# Simulation Models for Back-Office & Retail Store Management Integration in ERP

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*Abstract:* - The paper describes shortly the architecture of a complex system for managing back office activities and store management including MRP, Demand forecasting, stock evaluation system from the logistics and financial point of view, integrated in a company ERP. Simulation was the way to properly define the most suitable algorithm for demand forecasting among the many complex combinations proposed by default in the ERP Central Component plus the ones proposed by key users. This architecture was applied in a complex retail chain involving different classes/clusters of point of sales and selling many different sorts of goods (grocery, food, clothing, electronics, home goods etc.)

*Key-Words:* - ERP Enterprise Resource Management, ECC (ERP Central Component), SOA (Service Oriented Architecture) Modelling, customer behaviour, forecasting revenues, Key Performance Indexes

# **1. INTRODUCTION**

This work presents the logical and technical approach to define and implement a solution architecture for an ERP-Integrated system for store management and back office applications: the features included are devoted to managing goods in retail stores both from the point of view of quantities and values, considering all the possible phases of the process: from the order made by the store to the central warehouses (or directly to vendors), to the invoice process, passing through all stock movements available in the standard ERP functions and in customizing (goods receipt, good issues, stock transfer between stores, on-store food production, scrapping, claims and returns from customers and to vendors, and so on). The algorithms inside the material requirement planning tool for automated orders are chosen by simulation results on a baseline of historical data versus simulation output for the same period, compared with analysis and calculus technique (i.e. Mean Absolute Deviation).

The architecture proposed was challenging due to two main reasons; the first one is due to the problem size: the number of stores involved in the network is very high introducing heavy computation issues both for the application developed inside the ERP Central Component (ECC) and for the simulation model used for comparing forecasting algorithms, at the same time number of items to be managed (with a lot of management parameters to be customized store by store) can potentially generate an overload in the system control. The performance issue is a really important factor, since all the stores in the retail chain are supposed to process orders at almost the same time on the same items.

Demand & Supply Si	mu	lat	or					
Run	l	B	RВ					
Gratico	l							
Risultati Overall MEAN ABSOLUTE DEV.	L	М	М	G	V	S	D	TOT
Algoritmo Media Mobile 35 gg	3.28	3.41	3.43	5,18	3.24	3,92	5,18	27.64
Algorimo Media Mobile 35 gg Algorimo Media su Giorri Omologhi nel 35 gg	3.28 2.78	3.41 3.53	3.43	5.18	3.24 3.66	3.92 4.49	5.18	27.84
Algorimo Media Mobile 35 gg Algorimo Media su Giorri Omologhi nel 35 gg Algorimo Media Pesala sul Giorri Omologhi	3.28 2.76 2.49	3.41 3.53 3.14	3.43 3.34 2.61	5.18 4.77 3.41	3.24 3.66 3.12	3.92 4.49 4.11	5.18 2.60 0.26	27.64 25.14 19.14

Fig. 1: Simulating Supply and Sales Forecasts

The second main issue is related to the necessity to design the operative procedures in compliance with company MIS (Management of Information System) and usually with ERP/ECC transactional system; this aspect introduces additional complexity not only in relation to the data availability and reliability. The retail chain object of the case study was coming from the recent fusion of different smaller retail chains, so there is a big issue for instance in batch procedures for synchronization of data coming from different legacy software, can affect reliability of data along the day or along the week, and a procedure of backup in case of a missing connection was setup (i.e. interface with a specific cash checkout counter can be interrupted, and sales data can be not available, but the proposal must be any case available based everyday). So it was fundamental to define procedures able to be implemented in the real MIS and with reasonable performances.

# 2. REDESIGNING STORE MATERIAL MANAGEMENT

The innovative idea proposed by the authors is related to the fact that the store drives the inventory management along the entire retail supply chain, getting the most up-todate information related to real customer demand; therefore the proposed architecture is designed as a distributed system that allows to be easily accessible by remote users, but guaranteeing best computation performances from central servers and management optimization by central management. This was achieved by getting opportunities and identifying synergies in merging store requests.

