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**ΜΕ ΘΕΜΑ:**

**RFID Technology as an Innovative Tool for Effective Supply  
Chain Management in Greece**

**ΕΠΙΒΛΕΠΩΝ ΚΑΘΗΓΗΤΗΣ:**

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## **Abstract**

The latest trends of radio frequency identification (RFID) technology are gathered through literature review as far as supply chain management (SCM) area concerns. This thesis includes analysis, examination and exploration of a big variety of papers, publications and journals that are written for RFID technology in the area of SCM. The Greek environment area is the one that this thesis examines and explores. A collection of a huge number of case studies has been collected. The sources refer to a big number of publications in order to show the exact procedures that Greek industries and organisations follow for the adoption of RFID. Critical evaluation is one factor that authors paid attention to in order to examine the results of this specific technology and also the impact that the technology has to business flows and procedures.

The combination of literature review and Methodology helped us to examine three different systems in order for Greek businesses gain efficiency, effectiveness and competitive advantage through the Supply Chain Management area. These three systems are the “RFID technology system, Education system and Business Strategy” (Peppas et al., 2015). In-depth interviews in organizations operating in Greece took place through different industries in order to measure the value added in today’s organizations. We presented the offer of RFID systems to Greek organisations through specific indicators from the three above systems. Interviews also helped us to show the real value of RFID systems. We also presented the percentage that this value will offer to Greek students from the Higher Education System and how this system can give to the students the literature and experience for innovative technologies. At last we showed the level of Greek businesses to adopt innovative technologies such as RFID and what specific procedures they have to change or update. Critical evaluation also took place in order to examine the disadvantages or the drawbacks from the collaboration of their systems.

Furthermore, we developed the PEST (Political, Economic, Social, and Technological) analysis diagram concerning RFID (Radio Frequency Identification) technology in the area of supply chain management in Greece. Previous literature has shown the level of value by using RFID Technology in the supply chain management. RFID technology can lead to companies’ improvement, competitive advantage and effectiveness. Implementing such innovative technology can affect the way of conducting businesses and reorganize the whole supply chain. RFID can help Greek

businesses to allocate Supply Chain Innovation and Supply Chain process improvement.

We contributed to the knowledge of the following areas: (1) Creation of PEST analysis diagram of RFID technology in supply chain management in Greece, the lessons learned the reflection of the results, and the future use from the whole research, (2) Proposal of a new business model that will lead to Supply Chain Innovation, (3) Directions for further research.

Apart from the PEST Analysis, we continued the research by examining the Balanced Scorecard Model as far as the adoption of Radio Frequency Identification (RFID) Technology concerns in the Supply Chain Management (SCM) area in Greece. The Balanced Scorecard Model can help enterprises operating in Greece to examine specific variables in order to use RFID Technology at the right time and at the right place. This implementation and adoption can lead enterprises to get over the economic crisis and, therefore, become strong market leaders. Balanced Scorecard will be used by companies as a guide of measurement and managers can have a clear picture of their vision and mission of their companies.

This thesis contributed to the knowledge of the following areas: (1) Analysis of the Balanced Scorecard Model of RFID Technology in SCM in Greece, the reflection of the results and lessons learned, (2) Proposals for gaining competitive advantage by creating a unique Balanced Scorecard Model combined with Project Management Perspectives.



# Chapter 1

## 1. Introduction

Businesses face a great push from global competition and companies and industries need to make use from efficient production systems in the area of Supply Chain Management. Application packages or Modules (ERP, SCM, CRM, etc.) are used by most businesses in order to fully automate their business flows and gain competitive advantage to the Market. Customers also pay a significant role to this use because of the customer demand. If businesses use such application packages for customer demand then they become strong market players globally. Supply Chain Management Procedures (Inventory, Production Planning, Shop-Floor Scheduling, etc.) need to use huge information and data and these have to be accurate and safe. If companies can achieve this, competition will grow globally and also companies will get pressure from the global market in order to satisfy their customers, make loyal customers (Hsu, 2005). Manufactures need to use enterprise resource planning (ERP) systems. Therefore, manufacturers can prepare correctly their manufacturing assets and they can control their customers with visibility. Manufacturing assets will then become effective and efficient. Furthermore, manufacturers need to manage their internal business processes so the ERP system can become an opportunity to gain the competitive advantage while obtaining the internal business flows.

The application package of Enterprise resource planning (ERP) is a software system that integrates most of internal business flows of every business. This helps businesses to use the best management and industry practices. ERP software system can be used for the increase of profits, operations, efficiency and effectiveness. Information services will then work on an automated mode. ERP software system has been used by many industries. Manufacturing, insurance, aerospace – defense, retail, capital intensive industries, telecommunications, construction, pharmaceuticals, education, finance, etc., ERP system is a strong and reliable system and migration tool that has a standard software, reputation, integration capability, , three-tier client/server architecture and it is selected worldwide. (Chung and Snyder, 2000).Supply chain management procedure includes businesses and individual contributors from the level of the creation of the product to finished merchandise. From the other hand, logistics is a specialized field of its own that comprises of shipping, warehousing, courier services, road/rail transportation and air freight. Nowadays, most retail companies need to control the quality of the product, control the inventory levels the time and

expenses. One way to control this is to get involved into the automated supply chain area. Such businesses deal with contributors from foreign countries that require a level of involvement with politics, laws (trade & traffic), public relationships and quality control standards. Supply Chain management examples can be found in transportation, manufacturing, design, farming, refining, packaging, etc.

SCM can be viewed as the allocation of the operations of logistics from businesses in the value chain (Tan. et.al, 1998). Supply chain management focuses in shortening and consolidating the supplier base in order to promote and manage supplier relationships (Krause, 1997), evolving and growing strategic alliances with all suppliers (Copacino 1996; Mason 1996), functioning and running with suppliers in order to focus on expectations and demand (Copacino 1996), and linking suppliers at the beginning of product development process and appoint of their capabilities and competence (Monczka et.al, 1994; Ragatz et.al, 1997). From the supply point of view, the development of supplier (Scanell et.al, 2000), the partnerships of suppliers (Groves and Valsamakis 1998; Scanell et.al, 2000), the involvement of suppliers (Vonderembse and Tracey, 1999), and strategic sourcing (Narasimhan and Jayaram, 1998) all positively conclusive the transaction firm's operational work of performance. The partnerships of suppliers (Tan et.al, 1998), the development of suppliers (Curkovic et.al, 2000), and the flexibility of supply chain (Vickery et.al, 1999), have a strong impact of buying the best of business performance.

RFID technology is an innovative technology that can be found in Supply Chain Management Applications. Most companies are now using RFID technology in order to automate internal and external procedures such as tracking cases, pallets, inventory items, equipment, etc. The technology of RFID helps businesses to make information acquisition more quickly. RFID can provide a huge amount of information storage and speeds up all business procedures. Applications of RFID focus on specific areas such as in creating process transparency (Kemppainen and Vepsalainen, 2003). All of the applications were stimulated while the cost was high from the first-generation equipment and banned a larger-scale industrial roll-out.

Data should have been traced and tracked from tagged objects in the supply chain by the competition before sales in order to gain intelligence (Garfinkel et al, 2005).

After the sales trace and track needs to be done for customer privacy issues. Packages hide the tags inside (Ayoade, 2006). At last, RFID tags return to cross-examination

request from all readers. Then, data are allowed to be gathered by externals to the company (Juels, 2006).

## **1.1 Aims & Research Objectives**

The importance of Supply and Production systems through the Supply Chain Management area can be actually seen from the huge number of articles and books though the literature. Such systems edge of companies' competitive advantage, intelligence and efficiency in the Global Marketplace. Such systems implement and affect the way of conducting businesses and also coordinate the whole supply chain management area. Therefore, the importance of such systems needs to be understood and examined by those involved through the supply chain area.

Top Management, Middle Level and Operational Level in every company need to get involved in every stage of business procedures in order for the company to become competitive and effective.

This thesis will contribute to the knowledge of the following areas:

- Analysis of the operations of the Greek Market
- Focus on Business Strategy & RFID Systems
- The use of the RFID Systems in Greece
- The benefits of three different systems in Greek area
- The encouragement in Greek businesses for implementation of these systems
- The creation of PEST analysis diagram of RFID technology in supply chain management in Greece
- Reflection of the results, lessons learned
- Proposal of a new business model that will lead to Supply Chain Innovation
- Analysis of the Balanced Scorecard Model of RFID Technology in SCM in Greece
- Reflection of the results and lessons learned
- Proposals for gaining competitive advantage
- Creation of a unique Balanced Scorecard Model combined with Project Management Perspectives.

## 1.2 Thesis Layout

*Chapter 1* introduces basic meanings of Supply Chain Management and Radio Frequency identification technology features. Research aims and objectives and show the importance and the contribution to the knowledge of specific areas.

*Chapter 2* presents an overview of Supply Chain Management area. Supply Chain decisions are also introduced and presented to show the competitive strategy. Proceedings presented based on the push/pull form.

*Chapter 3* reports issues of the Supply Chain Management strategy and the Decision Making Process. Five Core disciplines are presented according to many authors through the literature. Decision Making Models from the literature are also presented over the last decade.

*Chapter 4* discusses the applications of Information Systems and Technology to the Supply Chain Management area. Innovations on the Supply Chain Management area are also presented.

*Chapter 5* introduces the innovative technology of RFID (Radio Frequency Identification). We present RFID components, tags and readers briefly. A few examples presented of the use of RFID applications in real life.

*Chapter 6* combines the RFID technology on the Supply Chain Management area. We collected data over the last decade on a big variety of research papers written on RFID in SCM and more specifically in Greece.

*Chapter 7* delves into the methodology of this thesis. Different case studies developed from different industries in Greece. We present the data collected from the quantitative research and evaluate the results. SWOT analysis applied on RFID technology in Greece as well as PEST analysis and Balanced Scorecard Model.

*Chapter 8* critically evaluates the results that were discovered through the research by creating tables and figures on results statistics. Three new and innovative models are presented that evidence the importance of RFID in SCM area in Greece as well as prove that if Greek Businesses follow such models will get over the economic crisis.

*Chapter 9* summarizes the conclusions from the research.

# LITERATURE REVIEW

## Chapter 2

### 2. Supply Chain Management: An overview

The area of SCM, according to Monczka et al. (1994), is a concept “whose primary objective is to integrate and manage the sourcing, flow, and control of materials using a total systems perspective across multiple functions and multiple tiers of suppliers”. “The SCM defined as a process which includes a number of various business entities (i.e., suppliers, manufacturers, distributors and retailers) in order to achieve the delivery of final products to the customer”, (La Londe and Masters, 1994). Moreover, Cooper et al. (1997) “argued that the Supply Chain Management is a philosophy in order to manage the total flow of a distribution channel from supplier to the final user – consumer. A lot of definitions exist for Supply Chain Management through the last decade”.

Cooper et al. (1993) defined supply chain management as follows:

*“Supply Chain management is a set of approaches utilised to efficiently 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 minimise system wide costs while satisfying service level requirements”.*

Lee and Billington (1995), have a similar definition:

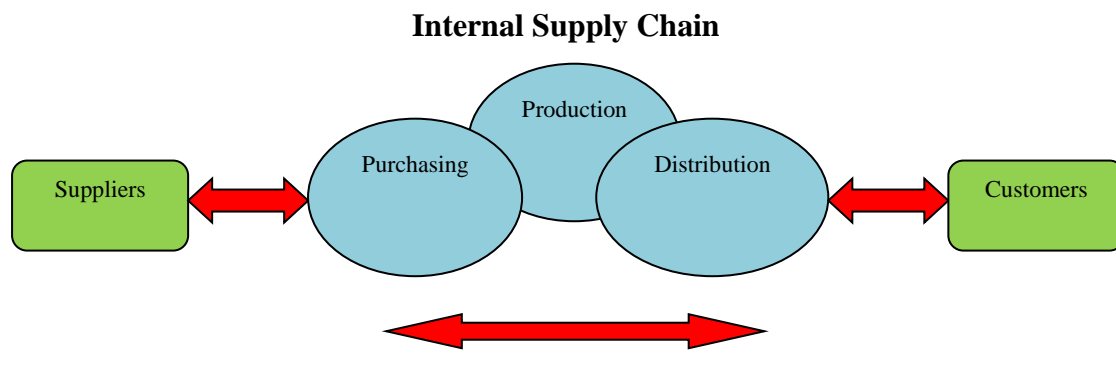
*“A supply chain is a network of facilities that procures raw materials, transforms them into intermediate goods and then final products, and delivers the products to customers through a distribution system”.*

Ganeshan and Harrison (1995) gave the following definition:

*“A supply chain is a network of facilities and distribution options that performs the functions of procurement of materials, transformation of these materials into intermediate and finished products, and the distribution of these finished products to customers”.*

La Londe (1997) defines supply-chain management as follows: *“The delivery of enhanced customer and economic value through synchronized management of the flow of physical goods and associated information from sourcing to consumption”.*

Figure 1 presents the integration and the connection between company, suppliers and the customer. All the above are part from the supply chain management area.



**Figure 1: Company's Supply Chain.**

SCM area, access a huge recognition in 2000 while Croom presents all the lines of transport and physical distribution that were based on the theory of Industrial Dynamics in Forrester. In order for an SCM to become successful it needs specific activities that influence the procedures of a company. According to Cooper et al. (1997) it is mandatory for every business to maintain its competitive advantage by sharing information through the supply chain stakeholders. Moreover, another action that will satisfy the assumptions of an effective SCM is the risk sharing and the bonuses or returns between the stakeholders of the supply chain (Cooper and Ellram, 1993). Additionally, the participation between the stakeholders is very critical and it is fundamental to be presented in every level of each business (Cooper et al. 1993). Another activity that impacts the flows and the results of the business is the common goal and the same focus on serving customers demand (La Londe and Masters, 1994). La Londe (1997) argues that the correct management of a business supply chain creates loyal and satisfied customers and, as result, assist its competitive advantage in the global market place. Cooper and Ellram (1993) compared supply chain management as a strong practice relay and balanced member's team. They pointed that the relationships are stronger between the players that pass the baton directly.

