is sold above its cost to the company, than it is a capital gain for the company.

There is also one method called Highest in - First out. Companies can prefer this method when they want to decrease their taxable income. When a company uses the highest fee purchased inventory first, they would record a maximum cost of goods sold on their income statement (Anonymous, nd).

3.2.3 Just in Time (JIT)

Just in time method needs accurate forecast on the forthcoming demand. Because in this method, companies to have lower inventory levels than using other methods. They only get inventory when they are ready to sell it just at that very time.

Just in time inventory method is very suitable for manufacturing. Especially car manufacturers prefer this method. Whenever their products are ready to go, they deliver them to their customers at that very time.

3.2.4 Average Cost Method

Average Cost Method shows the cost of per good. It is calculated by dividing total cost of goods into total quantity of goods.

$$\text{Average Cost} = \text{Total Cost of Goods} \div \text{Total Quantity of Goods}$$

3.2.5 Standard Cost Method

This Method is preferred by mostly manufacturing companies. They aim to make the best guess based on past costs and give their departments a suitable value per year (Wild, 1997).

3.3 Inventory on the Income Statement

The income statement is a report which shows a company's sales, expenses, and resulting profits. The cost of goods sold, on the income statement, shows the inventory costs of the company.

Companies use or sell inventory in order to increase their sales. On the income statement, inventory costs to the company during the accounting period, is shown as Cost of goods sold.

The inventory, which has not been used or saled during the period, is calculated and shown like this:

$$\text{Ending Inventory} = \text{Beginning Inventory} + \text{Purchases} - \text{Cost of Goods Sold}$$

To find the company's gross profit, the cost of goods which have been sold during the period, is subtracted from income that is earned from the sale of those goods.

3.3.1 Inventory Turnover Ratio

According to Muller (2003), “The inventory turnover ratio measures, on average, how many times inventory is replaced over a period of time.”

Inventory turnover ratio shows the company’s capability on moving inventory in appropriate time and turning it into liquidity. It is calculated as:

$$\text{Inventory Turnover Ratio} = \text{Cost of Goods Sold} / \text{Average Inventory}$$

When a product is sold, it is subtracted from inventory and moved to cost of goods sold. So, this ratio shows the inventory’s moving speed.

Low inventory turnover ratio may show, the company is holding wrong or quality lacking inventory. This will also help the company to decide on next year’s inventory level.

This ratio shows the company’s performance against industry averages. It will be very useful for companies on decision making for forthcoming company strategies.

3.4 Carrying Cost and Purchasing

Companies should have just the minimum quantity of inventory as they only need. On the other hand, companies also should have the optimum inventory to reply the demand.

Small amounts of inventory orders could cost more to the companies. This forces companies to have larger quantities of inventory in order to reduce carrying costs. So that companies pay less for carrying and they can also get discounts as a result of large quantity of inventory orders. This would reduce purchasing costs at the same time.

3.4.1 Reduction of Carrying Costs

Companies aim to reduce their costs as much as they can. In order to do this, they try to drop all company costs to minimum. Inventory cost is one of them. To reduce inventory costs, they order larger quantity of inventory and so they can drop their carrying costs by decreasing numbers of orders (Muller, 2003).

Companies can also reduce their carrying costs by using inventory management systems. This would help them to organize their inventory level and would minimize their inventory moving time and mistakes.

CHAPTER FOUR

PRINCIPLES OF COST ACCOUNTING

4.1 Cost Accounting

In the modern competition, companies require to organize their costs in order to reduce them. Companies also aim to raise their profit level. These two purposes are dependent on each other. Cost accounting takes affect in this point. Companies have to manage their costs and they need a system to accomplish that purpose. Cost accounting shows companies' costs in detail and minimizes mistakes on companies' decisions for every department.

4.2 Cost Accounting's Functions

Cost accounting has different functions for different purposes. Companies can have external reports for their financial purposes. They can also have internal reports for their departments on determining about companies' activities. Some of the other functions of cost accounting are; scorekeeping, budgeting, cost reduction analysis, pricing and cost – benefit analysis (Anonymous, nd).

4.2.1 External Reports

External reporting aims to report companies' financial situation. Every factor in companies' activities and costs are shown on these reports. Companies' cost analyses are declared on this report. By these reports, other companies in the same sector or companies from other sectors can view the companies' financial situation.

External reports play very important role on companies' credibilities. By these reports, financial companies and banks determine giving new loans to the companies or revising their loan debts.

4.2.2 Internal Reports

Internal reporting also aims to report companies' financial situation. But differently from external reporting, internal reporting is used by the departments of the company. This can be called as internal assistance. By these reports several departments of the company can make the right decisions on their activity fields.

These reports assist every staff from every rank on their tasks. While general director needs that report also the purchasing department would need it in order to perform their tasks properly.

4.2.3 Scorekeeping

Scorekeeping is mostly used for minimal tasks. While external and internal reports are prepared for large periods, scorekeeping aims to give detailed information about a single key measurement for smaller periods. These periods can be daily.

The main purpose on scorekeeping is having detailed reports for the determined measurement. Scorekeeping shows the performance of that measurement. While having detailed information about the determined measurement, actually that gains simple information about performance line of it.

4.2.4 Budgeting

Cost accounting helps on companies' budgeting decisions as it gains detailed information about their periodical costs. The planning department uses these reports, which gain detailed informations about the companies' costs, to announce the company's budget properly.

Last period's costs constitutes the bases of the next period's budget. For example; labor expenses constitutes the base of the labor budget of next period. Planning

department uses last period's labor costs to revise the labor budget and announces the next period's budget.

Cost accounting reports are prepared to assist budgeting periodically. This period becomes mostly for once a year. But this period can change from company to company.

4.2.5 Cost Reduction Analysis

Every company aims to drop their costs to minimum. Cost accounting reports gain useful information to reduce costs of the company. These reports include analysis on how to reduce company's costs. This can be used for every department of the company.

Cost accountant can prepare cost reduction analysis on a specific category. So in that category, planning department can revise their conditions during the report period and determine whether they reconsider it or not.

4.2.6 Pricing

Pricing is basically decided as the total of the product's cost and determined profit. To do that, companies' pricing department need to know the cost of each product sold. Cost accounting reports assist pricing department on their decision making on pricing.

Cost accountant prepares each product's costs in detail and presents it to relevant departments. So the pricing department gets the required information of product costs. Every cost that takes affect on the products is shown in the reports. So, the pricing department becomes capable of making the right decision on pricing the product.

4.2.7 Cost-Benefit Analysis

Cost – benefit analysis assists the management on making a decision of whether they acquire or dispose of some equipment in order to develop the company's condition. When an equipment to be disposed of; they have to know what the disposal costs to them. They have to know how much they would be incapable of manufacturing process. If that suits their needs they can make a decision on this way (Anonymous, nd).

When an equipment to be acquired; they have to know what that costs to them. They have to know how much they would be more capable of manufacturing process. If that purchase suits their needs they can make a decision on this way.

4.3 Future Role of Cost Accounting

In the modern global competition, companies require to organize their costs more than ever in order to survive. In such a hard competition environment, companies can not price their products as they really want. Market does not allow them to do that. So they have to organize their costs properly and they also have to reduce their costs. They can survive in this hard competition only this way.

Cost accounting will play a very important role in global competition. However it became important for companies now, later it will pay greater contribution to companies's organizations. Competition will get greater. Prices will get lower. And cost minimization will be the key factor. To minimize the costs companies will need well designed cost accounting systems.

CHAPTER FIVE

INVENTORY MANAGER

Inventory Manager is a user-friendly designed web-based inventory management system that can be used by any company needs to control and manage its inventory.

To store the required data, Inventory Manager uses Oracle Database 10g, which is the first database designed for "Grid Computing". Oracle Database 10g gives the following advantages to developers:

- Record-breaking performance and scalability on Windows, Linux, and UNIX servers and provides fast Return On Investment (ROI) by moving from a single server to Grid Computing without changing a single line of code.
- Better results by automating administrative tasks, providing industry-leading security and regulatory compliance features, and enabling the highest availability with Real Application Clusters.
- With a range of editions and lower operating cost versus IBM DB2 and Microsoft SQL Server, it's the ideal choice for large enterprises and small and medium businesses alike.

Oracle JDeveloper 10g is used as development platform. It is a free integrated development environment with end-to-end support for modeling, developing, debugging, optimizing, and deploying Java applications and Web services. Jdeveloper's visual and declarative development approach and the innovative Oracle Application Development Framework (Oracle ADF) work together to simplify application development and reduce mundane coding tasks.

Inventory Manager is built as an end-to-end J2EE Web application by using Oracle Jdeveloper, Oracle ADF, and Oracle TopLink. The application uses various J2EE technologies, including Enterprise JavaBeans (EJB) and JavaServer Faces (JSF).

The technologies employed in building the application are:

- The technology employed is Oracle ADF
- The data is stored in Oracle Database 10g.
- The data model and business logic is implemented by using Oracle TopLink and Enterprise JavaBeans.
- Databinding (mapping between client components and the business logic) is provided by Oracle ADF.
- The Web client layer is built using JSF pages and ADF Faces components.
- Authorization is based on J2EE container security.
- Report templates are prepared in IReport-1.3.0.
- JasperReports-1.3.0 is used to take reports from java pages.

