

Enterprise Resource Planning (ERP) and Integration of Purchase, Inventory and Sale processes: Proposition of a Common Minimal Model

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Abstract

After illustrating the contribution of information systems (especially ERP - Enterprise Resource Planning) in the supply chain optimization imposed by the current context of modern companies, this paper defines a theoretical framework for the purchase, inventory and sale processes according to the standard APICS (Advanced Productivity, Innovation and Competitive Success - The Association for Operations Management). Then it brings out the main ERP functionalities that satisfy the requirements resulting from the above-mentioned theoretical framework. Finally it proposes a common minimal model (that implements the purchase, inventory and sale processes) adopted by the most known ERPs (SAP, Oracle, JDEdwards, Sage...).

Keywords: *Information System, ERP, Integration, Data Model, APICS, Supply Chain Management*

1. Introduction

The supply chain optimization imposed by the current context of modern companies can be ensured only by the ERP implementation.

Purchase, inventory and sale processes are often implemented first in ERP and are then stabilized before integration of production and planning processes. Based on this observation, we will focus on these three processes purchase, inventory and sale (part of the supply chain).

Firstly we define a theoretical framework according to APICS considered as one of the best standards in industrial management area. Then we bring out the main functionalities offered by the most-known ERPs and we

can see that these functionalities widely cover the theoretical framework.

ERPs such as SAP, Oracle, JD Edwards, Sage ... offer the same core functionality because they refer to the same basic model that implements the supply chain: in this paper we propose a common minimal model that can be expanded to include any functionality.

The organization of the paper follows as Section 2 presents the literature review about Information System, ERP and supply chain optimization. The theoretical framework relating to the purchase, inventory and sale processes according to APICS is defined in Section 3. Section 4 presents the main ERP functionalities. A common minimal model that implements the purchase, inventory and sale processes is proposed in Section 5. Finally, conclusion and some research directions are presented in Section 6.

2. Literature Review

2.1. Current Context of Modern Companies

To be agile and responsive, companies nowadays should improve their competitiveness by rivaling each other in the 21st century global market electronically connected.

Indeed modern companies operate in a complex environment affected by:

- governmental regulations such as security, taxation...

- economic conditions which affect demand for companies' products / services: for example, during the economic recession, demand may decrease for many products and increase for others
- expectations of the customer who becomes more demanding:
 - o fair price
 - o high quality
 - o good delivery time
 - o enhanced service
 - o product flexibility

By operating in this complex and difficult environment, the major challenge for modern companies is to optimize the supply chain: maximize resource utilization and customer service compatible with company strategy. This requires an integrated information system for sharing information on various value-adding activities along the supply chain.

It has been demonstrated in [1] that information system is an essential ingredient for business survival and improves the competitiveness of companies.

2.2. Information System – Definition

In the term “information system”, we find the word “information” that [2] Ackoff defines as “data that is processed to be useful and to answer questions like who, what, where and when”.

[3] R.REIX defined an information system as it is an organized set of resources including hardware, software, personnel, data, procedures... to acquire, process, store information as data, text, images, sounds... within and between organizations.

Indeed an information system collects, processes and distributes information as quickly as possible and under the appropriate form to the receiver so as to facilitate decision making.

The informatics system includes only the computer tools (hardware and software) that mechanizes partly or totally the information system.

Note that an information system is related to its environment and thus with other information systems, which often raises problems in mutual understanding.

2.3. Information System – Evolution

The information systems implementation is insured through the setting up of informatics systems.

In this section we recall the evolution of informatics systems since the sixties until today.

In the sixties, the first software packages are emerging in the companies with the main objective of ensuring inventory control. In [4] it is mentioned that most software packages (usually customized) were designed during that period to handle inventory based on traditional inventory concepts.

Material Requirements Planning (MRP) systems were introduced in the seventies: for the first time, a computer could be used to calculate net material requirements by using bill of material files that identified the specific materials needed to produce each finished item and accurate inventory record files, the available quantity of on-hand or scheduled-to-arrive materials.

In the eighties, Manufacturing Resources Planning (MRP II) systems were aimed to incorporate finance, accounting, payroll and production management.

By the early 1990s, continuing improvements in technology allowed MRP II to be expanded to incorporate all resource planning for the entire enterprise. Then we've seen the coming of the ERP whose development was made possible by technological evolutions: computing speed, network technologies, databases management systems, data storage... [4] And ERP can be used not only in manufacturing companies, but in any company that wants to enhance competitiveness by most effectively using all its assets, including information.