The stages that a supply chain area consists include the suppliers' raw materials, the manufacturers, the distributors, the retailers and finally the end customers.



**Figure 2: Supply Chain Components**

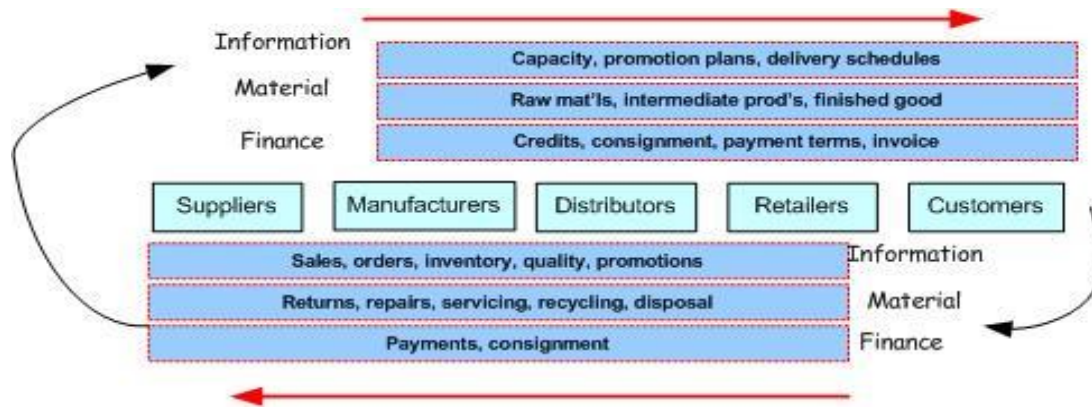
The representation above of the Supply Chain shows that every stage can consist of more than one participant. The supplier can obtain and supply raw materials by many providers, or there can also be many retailers that sell the end product to the customer. Most of the Supply Chains look like networks. For example, a lot of suppliers exist across the supply chain. These suppliers provide raw materials to manufacturers in order to make and prepare the final product. Manufacturers will then send the finalized products to the distributors in order to warehouse and distribute the products to several retailers. Retailers will sell the products to the end customers.

The use of the term **Supply Network** or **Supply Web** is more accurate when we want to present the design and format of the most of the Supply Chains. Therefore, when more than two organizations are directly linked by more than one flow, such as products, services, finances, and information that reveals from customers, then a supply chain is created.

All of the above stages are not necessary in every Supply Chain. The modulation of a chain bank on two aspects: the customer's needs and the role that every involving stage plays in the accomplishment of these needs. Many authors use the example of Dell Company in order to show that the stages showed above are not always the mandatory ones. The Supply Chain of a car retailer for example, consists of all the above stages, but Dell Company makes a computer after customers demand.

Generally the Supply Chain consists of all these functions that take part in the satisfaction of the customer's needs, such as new product making, production, sales delivery and customer's servicing. Zigiari (2000) states that managers recognize that if a company gets the products to the customers faster than the competitors, this will improve the company's competitive point of area and gain a competitive advantage.

The Supply Chain has a dynamic character, and presents steady information, money and product flow between its stages. Figure 3 represent the flows of supply chain management.



**Figure3:** Supply Chain Management Process Flow (Anand, 2008)

The main reason of the existence of Supply Chain is, first the satisfaction of a customer's needs and, secondly, the maximization of the total value that is being produced. The value that it is produced is the difference between the difference of what the final product is worth and the achievement that the Supply Chain makes in order to satisfy the customer's needs. For the most of the commercial Supply Chains, the value is closely associated to the **Supply Chain Profitability**, that is defined as the difference of change between the profits made by the customer and the total cost along the whole chain. The efficiency of the Supply Chain is the total profit that is being shared between the chain stages. The bigger the profit, the more successful the Supply Chain is. The success of the Supply Chain should have to do with the efficiency and not with the profits in one of its stages.

The flows of the Supply Chain produce cost and their effective management leads to the success of the Supply Chain. As a result of this, the aim of Supply Chain management is the effective management of the flows between the stages of the Supply Chain, in order to maximize the total profit.

Consequently, Supply Chain Management can be represented as the relationships and links that have been obtained through organizations and result the customers satisfaction.

Supply Chain Management is the repeated planning, developing, controlling, informing and monitoring of behaviors within and between the links of supply chain so that an integrated supply process results that accommodates all strategic goals through the chain.

The Supply Chain management is supported by:

- **Processes:** which include/contain added value activities, such as new product supply management, the knowledge management and the development management?
- **Organizational structures:** include a number of relationships, performance measurement and schemes of reward.
- **Capable technologies:** contain information processes and information technologies.



The Supply Chain performs two functions. a) **Physical functions** of modification, storage and transfer and b) **market mediation** function, whose aim is the match between supply and demand. Every single function has its own cost. Physical function includes the production procedure, the transfer of information and the storage cost. In the mediation function the cost increases when the offer increase, so the product has to be sold in a low price, or even with no profit at all. Also when there is a low offer of good and services conclude to the loss of sales and disappointed customers.

The main procedures that take places during the operation of a Supply chain system are:

- Product transportation and distribution
- Reserves Management

The process of all orders which have being made and other supplementary functions are:

- Warehousing
- Materials Handling
- Protective Packaging
- Acquisition
- Information Maintenance

## **2.1 Categories of Supply Chain Decisions**

For the successful management of Supply Chain flows, three kinds of decisions are demanded. The competitive strategy of a business can be defined as the offer of services and products by the organisation in order to satisfy all the customers' needs.

Many studies on the supply chain management area exist in order to indicate the importance of coordination among partners to improve the performance (Chen et al., 2012). Some other studies have adopted models such as cooperative game theory that appears to be a natural framework (Nagarajan and Sobic, 2008). The Intel Corporation produced internally its new 855 chipset for Centrino mobile technology and asserted that no third-party chipset manufacturers would be granted the licensing agreement to manufacture compatible devices in the near future (Hung and Robertson, 2003).

The parameters for the categorization of these decisions are the decisions' time scene and the frequency that decisions made. These decision categories are the following:

**Strategic:** Long-drawn out decisions with an important cost that is really hard to change. In order for these decisions to be made, the organization has to bear in mind all those temperamental factors that intervene, affect and form the market circumstances.

These decisions have to do with the location of production and storage plant, the productive capability, the products themselves, the ways that these products are transferred and the informative systems that are about to be used.

The strategic decisions draw the Supply Chain structure and determine the activities taking place in each stage.

A lot of studies of supply chain management spotlight on the practices of big organisations, while smaller ones are treated mostly from the viewpoint of larger organisations (Chopra and Meindl, 2001; Kukalis, 1989; Lambert and Cooper, 2000). As far as SME's strategic decisions, Wang and Fergusson (2007) pointed that:

- A SME's role in a supply chain could be as a supplier, a component manufacturer, a service provider and a distributor (Hong and Jeong, 2006)
- A SME should have an effective and efficient business/operations strategy
- SME owns limited resources
- A model as a virtual strategic expert group is a tool – applying case-based reasoning methodology

**Planning:** Decisions of medium-term character that move within the bounds and limit have been settled by the strategic decisions. The decisions being made during the phase of programming concern the demand and supply predictions for a specific period of time. The supplies/buys will be provisioned by which facilities is decided, product fund programming is made, issues that have to do with production subcontracting are determined, fund replacement politics are examined and alternative provision plants, in case of lack of funds, are specified. During the phase of programming and for the time horizon of the specific decisions, the company has to bear in mind factors such as the demand uncertainty, the parity of exchange and the competition.

**Operational:** These are short-lived decisions that have to do with the clients' orders. These decisions also concern the clients' order commitment to the fund or the production, the creation of the product list of the order, the sending-date specification, the way of sending, the way of sending-programming and the fund replacement.

Because of the short-lived horizon of these decisions, there is often a diminished uncertainty that regards information having to do with demand. The aim of operational decisions is to take advantage of the diminished uncertainty and the progress improvement, within the limits that have been specified by the two foregoing decisions.

## 2.2 Representation of Supply Chain Proceedings

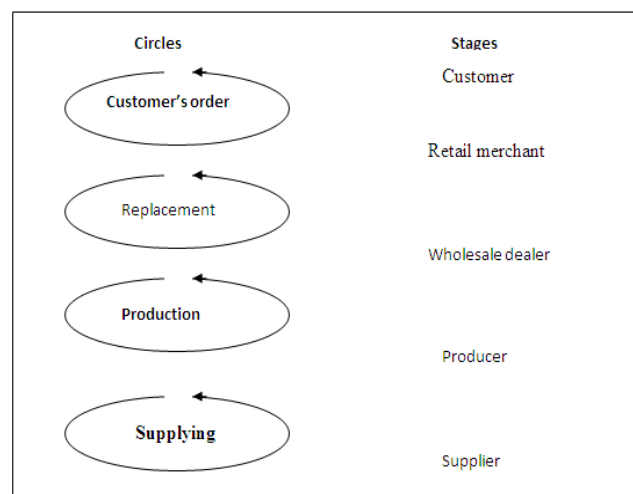
The Supply Chain proceedings can be represented by the form of **circles** that take place on the two-way communication contact between two continuous stages of the chain or with the **Push/Pull** form. With the **Push** term, we characterize the proceedings that set out from the customer while with the **Pull** term we characterize the proceedings that set out from the client's order prediction.

### Circular proceeding representation

The circle proceedings that appear between the stages of the Supply Chain are:

- Customer's order circle
- Replacement circle
- Production circle
- Supplying circle

The proceeding circles that take place are cohesion of the Supply Chain structure.



**Figure4:** Supply Chain Proceeding Circles

This representation structure gives us a full and clear image of the roles and responsibilities of each member of the chain.

### Customer's order circle

The circle focuses on the two-way communication between the retail merchant and the customer. This circle includes all those proceedings executed during the customer's receiving and the transaction.

The circle begins with the customer arrival to the retail merchant, goes on with the order introduction, its transaction and finally it's receiving by the customer.

The objectives of the first three proceedings of the circle are the conversion of the customer's arrivals to orders, the fast and accurate order transmission to all the affected proceedings of the chain and the order receiving by the customers on the agreed dates at the minimum possible cost.

### **Replacement circle**

This circle begins with the performance of the last circle's proceedings, where the need of the product replacement depends heavily on two-way communication between the retail merchant and the wholesale dealer. This circle consists of proceedings like: order activation, order import, processing and order receiving.

The objectives of these circle proceedings are: the increase of the profit through the product availability balance, the accurate transfer of the order to all the affected circle proceedings, the prompt and with the minimum possible cost processing, the stock updating and the accurate and prompt product display with the minimum cost.

### **Production circle**

The production circle is centered upon the two-way communication between producer-wholesale dealers or even between the producer-retail merchant's. It includes all the proceedings that have to do with the wholesale dealer's or the retail merchant are supply replacement.

The proceedings that are included in this circle are: the order's arrival, the programming of the production timeline, the production itself, the dispatch of the order and its receiving.

The objectives of the first three circle proceedings are: the supply replacement after sales or its availability according to demand predictions, the analogy maximization of the orders made on time and with minimum possible cost, the dispatch of products on the agreed dates, with the right quality and with the minimum possible cost.

### **Supplying circle**

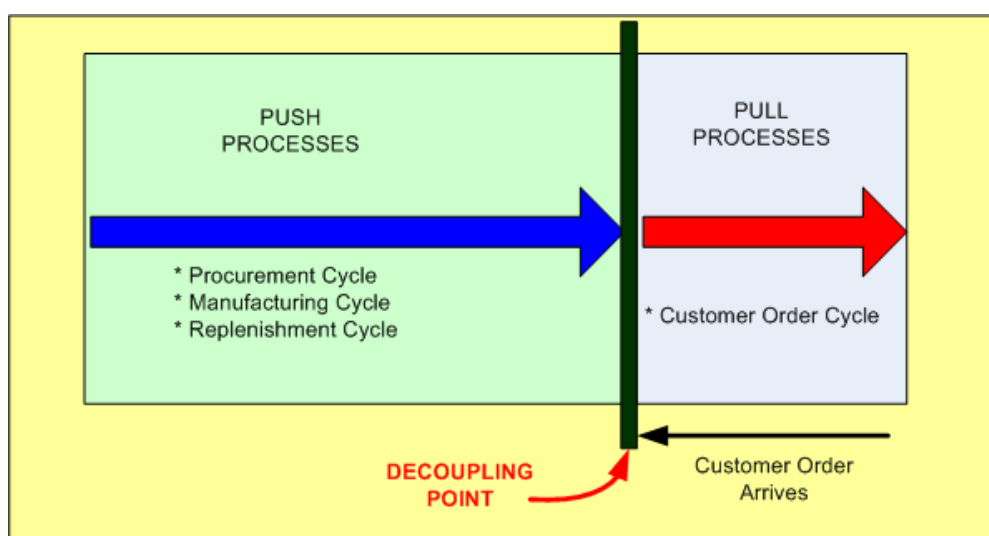
The supplying circle is centered upon the producer's and suppliers' two-way communication. The proceedings of this circle answer the following purpose: the replacement of the producer's production materials. One of the main features is that, while the wholesale dealer's and the retail merchants orders are activated by an uncertain demand, the orders of the materials can be determined from the exact point that the production plan has been determined. In this case the plan awareness would particularly help the producer, that most of the times turns to predictions, especially when the delivery time of the materials is high.

### **Push/pull representation**

The proceedings of Supply Chain can be branched into two categories: The **Push** category and the **Pull** category. Pull proceedings begin from the clients, as a response to their orders. Push proceedings are these proceedings that begin from the clients'

order prediction. Pull proceedings are characterized as reactive, and during their discharge the demand is noted. On the contrary, push proceedings are characterized as speculative, as they refer to a predicted and not an actual demand. The two proceeding categories appear simultaneously in the Supply Chain and are defined by a dividing line that defines the two proceeding types (Push/Pull boundary).

The two proceeding types are characterized from two elements. The pull-type proceedings are characterized from the certainty element because of the demand awareness, and the element of high trade responsiveness, so that the demand can be fulfilled on time. Push proceedings are characterized from the uncertainty element, due to lack of demand awareness, and the effectiveness element due to the better function programming.