5.1 Database Architecture

The most important advantages of the Inventory Manager database are reliability, integrity, flexibility and efficiency of the database. Primary and foreign keys of entities are given. Relationships between entities are set up carefully. Attribute names, their data type and length are carefully defined.

5.1.1 Definition of the Inventory Transaction

The basic concept of Inventory Management is Inventory Transactions. “STOK_HAREKET” table is used to store transaction data for Inventory Manager. Its attribute names, their data types and length are shown in figure 5.1. Relations between related tables are also shown in figure 5.1.

Inventory transactions start with waybill or invoice. Figure 5.2 shows “IRSALIYE_ALIS” and “IRSALIYE_SATIS” tables, their attribute names, their data types and length and also relations between related tables. Figure 5.3 shows “FATURA_ALIS” and “FATURA_SATIS” tables, their attribute names, their data types and length and also relations between related tables.

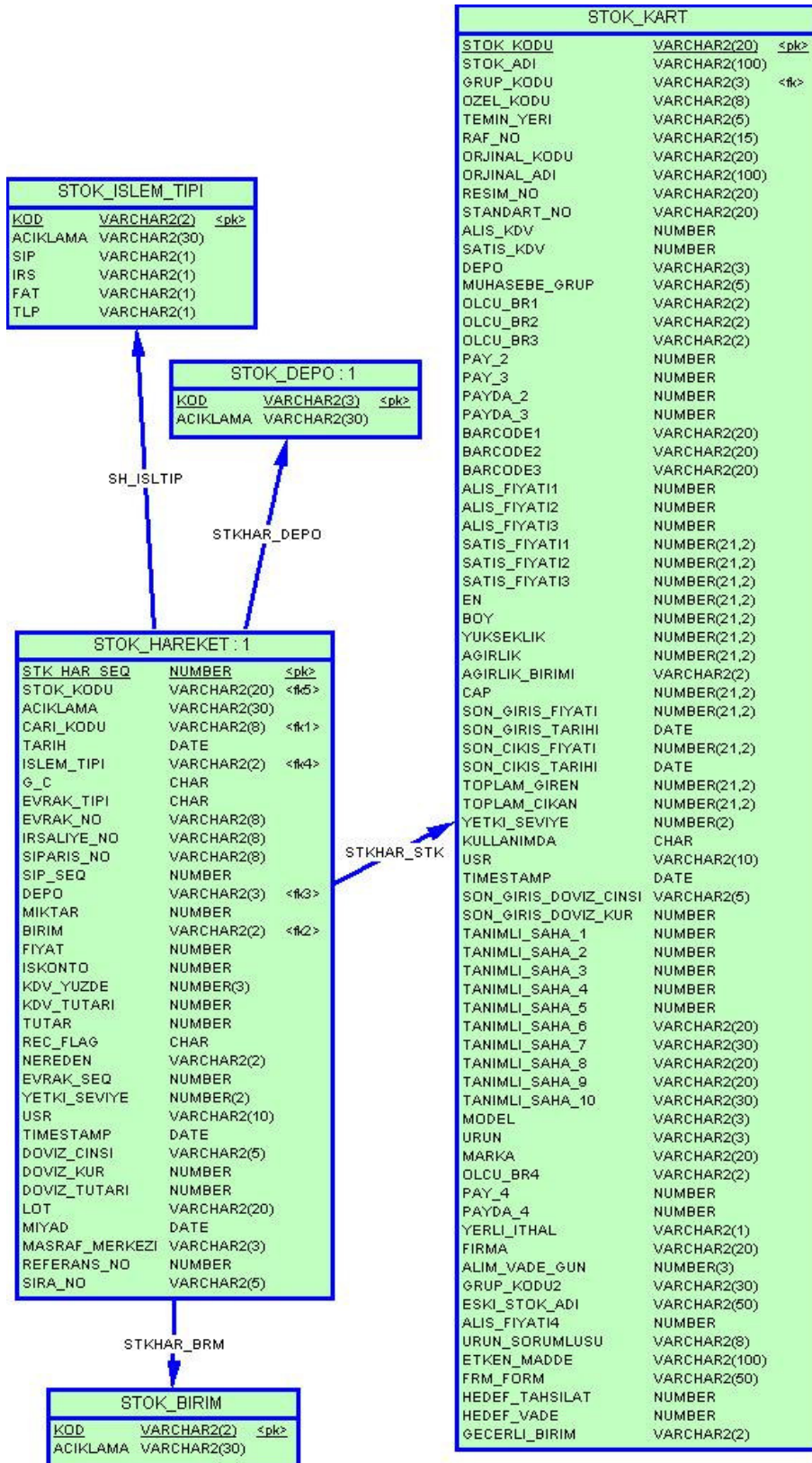


Figure 5.1 Database structure for Inventory Transactions

Some important attributes for STOK_HAREKET table are:

- STK_HAR_SEQ: primary key.
- STOK_KODU: foreign key to set up a relation with “STOK_KART” table that describes the inventory item transacted.
- CARI_KODU: foreign key to set up a relation with “CARI_KART” table, which describes the supplier, the inventory item is bought from or the customer the inventory item is sold to.
- G_C: defines whether transaction is out from or in to the location.
- ISLEM_TIPI: foreign key to set up a relation with “STOK_ISLEM_TIPI” table, which defines type of the document such as, sold or bought waybill, or sold or bought invoice.
- EVRAK_NO: defines serial number of document related with transaction.
- DEPO: foreign key to set up a relation with “STOK_DEPO” table that defines the location of the inventory item transacted.
- BIRIM: foreign key to set up a relation with “STOK_BIRIM” table that defines the unit of the inventory item transacted.
- REC_FLAG: defines if the waybill has also invoice to avoid duplication.
- USR: defines which user makes the transaction.

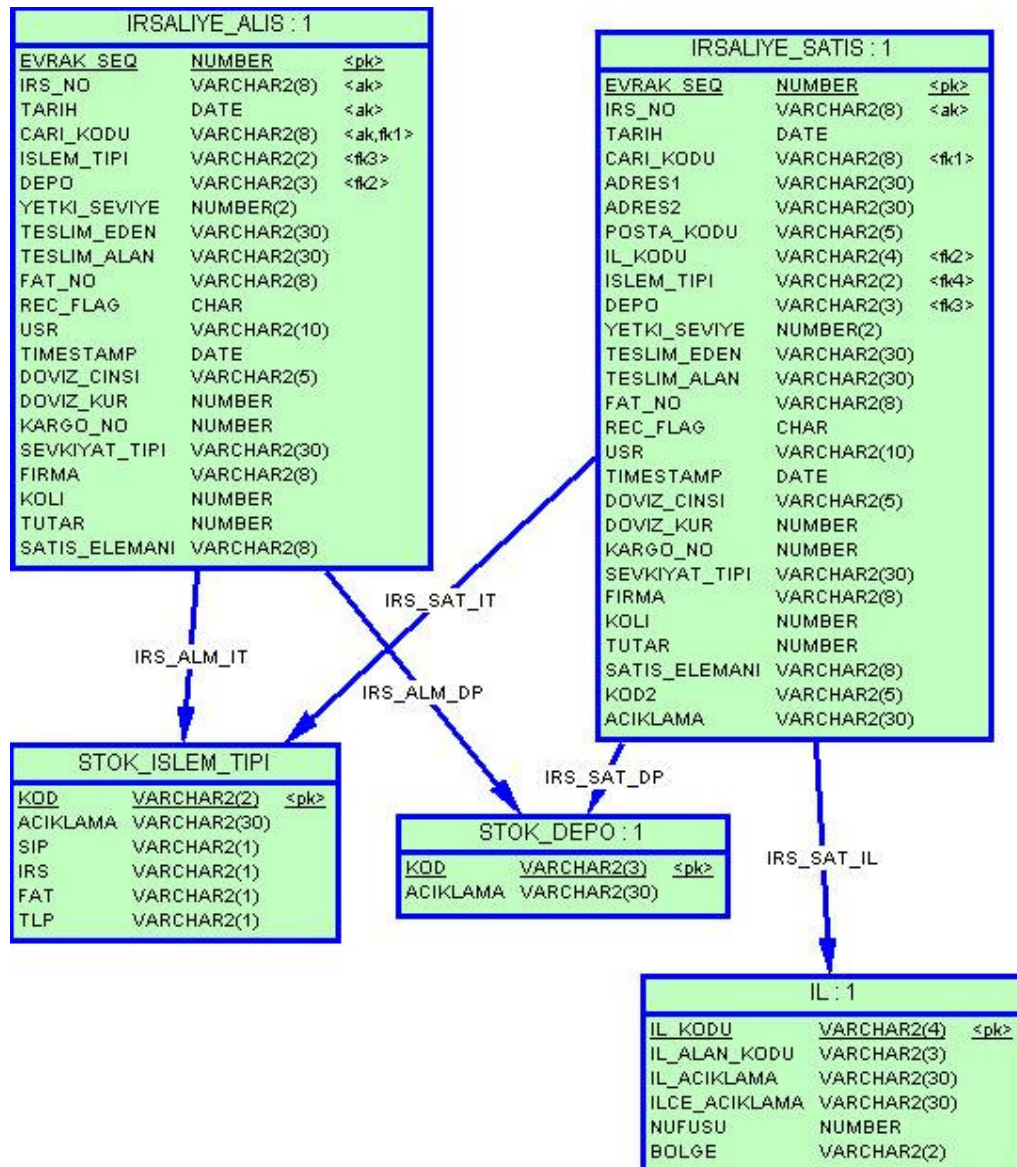


Figure 5.2 Database structure for Inventory Transactions by waybill

Some attributes for “IRSALIYE_ALIS” and “IRSALIYE_SATIS” tables are:

- EVRAK_SEQ: primary key.
- IRS_NO: serial number of waybill.
- CARI_KODU: foreign key to set up a relation with CARI_KART table that describes the supplier the inventory item is bought from or the customer the inventory item is sold to.