In the presented case, the automated order proposal is applied to a store network of about 300 sites, many of which having in assortment at least 20'000 different items belonging to different types and classes: grocery and home supplies, clothing, fresh food, electronics, furniture etc. It is easy to understand that this is a very heavy computational problem; in addition it requires extensive access to historical data for forecasting, an effective GUI (graphic user interface) to be used by each department manager in the store, accessing only to authorized data but at the same time of other users, each one is allowed to "correct" order proposed by the system by introducing their knowledge and feelings. This is the reason why very user friendly interfaces for employees updating and correcting data remotely is needed, such as efficient reporting for central management and executive company control.

The system developed was developed for the requirement of a big retail company operating in the field of food and no-food retail, holding about 350 supermarkets/hypermarkets/small city stores, clustered, but different as what concerns extension, assortment, pricing, location, typical average customers. The study and the implementation of the ECC integrated system started from some basic requirements:

- The creation of a set of tools able to manage all the aspects related to goods stock movements inside the stores (quantities and values) in order to build-up the store annual budget and economical/fiscal report (mandatory)
- the development of all the applications as centralized inside the ERP/ECC system already used for other applications by the company: the store application is in fact the front-end point collecting all the integrated information coming from all processes in the company: logistics, financial, marketing and promotional activities, etc.

The Integrated System, for all these reasons, is necessarily composed by a series of modules and functions interlaced among them:

- Order Proposal (custom MRP) for goods managed by company warehouses
- Order Proposal (custom MRP) for goods managed directly by vendors
- Administration and financial Procedures for on-store operations:
  - All types of goods waste declarations
  - Transfer between stores
  - Transfer of goods for internal on-store production of fresh food
  - Claims from customers
  - Errors from cash barrier
  - Inventory management
  - Claims from store to vendors (warehouses and direct ones)

In order to manage all these operations, the system needs the following input/output:

INPUT		
DATA	TIME/Frequency	INTERFACE
Sales	Each night	Cash counter to ERP
Warehouse Bills	Each night	ERP to ERP
Vendors' bills	On store request	Pre-compiled based on
		the store
Administrative	Registered by	Data entry or file from
movements of	the store day by	scanning devices
Goods	day	

OUTPUT		
DATA	TIME/Frequency	INTERFACE
Order	According with authorization calendar	Notify from ERP local store systems (on request)
Administrative movements of goods	Weekly	From ERP to local Administration tools (to be substituted by ERP Integrated System)

The transitory situation is characterized by a series of interfaces with local systems that are to be progressively substituted with ERP-integrated tools in the steady-state, but that represent any case a potential series of issues to be managed.

In order to reduce operations of data entry and make them as much user-friendly as possible, it has been integrated on the system the possibility of reading data from a batch wireless barcode scanner (PDT) programmed in order to collect all the necessary information in all the suitable applications.

This scanner integrates with various functions:

- Store goods display creation
- Stock fiscal/logistics evaluation (inventory management)
- Administrative/fiscal movements (transfers, scrapping) with all the particular details of each movement

At the moment there is also in evaluation the possibility of integrating all the system for use on wireless/RFID terminals and on palm-PCs. This second possibility is much more easy, but the cost and lack of robustness of the devices is still an open point for many companies.

In the present moment, the ERP/ECC-Integrated System for On store Goods Management runs on different kinds of goods (grocery, chemical products, frozen food etc.), on a network involving at least 10 different warehouses and logistic platforms. These numbers will grow up involving other kind of goods, other platforms and all the stores on the network, divided into clustered chains (managed in completely different ways) and organized into three macro geographical areas through part of the Country.