**Figure5:** Push/Pull Procedures Representation

**Source:** *Management & Development Center, Supply Chain Integration*

What the Supply Chains attempt is to diminish the limit as much as possible, so that the width of pull proceedings increases, and by extension, the certainty grade increases too, which is rather difficult. At this point is where the success of Dell, which through its electronic supply Chain managed to decrease this limit, shows. As a result of the limit decrease, the “pressure” increases at that of the chain that is beneath it, due to the maximization of the correspondence grade.

The structure of this representation is useful when we study strategic decisions that have to do with the drawing of the Supply Chain, and we get the opportunity of a more spherical examination of the proceedings executed during the carrying out of the client’s order.

## **Chapter 3**

### **3. Supply Chain Management Strategy & Decision Making Process**

Business decisions and manufacturing decisions are developed by the central supply chain management group. For example, it may get on from a manufacturing standpoint to abandon an old, off-patent drug that takes up valuable space that should be better used for a more beneficial product scope.

The Supply Chain Management issue can be considered at separate and contrasting levels depending on tactical, strategic and operational variables convoluted in the decision making process (Fox et al., 2000). The level of strategy is based on decisions that have a long lasting effect on organizations (Kostin, et.al, 2011) that include the Supply Chain Management design problem.

Some other products are more beneficial than the bottom line reveal. If these products gain the degree of wisdom, this means that looking beyond the manufacturing function and procedure (Shoshanah and Roussel, 2005).

A supply chain administrator, acts as a connector between the product team and the supply chain, depicts and translates the plan into supply chain tactics and targets. By this way, extensively circulate manufacturing units around the world are maintained with fair objectives that align accurately with the global marketing strategy for each product.

Strategic supply chain management is more than just an innovation. Supply chain strategy as well as decision making process need to be analyzed and reviewed for the better performance and accuracy of the supply chain management area.

The decisions around these components indicate how they interact together in order to define the supply chain strategy.

Until now, companies tended to either address these components informally or make decisions about them in isolation, usually as a part of a functional strategy related to sales, purchasing, or manufacturing.

However, companies that view the supply chain as a strategic asset see their components as interdependent.

Christopher et al. (2006) addresses that supply chain management procedures are based on the relationships that manage to achieve a more beneficial and commercial result for all parties in the supply chain. Therefore, it delivers significant challenges

since there may be incidents when the narrow self-interest of one party has to be classified for the benefit of the whole supply chain.

Supply chain management, according to Christopher and Towill (2000), should be termed as “*demand chain management* to reflect the fact that the chain should be driven by the market and not by the suppliers”. Furthermore, the word ‘chain’ should be displaced by the word “*network*” since the existence of multiple suppliers and, certainly, suppliers to suppliers as well as variable customers and customers’ to be included in the whole system.

### **3.1 Applying the Five Core Disciplines for Strategic Supply Chain Management**

The five core disciplines of strategic supply chain management are based on plentiful years of hands-on maturity and background (Shoshanah, 2006). Those disciplines address a broad and all-inclusive management framework of the theory, perception and practices of supply chain management through the adoption of the techniques, knowledge and strategies basic and crucial to create added value and achieve competitive advantage from the supply chain.

According to Cohen and Roussel (2005), disciplines refer to the following concepts: “*View your supply chain as a strategic asset*”. When the supply chain strategy is unified with the product and marketing strategies, then product life cycle creates additional revenues, customer response is delivered quickly, and businesses can make operations with lower costs base than the competitors do. Forming strategic alliances with suppliers and customers allow manufacturers to focus on core activities of providing quality products and services (Kannan and Tan, 2004). Closer buyer–supplier relationships offer plentiful financial advantages, strategic advantages and technical advantages (Mohr and Spekman, 1994).

“*Develop an end-to-end process architecture*. Excellent supply chains leverage a tailored set of processes that are derived from the business strategy and are adapted as the strategy evolves”. Bullen and Rockart (1986) notes that the skill to dynamically accept and support supply chain increases end-to-end visibility and leads to greater flexibility.

*Design organization’s performance*. An organization should develop competitive supply chain by having all the skills required to manage complex and rapid changing supply chain. The findings of the study made by Arawati (2011), suggest that SCM

enhances product quality and has a confident and clear response on business performance.

*Build the right collaborative model.* The model should adapt the relationships of the organization with its partners. Commitments should be clear and strong enough of both sides for strong and long term relationships. According to Berger et al., (2004) and Ross (2000), each stakeholder in a collaborative supply chain plays a particular role.

*Use Metrics and Critical Success Factors for business benefit.* The correct set of metrics can add all the information about the correct process of supply chain process and identify complication areas on which to focus and target.

Bullen and Rockart (1986) defined CSFs as the “limited number of areas in which satisfactory results will ensure successful competitive performance for the individual, department, or organization. CSFs are the few key areas where ‘things must go right’ for the business to flourish and for the manager’s goals to be attained”.

According to Badiru (1998), “communication is a prerequisite for the cooperation of employees in the successful implementation of any project. The internet can reduce the problem of internal coordination by allowing both internal and remote employees to access current information when it is released”. The internet and information systems can be considered as an effective tool of communication in SCM area (Strader et al. 1998; McIvor et al. 2003)

### **3.2 Developing a Supply Chain Strategy**

The last decade organizations attempt a broad range of products and services in different types of non-coherent business environments. There have not been supply chain strategies that can be approved and supported to all types of products and market places. Instead, the supply chain strategy demands to be bespoke in order to match the exact characteristics of demand from a product, family product or market place (Christopher et al., 2006). Furthermore, “it is not enough to employ a traditional “one-size-fits-all” supply chains strategy that uses either a lean, agile or hybrid SC strategy when offering a wide range of products in various types of markets” (Hilletofth, 2008).



### **3.2.1 Understanding the Business Strategy**

The business strategy characterizes and represents of how a specific business or organisation try and aims to succeed in its chosen market place against its competitors. Moreover, it shows the best attack that the management can produce at controlling, monitoring and securing the future of the specific business. A business strategy should provide clear and fair answers to the questions asked (Buyukozkan et al. 2008):

What is the business scope to which this business strategy applies?

What are the ongoing, present and future needs of customers?

What are the extraordinary competences that will give to the business competitive advantage in meeting the needs for now and for the future?

What should be done in procedures and flows in order to secure the future of our business?

The business strategy purpose is to accomplish the capabilities of the business in order to gain and assist a competitive advantage in serving the customer needs in a specific marketplace area. An efficient and effective business strategy will provide loyal answers to questions on business scope, customers' needs, the exploitation of business advantages, and the achievement of the competitive advantage. Business strategy will also describe the main behaviors and actions that are necessary in order to put in action the proper strategy and the reasons of the necessity of changes.

Aligning IT strategy with business strategy has become a critical issue in most organizations (Adcock et al., 1993; Asato et al., 2009).

The strategic management theory, the typology of strategic orientation reflects and shows the central role of managerial influence (Thomas & Ramaswamy, 1996). One of the most well-established business strategy typologies is the three viable strategic types proposed by Miles and Snow (1984). They include prospector, defender and analyzer.

### **3.3 Decision Making Models for Supply Chain**

Over the last decade, organizations try to improve their competitive and aggressive environment and enterprises seek to take advantage of the opportunities appear in order to improve their performance.

Business processes need to be optimized for the growing recognition. The main reason for the creation of any supply chain is the selection of the business supply partner (Mikhailov, 2002), that is emulated in the growing research interest over the last decades. De Boer et al. (2001) made a research through the literature on supply partner decision-making represented beginning and exploring of the work done that classifies the methods of supplier selection through different stages of the supplier selection process. Another two literature review papers are also very interesting. Aissaoui et al. (2007) adopted De Boer et al. (2001) a framework of three-stages. They focused on the final stage of the selection process. Ho et al. (2010) reviewed and examined multi-criteria decision-making approaches used by the supplier evaluation and selection process.

Miles and Snow (1984) recognized the priority and concern of supply partners as firms progressively adopt vertically disaggregated forms. They described the “dynamic network” as a consolidation of different type of businesses, each one of them contributing of what they do as the best result on the whole network. The meaning of outsourcing was researched by Huang et al. (2004) that they gave priority to the concept of the virtual enterprise as an efficient and applicable solution to any problem as far as the global markets requirements concern. Businesses should then coordinate with their supply stakeholders and partners in order to integrate their internal and external business processes, as well as working together in order to achieve the necessary levels of sharpness and quickness throughout the entire supply chain.

De Boer et al. (2001) introduced the selection of supply chain partner process within three main stages, by introducing the “criteria formulation” and “qualification” phases. In these phases they identified the suitable partners that were selected from the “choice” stage which was the final selection from all qualified and suitable partners. Huang et al. (2004) suggested a selection framework that was based on a two-stage selection. This framework positioned on the differentiation between hard and soft levels that change and alter the process of the partner selection. The first stage labeled the potential candidates referred to partners that they can meet all

criteria needed. These criteria included the quality, price and time for the products or services that businesses need. The second stage referred on the assessment of their cooperation potential. Che (2010) also established a model that refers to a two-phase model. In the first phase, suppliers were bundled through their characteristics in order to meet customers' demands and needs. The first phase based on multiple dimensions of quality, time and cost. The second phase included a mathematical model with multi criteria. This mathematical model was the basis of the clusters introduced before.

The following figure presents a summary of studies that are based on the selection and formulation of partners' criteria in a chronological order Chou et al. (2007).

Researchers	Respondents/empirical cases	Measurement approach	Main evaluation criteria
Dulmin and Mininno (2003)	A mid-sized Italian public road and rail firm	The PROMETHEE approach	1. Make-up; 2. Processing time; 3. Prototyping time; 4. Quality system; 5. Co-design; 6. Technological levels
Lin and Chen (2004)	A international personal computer company	Fuzzy framework	1. Finance; 2. HR management; 3. Industrial characteristic; 4. Knowledge/technology management; 5. Marketing; 6. Organizational competitiveness; 7. Product development and logistics; 8. Relationship building and coordination
Wang et al. (2004)	A hypothetical car manufacturer producing various functional components	AHP (pairwise comparisons)	1. Delivery performance; 2. Fill rate; 3. Lead time; 4. Perfect order fulfilment; 5. Supply chain response time; 6. Production flexibility; 7. Total logistics management cost; 8. Value-added productivity; 10 warranty cost or returns processing cost; 11. Case-to-cash cycle time; 12. Inventory days of supply; 14 Asset turns
Lin et al. (2006)	A Taiwan based international IT products company	Fuzzy logic and aggregate fuzzy ratings and weights	1. Collaborative relationships; 2. Process integration; 3. Information integration; 4. Customer/marketing sensitivity
Xia and Wu (2007)	Literatures and numerical examples	AHP (pairwise comparisons)	1. Price; 2. Technical level; 3. Defects; 4. Reliability; 5. On-time delivery; 6. Supply capacity; 7. Repair turnaround time; 8. Warranty period
Kannan and Haq (2007)	A company southern India	Interpretive structural modeling	1. Quality; 2. Delivery; 3. Production capability; 4. Service; 5. Engineering/technical capability; 6. Business structure; 7. Price
van der Rhee et al. (2009)	200 respondents from Germany, the UK, Italy and France	Discrete choice analysis	1. Flexibility; 2. Cost; 3. Delivery; 4. Value-added support; 5. Value-added service
Wu and Barnes (2010)	Literatures and interviews with operations managers	Dempster-Shafer and optimization theory	1. General Hierarchy Criteria; 2. Industry-oriented Hierarchy Criteria; 3. Optimal Hierarchy Criteria

**Figure6:** Studies on Evaluation and Formulation Partner Selection Criteria (Wu & Barnes, 2011)

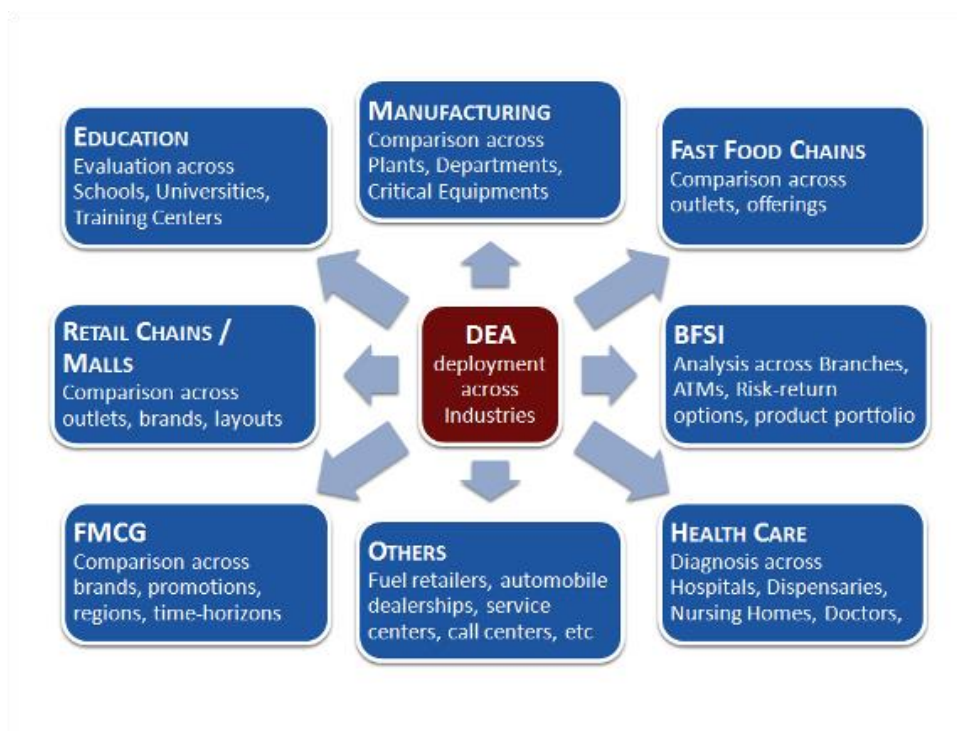
The formulation of criteria selection determines of the specific criteria that we have to follow and use through the decision making process. The most important criterion refers to the purchasing process. Purchasing process cost is the main factor of criteria selection. According to Aksoy and Ozturk 2011, the main categories of partner selection criteria conform to the priorities of competition that include the quality, cost, flexibility and delivery. Competitive performance and corporate strategy are very important to organizations as supply has a direct impact.