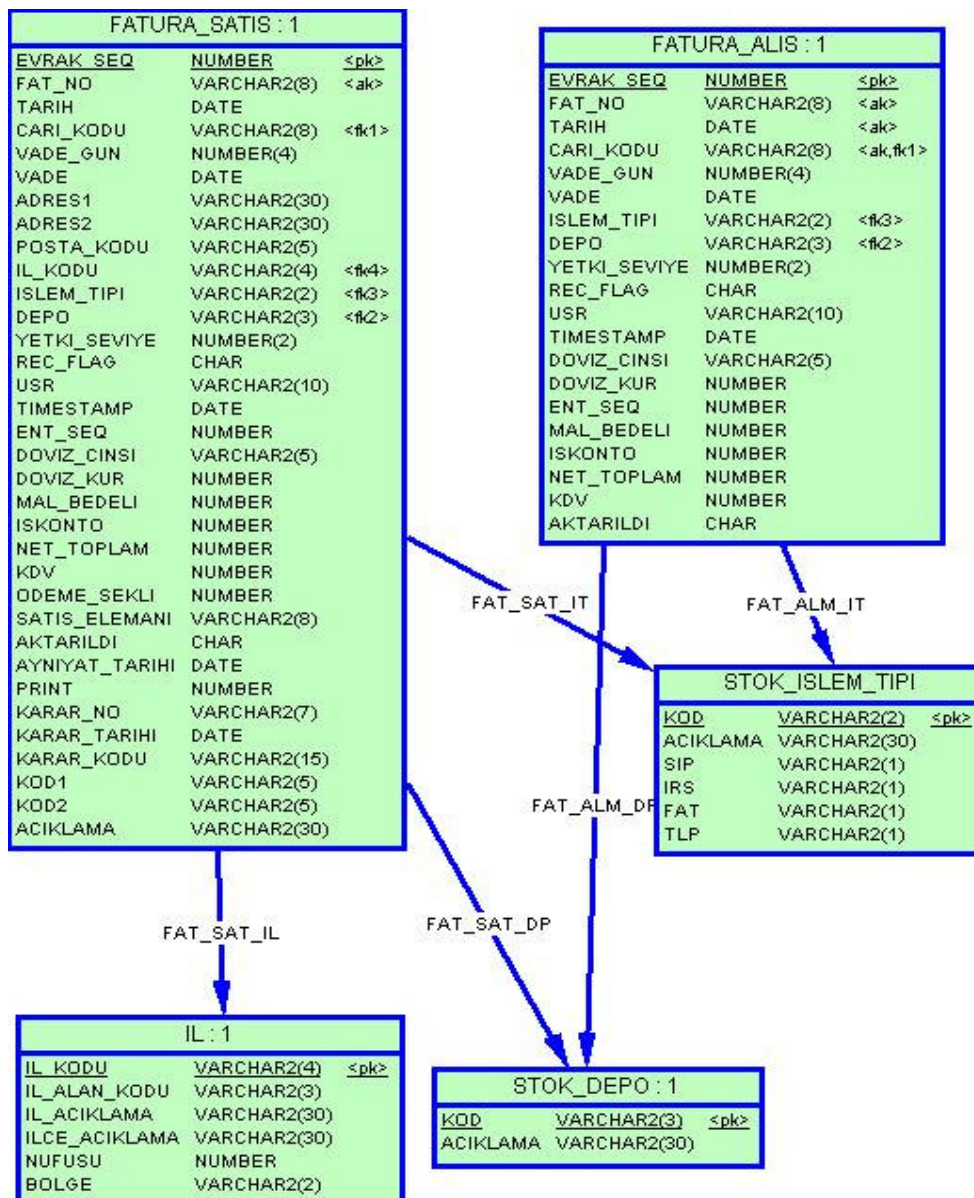


Figure 5.3 Database structure for Inventory Transactions by invoice

Some attributes for “FATURA_ALIS” and “FATURA_SATIS” tables are:

- EVRAK_SEQ: primary key.
- FAT_NO: serial number of invoice.
- CARI_KODU: foreign key to set up a relation with “CARI_KART” table that describes the supplier the inventory item is bought from or the customer the inventory item is sold to.

Figure 5.4 and 5.5 show relations between current card, invoice, waybill, and inventory transaction.

“CARI_KART” table holds required information about suppliers, customers, and vendors. Some important attributes of “CARI_KART” table are:

- CARI_KODU: primary key.
- GRUP_KODU: foreign key to set up a relation with “CARI_GRUP” table to group related supplier, customer, or vendor.
- UNVAN1: full name of supplier, customer, or vendor.
- I_IL_KODU: foreign key to set up a relation with “IL” table for waybill.
- F_IL_KODU: foreign key to set up a relation with “IL” table for invoice.

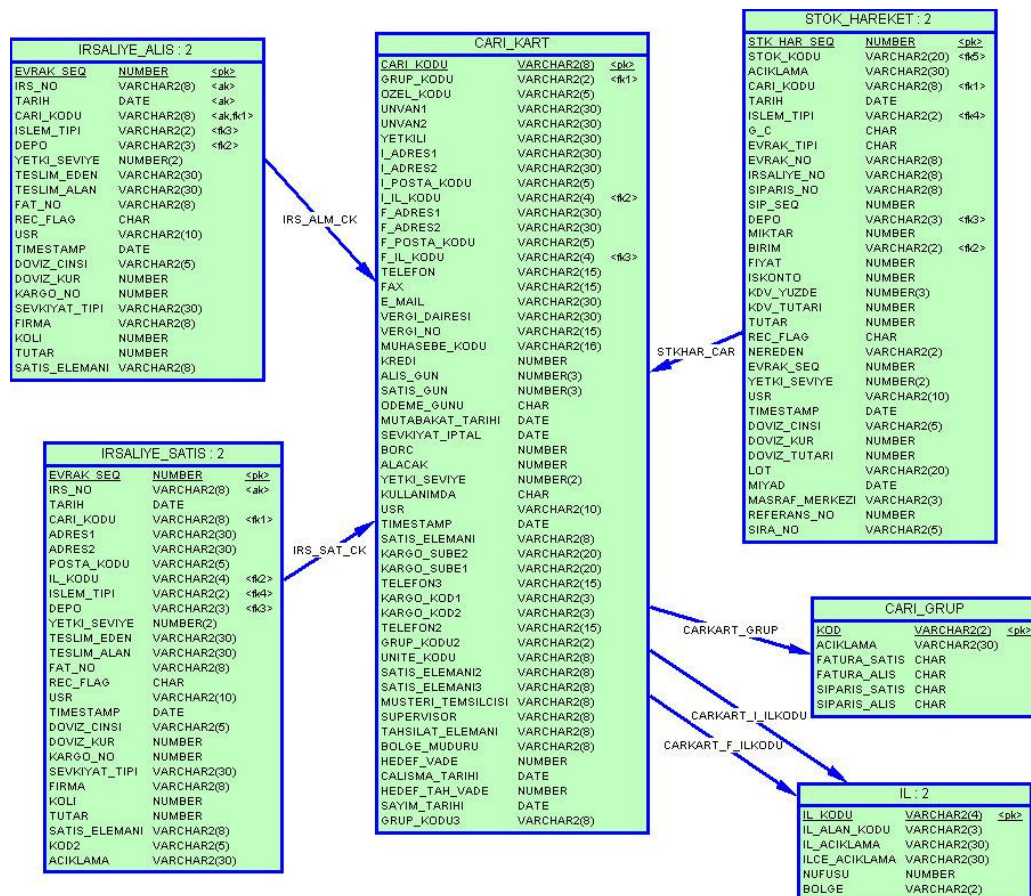


Figure 5.4 Current card and its relations with waybill and inventory transaction tables.