# **3. LOGICAL FLOW OF OPERATIONS IN THE SYSTEM**

The order made by each store is somehow authorized by a calendar of possible transmissions set up by the logistic area (for warehouses) or by the commercial area (for direct suppliers). Each day each store finds in the proposal area only the items and the suppliers for which in that day there is the authorization for the order. The system automatically pre-proposes the quantity of each item that is necessary for covering the forecasted needs considering:

- Days in which the store is authorized to send orders and related days of delivery of goods (based on lead time of each warehouse/vendor for each store)
- Days in-between the next deliveries in which the store is opened to customers

The proposed coverage order considers:

- Minimum stock to be guaranteed for each item
- Stock at the present moment
- Orders to be delivered in the next period
- Forecast of sales in the period
- Other possible correction factors to be defined by the store (multipliers, leveling factors, extra-coverage etc.)
- The calculation is the following:

Stock +

Orders to be delivered – Forecast in the period of coverage – Minimum Stock guaranteed =

ORDER PROPOSAL

The forecast algorithm has been chosen thanks to the use of a simulation model as decision support systems (DSS).

# 4. SIMULATION AS DSS FOR CHOSING FORECAST ALGORITHM

In order to evaluate efficiency and efficacy of different possible algorithms (ECC standards and customs), it has been developed a simulation model able to test all possible algorithms with different parameters. The data used for testing the forecasts was an historical series of demand (sales) data for 35 days in the past, plus one week to be considered as "future" (total: 42 days) on 5'000 items (basic assortment, common to all stores).

The forecast is evaluated each day for each item for the seven days forward, based on the 35 days in the past.

The evaluation of performance is based on the Mean Absolute Deviation technique, according with the standard performance indexes used in the ECC system. The data resulted as output from the simulation run are compared with the real data with the M.A.D. technique:

$$MAD = \frac{1}{n} \sum_{i=1}^{n} \left| \mathbf{x}_{i} - \overline{\mathbf{x}} \right|$$

Through simulation it was possible to compare different algorithms (both ERP standards and custom) such as:

- Moving average on 35 days
- Average of homogeneous days in the week (without weights)
- Average of homogeneous days in the week (with smoothing weights)
- Average of homogeneous days in the week (with smoothing weights, deviations and correction coefficients)

The result of the simulation run has led to the choice of the Average of homogeneous days in the week with smoothing weights.

This algorithm is based on the historical data of past 5 weeks starting from the present date with a scheme that can be summarised as follows:

Item.YYY	М	Т	W	Т	F	s	s
week5			V13	V14	V15	V16	V17
week-4	V11	V12	V23	V24	V25	V26	V27
week-3	V21	V22	V33	V34	V35	V36	V37
week-2	V31	V32	V43	V44	V45	V46	V47
week-1	V41	V42	V53	V54	V55	V56	V57
Current	V51	V52					

Current day: Wednesday

*Day for Item Demand forecasts: Thursday* 

In this case weighted average of the sales values on the last 5 Thursday per item/sales point, is applied. The weight of each date decreases in proportion to his oldness.

Forecasts for the j-th day of the week

$$\frac{1}{5}\sum_{i=1}^{5}C_{i}V_{ij}$$

In this case it was used 5 as fixed value, based on a simplified hypothesis that considers this as the regular value of corresponding sales data available on the history; this assumption improve system efficiency and it is reasonable for all the items characterized by low demand. In the case of goods with high demand rates, the relation it is similar, therefore in this case in this necessary to properly compute days in which sales take place (excluding days in which the store is closed) and to evaluate (if exists) presence of inweek closings; due to this fact the fixed value is substituted by the real number n, properly computed, as real number of historical data available in the database over the last five weeks, for the corresponding day of the week needed by the forecast algorithm.

The weights are normalized in order to properly proceed in the computation by the following relation:

$$1 = \sum_{i=1}^{5} C_i$$

In the latest release of these algorithms, implemented for Retail ECC in continuity with previous logics in old legacy systems, the weights were predefined with the following settings, defined on the experience of subject matter experts and moving from the most recent week to the oldest:

1.0 - 0.4 - 0.3 - 0.2 - 0.1

The correction of demand is based on the mean value of sales on the corresponding days where none promotional activity was active for the item under analysis. To do so, the system is able to automatically recognise which items are subject to promotional activities in the period, if this information is stored and correctly maintained in the database (i.e. item master data, specific custom applications and so on).