### 3.3.1 Decision Models for Qualification

Decision models for qualification refer to the minimal number of the supplies accepted (De Boer et al., 2001). This is because when reducing the number of suppliers it constructed a closer relationship with partners. The methods that Wu and Barnes (2011) introduced were:

#### *Data envelopment analysis models*

Data Envelopment Analysis (DEA) is a nonparametric access for generating the efficiency and effectiveness. It is a linear programming method that deals with the multiple inputs and multiple outputs without the weights that are pre assigned and without functional forms that impose on the relationships between the variables (Charnes et al. 1978).



**Figure 7:** Deployment of DEA across Various Industries (Beacon Analytics (P) Ltd, 2007)

The analysis of data envelopment is based on approach of the efficiency and effectiveness of a decision alternative process. Weber et al. (1991, 1998) analysed the DEA application through the selection of the partner. Wu and Blackhurst (2009) presented and pointed that selecting the proper suppliers will help businesses to gain an essential sector of effectively managing dynamic supply chains in each time. They presented a new methodology based on supplier evaluation and made an extension of DEA, which they called “augmented” DEA. This model had a lot of advantages as far

as weight inputs concern. They used proper and right weight constraints and as a result the gained correct input and output weight factors. Wu (2012) introduced a hybrid model using DEA, with the use of neural networks and decision trees in order to assess supplier performance. DEA model classification reverses the suppliers into efficient and inefficient clusters that are placed on the resulting efficiency scores. It classifies any field of favorable classification and predicts the rate of accuracy. Wu and Beacon (2007) introduced the current status and development of the risk management enterprise in vendor selection process. The new development called DEA VaR model that examines the risk management in vendor selection process.

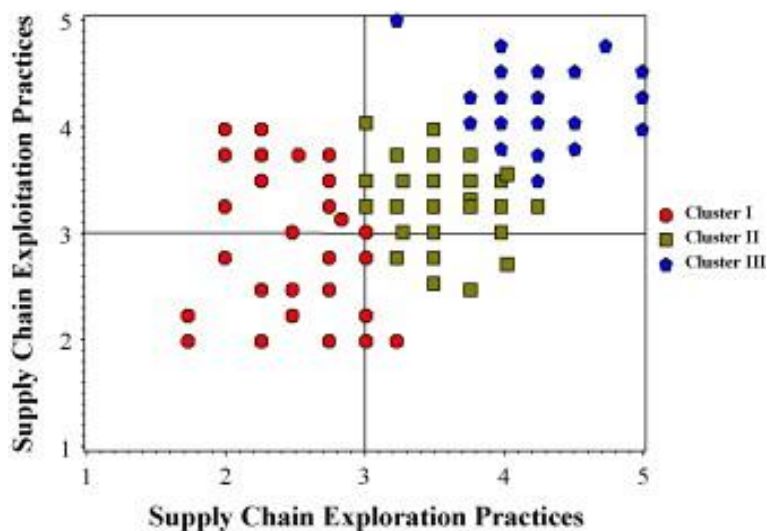
All the models presented, show the means to improve quantitatively the decision making process with respect to risk factors. Saen (2010) also presented a DEA-based methodology model for supplier selection process. The model that introduced had a basic point that considered undesirable outputs and imprecise data at the same time. The target was to increase the supplier selection process and the quality of evaluation. Zeydan et al. (2011) studied qualitative and quantitative variables for evaluating the performance for selection of suppliers based on effectiveness and efficiency. The model introduced quantitative variables that were transformed from qualitative variables in order to use DEA methodology.

### ***Cluster analysis models***

The analysis of cluster is based on statistics. Cluster analysis models use a specific algorithm to join different items that are represented by a set of numerical scores of attributes into a number of clusters. These refer to the differences between these items within a cluster. They are minimal and the items changes from different clusters are maximal (De Boer et al, 2001). Cluster analysis can be developed to a variety of partners. These partners are characterized by different scores and on some criteria.

Kristal et al. (2010) analysed and investigated the impact of a deceptive strategy of supply chain on manufacturers' combinable competitive capabilities. They presented the export of such competitive capabilities at the same time. These capabilities referred to cost, quality, flexibility and delivery on each business performance. The following figure shows the results found from the research of Kristal et.al. (2010). Their analysis concludes to three cluster solution, within 35 manufacturers. The cluster analyses showed that 63 (36.0%) manufacturers pursue a deceptive supply

chain strategy, with significantly higher mean scores ( $p < 0.01$ ) relative to their Clusters.



**Figure 8:** Cluster Analysis for Supply Chain (Kristal et al., 2010)

The conclusion shows the classification of partners in clusters of partners that are comparable. Hinkle et al. (1969) made the first research in adopting this point of view. Ha and Krishnan (2008) introduced another method that was based on a hybrid method. This consolidated a lot of techniques through the partner evaluation process, in order to select the most competitive ones in supply chain area. They also proposed a new and flexible model. That new and flexible model calculated and combined the supplier score in order to do a single sourcing and multiple sourcing procedures. The new method performed a cluster analysis that mapped the supplier position through qualitative and quantitative dimensions. The effectively segment to select the suppliers, Che (2010) produced a genetic simulated annealing k-means algorithm. Che (2010) developed an algorithm and the suppliers were clustered. Clusters referred suppliers' characteristics for customer needs and demands and included a lot of dimensions such as product cost, quality and the manufacturing time needed.

### ***Categorical models***

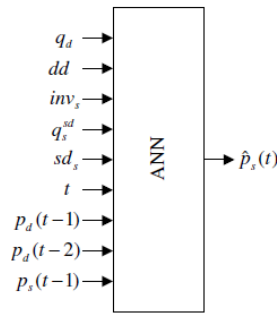
Qualitative models include categorical methods. A huge variety of literature exists on categorization, and a lot of models exist that have been developed for use. These models analyses the data in order to understand the categorization work and effort (Ashby and Maddox, 1993; Ashby and Waldron, 1999, McKinley; Reed, 1972;

Rosseel, 2002). The stakeholders and partners are assessed on a set of criteria. These criteria are based on historical data and/or the businesses experience. This evaluation process includes categories that show the performance of the potential partner's as either "positive", "neutral" or "negative" performance. The potential partner is then rated on all selected criteria. Decision makers give an overall rating by clicking one of the three options above. By this way, the potential partners are sorted out into these three categories as presented above. There is no variety of literature that shows this research by using categorical approaches as quantitative methods.

### *Artificial Intelligence models*

Another section is based on artificial intelligence models. These models are based on computer-aided systems. Historical data are retrieved by experts. Humphreys et al. (2003) made a research and presented a framework that was based on environmental criteria that businesses can consider during their supplier selection process while there is an increase on environmental pressure. A new model that was based on knowledge-management decision support system was developed quantitative and qualitative environmental criteria into the supplier selection process. This new model was developed within the framework. It is very difficult to set a reasonable and appropriate value origin. Lee and Ou-Yang (2009) presented an artificial neural network- based model. This model was able to maintain and prepare all the support and recommendations to buyers that were involved in partner negotiations selection. A new intelligent system was developed for negotiation support through the supplier process of selection. This new model was artificial neural network-based predictive model. It also included application for making forecasts as far as the supplier's bid prices. The authors showed that the ANN approach offers an innovative and integrated tool that supports sophisticated and challenging negotiations that can add value of buyer's objective. This model also has some limitations as well. It includes an inadequate number of input factors and its predication objective (i.e. the bid price only).

Figure 9 shows the artificial neural network-based model for predictions.

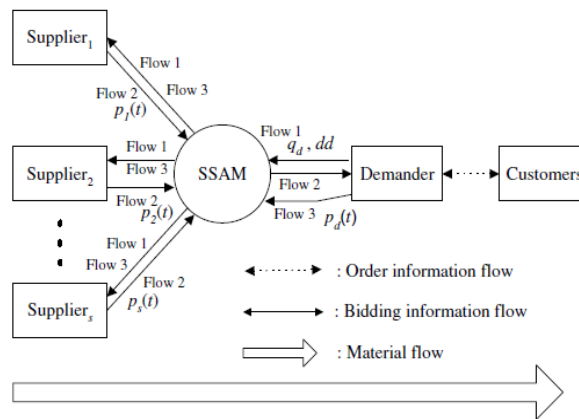


**Figure 9:** Artificial Neural Network-Based Predictive Concept Model (Lee and Ou-Yang, 2009).

This artificial neural network is based on predictions and it is depicted above on Fig 9 and developed through the following assumptions:

- The use of the model predicts most of the bid prices of a supplier.
- The supplier makes the offers first, and then turns are taken place.
- Information are not shown through suppliers but are shared into the application of supply chain system.
- The negotiation process of supplier selection is bilateral.

Figure 10 below represents the four entities: suppliers, a supplier selection auction market (SSAM), demander and customers.



<b>Flow 1: Invitation to bid</b> Required quantity $q_d$ Due date $dd$	<b>Flow 2: Suppliers' bids</b> Bid prices $p_s(t), s = 1, 2, \dots, S, t = 1, 2, \dots$ $S$ is the number of suppliers in SSAM.
<b>Flow 3: Demander's bid</b> Bid price $p_d(t), t = 1, 2, \dots$	<b>Flow 2 and 3 are repeated sequentially until the deal is finished or failed.</b> $p_s(t) \leq p_d(t), s \in \{1, 2, \dots, S\}, t = 1, 2, \dots$
<b>Bidding negotiation process</b> $p_s(1) \rightarrow p_d(1) \rightarrow p_s(2) \rightarrow p_d(2) \rightarrow \dots$	

**Figure 10:** Supplier Selection Framework (Lee and Ou-Yang, 2009)



Luo et al. (2009) presented another model that contributes to overcome the difficulties of information processing in a huge number of crucial suppliers in the early stages of the selection process. The model was based on radial basis function artificial neural network. The model implements the potential suppliers in order to be assessed against multiple criteria by using quantitative and qualitative measures.

Aksoy and Ozturk (2011) introduced an ANN- based supplier selection and supplier performance evaluation systems. This system focused on JIT (just in time) manufacturers selection process. This means that this system selected the most appropriate suppliers and evaluated the supplier performance. This model had a very important advantage. The decision-makers could check the points and procedures that need to be developed in the output value of the ANN model. Expert systems also used an artificial intelligence technology for the supplier evaluation process. Choy et al. (2002) analysed and introduced a new intelligent partner relationship management system. This system used hybrid case based reasoning and ANN techniques made the selection of the partners that were potential.

Yigin et al. (2007) also introduced an expert system for partner selection criteria. This system was based on six rules and fourteen criteria which are grouped step by step. This system could never fully arrest the expertise used in crucial situations that is mandatory in ASCs partner selection system. Artificial intelligence approach also includes case based reasoning (CBR) systems. Firstly, a case based reasoning system is database software that includes a decision-maker with useful information and experiences from previous and similar situations of decisions.

Choy et al. (2002) used management system of supplier relationship in order to integrate product coding system and supplier rating system. This system includes a case-based-reasoning technique, to select suppliers needed through the new product development process of suppliers. The system reduced the outsource cycle time and manufacturers identified the suppliers needed and therefore they formed an effective supply network. Faez et al. (2009) integrated integer programming, fuzzy set theories and CBR method for the program of selection vendor. This specific model enhanced the meeting of CBR systems by taking into account parameters of fuzzy logic. Moreover, they applied a mixed integer programming model in order to consider suitable selection of vendors and allocation of orders at the same time. Zhao and Yu (2011) based on data mining techniques in order to improve the level of knowledge. They analysed the data mining in multi data resources and they came to a point to invent case-based-reasoning system and improved the automation level of knowledge,

performance of the system, and expedite the exploring period of the intelligent system.

The main drawback from all the above systems is that these systems are complex and difficult to operate.

### **3.3.2 Decision Models for Final Selection**

Another set of decision models exist that refer to the final selection. The final selection models include the right selection of the best qualified partners in order to make the specific purchases of products or services. There are many studies that focus on “multiple business processes, multi criteria, and multi products cases”. Most of these studies are executed to the final selection phase of suppliers.

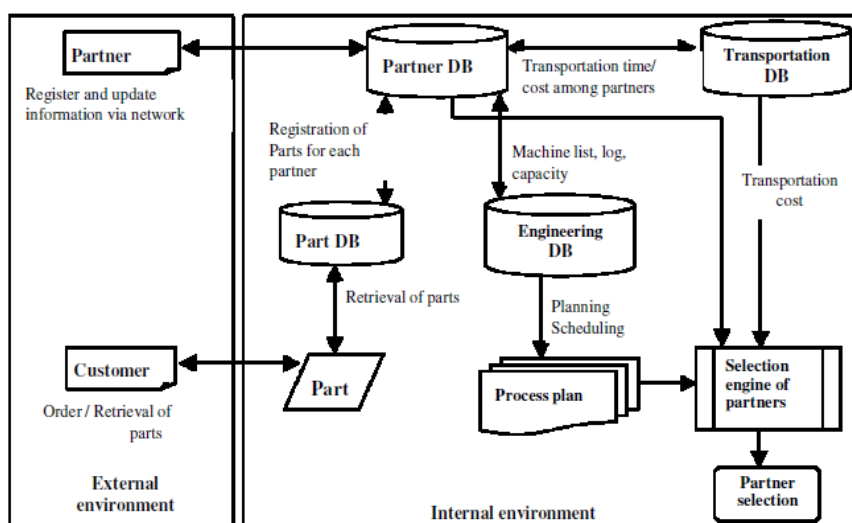
The selection models of suppliers can be divided due to single or multiple deals/products, and also the level of involvement on inventory management procedure. “Multiple deals/products” models refer to situations that include different products in different product groups. Moreover, the literature that exists does not include the items purchased in inventory management.