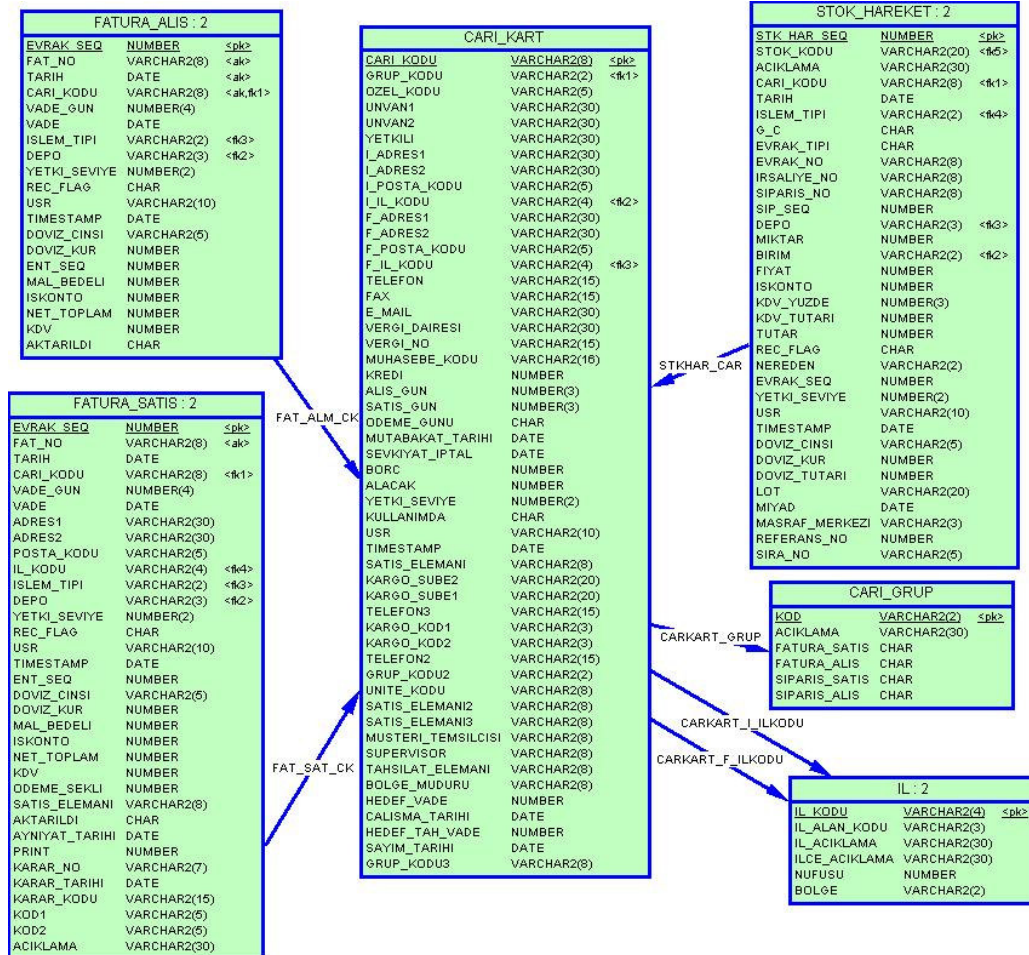


Figure 5.5 Current card and its relations with invoice and inventory transaction tables.

Figure 5.6 shows tables that use inventory card and relations with inventory card. Some tables are:

- STOK_DEPO_ICMAL: holds inventory in and out for each described warehouse.
- STOK_KART_PARAMETRE: can be used to lock inventory card.
- STOK_KART_NOTLAR: can be used to take some notes about inventory card.
- STOK_GRUP: is used to group inventory cards.

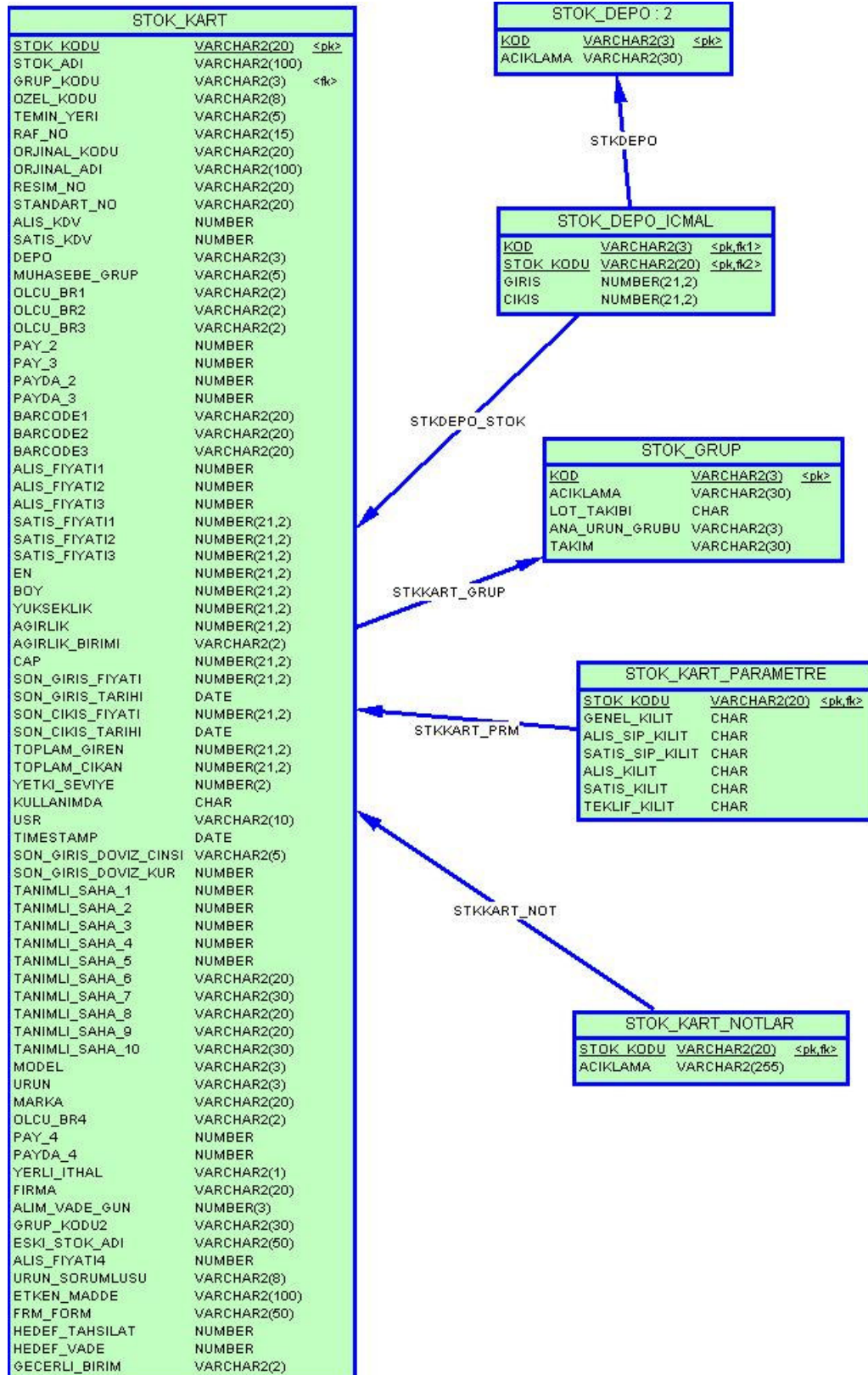


Figure 5.6 Tables that use inventory card and relations

Some important attributes for “STOK_KART” table are:

- STOK_KODU: primary key.
- STOK_ADI: name of the inventory item.
- GRUP_KODU: is used to group inventory items.
- DEPO: warehouse that inventory item is stored.
- USR: user who enters the inventory card to system.

Following tables are unrelated tables in the database:

- ALT_URUN_GRUBU: is used to group inventory items at lower level.
- TANIMLI_SAHA_7: is used to group inventory items at medium level.
- ANA_URUN_GRUBU: is used to group inventory items at higher level.
- BOLGE: defines regions.
- USERS: defines users.
- STOK_KART_STOK_DURUMU: holds actual inventory, last transaction date, input and output information about inventory items.

ALT_URUN_GRUBU		
KOD	VARCHAR2(3)	<pk>
ACIKLAMA	VARCHAR2(30)	

TANIMLI_SAHA_7		
ACIKLAMA	VARCHAR2(4000)	
KOD	VARCHAR2(4000)	<pk>

ANA_URUN_GRUPLARI		
ACIKLAMA	VARCHAR2(30)	<pk>
KOD	VARCHAR2(3)	

BOLGE		
KOD	VARCHAR2(4000)	<pk>
ACIKLAMA	VARCHAR2(4000)	

STOK_KART_STOK_DURUMU		
STOK_KODU	VARCHAR2(20)	<pk>
VERILEN_SIPARIS	NUMBER	
VERILEN_SIPARIS_SEVK	NUMBER	
ALINAN_SIPARIS	NUMBER	
ALINAN_SIPARIS_SEVK	NUMBER	
GIRISLER_TOPLAMI	NUMBER	
CIKISLAR_TOPLAMI	NUMBER	
FIILI_STOK	NUMBER	
KONSINYEDEKI_MALLAR	NUMBER	
ELDEKI_KONSINYELER	NUMBER	
REZERVASYON_MIKTARI	NUMBER	
SON_HAREKET_TARIHI	DATE	

USERS		
USER_ID	NUMBER(8)	<pk>
USER_ROLE	VARCHAR2(10)	
EMAIL	VARCHAR2(50)	<ak>
FIRST_NAME	VARCHAR2(30)	
LAST_NAME	VARCHAR2(30)	
STREET_ADDRESS	VARCHAR2(40)	
CITY	VARCHAR2(30)	

Figure 5.7 Unrelated tables

5.2 Data Model

The data model for the application is built using Oracle TopLink and Oracle ADF. TopLink provides Java object-to-relational persistence to create Java objects for accessing and persisting relational data. These TopLink objects are used in the user interface through ADF data controls.