2.4. ERP – Definition

The company which is not endowed with an ERP, its information system is composed classically by systems called specifics (non-standard, custom developed we cannot find on the market). To accompany the company development, these specific systems must communicate with each other using interfaces that make after a while the company's information system non-optimized.

An ERP can be defined as a suite of application modules that can link back-office to front-office operations, as well as internal and external supply chains [5].

Indeed the ERPs are software packages composed of several modules that integrate the major functions needed to manage flows and procedures of the company (accounting and finance, logistics, business management...) providing cross-organization integration of data through embedded business processes. These software

packages can be customized to cater for the specific needs of an organization. All these modules are accessing shared resources (a database).

Also the CXP [6] (that is defined as “an independent group whose mission is to provide full assistance service in the evaluation and selection of ERP”) confirm that an ERP should:

- be provided from a single designer
- ensure the uniqueness of the user’s information through a database serving all the modules
- ensure the traceability of operations management to enable the audit
- cover an entire function of management (accounting and financial management, human resources management...), or all of the information system

ERPs allow a company to manage and optimize all of its resources, from production to after sales service through human resources, finance, logistics and sales. These complex projects lead to rethink existing organizations, to identify the needs and carefully plan the information system implementation.

2.5. ERP – Supply Chain Optimization

Today the supply chain optimization is the major issue of the company.

To understand this, we must cast a glance at the past to distinguish three evolution phases in the business environment:

- first phase: demand exceeds supply and it is sufficient to produce and sell
- second phase: demand equals supply, the company produces what will be sold
- third phase: supply exceeds demand and that creates tough competition in front of a customer who becomes demanding. The company tends to produce what is already sold. This third phase characterizes most companies nowadays.

Today and tomorrow, the companies problematic will move towards a global improvement in the product achievement process from the first supplier to ultimate customer: this is called supply chain logic.

To face these challenges, today's companies are now obliged to communicate and share data with other partners to reduce time to put products on market and to make more accurate forecasts in order to achieve waste elimination.

Logistics performance improving can be achieved only if companies are endowed with ERP to ensure synchronization between physical flows, financial flows and information flows imposed by the supply chain logic.

[7] An ERP system can facilitate the smooth flow of common functional information and reduce cycle times. However, without top management support and an appropriate business strategy, plan and vision, the reengineering of business processes, effective project management, user involvement and education and training, companies cannot embrace the full benefits of such complex systems.

3. Theoretical Framework

3.1. Introduction

According to SimchiLevi [8], Supply Chain Management is a set of approaches utilized to effectively integrate suppliers, manufacturers, warehouses, and stores, so that merchandise is produced and distributed at the right quantities, to the right locations, and at the right time, in order to minimize system wide cost while satisfying service level requirements.

In this section we will detail only the operational processes (part of supply chain management) that involve the fields purchase, inventory and sale: in the following paragraphs, these fields will be defined according to the standard APICS.

3.2. Purchase Field

[9] Industrial companies spend about 50% of their sales in the materials purchase.

The four objectives of purchase are:

1. obtaining the items in required quantities and qualities
2. getting the items at a lower cost
3. ensuring the best customer service and immediate delivery from supplier
4. developing and maintaining good relationship with supplier

There are seven steps to consider in the purchase circuit:

1. receiving and reviewing purchase requisitions: the purchase requisition must contain at least the following information: author identity, signed approval, account in which the cost is assigned, material specification, quantity and unit of measure, place and date of delivery...

2. sourcing (request for quotation): after quotations receiving, the final choice is a compromise between technical and price factors
3. determining the right price: this step is closely related to step 2
4. launching the purchase order: once accepted by the supplier, it becomes a legal contract and is prepared from the purchase requisition and quotation; copies are then sent to accounting service, requesting service and reception
5. ensuring that delivery is honored
6. receiving and accepting the items with the documents: purchase order copy , bill of lading, receiving report
7. approving the invoice for payment by bringing the documents: purchase order, receiving report and invoice

3.3. Inventory Field

[9] Stocks are raw materials and supplies that a company keeps either for sale or as inputs into the production process. Stocks are important to an industrial company as they represent 20 to 60% of total asset in balance sheet.

According to the material flow, there are four classifications of stocks:

1. raw materials
2. work in process
3. finished goods - distribution inventories
4. MRO (Maintenance, Repair and Operational supplies)

Keep a stock is expensive and increases operating costs: we therefore need an inventory management.