To correct manually demand based on special events that are supposed to happen, but that shall not influence future forecasts, the users have the possibility to add a manual percentage on the demand of the next rolling week for each family of products, in which the assortment is classified. The classification, and the subsequent authorizations for users to apply multipliers, is inherited from the ECC product classification. This feature, called "multipliers", allows to increase/decrease forecasts of a predetermined percentage (different for each day of the rolling week) due to an exceptional event: i.e. a strike, a special discount sale, etc.



#### AUTOMATED STORE ORDER GENERATION

# 5. GENERAL ARCHITECTURE OF BUSINESS PROCESSES AND OPERATION MANAGEMENT

The following processes was simulated in order to check the effectiveness of an new Automated Proposal for Orders to suppliers and central warehouses ( in the following called OAP) that elaborates the quantities and it is directly integrated in the company ERP Central Component (successfully applied to SAP R/3 Retail); at the same time the procedures for the Administrative Module for Order Proposal Management (AMOPM) are designed and tested with the support of simulation.

## ORDERS TO DIRECT SUPPLIERS AND INVOCING

The Process includes the following steps:

(Prerequisite is the correct data entry related to suppliers in the ERP system)

- Order Automated Proposal (OAP) generates the order for each Store based on available data, with the same algorithms used for goods managed by the OAP through the central warehouses
- Each Store confirms the order to the Central Company Management system (CCMS)
- CCMS groups all the orders and check for possible synergies on supplier orders (i.e. reaching quantities for getting logistics or commercial discounts). Here is the possibility to implement semi-automated proposals on demand.
- CCMS sends to each suppliers the orders with the details for directly delivering the proper quantities to each store or for central delivery on the Central Warehouses (CW)

- The ordered quantities are confirmed by CCMS back to the Stores
- Bills of Parcel are confirmed by CCMS back to the Stores
- If needed: Claim Management
- If needed: Return of goods from Stores to CWs
- Invoice Production (extra OAP/AMOPM)

The centralization of direct deliveries from vendors includes all the items that usually are managed by CWs but eventually can be directly delivered by suppliers in correspondence of marketing or logistics opportunities.

This management change (from CWs to direct delivery) need to be defined in ERP Item Databases for each item/store entity (master data attributes).



#### **Direct Deliveries to be Centralized**

## **Occasional Direct Deliveries**



## **Local Direct Deliveries**



**General Operation Flow Chart – Direct Deliveries** 



The operational logic for direct delivery from suppliers to stores is based on the following general process:



## **Inventory Decreasing Operations due to Dispersions**

These procedures are devoted to manage cases of items damaged, broken, lost or robbed inside the store, at different management levels, and with different results on final stock evaluation. They include:

- Updates on inventory level both for items managed by the OAP and by traditional ERP procedures
- Stock adjustments for Administration/financial procedures
- Report creation for item damaged and stolen for the following organizational layers:
  - Store Management Level (Summary and Detailed Reports) including just sales price for the involved items
  - Marketing Management Level (Summary and Detailed Reports) including also values of purchase and margins on goods.

The changes in inventories due to broken items and robberies (BIR) have different impact on the ERP system, since they require:

- Correction in Inventory Levels in OAP for the items managed by this system
- Recording inventory change due to BIR for administration/financial purposes, and periodic generation of an automated file to be examined by central administration, with checks on already processed records in order to avoid information duplication.
- Recording special causes of BIR (i.e. freezing system malfunctions FSM) for special procedures (i.e. administrative actions with insurances) can be activated as special inventory modifiers

For administration and legal reasons, each dispersion must have a Reason to be justified. This in accord with ECC mandatory regulations but also to company rules and policies: in fact, a scrap/disposal of an item without any precise cause, could be an incentive to robberies: due to mandatory laws in fiscal inventory, and to invoicing/stock coherence in quantities and values, each damage must be justified, and can be part of the Store Department productivity calculation / bonus evaluation. It is common in fact in some retail chains to evaluate store personnel's performance based on the revenues of their department divided per working hours. This is indeed disputable for correctness, because many operations for customers satisfaction require time but do not produce immediate and tangible revenue, but it's a common practice on which also scrapping without reason have a bad influence.