#### ***Linear weighting models***

The models of linear weighting introduce the different weights given to different kind of criteria, with the biggest weight so they indicate the highest importance. A lot of adaptations have been suggested by many authors on the behalf of making linear weighting models. These models are capable of dealing with better capable of dealing with the ambiguity and unpredictability that involves the selection of partner in real life of business.

Kumar et al. (2006) introduced a new idea for partners’ selection process in a distributed dynamic manufacturing environment. This environment let businesses to share their machinery and machine capacities. The authors introduced a new model in order to minimize the sum of operation and transportation costs. These costs are based on different process plans considering a variety of variables of operation procedures.

The following figure shows the architecture of the system for selecting manufacturing partners in a distributed environment.



**Figure 11:** Conceptual Diagram for the External Partner Selection via Network (Kumar et al., 2006)

Amid et al. (2006) introduced a fuzzy multi- objective linear model. This model was designed to solve the partner selection problem in a supply chain. It included an asymmetric fuzzy-decision making technique. Jarimo and Salo (2009) investigated a mixed-integer linear model. This model was designed to assist the selection of partners in a virtual organization. The model reversed the fixed and variable costs to transportation costs, capacity risk measures, and inter-organizational dependencies such as the success of past collaboration technique. Ng (2008) developed another weighted linear program for the multi-criteria supplier selection problem. This program was based on a transformation technique that solved the problem area without applying an optimizer factor. By working on this model it was not necessary for the users to learn any optimization techniques.

### ***Mathematical programming models***

Geoffrion and Graves (1974) worked on mathematics in the area of supply chain design. They invented a multi- commodity logistics network design model. This new model could optimize the different product flows through the whole supply chain. It involved all the stages from raw material vendors to producers to distribution centers, and to customers as well. A big variety of different mathematical programming models have been proposed and introduced. The three following sub categories can be divided by the mathematical programming models.

### ***Goal programming***

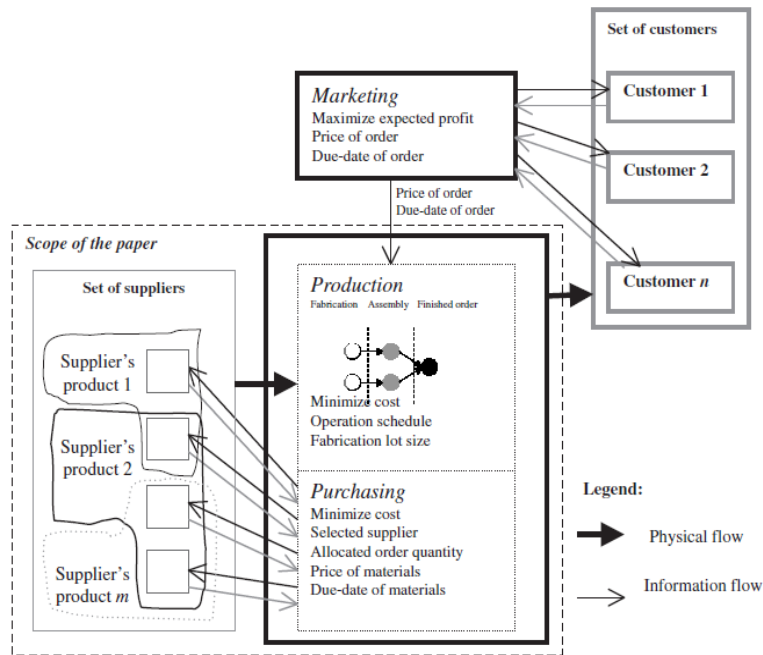
Hajidimitriou and Georgiou (2002) proposed a goal programming (GP) technique for the supply partner selection problem. This technique was able to achieve multiple goals for different levels of performance of the corresponding attributes. A drawback of this method was that it did not consider the consolidation of potential partners that may result in better solutions for the whole supply chain. Only one partner was identified and analysed. Basnet and Leung (2005) introduced a new supplier selection problem in a multi- period inventory lot sizing plot. Their research gave answers to crucial questions about products, orders, quantities, suppliers and periods of time. The new algorithm that they invented and proposed was based on the traditional lot sizing. Also it was fast to solve all the practical problems that had been raised. Ravindran et al. (2010) invented two different types of risk models. The first was the “value-at-risk” and the second was the “miss-the-target”. Both of the methods referred to the partner selection problem that is seen as a multi- criteria optimization problem area.

The researchers used the goal programming approach in order to solve the problem in two separate steps. Qualification and order quantities allocation step. Vanteddu et al. (2011) proposed the inventory costs and the supply chain “cycle time” reduction costs. They proposed a new programming model that spotlights on the different supplier selection problem. This model does not involve any qualitative factors such as “quality, supplier’s reputation, cultural match”, etc.

### ***Multi-Objective programming***

Cakravastia and Takahashi (2004) presented a multi-objective non-linear model for the process of negotiation. They generated a set of effective options in each period of negotiation.

The framework of Cakravastia and Takahashi (2004) research is depicted in figure 12. Three main entities are included: a set of customers, a make-to-order (MTO) manufacturer and a set of suppliers. Within the MTO manufacturer, three main internal activities are taken into account marketing, production and procurement.



**Figure 12:** Framework (Cakravastia and Takahashi, 2004)

Zhao et al. (2006) believes that the virtual enterprise is a basic organization form. This form will gain manufacturing of agile. The previous author selected the most appropriate supply partners as a key success factor. This theory was based on the inefficient entity, the construction of a multi-objective optimization model and during the selection process; applications of “fuzzy factors-based rules” and “genetic algorithm” were working together on the phases on selection process. Wadhwa and Ravindran (2007) indicated on price criteria, lead-time and quality criteria. These criteria will be minimized at the same time in a multi- objective optimization model. They also presented and proposed several methods of multi-objective optimization that included weighted objectives, goal programming and compromise programming. All of the above could solve the multi-objective optimization problem that has been raised.

Cao and Wang (2007) presented vendor selection framework that included two stages in outsourcing. The first stage shows the client to find the best process between the vendor and the project outsourced. The second stage, the vendor that has been chosen was employed for the full implementation of the project. This specific work showed that the selection of vendors from the first stage is better for creating a good vendor portfolio. Nowadays, Wu et al. (2010) presented a fuzzy multi-objective programming model. This model made decisions on supplier selection of taking risk factors. They presented a model of a supply chain that consists of three levels. They also used

simulated historical quantitative and qualitative data in order to measure the fuzzy events into the fuzzy multi-objective programming models procedures. Rezaei and Davoodi (2011) implemented two multi-objective mixed integer non-linear models. These models referred to multi-period lot sizing problems that involved multiple suppliers and multiple products. The outputs of these two models, point that buyers can better optimize their objectives in a situation of backordering.

### ***Integer programming***

Talluri and Baker (2002) presented a three-phase approach for the partner selection. This approach combined the pair-wise efficiency and effectiveness game model. This model included integer and linear programming. This model affects the drawbacks of weight flexibility and risks producing a sub-optimal solution as the phase of filter might filter the optimal phase.

Sha and Che (2005) argued that virtual integration attempt the way of making manufacturing procedures more agile and competitive. Therefore, the problem area of the selection of partner is crucial and too important procedure. The AHP and multi-attribute utility theory and integer programming, developed a partner selection procedure and a production-distribution planning model. They also introduced a Branch & Bound algorithm to solve the problem. In addition, Keskin et al. (2010) considered the typical costs accomplishing to the selection of vendors and delivery. Adding, they paid attention to the costs of inventory and the decisions. They gained on the connection between locations of facilities and presented a model that integrates the vendor selection and the optimization of inventory. Zhang and Zhang (2011) presented a mixed integer programming model. This model minimized mostly the total cost. The reduction of the total cost included the selection, the purchase and the shortage costs. This model disrespects the risk of supply chain and the discounts of prices according to the quantity of orders. Sawik (2011) proposed a problem that refers to the risk-neutral and risk objective functions. He separated in a bi-objective optimization problem at the same time. The problem was based on programming models. Therefore, this specific approach provided an easy tool for the decision-maker to evaluate the relationship between costs. These costs included the expected costs and the worst-case costs.

### *Analytic hierarchy/network process models*

Tam and Tummala (2001) presented a model that was based on the Analytic Hierarchy Process (AHP). They selected a real life case study based on a company that existed in the telecommunications industry. After their research they came to a point that this new model was very useful and capable of improving the decision making of groups. The new proposed model also reduced the time taken to select a company.

Mikhailov (2002) also utilized an Analytic Hierarchy Process (AHP) in order to manage the fuzzy logic that takes place while a decision-maker collates the meaning and importance of different attributes. This specific method, in contrast with other methods, obtains crisp priorities from erratic interim matrices with a meaning of comparison. To conclude with this specific method, it disregards the results found from attributes that are interconnected. Chan (2003) presented another method that refers to Interaction of Chain. This method illuminated the problem situation that deal with the dynamic nature of supply chain management issues. The method also used human resources management issues for judgment in comparison to the importance of tangible factors for selection. This Interactive Selection Model was introduced in order to take the previous steps and include them into a system. This procedure followed by the implementation of the AHP and also a software system that had a multi criteria selection processes in order to add value. The last part of this Interactive Selection Model included and based on quality data. This means that this new model depended on the quality of data that were collected. These data were selected in a systematic way with a new data collection method.

Liu and Hai (2005) implemented an Analytic Hierarchy Process (AHP) of voting. This method combined AHP methodology and DEA. This method was based on some steps of procedures. First, they regulated the weights from a selected rank. This specific method also selects the partners and the stakeholders by the weighted sum of the vote rank from the selection number. Sevkli et al. (2007) developed another method based on the selection of suppliers on hybrid. This new method was named “data envelopment analytic hierarchy process” (DEAHP). It was developed in a famous enterprise based in Turkey in the industry of appliances. DEA approach was included into AHP methodology by this method. It was using some criteria that have shown a reflection that was close to the decision taken. Sari et al. (2008) presented another AHP model to grant and select the partners and stakeholders due to a dynamic

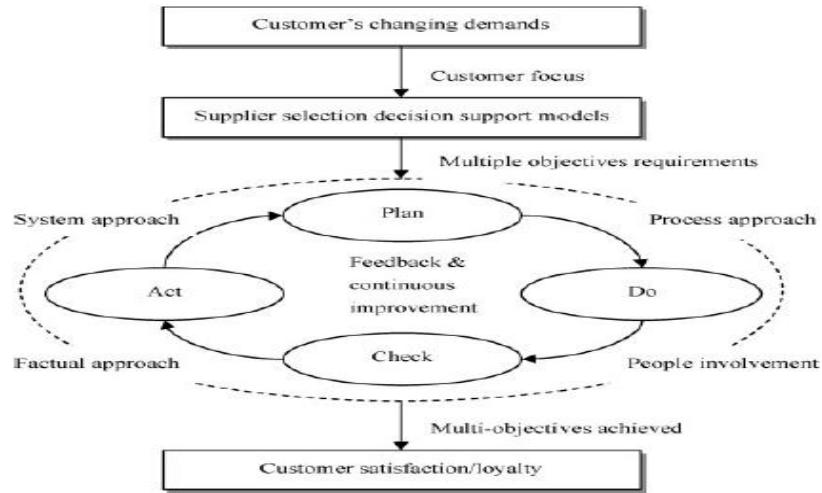
environment through the enterprise. This specific model was related to a generic model of multi criteria. It also provided different ways of the decision model structure. Also, it added and estimated the most important weights that different stakeholder groups included. All methods and aspects that were introduced were using the AHP method only and one way factors between the relationships. It was a simple model that did not take into account the big number of the relationships between the stakeholders. Moreover, the method of AHP does not include the relationships between all different factors. This means that this method has some of drawbacks and also disadvantages. A few authors tried to examine these methods and minimize the disadvantages and overcome the obstacles. For example, Sarkis et al. (2007) developed a model that referred to partners' selection. He used the Analytical Network Process (ANP) method. In 1996 this model was used broadly (Saaty, 1996). In contrast the model of AHP shows a framework that includes a uni-directional hierarchical relationship between the stakeholders, but from the other hand, the ANP model offer more complicated procedures that refer to relationships between the attributes and the different levels and factors. To conclude, when we have a complex system we need more than a simple hierarchical structure with linear top-to-bottom form. Sarkis et al's. (2007) concluded that an ANP model is more effective and get over all drawbacks and obstacles of ranking procedures than an AHP model offers.

Demirtas and Ustun (2008) integrated ANP and multi-objective mixed integer linear programming approach to answer two questions: (1) which suppliers are the best, and (2) how much should be purchased from each selected supplier if anyone supplier could not fulfill the whole demand? The special characteristic of the model is that it could include the decision makers' preferences.

Wu et al. (2010) proposed a two-stage approach, based on the application of an analytic network process-mixed integer multi-objective programming (ANP-MIMOP) model, to solve the problem of partner selection in ASCs. The Application feedback and continuous improvement model for supplier selection in ASCs that they used is shown at figure 13.

In their first stage, an ANP methodology is applied to calculate the priorities of different criteria for partner selection. Secondly, using these priorities, a MIMOP method is used to determine the supply chain structure and optimize the allocation of order quantities.





**Figure 13:** Application Feedback and Continuous Improvement Model for Supplier Selection (Wu et al., 2010)

Buyukozkan and Cifci (2011) developed a fuzzy ANP approach within multi-person decision making schema under incomplete preference relations for sustainable suppliers' selection. These ANP models can overcome the shortcomings of AHP approaches but cannot solve the detailed lot-sizing problem.