5.2.1 TopLink Mappings for the Database Objects

TopLink requires a TopLink map file for each project. This file contains information about how classes are mapped to database tables. For this project StokMap is used. Figure 5.8 shows the object-to-table mappings.

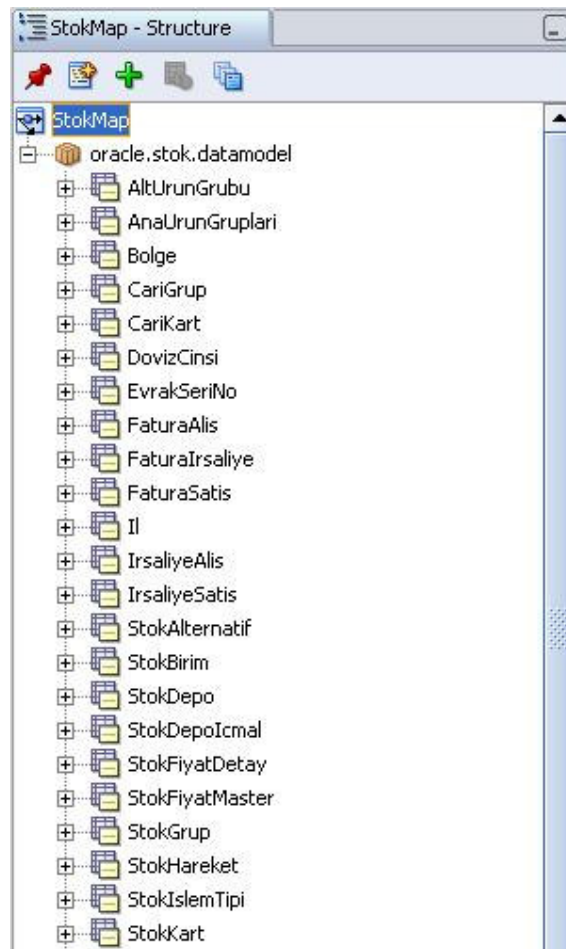


Figure 5.8 StokMap created objects

Figure 5.9 shows the mapped attributes and relations for StokHareket object. Relations represent the relationship of the selected object to other objects in the model.



Figure 5.9 StokMap mapped attributes and collections

Figure 5.10 shows TopLink POJOs for each of the tables from the Stok schema. Each of the java files contains the code for the attribute definitions, constructors, getters, and setters.

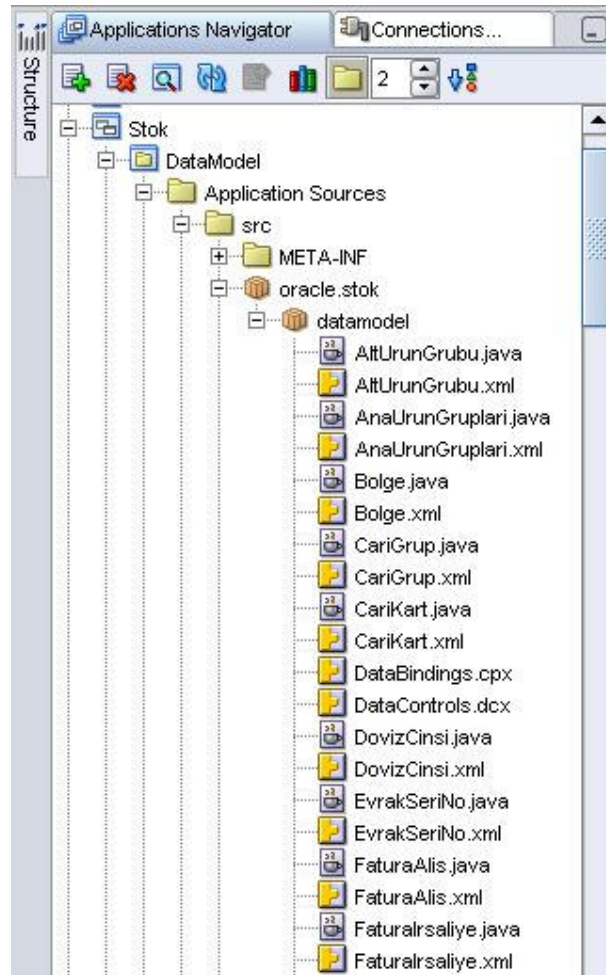


Figure 5.10 TopLink POJOs from Stok schema

5.2.2 TopLink Named Queries

Named queries provide a means of defining complex or commonly-used queries to access the database. Named queries offer some key advantages: they enable TopLink's internal performance optimizations to work better and make maintenance easier by centralizing the management of queries. Figure 5.11 shows named queries for Inventory Manager.

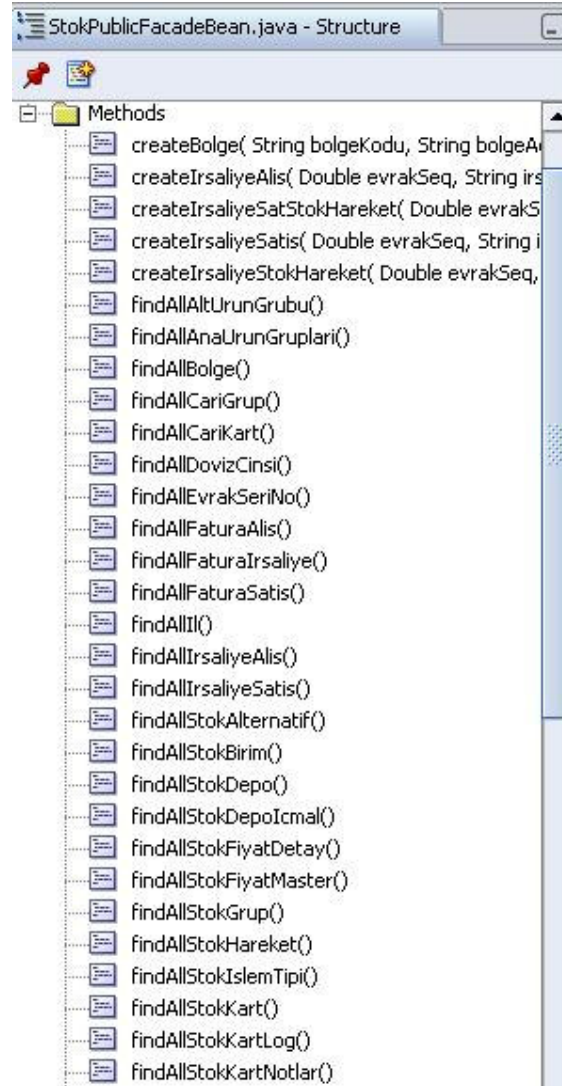


Figure 5.11 TopLink Named Queries

5.2.3 TopLink Session

The TopLink session configuration is used at run time to maintain state information about each running session. It also supplies database connection information for the session. Each active connection to the application receives a unique session object. StokSession is used in this application.

5.2.4 EJB Session Bean

EJB session bean is used to provide an access point for the application. The client application uses this session bean for its access to the data model. This approach follows the Session Facade design pattern for constructing applications.

Session beans encapsulate business logic and business data while exposing the necessary interfaces. As such, the client tier can make use of the distributed services within the model without concern for its complexity. The session bean is made up of two files:

- **StokPublicFacadeBean** contains the bean code.
- **StokPublicFacadeLocal** is a local interface for the session bean.

5.2.5 ADF Data Controls

Data controls provide the interface that binds the data model to user client application. This means that when developing client application, page components can be based on the data controls without concern for the actual technology that was used to build the data model (in this application, TopLink and EJB session beans).

Figure 5.12 shows ADF Data Controls. All POJOs has XML files that represents an individual POJO (one for each) and describes its attributes, accessors, and parameters. UpdateableSingleValue.xml controls operations on objects with single values. UpdateableCollection.xml controls operations on objects with multiple values. DataControls.dcx defines the interface used for the data control.

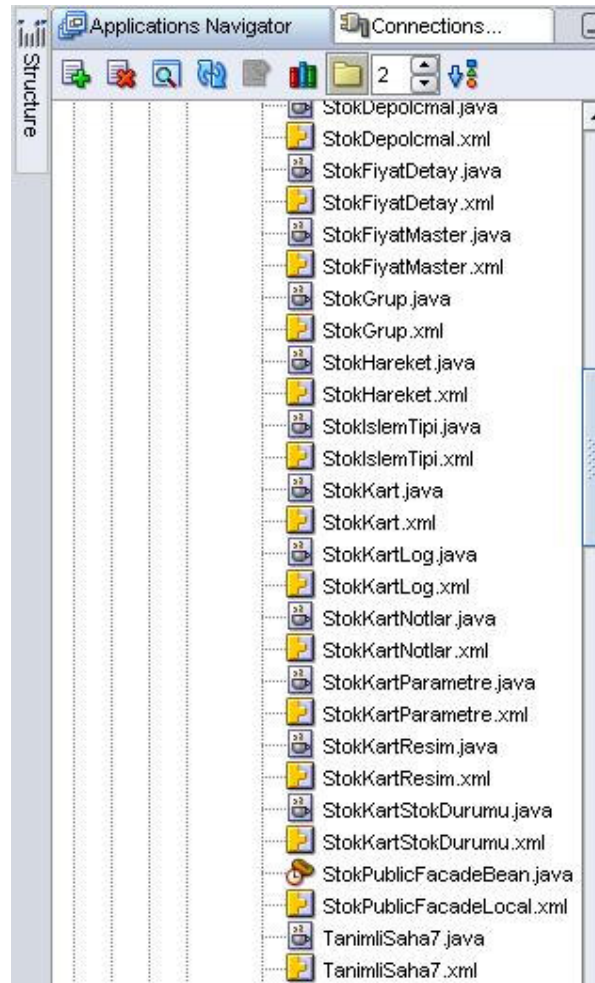


Figure 5.12 ADF Data Controls

5.3 Page Flow Diagram

The page flow diagram is carefully organized as shown in figure 5.13. Navigation rules between pages are also described clearly.