## **Operation Flow Chart**



Material Transfer among store departments due to Internal Production activities

In a huge retail store it is often required to simulate also material transfer "among Stores" and "among Store Departments" devoted to support internal production activities (i.e. delicatessen); these activities require the following procedures:

- Administration/financial File Support Generation
- Inventory Level Update for Stores and Departments
- Stock Evaluation attributed based on lot values using for instance FIFO Logic (first in first out logic).

#### **Stock Evaluation Issues**

ERP normally provide also a series of models for stock evaluation, that is another issue considered as critic from majority of companies. The most common ECC for instance considers this issue in the traditionally-called Material Management Module, but integrating values directly in Financial Accounting.

There are three standard methods to evaluate stock for Balance Sheet purposes in common ECCs:

1. LIFO (Last-In-First-Out): materials received last are the ones issued/consumed first. The valuation is based on the initial receipt. 2. FIFO (First-In-First-Out): materials received first are the ones consumed/issued first. So, the valuation is based on the most recent receipt. The FIFO method can also be used in conjunction with the lowest value method. In this way it's possible to determine whether the system should make a comparison between the FIFO determined price and the lowest value price. It's also possible to determine whether the FIFO price should be updated in the material master record.

3. Lowest Value Method: stocks are valued at their original price or the current market price whichever is lower. This method is suitable when the inventory needs to be valued to take into account material obsolescence, physical deterioration, or changes in price levels.

Also cost of sales (configured in Sales and Distribution and Controlling modules) is an issue very important for companies. Calculation can be affected by various factors, considering not only the possibility to choose fixed price or moving average price, pricing conditions involved, cost of purchases, goods issues, scrapping, returns etc. Depending on the rules that a company shall adopt, it is indeed possible the need of a non-standard stock evaluation /cost of sales evaluation method, but in this case the issue shall be evidenced in the analysis of the solution architecture: the tobe process needs to be designed accordingly to this requirement.



Flow of Costs through Manufacturing and Merchandising Companies

An example of stock evaluation affected by various factors is given in the following.

#### **Example of Moving Average Price Calculation**

In the ECC Standard, there are two types of price control:

- Standard Price
- Moving Average Price

These two types of price control differ in how they handle price variances resulting from goods receipts or invoice receipts. It's possible to determine the price control that should be used for a material when creating the material and entering the accounting data for it.

Valuation using a Moving Average Price results in the following characteristics:

• Goods receipts are posted at the goods receipt value.

• The price in the material master is adjusted to the delivered price.

• Price differences occur only in exceptional circumstances.

• Manual price changes are usually unnecessary. However, they are possible.

If a material is assigned a Moving Average Price, the price is automatically adjusted in the material master record when price variances occur. If goods movements or invoice receipts are posted using a price that differs from the Moving Average Price, the differences are posted to the stock account; as a result, the moving average price and the value of the stock change. The Moving Average Price displayed in the material master record is rounded off. For valuation calculations, the system always uses the exact price (stock value / stock quantity).

Quantity ne	= w	Quantity +	Quantity receipt	
Value new	=	Value +	Quantity receipt * Price receipt Price unit	eipt
Price	=	Value new *	Price unit	
new		Quantity	material master	

The value of the goods receipt is posted to the GR/IR clearing account; the offsetting entry depends on the type of price control for the material. In the case of a material valuated at a Moving Average Price, the delivered quantity per net order price (or invoice price) is posted to the stock account. If the purchase order price (or the invoice price) is the same as the price in the material master record, there is no change in the value per piece. If the purchase order price (or the invoice price) is not the same as the price in the material master record, there is no change in the value per piece. If the purchase order price in the material master record, there is a change in the value per piece.