Inventory management must establish decision rules about the stock items that the staff responsible for monitoring stock can do its job effectively. These rules are:

- what are the most important items
- how the items are controlled
- how to order each time
- when placing an order

Inventory management helps to decouple supply and demand; stocks provide a buffer in 4 areas:

- customer demand & finished goods
- finished goods & component availability
- needs of an operation & output of the previous operation
- parts and materials to begin production & suppliers of materials

Customer service is linked to the items availability when necessary and is an efficiency measure of inventory management. Inventory management helps to maximize customer service and to protect against uncertainty in demand and lead time that will cause customer dissatisfaction and shortage respectively.

3.4. Sale Field

[9] The purpose of a distribution system is to provide a required level of service at lower cost: give the customer what he wants and on time. To achieve this objective, all activities of this system must be organized into an integrated system:

1. transport represents 30 to 60% of the distribution cost
2. inventory distribution that represents 25 to 30% of the distribution cost and adds time value by placing the product close to the customer
3. warehouses that store distribution inventory
4. materials handling which is the set of storage movements of the products inside warehouses
5. packaging that identifies the product and contains / protects it against shock and heat
6. order processing and communications are a time element of delivery and an important part of customer service. Many intermediaries are involved in the movement of products which requires good communication

4. ERP Functionalities

4.1. Introduction

ERPs are widely implemented as the backbone of many manufacturing and service companies.

[5] Today's ERP solutions offer even more benefits. Many vendors have begun to enhance their offerings with extended supply chain applications in an effort to create a seamless, integrated information flow, from suppliers through manufacturing and distribution.

After consulting various technical and commercial documentations for different ERP vendors [10,11,12,13,14,15,16], we have identified the main functionalities offered to support the purchase, inventory and sale processes.

4.2. Purchase Process

The ERPs cover completely the purchasing process: the request for quotation, purchase requisition, purchase order, signatures circuit, receipt and invoices checking.

They offer various analysis tools which allow monitoring exchanges with suppliers to meet the main objectives of purchasing departments in terms of quality assurance, respect of deadlines and purchase cost.

The accounting integration proposed by default by ERPs helps to activate the budgetary control starting from the management of purchase requisition and order.

The main functionalities are:

Supplier File:

- Multi-address
- Contact management
- Recent operations consultation
- Supplier prices consultation
- Supplier relaunching for undelivered orders on expected items

Tariff:

- Tariff structure customized by supplier
- Tariff management by currency, by coefficient, by quantity or by configurable formula
- Inter-company tariffs
- Tariffs by date intervals
- Tariffs simulation
- Supplier catalog import

Inter-site:

Management of logistics flows between sites:

- Inter-site shipping
- Inter-site receipt

Commercial document:

Customizable purchasing cycle:

- Request for quotation / purchase requisition / purchase order
- Purchase requisition / request for quotation / purchase order
- Request for quotation / order
- Purchase order / invoice

- Purchase order / receipt / invoice
- Purchase order / invoice / receipt

Request for quotation:

This function allows you to enter information such definition of needs, limit date of response, indicative price... and send it to a selection of suppliers. A responses processing function allows recording data from the supplier to automatically generate the supplier tariffs.

Their main functionalities are:

- Requisitions management: multi-item and multi-supplier
- Quotations comparison
- Responses and relaunching

Purchase requisition:

This function allows managing the needs in terms of purchasing performed by company's different services. Each requisition can have multiple lines for different required items.

Their main functionalities are:

- Purchase requisitions entering / editing
- Requests for general or commercial purchasing
- Taking into account the replenishment suggestions
- Taking into account the request for quotations

Purchase order:

Purchase orders can be processed in two different ways:

- via a punctual order
- or through a contract (open order) with a delivery schedule

When entering a new order, we should inform the supplier. Elements of order header are fed through the supplier file and modifiable for some.

If a tariff file is set for the ordered item then the line will be valued automatically, otherwise, the unit price is to be filled.

Their main functionalities are:

- Purchase orders entering / editing with delivery schedule
- Orders for general or commercial purchasing
- Taking into account the replenishment suggestions, purchase requisitions

Contract:

Contract management can record, over a period, a contract with a supplier for the raw materials delivery.

We define a global contract, item, quantity and price. This order has a provisional status. The real needs are registered in the function "request for delivery" and follow the same logic as the firm purchase orders entering.

Receipt:

This function is used to enter receipt of purchase orders and integrate them in received goods stock.

It also allows, for a given site and a given supplier, receiving a set of orders totally or partly.