CHAPTER SIX

HOW TO USE INVENTORY MANAGER

Inventory Manager is a user-friendly inventory management system. On the following pages, the usage of system will be described.

To use Inventory Manager, user must enter “User Name” and “Password” in the log in page as shown in figure 6.1.



**INVENTORY
MANAGER**

..Inventory Manager..

User Name:

Password:

Figure 6.1 Log in page of Inventory Manager

After a successful log in, main screen is appeared as shown in figure 6.2.



**INVENTORY
MANAGER** **INVENTORY
MANAGEMENT** [log out](#)

[Reports](#) [Invoice](#) [Waybill](#) [Admin Module](#)

[Waybill for Purchases](#) | [Waybill for Sales](#) Logged in as musti

Inventory Manager

Welcome to Inventory Manager. Please select the process that you want to do from the above menu.

[Reports](#) | [Invoice](#) | [Waybill](#) | [Admin Module](#) | [log out](#)

©Oracle 2007
Meditera Inventory Manager [Contact us](#)

Figure 6.2 Main Screen of Inventory Manager

6.1 Waybill

All inventory movements are made with waybill. Following figures show how to record a waybill.

On the main screen, if user clicks “Waybill for Purchases” tab, search page disappeared as shown in figure 6.3. User can make search by pressing “Search Waybill” button or user can click on “Create Waybill” button to call Create Waybill page.


The screenshot displays the 'Waybill for Purchases' search interface. The header includes the 'INVENTORY MANAGER' logo and 'INVENTORY MANAGEMENT' text. Navigation links for 'home' and 'log out' are present, along with a 'Logged in as musti' status. The search form contains the following fields and controls:

- Waybill No: Text input field with a search icon.
- Supplier: Dropdown menu with a search icon.
- Warehouse: Dropdown menu with a search icon.
- User Name: Dropdown menu with a search icon.
- Date From: Text input field with a search icon.
- Date To: Text input field with a search icon.

At the bottom of the form are two buttons: 'Search Waybill' and 'Create Waybill'. The footer contains the text '©Oracle 2007 Medifera Inventory Manager' and a 'Contact us' link.

Figure 6.3 Waybill search page of Inventory Manager

User can use the parameters to limit the search results, such as “Waybill No”, “Supplier”, “Warehouse”, “User Name”, or “Time Period”. Figure 6.4 shows an example of waybill search. These results appear in a table with four fields.



**INVENTORY
MANAGER**

**INVENTORY
MANAGEMENT**

[home](#) [log out](#)

Logged in as musti

Waybill for Purchases

Waybill No

Supplier

Warehouse

User Name

Date From

Date To

Select	Document No	Waybill No	Date	User Name
<input checked="" type="radio"/>	2	11	Sep 2, 2006	musti
<input type="radio"/>	9	w345	Sep 10, 2006	cembo
<input type="radio"/>	14850	mus16	Mar 13, 2007	musti
<input type="radio"/>	11	irsA1	Oct 31, 2006	musti
<input type="radio"/>	50	ddd	Sep 2, 2006	musti
<input type="radio"/>	14830	mus14	Mar 13, 2007	musti
<input type="radio"/>	5	B-737	Sep 5, 2006	musti
<input type="radio"/>	6	r343	Sep 3, 2006	cembo
<input type="radio"/>	7	q989	Sep 3, 2006	musti
<input type="radio"/>	14750	sonirs	Feb 27, 2007	musti

[home](#) | [log out](#)

[Contact us](#)

© Oracle 2007
Meditera Inventory Manager

Figure 6.4 Waybill search page of Inventory Manager with some results

User can also create a new waybill. Figure 6.5 shows creation page for purchase waybill. “Waybill No”, “Date”, “Supplier”, “Operation Type”, “Warehouse” and “Foreign Currency” are required fields in the form.

INVENTORY MANAGER **INVENTORY MANAGEMENT**

home log out

Logged in as musti

Waybill For Purchases

* Waybill No

* Date Mar 22, 2007

* Supplier DOKUZ EYLUL UN.

* Operation Type IC PIYASA

* Warehouse MERKEZ DEPO

Sender

Recipient

* Foreign Currency DOLLAR

Shipping No

Save


home | log out

©Oracle 2007
Mediterra Inventory Manager

Contact us

Figure 6.5 Waybill create page of Inventory Manager

After master record is entered to the system for waybill, the detail records must be entered to the system. “Stock Item”, “Description”, “Quantity” and “Unit” are required fields in the form. Creation page for detail records of purchase waybill is shown in figure 6.6.



**INVENTORY
MANAGER**

**INVENTORY
MANAGEMENT**

[home](#) [log out](#)

Logged in as musti

Waybill for Purchases

Document Sequence 14870
 Waybill No wb714
 Date Mar 22, 2007
 Supplier DOKUZ EYLUL UN.
 Warehouse MERKEZ DEPO
 Operation Type IC PIYASA
 Foreign Currency USD

* Stock Item LC5000 STD PUMP SET
 * Description
 * Quantity
 * Unit ADET
 Price
 Discount
 Lot
 Expiry Date


Movement Seq	Stock Item	Description	Price	Discount	Lot	Quantity	Unit
No rows yet.							

[home](#) | [log out](#)

©Oracle 2007
[Meditera Inventory Manager](#)
[Contact us](#)

Figure 6.6 Waybill detail records create page of Inventory Manager

Figure 6.7 shows the result of the entered detail record for purchase waybill. “Movement Seq”, “Stock Item”, “Description”, “Price”, “Discount”, “Lot”, “Quantity”, and “Unit” are displayed in the table.



**INVENTORY
MANAGER**

**INVENTORY
MANAGEMENT**

[home](#) [log out](#)

Logged in as musti

Waybill for Purchases

Document Sequence 14870
 Waybill No wb714
 Date Mar 22, 2007
 Supplier DOKUZ EYLUL UN.
 Warehouse MERKEZ DEPO
 Operation Type IC PIYASA
 Foreign Currency USD

* Stock Item LC5000 NITRO SET
 * Description nitro set
 * Quantity 5
 * Unit ADET
 Price 34
 Discount 4
 Lot 23313
 Expiry Date Mar 12, 2012

[Save](#)

Movement Seq	Stock Item	Description	Price	Discount	Lot	Quantity	Unit
525418	LC5000 STD PUMP SET	standard set 26	3	45687	10	ADET	

[home](#) | [log out](#)

© Oracle 2007
 Meditera Inventory Manager [Contact us](#)

Figure 6.7 Result of the entered waybill detail records create page of Inventory Manager

6.2 Invoice

Invoices cannot be entered to the system without a waybill. First, a waybill is selected. Then, required fields are copied from waybill to invoice. Figure 6.8 shows main screen with invoice tab selected.

The screenshot shows the main interface of the Inventory Manager. At the top left is the logo "INVENTORY MANAGER" and "INVENTORY MANAGEMENT". A navigation bar contains "Purchase Invoice", "Sales Invoice", "Reports", "Invoice" (selected), "Waybill", and "Admin Module". A "log out" link is in the top right. Below the navigation bar, it says "Logged in as musti". A central message box reads: "Welcome to Inventory Manager. Please select the process that you want to do from the above menu." At the bottom, there is a footer with "©Oracle 2007 Meditera Inventory Manager" and "Contact us".

Figure 6.8 Main screen with invoice tab selected

When user selects “Purchase Invoice” tab, a table appears in the Create Purchase Invoice page. This table shows list of waybills without invoice. User selects the appropriate waybill from the table and presses the “Copy” button. Then all required fields are copied to the invoice as shown in figure 6.9.

The screenshot shows the "Purchase Invoice" page. At the top, it says "Logged in as musti". Below the header, there is a "Select and Copy" button and a "Previous" button. A table lists waybills with columns "Waybill No" and "Date". The "wb714" row is selected. Below the table, there is another "Select and Copy" button and a "Next 5" button. The form below contains the following fields:

- * Invoice No:
- * Date:
- Supplier:
- Operation Type:
- Warehouse:
- * Maturity Date:
- Foreign Currency:
- Exchange Rate:

At the bottom, there is a "Save" button. The footer contains "©Oracle 2007 Meditera Inventory Manager" and "Contact us".

Figure 6.9 Invoice master record create page

After user enters the master record of the purchase invoice, the detail records for the invoice that is copied from waybill is listed in a table on the detail record page of the purchase invoice as shown in figure 6.10.