Invoice Verification generally happens at the end of the material procurement process: The vendor presents an invoice for a delivery made on the basis of a purchase order. In the ECC System, the goods receipt and invoice receipt are managed using a GR/IR clearing account. Either the goods receipt or the invoice receipt for a purchase order can be entered first. When a goods receipt is entered before an invoice, the posting of the invoice clears the GR/IR clearing account. When an invoice is entered before a goods receipt, the posting of the goods receipt clears the GR/IR clearing account. If there are price differences between the purchase order and the invoice, the account movements vary depending on the sequence of goods receipt and invoice receipt.

So there are two possibilities:

Invoice Receipt Before Goods Receipt: If the invoice receipt is posted before the goods receipt, the invoice price becomes the basis for the posting. The goods receipt that follows is posted with the value posted at invoice receipt.

Goods Receipt Before Invoice Receipt: Goods are generally received before the invoice. In this case, the goods receipt is posted at the net order price. If the invoice price differs from the net order price, the value posted at goods receipt must be corrected when the invoice is posted.

In either case, the invoice receipt is posted at the value of the invoice (invoiced quantity x invoice price). The account movements depend on the price control defined for the material. For a material valuated at a Moving Average Price, the price difference is posted to the stock account, provided there is sufficient stock coverage for the quantity invoiced. If sufficient stock coverage is not available, only the amount for the available quantity is posted to the stock account; the remaining amount is posted to a revenue or expense account.

#### **Examples of Possible Stock Evaluation Method**

A stock evaluation in a retail store consists mainly of the following macro-flows:

- bills from warehouse
- bills of goods from direct vendors
- bills of transfer between stores
- sales receipt,
- sales invoices,
- returns by customers
- positive corrections,
- inventories
- price variations
- losses of goods
- negative adjustments,

on store production,

each of them is a single item in the budget and balance. Core-System reflects the calculation models mentioned above. The information granularity is per item /store.

The fiscal inventory is valued at FIFO from deliveries. The balance of the initial period is treated like a bill on January 1st (supposing a fiscal year closing at December 31st) and coincides with the end of the previous period.

Inventories of store goods are made on the first day in which the point of sales is closed (not necessary January 1st), with procedures and arrangements both manual both by PDT.

The calculation of stocks at January 1st is made through recalculations performed on ECC

Hypothesis: inventory check at January 12th

+ cash sales from January 1st to 11th per day/store/item

+/- stock movements from January 1st to 11th per day/store/item

+/- inventory corrections from January 1st to 11th per day/store/item

+ returns to warehouse / vendor from January 1st to 11th per day/store/item

- bills from warehouse / vendor from January 1st to 11th per day/store/item

The quantity calculation is based on a mathematical formulation:

Quantity (1-01) = Quantity (12-01) - Good Entries(from 1 to 11/01) + Good Issues (from 1 to 11/01)

The calculation is made with quantities, considering all the processes in the flow, and the stock evaluation is made considering bills that composed the stock

Example:			
Count at 12-01:	15	50	PC
Bill at 3-01:	4	0	PC
Sales of 2-01:	5	50	PC
Inventory recalculation	at 31.12: 16	50	PC
	(150-40+50	)F	PC

The stock evaluation is made saturating the quantity with the bills that are previously issued to the store:

Bill 30-12: 80 PC unit cost 1 €	total cost	80 € →	
Bill 27-12 100 PC unit cost 1,2 €	total cost	120 € →	
Stock evaluation:			
(80 PC x 1 €)	+ (80 PC x 1,2 €) =	80 € + 96	€

= 176 €

#### **Stock Transfer between Stores**

The stock transfer between stores can be performed due to different motivations, and typically involves complex logistics and administration/financial procedures for properly attributing the final stock evaluation; in this case in fact it is necessary to define precisely and correctly the procedures in order to guarantee effective management. Different stores, in fact, can manage different assortments and different prices for the same items. Plus or minus value calculation in stock must be correctly assigned to the stores, and items not part of the assortment of the destination store are inhibited/rejected from the system. An operation of delivery confirmation both in inbound and outbound is considered, transferring the stock on correct logical warehouses and storage locations step by step.