Their main functionalities are:

- Direct receipt
- Indirect receipt

Return:

- Returns creation by selecting receipt lines
- Direct entry
- Re-integration of returned quantities to order

4.3. Inventory Process

Inventory management is common to sales, purchasing and production functions, ensuring optimum consistency

and monitoring the stock status in real time. It is also fully customizable to each site through a multi-site management. Finally, the stock module provides powerful functions of quality control and allows through material flow management full inventory traceability in real time upstream and downstream.

The main functionalities are:

Item File:

- Item description management
- Negative stock management
- Batch number management
- Serial number management
- Quality management
- Units of measure management:
 - Packaging units with conversion factors fixed or variable
 - Commercial units (sales, purchases)

Multi-site:

- Management of transfer orders between sites
- Inter-site replenishment

Multi-location:

- Locations structure definition
- Fixed or random storage
- Policy for allocating locations
- Policy for releasing locations

Inventory movement:

- Receipt movements
- Issue movements
- Internal movements, assembly, disassembly
- Preparation and delivery
- Customers and suppliers return
- Inventories
- Inter-site Movements

Inventory management:

- Physical inventories
- Inventories sessions management per location, per item

Replenishment management:

- Economic quantities
- Reorder points
- Stock security

4.4. Sale Process

Sales management allows tracking all information about customers or prospects and managing the monitoring of their objectives and commissioning. At a glance, it gives information about the items, prices, discounts. It allows:

- Issuing quotations
- Recording orders and issuing acceptance of orders receipt
- Managing contracts
- Viewing and allocating inventory
- Managing shipping before billing

Commercial activities management allows monitoring the commercial prospecting activity. This monitoring is characterized by the identification of new prospects and management of incoming / outgoing calls, tasks and appointments.

The main functionalities are:

Customer File:

- Multi-address, multi-delivery point
- Contact management
- Multi-type and multi-term payment methods
- Commercial and financial monitoring
- Recent operations consultation
- Customer tariffs consultation

Tariffs:

The tariff notion is to be understood as commercial conditions applicable according to criteria.

Their main functionalities are:

- Configurable and multi-criteria tariffs
- Tariffs management by currency, by coefficient, by quantity or by configurable formula
- Inter-company tariffs
- Tariffs by date intervals

- Tariffs simulation
- Applied prices and discounts archiving
- Tariff catalog
- Tariff revision
- Tariffs import

Commercial document:

Customizable sales cycle:

- Quotation / order / invoice
- Order / invoice
- Quotation / order / delivery / invoice
- Order / delivery / invoice
- Delivery / invoice

Quotation:

Quotations management allows managing the bids or quotations that you want to send to clients or prospects. Therefore, this management can create, edit, delete, duplicate, display, print quotations. It is possible at any time to value a quotation and generate an invoice like a Pro Forma invoice.

Their main functionalities are:

- Quotations entering / editing for customers or prospects
- Delivery address, shipping site, delivery date
- Applied prices querying / justification
- Validity dates monitoring
- Pro Forma invoices calculation / edition

Order:

Orders management enables you to manage orders placed by customers. This management allows monitoring and editing orders acknowledgments. Orders can be of different types:

- Normal orders which are delivered and invoiced
- Direct billing orders which are not delivered but are billed directly

- Lending orders which are delivered, not invoiced, but subject to a loan return
- Open orders (or contracts) that allow customers to make commitments on one or more items, for a given period, and with specific tariff conditions. These orders are then broken down into delivery calls

Their main functionalities are:

- Orders entering / editing for customers and prospects with automatic conversion of prospects into customers
- Applied prices querying / justification
- Quotation transformation totally or partly

Allocation:

Allocation management allows automatically to book items for which orders have been recorded previously. An allocation may be global or detailed:

- Global, this is a stock reservation without identifying the batch number or location
- Detailed, this is a reservation that specifies stock location, batch number, status

It can be performed at different stages:

- Before ordering, and in this case, the allocation shall be global
- When entering the order if the manual allocation is possible either globally or detailed as selected in the settings

After ordering and in this case two functions can be used:

- Automatic allocation, to make the reservation of a series of orders and articles
- Manual allocation, to make the reservation of any kind of order or to change allocations made previously.

Their main functionalities are:

- Customer reservation with deadlines
- Stock allocation manually or automatically with configurable criteria
- Global or detailed allocation
- Shortages management
- Allocation consultation

Logistics:

Delivery management can track shipping and preparations of customer orders. For this delivery, a packing list may be attached. It is possible at all times to value delivery and generate an invoice of Pro Forma type.