INVENTORY MANAGER **INVENTORY MANAGEMENT**

home log out
Logged in as musti

Purchase Invoice

Document Sequence 14871
 Invoice No iw714
 Supplier DOKUZ EYLUL UN.
 Warehouse MERKEZ DEPO
 OperationType IC PIYASA
 Foreign Currency USD
 Exchange Rate 1.45
 Date Mar 22, 2007

Select and Edit

Select	Movement Seq	Invoice No	Waybill No	Stock Item	Description	Date	Foreign Currency	Exchange Rate	Currency Amount	Price	Discount	KDV Percentage	KDV Amount	Lot	Quantity	Unit	Amount
<input checked="" type="radio"/>	525419	iw714	wb714	LC5000 STD PUMP SET	standard set	Mar 22, 2007	USD		177.241	26	3		46.26	45687	10	ADET	260

home | log out

©Oracle 2007
Mediterranean Inventory Manager

Contact us

Figure 6.10 Invoice detail records create page

User can change the price information of the detail invoice record by clicking Edit button in the table. Update page for the invoice detail record is shown in figure 6.11.

INVENTORY MANAGER **INVENTORY MANAGEMENT**

home log out
Logged in as musti

Purchase Invoice

Movement Sequence 525419
 Date Mar 22, 2007
 Invoice No iw714
 Waybill No wb714
 Description standard set
 Lot 45687
 Expiry Date Mar 20, 2013
 Stock Item LC5000 STD PUMP SET
 Quantity 10
 Unit ADET
 Foreign Currency USD
 Exchange Rate
 KDV Percentage
 Price 26
 Discount 3
 Total Amount 260
 KDV Amount 46.26
 Currency Amount 177.241

Save Back

home | log out

©Oracle 2007
Mediterranean Inventory Manager

Contact us

Figure 6.11 Invoice detail record update page

6.3 Reports

Many reports can be received from Inventory Manager via Jasper Reports. Figure 6.12 shows main screen with reports tab selected.



Figure 6.12 Main screen with reports tab selected

Figure 6.13 shows distributions report page. Form parameters can be used to limit the report results.

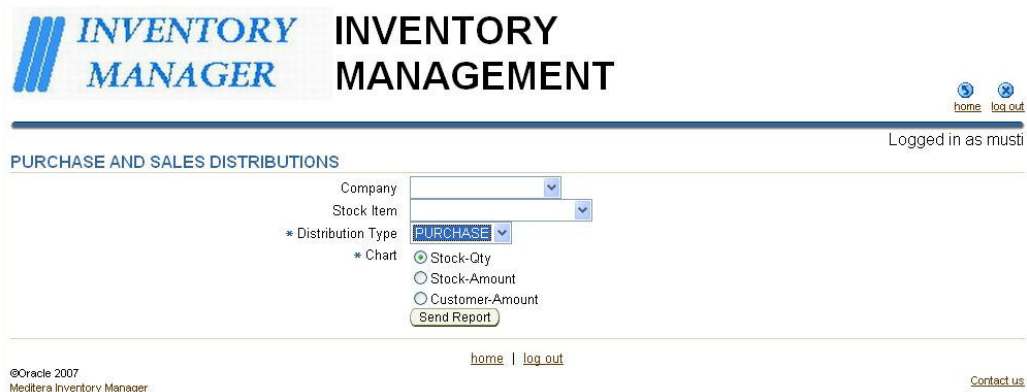


Figure 6.13 Distributions report page

A sample report for Purchase Distribution is shown in figure 6.14

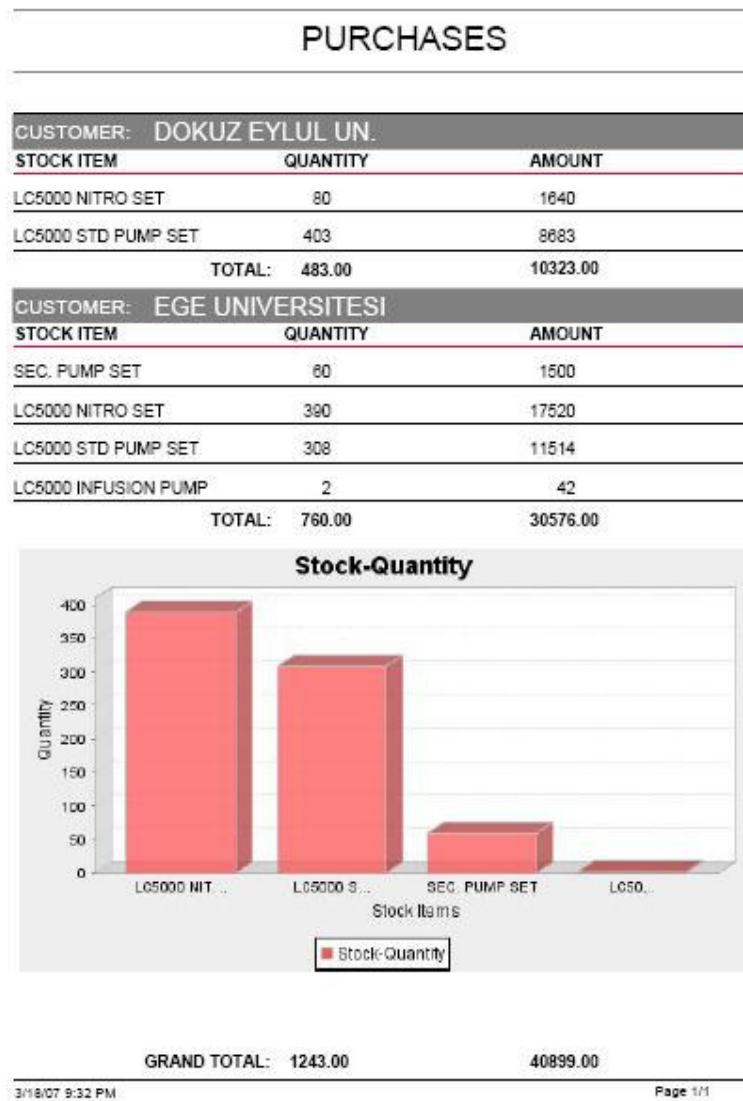


Figure 6.14 Destrubtions report from Jasper Report

Figure 6.15 shows warehouse costs report page. Form parameters can be used to limit the report results.

INVENTORY MANAGEMENT

[home](#) [log out](#)

Warehouse Costs
Logged in as musti

Warehouse
 Stock Item
 * Chart
 Stock-Quantity
 Stock-Amount
 Warehouse-Amount

©Oracle 2007
Meditera Inventory Manager
[home](#) | [log out](#)
[Contact us](#)

Figure 6.15 Warehouse Costs report page

A sample report for Warehouse Costs shown in figure 6.16

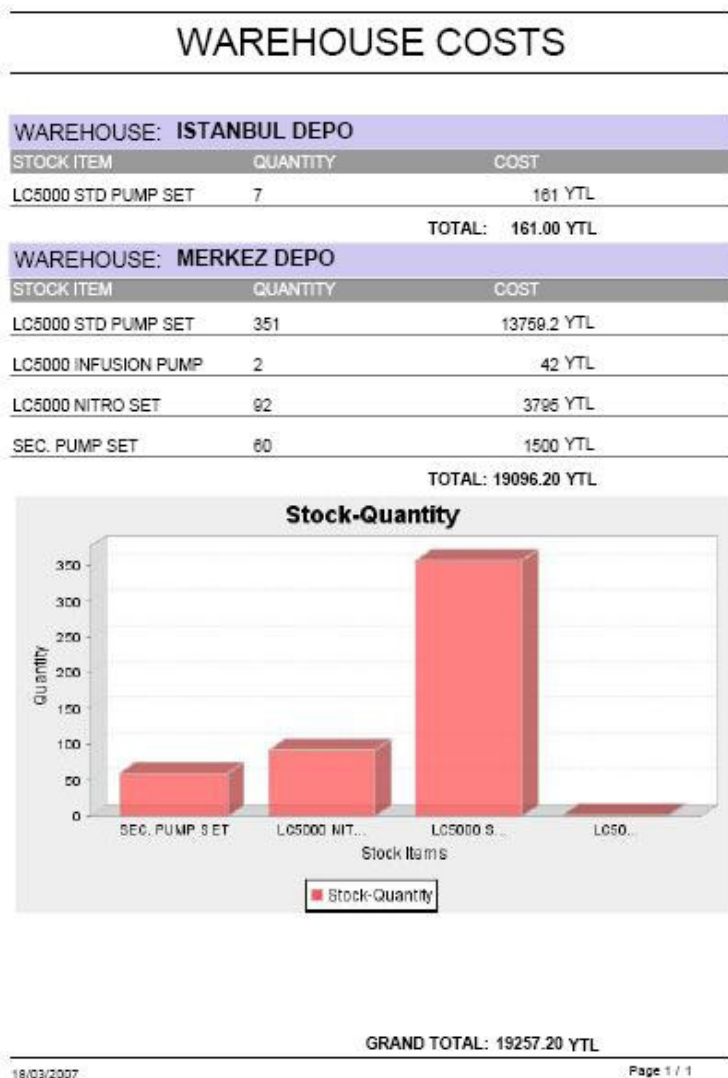


Figure 6.16 Warehouse Costs report from Jasper Report

Figure 6.17 shows invoice-profit report page. Form parameters can be used to limit the report results.