#### **Operations Flow Chart**



The item list with all relevant attributes and details can be downloaded into ERP database by Portable Data Collection Terminal (PDT) or can be directly inserted manually into ECC transactions by users. The main idea is obviously to use PDTs for massive transfers/updates and manual entry for checks and adjustments.

## **Internal Production Transfer - Operation Flow Chart**

Manual Input Data	
Database Check about Item Characteristics	Manual Correction
Item Inventory Update	
Table Update Department Material Transfer	
Internal Document Printing	Administrative File Creation Creation

This procedure is the last step completing the "transfer among departments" procedure, typical from those retail stores that sale self-made products, such as cakes, delicatessen and so on. In inventory input there are items that then will be "transformed" in something different, to be sold in a different shape and with a different value. The inventory management needs to have this information to calculate properly quantity and values of the as-is situation and make correct forecasts for the future.

#### Goods Return from Customers and Checkout Counter Record Correction

A phenomenon to be modelled is the return of goods by unsatisfied customers (goods can be reusable or not) that needs to correct stock with quantities and values, but another case is the one of errors at checkout counters that need to be corrected. The process has been re-engineered and implemented on ERP/ECC

These processes are not very simple to be managed due to the multiple cases of outputs at the end of whole life cycle of the goods flow, that includes, among the others, issues such as:

- Inventory level updated for OAP Managed Items and for items managed with standard/manual MRP
- Returns Management with all its final possibilities: scrapped, resent to supplier, blocked in quality control, checked/repaired and re-sold, gifted to non profit associations etc.
- Corrections to checkout counters errors, that can be made in different ways depending on the mistake nature.



#### Inventory Store Check for Material managed by ERP

This procedure corresponds to the inventory management activity for checking and updating storage levels regarding each single item controlled by the ERP/ECC, both the ones managed with the new MRP custom solution both with the traditional/standard procedures (if existing); the inventory check procedure applies the following policies:

#### **Inventory Store Check Procedure**



#### **Claims and Material Return**

The flow chart for operations in this case is based on team activities devoted to design administration (financials) and logistics procedures, and includes different phases:

• Confirmation (or not acceptance) of the Bills Parcel

- Claim Management
- Materials Return Management
- Invoice Production (extra OAP/AMOPM)

#### **Claim Management**



#### **Goods Returns Management**





#### Value of Inventory Changes for Store Budgeting

The main target for this new integrated solution is to develop a Knowledge Management System for consolidating store budgets by dynamic management.

This goal is defined as Credit/Debit Accounting and it is developed by a real time calculation of the stock evaluation going in and out from the stores.



# Procedure Reproducing Transitory ERP Configuration



At the end, just ERP and Data Warehousing will exist. All other steps will be integrated into ERP Central Component. In another publication in fact will be described the implementation of an ERP-integrated system for defining item pricing at the level of single store, with different levels of authorization and linked to a release procedure involving different users. This tool, integrated with checkout cash counter, allows an on-line stock reevaluation based on the quantities available in the database.

At the end, when most legacy systems have been dismissed, the flow becomes simplified. The schemes are referred to the case study, but can obviously be adapted to different real applications:



## 6. CONCLUSIONS and DEVELOPMENT

This work proposes a general architecture for managing store operations in retail networks: a complex logic implemented inside company ERP generates automatically store requests based on historical data and updates in realtime. A simulation model has been developed to properly define the general architecture of the demand forecasting system and the procedures were the result of a business process reengineering made by the solution architects, i.e. the authors.

The authors implemented in fact a tailored solution for a large retail company involved in distribution of various classes of goods, from grocery to fresh food, from clothing to electronics. This architecture can be adapted to other different business situations, both companies operating over a big logistic network, both medium size companies with a smaller, simplified series of processes. The new challenge would be to apply the same architecture in a luxury fashion retail chain. References:

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