Their main functionalities are:

- List of items to be delivered
- Total or partial shipping
- Direct delivery of materials to a subcontractor
- Management of transporters and related costs
- Management of customer returns with or without quality control

Commercial kit:

Commercial kits are used in order entering. And to sell a commercial kit, it is possible to detail the components of this kit.

It is also possible to manage options and variation for kits in specifying the component type. This may take the following values:

- Normal: component is part of the kit without functionality
- Optional: the component is not mandatory, and may be selected from a list of possible components
- Variation: the component is required and can be chosen from a list of possible components

Return:

This functionality allows you to manage product returns from customers:

- Customers returns due to a dispute with the customer
- Returns for lent or on hire merchandise

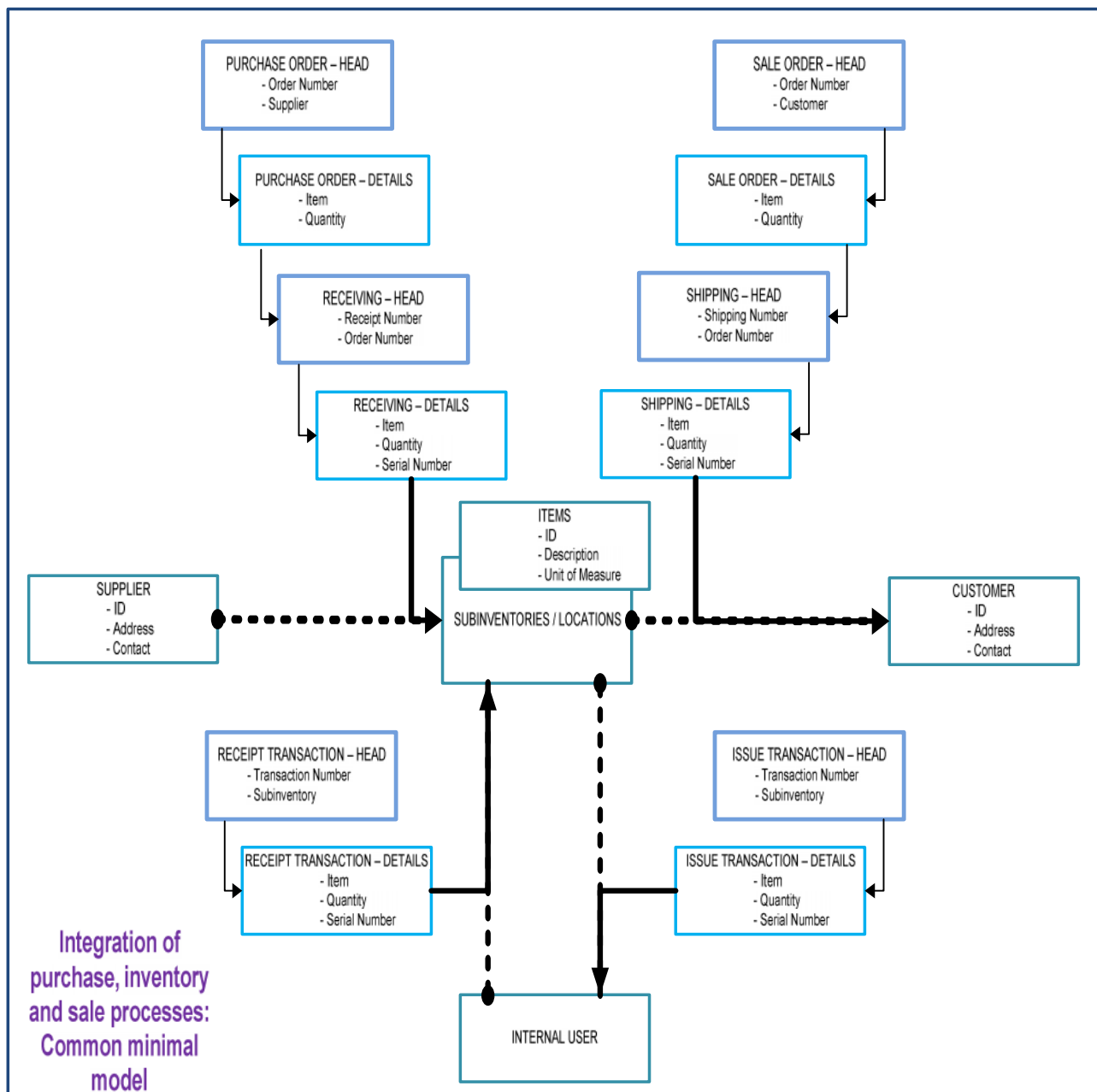
The administration of these returns resets the returned goods in stock.