Figure 6.17 Invoice-Profit report page

A sample report for Invoice-Profit shown in figure 6.18

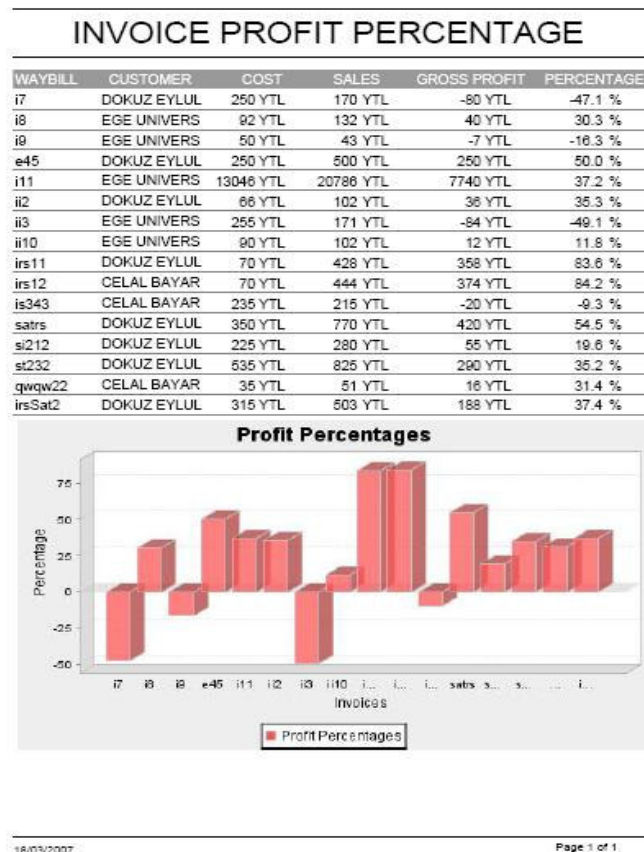


Figure 6.18 Invoice-Profit report from Jasper Report

Figure 6.19 shows periodic sales report page. Report can be received as daily, monthly or quarterly.



Figure 6.19 Periodic Sales report page

A sample report for Periodic Sales shown in figure 6.20



Figure 6.20 Periodic Sales report from Jasper Report

Some other useful reports can be received from the system. Such as; Dead Stocks, Nearly Dead Stocks, Group A Critical Stocks, Minimum Stocks, or Order for Minimum Stocks. Figure 6.21 shows the report page for these reports.

INVENTORY MANAGER **INVENTORY MANAGEMENT**

home log out

Logged in as musti

Reports

- A Class Critical Stocks
- Dead Stocks
- Nearly Dead Stocks
- Minimum Stocks
- Order for Min Stocks

send report

home | log out

©Oracle 2007
Meditera Inventory Manager

Contact Us

Figure 6.21 Other reports page

Sample reports for Dead Stocks, Nearly Dead Stocks, Group A Critical Stocks, and Minimum Stocks can be received as shown in figure 6.22, figure 6.23, figure 6.24, and figure 6.25, respectively.

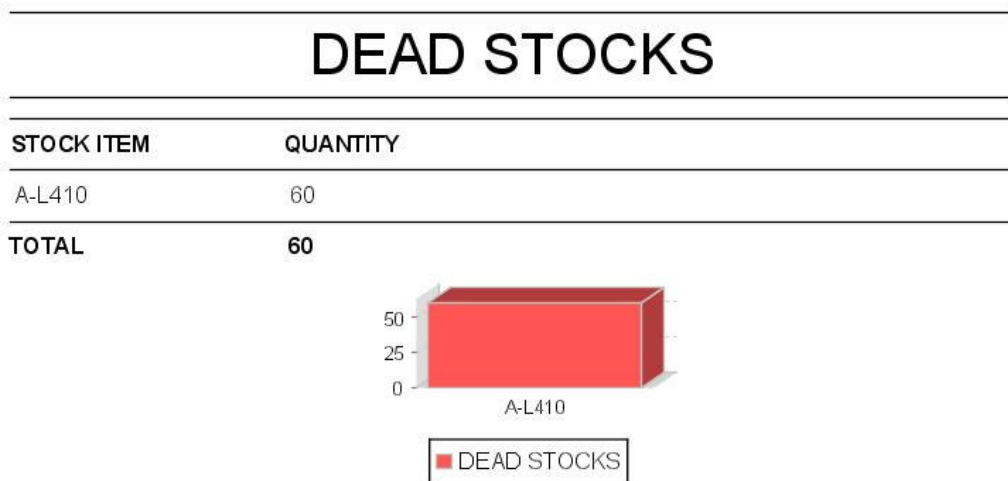


Figure 6.22 Dead Stocks report from Jasper Report

NEARLY DEAD STOCKS

STOCK ITEM	QUANTITY
A-G868	10
A-L217	42
TOTAL	52



Figure 6.23 Nearly Dead Stocks report from Jasper Report

GROUP A CRITICAL STOCKS

STOCK ITEM	QUANTITY
A-G868	144
A-L217	52
A-L410	60
TOTAL	256

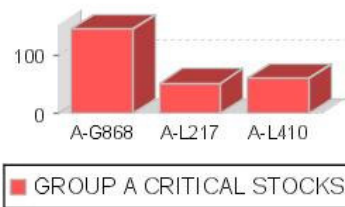


Figure 6.24 Group A Critical Stocks report from Jasper Report

MINIMUM STOCKS

STOCK ITEM	QUANTITY
A-2507	10
A-G868	50
A-L217	15
A-L410	10
TOTAL	85



Figure 6.25 Minimum Stocks report from Jasper Report

CHAPTER SEVEN

CONCLUSION

Up to the early 1990's, many software systems were based on only sales and accounting. However, after that time companies needed to control and manage their biggest asset, inventory. Nowadays, companies try to cope with raising competition level as a result of Global Economy. In this competition, inventory management and cost accounting systems are developed to use inventory efficiently and to drop inventory costs to minimum.

Inventory management and cost accounting systems are very important factors for companies to survive in such a hard competition. A good working inventory management system provides application comfort and also reduces inventory costs.

Inventory management and cost accounting systems aim to achieve a very important common goal: to drop company costs to minimum. This is one of the most important objectives that companies eager to achieve.

Actually, inventory management constitutes a vital part of cost accounting. So inventory management systems must be developed integrated with the cost accounting systems. To achieve companies' one very important goal, to reduce company costs, these two systems must work in a harmony. That is an inevitable fact.

In order to provide effective and user-friendly web-based Inventory Management System, Inventory Manager is developed. Inventory Manager meets companies' expectations on efficient inventory management, from all sectors. As a result of it's developed as web-based, Inventory Manager gains access to system from all over the world. Companies can control their inventory levels and they can also manage their inventories easily, both locally and abroad whenever they need. So that they can minimize their inventory costs by utilizing the efficient inventory level which suits

their company. Since, it is designed as user-friendly; user can easily use this software without much training.

It is also created in flexible features. So, various extra features and reports can be added to this project easily to response companies' special needs. After some examinations on the companies' requirements, the required modules can be designed and added to system.

Since Inventory Manager's development platform, Oracle Jdeveloper 10g, still insufficient on various subjects, lots of problems had been met during the development process of the software. Especially, existence of design restrictions which causes difficulties to user during Oracle connections and demonstration of datas, had affected the developing process of the software unfavorably. Besides, because of Jdeveloper's lacking of an embedded reporting tool, free reporting tools, JasperReports and JChart, have been used. But, also lacking of any document on how to use these tools had decelerated the development process. Against all these difficulties, the development process of Inventory Manager has been accomplished.

The most important properties that seperates Inventory manager from other classical inventory management systems are: free development platform, numerous, alterable and additional reporting options depending on users' needs. Through free development platforms, Inventory Manager is much more economical in comparision with its competitors. Additionally, through its great reporting skills, it provides decision makers to access the datas in every format and from everywhere they want and it also gives great chance to them for making decisions on their activities easily.

REFERENCES

- Chu, K., Cordero, O., & Gordon, R. (2006). *Application development framework developer's guide*. Retrieved April 13, 2006, from <http://www.oracle.com>
- Donath, B., Mazel, J., & Dubin, C. (Eds.). (2002). *Handbook of logistics and inventory management*. NY: John Wiley & Sons, Inc.
- Inventory*. (n.d.). Retrieved January 29, 2007, from <http://www.investopedia.com>
- Jit inventory management*. (n.d.). Retrieved August 17, 2006, from <http://www.themanager.org/Knowledgebase/Operations/JIT.htm>
- Muller, M. (2003). *Essentials of inventory management*. NY: Amacom
- Purpose of cost accounting*. (n.d.). Retrieved August 7, 2006, from http://media.wiley.com/product_data/excerpt/53/04713865/0471386553.pdf
- Schreibfeder, J. (2000). *Analyzing inventory adjustments*. Retrieved September 6, 2006, from <http://www.effectiveinventory.com/article37.html>
- Wild, T. (1997). *Best practice in inventory management* (2nd ed.). NY: John Wiley & Sons, Inc.