### *Fuzzy sets models*

A number of authors used fuzzy sets theory (FST) to model uncertainty and imprecision in partner selection situations. Sarkar and Mohapatra (2006) used a fuzzy set approach to measure the imprecision of these two dimensions to rank and reduce the number of potential partners, by focusing on their performance and capability. However, there is a compensation problem with this method, in that a potential partner scoring highly in one dimension may compensate for a low score in some other. Using fuzzy analytical hierarchy process and a genetic algorithm, Ha and Krishnan (2008) developed an integrated supplier selection and multi-echelon distribution inventory model in a built-to-order supply chain environment. Kumar et al. (2006) combined the multi-objective integer programming and fuzzy set theories for vendor selection. In their model, various input parameters have been treated as vague with a linear membership function. The proposed model provides a tool that facilitates the vendor selection and their quota allocation under different degrees of information vagueness. Bevilacqua et al. (2006) proposed a fuzzy quality function deployment (QFD) approach to support supply partner selection. This approach uses both internal and external variables to rank the potential partners. The advantage of this method lays in its ability to transforming decision makers' verbal assessments to

linguistic variables, which are more accurate than other non-fuzzy methods. However, it is used to rank potential partners, which is not the main objective in the early phase of partner selection.

Chou et al. (2007) utilized the supplier positioning matrix to link the capability of potential suppliers with the requirements of the customers. Then, their research identified the strategy-aligned criteria for vendor selection in a modified re-buy situation. Finally, based on the type of components required by the customers, a fuzzy factor rating system was used to evaluate the potential vendors. Bayrak et al. (2007) also proposed a fuzzy approach method for partner selection by assessing delivery, quality, flexibility, and service criteria. However, it is a pure subjective method that will inevitably depend heavily on experts' experiences. Buyukozkan et al. (2008) proposed a fuzzy AHP and fuzzy Technique for Order Preference by Similarity to Ideal Solution approach to rank partners under conditions of uncertainty and complexity. To avoid the single decision maker's bias, it would be beneficial to extend the model in a group decision-making environment. As different enterprises have different motivations for establishing supply partners, the identification of universal criteria weights for use in any situation will not be appropriate. Based on fuzzy sets theory and VIKOR method, Sanayei et al. (2010) applied linguistic values to assess the ratings and weights for the established criteria, and built a hierarchy multiple criteria decision making model to deal with the supplier selection problems in the supply chain system. The VIKOR method in their model is developed to solve multiple criteria decision making problems with conflicting and non-commensurable criteria.

Yucel and Guneri (2011) developed a weighted additive fuzzy programming approach for multi-criteria supplier selection. Their model has not very computational procedure, so it can deal with the rating of factors effectively.

### ***Genetic algorithms models***

A lot of studies exist that try to use genetic algorithms to solve the partner selection problem. Ip et al. (2003) pointed out that dynamic alliances are essential components of global manufacturing. Based on the concept of the inefficient candidate, they built a risk-based partner selection model by using genetic algorithm (GA) to minimize the risk in partner selection. However, they failed to simultaneously consider both qualitative and quantitative evaluation attributes.

Sha and Che (2005) proposed an approach which is based on the GA, AHP and the multi-attribute utility theory to satisfy simultaneously the preferences of the suppliers and the customers at each level in the network. This approach seems likely to outperform that of the single-phase genetic algorithm in supplier selection. Liao and Rittscher (2007) constructed a multi-objective supplier selection model under stochastic demand conditions. They extended the measurement of supplier flexibility to consider demand quantity and timing uncertainties comprehensively. Moreover, they proposed a problem specific genetic algorithm to handle the combinatorial optimization problem. Their solution alternatives and objective trade-offs are valuable for the final supplier selection. Wang et al. (2009) emphasized that partner selection is a key step in organizing a well-designed dynamic supply network. They carefully analyzed various collaboration patterns between distributed partners with the corresponding evaluation criteria for collaboration time and cost, and then proposed a genetic algorithm solution for collaboration cost optimization-oriented partner selection. Yeh and Chuang (2011) also developed an optimum mathematical planning model for green partner selection by adopting two multi-objective genetic algorithms to find the set of Pareto-optimal solutions. However, the main drawback of GA is that it requires users to have a level of specialized knowledge that is likely to be well beyond that possessed by most managers and organizational decision makers. Also a severe drawback is that some feasible solutions cannot be generated by crossover operation.

### ***Other models***

Besides the models and methods for ASCs mentioned above, there are other several models and methods which do not belong to the above categories. These models and methods consider the dynamic decision-making situation, like ASCs.

Recognizing that virtual enterprises and agile supply chains are becoming a growing trend, Lau and Wong (2001) make use of the technologies such as MRPII, CAD, CAPP, DNC Link, to address the problem of selection and management in dynamic networks. Their paper provides insights into the issues raised by managing dispersed production networks using electronic media. Valluri and Croson (2005) applied agent-based modeling approach to improve the small numbers outsourcing model, which displays a complicated reward and punishment profile under incomplete information and dynamic decision-making condition. Moreover, their research shows that it is better for a buyer to transact with relatively few suppliers. Yet, in their model, they

allowed only relative quality evaluation while assuming the relative ranking to be 100% accurate. Sucky (2007) proposed a dynamic decision making approach for strategic vendor selection based on the principles of hierarchical planning. This approach considered the interdependencies in time arising from investment costs of selecting a new vendor and costs of switching from an existing vendor to a new one. Chen and Huang (2007) built a logic model to describe the relationships among the manufacturing capabilities of virtual enterprises and the manufacturing requirements of clients in the formation of dynamic virtual enterprise. Based upon the logic model, three search algorithms were developed for three different optimal goals, respectively. Fulga (2007) dealt with the partner selection problem which considers the bid cost and the bid completion time of subprojects, the due date and the budget constraint, in the fast changing business environment which potential partners dispersed geographically and had different core competencies. They gave two algorithms to solve their model. Zarvic and Seifert (2008) described an approach for the partner selection process, which is based on task-resource dependencies, with related constraints and priorities. Their dependency concepts between resources and tasks, stemming from coordination theory, have proved to be a helpful instrument for the purpose of partner selection in ASCs. The partner selection problem was modeled as a nonlinear integer programming problem by Cheng et al. (2009). Also, they gave an Ant Colony Optimization (ACO) algorithm with embedded project scheduling to solve the problem with the lead time, subproject cost and risk factor constraints in the dynamic environment. Comparing with the GA and enumeration algorithm, the effectiveness of the ACO algorithm was shown. Darwish (2009) built a model that integrates the single-vendor single-buyer problem with the process mean selection problem. The integrated model allows the vendor to deliver the produced lot to buyer in a number of unequal-sized shipments and reduces the processing cost. Yeh and Chuang (2011) constructed two MADM (multi-attribute decision model) methods for group decision making with interval values to solve partner selection problem under incomplete information in dynamic business situation. Based on deviation degree, the first method is a technique for order preference by similarity to ideal solution (TOPSIS) for group decision making. The second method is a TOPSIS for group decision-making based on risk factor. These two methods for group decision making can not only be applied to solve the partner selection problem, but also be utilized in other similar fields, such as investment and subcontractor selection. Stoica and Ghilic-Micu (2009) introduced a new paradigm of the dynamic organization named the

cybernetic economic system. Their multi-dimensional algorithm for dynamic organization partner selection is much depended on the technical and economic evaluation criteria. Crispim and de Sousa (2009, 2010) found that partner selection in ASCs, in general, is a very complex problem due to the dynamic topology of the network, the large number of alternatives and the different types of criteria. They proposed an exploratory process to help the decision makers to obtain knowledge about the network in order to identify the criteria and the potential partners that best suit the needs of each particular project. The processes they proposed involve a multi-objective search meta-heuristic and a fuzzy TOPSIS algorithm.

### **3.3.3 Decision Models for Application Feedback**

Luo et al. (2009), Wu and Barnes (2009) and Wu and Barnes (in press) added a further stage to the supply partner selection process, stated as application feedback, which to date has not been adopted by other researchers. They argue that such a stage is important and necessary in today's highly competitive environment (Christopher et al. 2006). By applying principles of continuous improvement and organizational learning, this stage is designed to provide feedback so that the process of supplier selection process in ASCs can be continuously improved. Their model seeks to capitalize on the increased number of applications of the supplier selection process that are inherent in the more dynamic conditions that prevail in environments in which ASCs are likely to be best suited. Its aim is to support organizational decision-makers in their efforts to optimize the performance of the supply chain by ensuring that the most appropriate suppliers are selected at all times. Their test within two simulation groups showed that participants found the model was likely to have significant benefits when used in practice.

### **3.3.4 Critical Evaluation of Decision Models**

It is possible to identify several main approaches used for final phase partner selection: linear weighting, mathematic programming, analytical hierarchical/network process and fuzzy set approach. Although each has its own specific merits, each also has its own shortcomings. Linear weighting is a very simple method, but it depends heavily on human judgment. As such, different weights could be given to the various attributes according to the decision-makers' subjective judgment. However, as Bevilacqua et al. (2006) note, all linear weighting techniques are fully compensatory. Secondly, given an appropriate decision setting, mathematic programming allows the

decision-makers to formulate the decision problem in terms of a mathematical objective function. It may be argued that mathematic programming models are more objective than rating models because they force the decision-maker to explicitly state the objective function. At the other hand, mathematic programming models often only consider the more quantitative criteria and this may cause a significant problem in considering qualitative factors. They also require arbitrary aspiration levels and cannot accommodate subjective attributes.

Fuzzy set theoretic analysis does allow simultaneous treatment of precise and imprecise variables. However, fuzzy set theory is complex and it would be difficult for the users to comprehend and understand the rationale for the output results. As Huang et al. (2004) noted, there appears to be something of a dichotomy between the quantitative and qualitative approaches to partner selection, which typically betrays the academic backgrounds of the researchers. On the one hand, engineering scholars, who typically operate within the OR/MS paradigm, have mostly treated partner selection as an optimization problem. On the other hand, business school scholars often emphasize philosophical issues and focus on developing qualitative principles to guide management decision making. However, strategic thinking cannot provide practical solutions. A mathematically optimization solution will have no meaning if it does not match the business strategy. Consequently, effective and efficient decision-making for partner selection seems to require that approaches based on qualitative strategic thinking be combined with those of quantitative optimization.

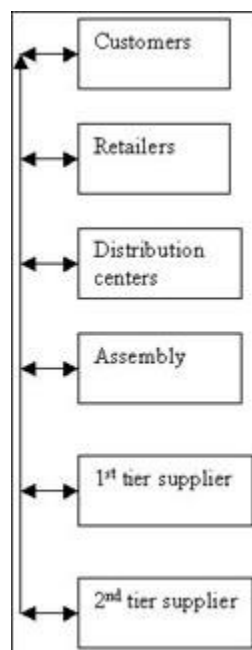
Construction of an effective and efficient partner selection model is one of the most important issues before a partnership can be built.

More attention needs to be given to partner selection in the service operations context. As De Boer et al. (2001) point out there is still very little research on partner selection in public procurement. Furthermore, there is an important trend in the field of purchasing and supply management which was less prominent at the time of De Boer et al's. (2001) work, namely electronic reverse auctions (ERA).

## Chapter 4

### 4. Applying Information Systems & Technology to Supply Chain

Supply chain management can be introduced as the flow of products/services and information between the members of supply chain. Nowadays, that the technology applications and information systems are widely used, organizations can easily obtain and manage their operations and procedures. Therefore, organizations can easily manage and control the whole supply chain. Information cost is decreasing due to the inventions of technology innovations and procedures. The supply chain that is integrated can allow directional procedures that obtain the reverse materials and also the flows of information feedback. Therefore, managers have to take into account that technology is very important and will help them automate their everyday operations and work.



**Figure14:** Integrated Supply Chain Model

Information systems and new technology applications consist as innovative tools for managers to control the whole supply chain.

Information Technology is more than computations and managers need to be aware of it. A lot of procedures are included such as communication technologies, automated production line, data recognition, hardware, software etc.

Before 1980s the flow of information was only with the traditional way (paper work) throughout the functional operations of the organisation and the members of the organisation. Information was introduced as a critical competitive resource. Bowersox and Daugherty (1995) emphasized on timely and accurate information for American Business.

Most of the organizations in the supply chain management area have an initiative role to play and perform in everyday flows. Power within the supply chain is a central issue. Retailers play an important role in terms of information access and have risen to become an important factor by using innovative technologies and information systems. For example, the Wal-Mart & P&G work can present the importance of using such information systems throughout their supply chain. The information that they are sharing inside and outside the company is on real time and automated procedures are taking place. Wal-Mart information systems and applications are using a common point of sale from their retailers directly with P&G and other suppliers outside the company.

Application modules and information systems that exist throughout the supply chain include three main advantages: the cost reduction, the improvement of productivity and the creation of proper and advance strategies for their products and the market. The interorganizational system occupied many authors as far as the basic levels of participation. Remote Input/output mode (the member participates from a remote location within the application system supported by one or more higher-level participants), Application processing mode (a member develops and shares a single application such as an inventory query or order processing system), Multi participant exchange mode (the member develops and shares a network interlinking itself), Network control mode (the member develops and shares a network with diverse application that may be used by many different types of lower level participants) and Integrating network mode (the member literally becomes a data communications/data processing utility that integrates any number of lower level participants and applications in real times).



## **4.1 Information and Technology: Application of SCM**

Information systems and the technology included in the supply chain management area include software applications and hardware systems to support the software installed. Hardware systems include computer's input/output devices and storage media. Software systems include the programming language from the entire system and application packages that are used for processing all the business flows and procedures such as the strategic planning of the organisation, the decision making process and the management control flows. IT investment in the supply chain process does not guarantee a stronger organizational performance. Other evidence suggests that the impact of IT on firm performance remains unclear (e.g., Brynjolfsson, 1993). According to Barney et al. (2001) and Wernerfelt (1984), differences in market performance are fundamentally coming from the resources that are distinctive and valuable capabilities, the rare, inimitable and non-substitutable. Taylor (2003) presents that the technology incompatibility is often cited as one of the main causes of the disruption of the supply chain area. The findings suggest that the connection of IT with all stakeholders and partners is also very important, if not more, in gaining the competitive advantage of the organisation through communication systems in the supply chain. Based on a survey of 400 supply chain professionals, Jayaram and Vickery (2000), state that the absence of a significant connection between EDI and interorganizational communications. Bakos and Brynjolfsson (1993) proposed that the deployment of Information systems and technology in supply chains areas leads to closer relationships between buyers and suppliers. Stump and Sriram (1997) came to the point that information systems use is associated with the overall close relationships between buyers and suppliers. Subramani (2004), evidenced that a certain and a positive relationship between buyers and suppliers lead to company's competitive advantage and effectiveness. Grover et al. (2002), suggest that the decision to use IT within the dyad could encourage the commitment to establishing relational behavior. Authors' conclusions show that information systems and the technology reduce the costs of transactions between buyers and the suppliers. Adding, the technology can lead to a more relational structure with the government.