5. Common Minimal Model

It is judicious to follow a standard way to model company information: organizations can save time and money by using common or universal database structures [17].

After handling the data models of the most-known ERPs, we have noticed that ERPs base on the same basic model to implement the supply chain management.

In this section, we propose a common minimal model (indicated as below) on which ERPs rely to implement the purchase, inventory and sale processes:



The elements contained in the above model can be classified by two categories:

- category "Referential": item, supplier and customer files and the list of subinventories / locations are the basic referentials shared by all modules of the ERP
- category "Transactional": two types of transactions can be identified:
 - o transactions of request type such as purchase orders and sale orders
 - o transactions of execution type such as receipt / issue transactions and receiving / shipping transactions knowing that the last are closely related to transactions of request type and inherit all the required information

6. Conclusion

In relation to the integration of purchase, inventory and sale processes, the concept of ERP has been decorticated in this paper according to the following 5 areas:

1. "Competition" area: ERP is henceforth an indispensable tool that allows companies to be more flexible and responsive in the 21st century global market
2. "Technology" area: it is obvious that the technological evolutions (computing speed, network technologies, databases management systems, data storage) have contributed predominantly to the success of ERP
3. "Business" area: due to the complexities of most ERP systems, most ERP vendors have included "best practice" (as dictated by standards) into their software in order to adapt to various activity sectors in standard [7]
4. "Commercial" area: often companies that have implemented an ERP exploit only a small part of the offered functionalities
5. "Implementation/Modeling" area: ERPs are based on a single database to model business processes and use the same model to implement especially the purchase, inventory and sale processes

In some especial cases, the data model of ERP might seem inadequate to integrate specificities in standard, and then we could be constrained to develop specifics whose development and maintenance cost is very expensive. As these specifics are unsupported by ERP editors, ERPs

should often be customized by functional actors rather than being modified by technical actors.

In order to allow the ERP to broaden its functional coverage, this basic model presented in this paper might provide a good starting point for guiding optimally the model evolution: instead of distorting the common minimal model, it is recommended to expand it to add a new specificity uncovered in standard.

References

- [1] Information systems in supply chain integration and management – A. Gunasekaran, E.W.T. Ngai in *European Journal of Operational Research* 159 (2004) 269–295
- [2] *Management Misinformation Systems* – Ackoff Russel, Management Science, 14, 1967
- [3] *Information Systems and Organizations Management, Systèmes d'Information et Management des Organisations* – R.REIX, Vuibert, 1988
- [4] *ERP: Tools, Techniques, and Applications for Integrating the Supply Chain* – C. Ptak, E. Schragenheim. St. Lucie Press, Boca Raton, FL, 2000
- [5] Why are enterprise resource planning systems indispensable to supply chain management? – Yi-fen Su, Chyan Yang in *European Journal of Operational Research* 203 (2010) 81–94
- [6] Les progiciels intégrés et la G.R.H. Quand l'ambiguïté des enjeux est fonctionnelle , ERP and HR Management. When the ambiguity of the issues is functional – P. GILBERT et D. GONZALEZ, in *Gérer & Comprendre* , n° 59, mars 2000, pp. 26-34
- [7] *Practical Studies In E-Governance: An Empirical Exploration Of Enterprise Resource Planning* – JD Thomson in *International Review of Business Research Papers* Vol.6, No.1 February 2010, Pp.432-466
- [8] *Designing and managing the supply chain: Concepts, strategies, and cases.* – Simchi-Levi, D., Kaminsky, P., & Simchi-Levi, E. (1999). McGraw-Hill
- [9] *Introduction to Materials Management* – J .R. Tony Arnold, Stephen N. Chapman
- [10] SC001 - Description of Standard Solution, Descriptif de la Solution Standard – Sage ERP X3 Standard Edition
- [11] *Oracle Purchasing User's Guide*
- [12] *Oracle Inventory User's Guide*
- [13] *Oracle Order Management User's Guide*
- [14] *Reference Manual - Purchase Management, Manuel de Référence - Gestion des achats – JDEdwards*
- [15] *Reference Manual - Inventory Management, Manuel de Référence - Gestion des stocks– JDEdwards*
- [16] *Reference Manual - Sale Management, Manuel de Référence - Gestion des commandes clients– JDEdwards*
- [17] *The data model, a library of universal data models for all enterprises* – Len Silverston