Avery small number of studies has stated that there is no association between buyer-supplier relationships with IT implementation (Jayaram and Vickery, 1998).

## 4.2 E-Commerce

Electronic Commerce is usually combined with the ordering and the payments of goods and services via the internet (electronic means) with a physical delivery. Kalakota & Whinston (1996) “defined electronic commerce as the buying and selling of goods and services involving some sort of payment”. Therefore, electronic commerce includes transactions such as EDI, e-mail applications, electronic fund transfers for electronic payments, electronic publishing, image processing, electronic bulletin boards, shared databases and magnetic data capture through the business flows and procedures. Businesses can be able to work on a fully automated environment by transferring all data and information electronically and in real time between their customers and of course their suppliers.

Kalakota & Whinston (1996) defined electronic commerce into three distinct classes. These three classes are: Inter-organizational (business - to - business), intra-organizational (within businesses) and customer business.

### **Electronic Data Interchange:**

Aviv (2001) refers to retailers that make use of initiatives such as EDI (Electronic Data Interchange) in order to share demand of information to suppliers by soft-orders. These types of orders are costless and non-binding and are employed to quickly and directly transfer market information to suppliers (Holmström et al., 2002). Buyers, with the help of IT technologies, can make exchanges across many different channels, including physical store, laptop, and smart phones, among others (Martino et al., 2016). In order to meet customers’ requirements in the competitive circumstance, companies tend to align all of their channels in a new synchronized operating model called omni-channel retailing. EDI systems and EPOS (Electronic Point of Sale) systems provide valuable historical data to make quick cooperative operations in omni-channel retailing strategy (Martino et al., 2017).

Electronic data interchange system refers to computer-to-computer exchange of business documents in an accepted format. EDI describes both the capability and practice of communicating information between enterprises in electronic way rather than the traditional way like mail, courier, & fax. Advantages of the above information system are:

1. Agile information process.
2. Improved customer service.
3. Minimize paper work.
4. Raising productivity.
5. Upgrade of tracing and expediting procedures.
6. Cost efficiency.
7. Gaining a competitive advantage.
8. Upgrade billing flows.

Partners can overcome a great number of obstacles by using EDI and demand information by improving technologies to facilitate real time sharing of actual demand and supply information.

### **Bar Coding and Scanner:**

Bar code scanners for example are the most used for the checkout counter of super markets. This specific code identifies the name of the product and its manufacturer. Other applications of bar coding and scanners include the tracking procedure by moving items such as the components in a personal computer, assembly operations, automobiles in assembly plants, etc.

### **Data Warehouse:**

The data warehouse is a “consolidated database maintained separately from an organization's production system database”. Enterprises use multiple databases. A data warehouse is “organized around informational subjects rather than specific business processes”. The data are stored in the data warehouses; they are time dependent and refer to the historical data of each organisation.

### **Enterprise Resource Planning (ERP) Tools:**

ERP systems are widely used by most businesses (e.g. Baan, ORACLE, SAP, People soft, etc.). It is defined as the core of their IT infrastructure. ERP captures the data and reduce the manual activities and task associated with processing financial, inventory and customer order information. ERP system achieves a high level of integration by utilizing a single data model, developing a common understanding of what the shared data represents and establishing a set of rules for accessing data.

### 4.3 IT in Supply Chain

Most companies work under pressure in order to better manage the supply chain and to improve efficiency and logistics operations. Changes in market activities press companies to respond quickly to these market conditions and customer demands. IT is a valuable tool for all companies to support their supply chains and increase their efficiency by achieving tighter cooperation over the supply chain.

Buyers and sellers need to know where their product is. Innovative companies that make use of IT support and technology applications make it easier than ever for logistics managers to track and manage international shipments, and to serve their changing needs. Web-based applications help them to identify where their goods are in real time, and delays along the way should be corrected to avoid broader supply chain disruptions and expensive recovery work.

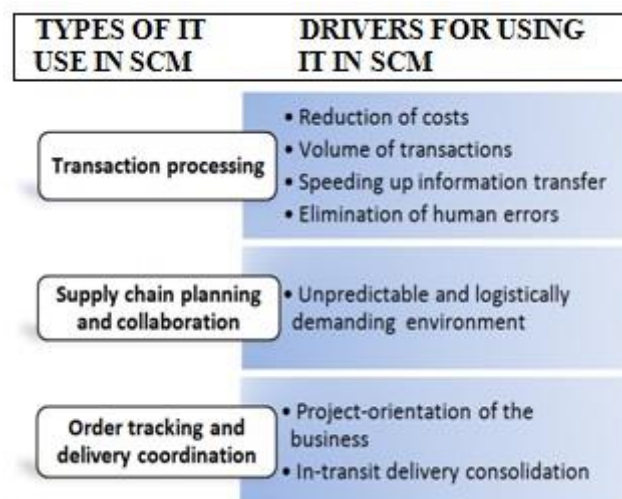


Figure15: IT use for optimizing SCM

The use of IT for optimizing SCM can be divided into:

Transaction processing: stands for the use of IT in order to increase the efficiency of repetitive information exchanges between supply chain partners. Tasks as order processing, billing, delivery verification, generating, sending dispatch advices, and producing order quotes are included in transactions processing.

Supply chain planning and collaboration: the use of IT applications and systems that stands for demand forecasts and information, inventory information and production capacity.

Order tracking and delivery coordination: the use of IT of monitoring individual orders or shipments with the aim of delivering information on time.

“Radio Frequency Identification” (RFID) is used with IT. The combination promises to enable an automatic collection of supply chain data for optimization purposes. The above combination makes it possible to implement a finely grained and immediate collection of data, which in turn enables more detailed and precise analyses on the “Business Intelligence” (BI) side.

RFID, IT & BI have powerful business potential. Tracking & tracing, and sensor technologies additionally enable the identification and localization of root causes for quality issues. Sensor data such as abrasion, temperature, humidity, or brightness can be measured automatically for each transport unit and stored on the RFID chip. Later this data is made readily available by IT for aligning the flow of goods with the actual demand.



**Figure16:** IT & Stakeholders

The combination of IT, RFID and BI help manufacturers to gain efficiency within production environments.

#### **4.4. Supply Chain Management Technology Innovations**

Some of emerging technologies that will have an impact on supply chain procedures are:

1. The inventory and network optimization tools.
2. Automatic identification and Sensors.
3. Storage and cloud computing.
4. Automation and robotics.
5. Predictive analytics.
6. Mobile technologies and telecommunications.
7. 3D printing.
8. Driverless vehicles and drones.

According to the 2015 IMH Industry survey, the pressure on customer pricing was (51%), of demands for quicker response times (50%), and the customer service expectations was (49%) that refer to the top three issues that supply chain leaders and manager find it very interesting. Enterprises made efforts in innovations of technology systems but yet their flows are working in a manual way by putting hundreds of resources aside.

From the other hand, reverse logistics is efficiently planned on the route of forward logistics. The major benefits include:

1. Optimize operations to meet time bound deliveries
2. Measure performance and track SLAs with transporters
3. Pay delivery boys based on distance traveled
4. Measure daily planned vs. actual number of deliveries

Having seen promising results and believing that complete automation is possible to reduce operational cost, many companies launch their own automated operations. The new products that are being introduced are targeted specifically to those entities that could focus on their core business and outsource last mile delivery part to the experts. This helps the operators to collect more data to improve the accuracy of prediction, route planning and dispatch optimization. Moreover, they increase the market size by offering a completely automated delivery fleet to their customers. More and more traditional companies would start leveraging technology to gain competitive advantage. The tech teams of the companies and startups are developing more interesting features and the future of the sector looks promising.

## **Chapter 5**

### **5. RFID Technology**

It is true that the field of radio frequency identification (RFID) technology in supply chain management is one of the most innovative and challenging, since information technology (IT) is a constantly changing and evolving area (Sauer and Reich, 2000). Companies seek to gain competitive advantage through the extended use of IT. Sometimes this promising approach to company development turns out to be a disaster. RFID technology is not a particularly new technology. It was first developed just after World War II. Germany, Japan, USA and Great Britain were all using radar (which had been discovered in 1935 by Scottish physicist Sir Robert Alexander Watson-Watt) to warn of approaching planes while they were still miles away.

The problem was there was no way to identify which planes belonged to the enemy and which were a country's own pilots returning from a mission. The work in radar during World War II was a significant technical development. Radio frequency identification (RFID) was invented in 1948.

RFID is a technology that automatically identifies goods. Information systems are the means that can be used to capture data and keep those data up-to-date and accurate. RFID is already being used in industries, such as warehousing, maintenance, pharmaceuticals, medical devices, agriculture, food, retailing and defense (Schuster et al., 2007).

The basic functionality of an RFID system is asset management. The core ingredients are: identification, alerting, monitoring and authentication. The proper asset visibility can prevent losses due to spoiling of perishables, theft and counterfeiting. Today most organizations see whether RFID can add value to their business operations, supply chain partnerships and customer service relationships.

RFID can be considered as a data collection technology. This specific technology has unique characteristics and constitutes the entire technology end to end.

## 5.1 RFID Components

RFID technology use radio waves to automatically identify people or objects. This technology system consists of the following components:

- “Tag”
- “Reader”
- “Reader antenna”
- “Controller”
- “Sensor, actuator and annunciator”
- “Host and software system”
- “Communication infrastructure”

RFID devices can be divided into two broad categories (Roberts, 2006): those with a power supply (a battery) and those without. RFID device that actively transmitted to a reader is known as “tags”. Common usage has described transponders as “active tags” and unpowered devices as “passive tags”. Active tags are also read/write devices while passive tags are generally read only. Active tags are larger and more expensive than passive tags.

RFID system deducts tags within antennas’ range and performs various operations in each tag. In order for RFID system to work effectively, all RFID components must be logically connected together and need to be compatible each other.

Every tag needs to have a unique ID and use for unique identification. The existing tags need to be attached with objects in RFID solutions. The use of antenna is mandatory because it is reading the tags. Every antenna has its own magnetic field and antenna can only read tags within these magnetic fields. For the other hand, reader works for handling antenna signals and manipulate tags’ information. The communication infrastructure can be used for reader in order to communicate with IT infrastructure and works as a middle layer between the application and the reader.



**Figure17:** Components of an RFID System

Source: United States Government Accountability Office, 2005.



## 5.2 RFID Tags

The tags contain electronically stored information. Passive tags collect energy from a nearby RFID reader's interrogating radio waves. Active tags have a local power source such as a battery and may operate at hundreds of meters from the RFID reader. RFID tags are used in many industries. For example, an RFID tag attached to an automobile during production can be used to track its progress through the assembly line; RFID-tagged pharmaceuticals can be tracked through warehouses etc.

Since RFID tags can be attached to cash, clothing, and possessions, or implanted in animals and people, the possibility of reading personally-linked information without consent has raised serious privacy concerns.

A radio-frequency identification system uses *tags*, or *labels* attached to the objects to be identified.

RFID tags can be passive, active or battery-assisted passive. An active tag has an on-board battery and periodically transmits its ID signal. A battery-assisted passive (BAP) has a small battery on board and is activated when in the presence of an RFID reader. A passive tag is cheaper and smaller because it has no battery; instead, the tag uses the radio energy transmitted by the reader. Tags may either be read-only, having a factory-assigned serial number that is used as a key into a database, or may be read/write, where object-specific data can be written into the tag by the system user. Field programmable tags may be write-once, read-multiple; "blank" tags may be written with an electronic product code by the user.

RFID tags contain at least two parts: an integrated circuit for storing and processing information, modulating and demodulating a radio-frequency (RF) signal, collecting DC power from the incident reader signal, and other specialized functions; and an antenna for receiving and transmitting the signal. The tag information is stored in a non-volatile memory. The RFID tag includes either fixed or programmable logic for processing the transmission and sensor data, respectively.

An RFID reader transmits an encoded radio signal to interrogate the tag. The RFID tag receives the message and then responds with its identification and other information. This may be only a unique tag serial number, or may be product-related information such as a stock number, lot or batch number, production date, or other specific information. Since tags have individual serial numbers, the RFID system design can discriminate among several tags that might be within the range of the RFID reader and read them simultaneously.

A few different groups work to further divide passive hard tags; however, some tags will exist within two or more groups.

**High Temperature** – “Certain industries, like healthcare, track the number of cycles that instruments undergo in punishing autoclaves. Specific passive RFID tags are designed to withstand extreme temperatures and accommodate for those types of applications, among others”.

**Rugged** – “Applications in outdoor environments or tough warehouses need a tag that can withstand snow and ice, dust and debris, or even the crushing forces felt under a tractor wheel. For these applications, a highly rugged passive tag is needed to make the application successful”.

**Size** – “Some applications have specific size constraints when tracking small or large items. Size is one of the more important questions to answer when choosing an RFID tag because there are many different sizes available”.

**Materials** – “If an application requires tracking metal assets, UHF metal-mount tags may be the only option. These tags are specifically designed to mitigate the problems UHF RFID faces around metal”.

**Embeddable** – “If tagging an item becomes a problem for specific applications due to significant wear and tear, embeddable tags can fit in small crevices and be covered in epoxy so the RFID tag is out of harm’s way”.

**Dry Inlays** – “An RFID microchip (IC) and antenna attached to a material or substrate called a web. These inlays look like they have been laminated and come standard with no adhesive”.

**Wet Inlays** – “An RFID microchip (IC) and antenna attached to a material, usually PET or PVT, with an adhesive backing. Most of the time these inlays are clear and can be peeled off their roll and immediately stuck on an item”.

**Paper Face Tags** – “These are essentially wet inlays with a white paper or poly face. These are ideal for applications that need printed numbers or logos on the front for identification”.

Passive RFID tags do not all operate at the same frequency. There are three main frequencies within which passive RFID tags operate. The frequency range, along with other factors, strongly determines the read range, attachment materials, and application options.

**Transponders** – “In a system that uses an active transponder tag, the reader (like passive systems) will send a signal first, and then the active transponder will send a signal back with the relevant information. Transponder tags are very efficient because they conserve battery life when the tag is out of range of the reader. Active RFID transponders are commonly used in secure access control and in toll booth payment systems”.

**Beacons** – “In a system that uses an active beacon tag, the tag will not wait to hear the reader’s signal. Instead, true to its name, the tag will ‘beacon’, or send out its specific information every 3 – 5 seconds. Beacon tags are very common in the oil and gas industry, as well as mining and cargo tracking applications. Active tag’s beacons can be read hundreds of meters away, but, in order to conserve battery life, they may be set to a lower transmit power in order to reach around 100 meters read range”.

### 5.3 Readers

The RFID technology systems can be divided by the type of a tag and a reader. A **Passive Reader Active Tag (PRAT)** system has a passive reader which only receives radio signals from active tags. An **Active Reader Passive Tag (ARPT)** system has an active reader, which transmits interrogator signals and also receives authentication replies from passive tags.

An **Active Reader Active Tag (ARAT)** system uses active tags awoken with an interrogator signal from the active reader. A variation of this system could also use a Battery-Assisted Passive (BAP) tag which acts like a passive tag but has a small battery to power the tag's return reporting signal.

Fixed readers are set up to create a specific interrogation zone which can be tightly controlled. This allows a highly defined reading area for when tags go in and out of the interrogation zone. Mobile readers may be hand-held or mounted on carts or vehicles.

## 5.4 Applications of RFID

The applications of RFID are divided in two main categories: first, the short range applications where the reader and tag must be in close proximity (such as the control access), and second, the medium to long applications where the distance may be greater.

- **People access control:** There are many areas in which RFID tags are carried by people to allow them to gain access to facilities or services:
  - To secure the access in work places
  - To safe the access of dangerous/secure equipment
  - To access vehicles or computers
  - To access the travel on trains/buses
  - To access facilities of leisure
- **Vehicles access control:**
  - To secure on site access
  - To toll road
  - To pay fuels in real time
- **Automation in manufacturing:**
  - To control flexible processes of manufacturing by recognizing all items being built on a production line
  - To label components for future recycling work
- **Distribution and Logistics:**
  - To track the parcels from shipment to end consumers
  - To track products from manufacturers to retailers
- **Retail:**
  - Supply chain management
  - Controlling stock
  - Minimizing losses through shrinkage
  - Reverse logistics
  - Availability of products
- **Maintenance:**
  - Plant & Equipment
  - Fixed assets
  - Patients
- **Product security:**

- Tamper evidence
- Authentication of goods and services
- Anti-counterfeiting

## **5.5 Transportation and Logistics**

“Yard management, shipping and freight and distribution centers use RFID tracking. In the railroad industry, RFID tags mounted on locomotives and rolling stock identify the owner, identification number and type of equipment and its characteristics. This can be used with a database to identify the lading, origin, destination, etc. of the commodities being carried.

RFID is used to support maintenance on commercial aircraft. RFID tags are used to identify baggage and cargo at several airports and airlines.

Some countries are using RFID for vehicle registration and enforcement. RFID can help detect and retrieve stolen cars.” (Wikipedia.com)

RFID is used in intelligent transportation systems. In New York City, RFID readers are deployed at intersections to track E-ZPass tags as a means for monitoring the traffic flow. The data is fed through the broadband wireless infrastructure to the traffic management center to be used in adaptive traffic control of the traffic lights.

### ***5.5.1 Hose stations and conveyance of fluids***

The RFID antenna in a permanently installed coupling half (fixed part) unmistakably identifies the RFID transponder placed in the other coupling half (free part) after completed coupling. When connected the transponder of the free part transmits all important information contactless to the fixed part. The coupling’s location can be clearly identified by the RFID transponder coding. The control is enabled to automatically start subsequent process steps.

### ***5.5.2 Track & Trace test vehicles and prototype parts***

In the automotive industry RFID is used to Track & Trace test vehicles and prototype parts.

### ***5.5.3 Public transport***

RFID cards are used for access control to public transport.

In London travelers use Oyster Cards on the tube, buses and ferries. It identifies the traveler at each turnstile and the system can calculate the fare.

In the Chicago area, riders use the open standard Ventra card to board CTA buses and trains, along with PACE buses.

In Ontario, Canada, riders in the GTA and Ottawa Area use the Presto card to board trains, buses and street cars across multiple different transit companies.

#### ***5.5.4 Passports***

“The first RFID passports (“E-passport”) were issued by Malaysia in 1998. In addition to information contained on the visual data page of the passport, Malaysian e-passports record the travel history (time, date, and place) of entries and exits from the country.

Other countries that insert RFID in passports are Norway (2005), Japan (March 1, 2006), most EU countries (around 2006), Australia, Hong Kong, the United States (2007), India (June 2008), Serbia (July 2008), Republic of Korea (August 2008), Taiwan (December 2008), Albania (January 2009), The Philippines (August 2009), FYROM (2010), and Canada (2013).

Standards for RFID passports are determined by the International Civil Aviation Organization (ICAO), and are contained in ICAO Document 9303, Part 1, Volumes 1 and 2 (6th edition, 2006). ICAO refers to the ISO/IEC 14443 RFID chips in e-passports as “contactless integrated circuits”. ICAO standards provide for e-passports to be identifiable by a standard e-passport logo on the front cover.” (central.gutenberg.com)

#### ***5.5.5 Transportation payments***

“In many countries, RFID tags can be used to pay for mass transit fares on bus, trains, or subways, or to collect tolls on highways.

Some bike lockers are operated with RFID cards assigned to individual users. A prepaid card is required to open or enter a facility or locker and is used to track and charge based on how long the bike is parked.

In Singapore, RFID replaces paper Season Parking Ticket (SPT).” (Wikipedia.com)

#### ***5.5.6 Animal identification***

RFID tags for animals represent one of the oldest uses of RFID. Originally meant for large ranches and rough terrain, since the outbreak of mad-cow disease, RFID has become crucial in animal identification management. An implantable RFID tag or transponder can also be used for animal identification. The transponders are better known as PIT (Passive Integrated Transponder) tags, passive RFID, or “chips” on

animals. The Canadian Cattle Identification Agency (CCIA) began using RFID tags as a replacement for barcode tags. Currently CCIA tags are used in Wisconsin and by United States farmers on a voluntary basis. The USDA is currently developing its own program.

RFID tags are required for all cattle, sheep and goats sold in Australia.

### ***5.5.7 Human identification***

“Implantable RFID chips designed for animal tagging are now being used in humans. An early experiment with RFID implants was conducted by British professor of cybernetics Kevin Warwick, who implanted a chip in his arm in 1998. In 2004 Conrad Chase offered implanted chips in his night clubs in Barcelona and Rotterdam to identify their VIP customers, who in turn use it to pay for drinks.

The Food and Drug Administration in the United States has approved the use of RFID chips in humans. Some business establishments give customers the option of using an RFID-based tab to pay for service, such as the *Baja Beach* nightclub in Barcelona. This has provoked concerns into privacy of individuals as they can potentially be tracked wherever they go by an identifier unique to them. Some are concerned this could lead to abuse by an authoritarian government, to removal of freedoms, and to the emergence of an "ultimate panopticon", a society where all citizens behave in a socially accepted manner because others might be watching.

On July 22, 2006, Reuters reported that two hackers, Newitz and Westhues, at a conference in New York City, showed that they could clone the RFID signal from a human implanted RFID chip, showing that the chip is not hack-proof as was previously claimed. Privacy advocates have protested against implantable RFID chips, warning of potential abuse.”(Wikipedia.com)

### ***5.5.8 Institutions***

#### **Hospitals and healthcare**

“In Healthcare, there is a need for increased visibility, efficiency, and gathering of data around relevant interactions. RFID tracking solutions are able to help healthcare facilities manage mobile medical equipment, improve patient workflow, monitor environmental conditions, and protect patients, staff and visitors from infection or other hazards.

Adoption of RFID in the medical industry has been widespread and very effective. Hospitals are among the first users to combine both active and passive RFID. Many

successful deployments in the healthcare industry have been cited where active technology tracks high-value, or frequently moved items, where passive technology tracks smaller, lower cost items that only need room-level identification. For example, medical facility rooms can collect data from transmissions of RFID badges worn by patients and employees, as well as from tags assigned to facility assets, such as mobile medical devices. The U.S. Department of Veterans Affairs (VA) recently announced plans to deploy RFID in hospitals across USA to improve care and reduce costs.

A physical RFID tag may be incorporated with browser-based software to increase its efficacy. This software allows for different groups or specific hospital staff, nurses, and patients to see real-time data relevant to each piece of tracked equipment or personnel. Real-time data is stored and archived to make use of historical reporting functionality and to prove compliance with various industry regulations. This combination of RFID real-time locating system hardware and software provides a powerful data collection tool for facilities seeking to improve operational efficiency and reduce costs.”(Wikipedia.com)

### **Libraries**

In libraries RFID technology is used to replace the barcodes on library items and especially books. The tag contains identification of information or may just be a key into a database. The RFID technology system may replace or supplement bar codes and may offer another method of inventory management and self-service checkout. RFID system can also act as a security device, taking the place of the more traditional electromagnetic security strip codes.

“It is estimated that over 30 million library items worldwide now contain RFID tags, including some in the Vatican Library in Rome.

Since RFID tags can be read through an item, there is no need to open a book cover or DVD case to scan an item, and a stack of books can be read simultaneously. Book tags can be read while books are in motion on a conveyor belt, which reduces staff time. This can all be done by the borrowers themselves, reducing the need for library staff assistance. With portable readers, inventories could be done on a whole shelf of materials within seconds. However, as of 2008 this technology remains too costly for many smaller libraries, and the conversion period has been estimated at 11 months for an average-size library. A 2004 Dutch estimate was that a library which lends 100,000 books per year should plan on a cost of €50,000 (borrow- and return-stations: 12,500 each, detection porches 10,000 each; tags 0.36 each). RFID taking a large burden off



staff could also mean that fewer staff will be needed, resulting in some of them getting laid off. This so far has not happened in North America where recent surveys have not identified a library that cut staff because of adding RFID. In fact, library budgets are being reduced for personnel and increased for infrastructure, making it necessary for libraries to add automation to compensate for the reduced staff size. Also, the tasks that RFID takes over are largely not the primary tasks of librarians. A finding in the Netherlands is that borrowers are pleased with the fact that staff is now more available for answering questions.” (Wikipedia.com)

### **Museums**

In museums the RFID technologies are implemented in end-user applications. An example was the custom-designed temporary research application. The "eXspot," at the Exploratorium, a science museum in San Francisco, California. A visitor is entering the museum received an RF Tag that could be carried as a card. This technology of the eXspot enables the visitor to receive information about specific exhibits. Apart from the exhibit information, the visitor can take photographs of themselves at the exhibit. The data can be used for later analysis. Information collected can be retrieved at home from a "personalized" website keyed to the RFID tag technology.

### **Schools and universities**

In School authorities in the Japanese city of Osaka are now chipping children's clothing, backpacks, and student IDs in a primary school. Another secondary school in Doncaster in England is piloting a monitoring system designed to keep tabs on pupils by tracking radio chips in their uniforms. Another school in St Charles Sixth Form College in West London, England, started September 2008, is using an RFID card system to check in and out of the main gate, to both track attendance and prevent unauthorized entrance. Similarly, all of the above schools use the technology of RFID to track pupils and staff in and out of the building via a specially designed card. Around the world, in the Philippines, some schools already use RFID in Identification cards for borrowing books and also gates in those particular schools have RFID ID scanners for buying items at a school shop and canteen, library and also to sign in and sign out for student and the attendance of the teachers.

## **Sports**

In sports, RFID for timing races began in the early 1990s with pigeon racing, introduced by the company Deister Electronics in Germany. The technology of RFID can provide race start and end timings for individuals in large races where it is impossible to get accurate stopwatch readings for every entrant.

During the race, the racers wear the tags that are read by antennas placed alongside the track or on mats across the track. These tags provide accurate readings with specially designed antennas. Rush error, lap count errors and accidents at start time are avoided since anyone can start and finish any time without being in a batch mode.

## Chapter 6

### 6. RFID in Supply Chain Management

According to literature and research a lot of organizations are adopting new technologies and innovations in order to achieve competitive advantage and of course automate the processes inside and outside of their organizations. These implementations act as a strong tool for organization's benefit and to give value. Data synchronization, real-time tracking, planning, scheduling and reporting are some of Supply Chain Management issues that organizations are trying to automate and solve problems that might exist. Radio Frequency Identification (RFID) Technology is coming as the innovative technology to provide answers and solve most of the problem areas.

Roberts (2006) points that RFID is the latest magic bullet in the technological scope that has the potential to make a sweeping shift in the way any organizations approach their supply chain.

This specific technology is using tags, readers and radio waves to communicate between the two. RFID technology is combined with the EPC (Electronic Product Code). This combination will help to overcome organization's pains in the area of manufacturing, distribution, retail, logistics, and security.

It is not proper to believe that RFID is a replacement for the bar code. There are more benefits to exist for the Supply Chain Management area and the Operations Management. RFID technology acts as a successful weapon for supply chain. The following points are some of the advantages of RFID on Supply Chain and Operations Management.

***Quality of Data and Time Improvement:*** Information can be read from the reader in less than a second, giving to the organization immediate information on product number, invoice data order number and other useful information.

***Error Redundancy:*** Zebra Technologies note that if we gather product / service information manually "is time consuming, because the information first must be recorded at the point of activity, then later transcribed and entered into the computer system", every additional stage increasing the already high chance of error.

***Increase Efficiency:*** Automation of processes can dramatically increase speed and efficiency throughout the supply chain without risking accuracy.

***Theft Avoidance:*** Item-level tracking opens the door to a whole range of potential benefits, for example theft detection or customized manufacturing.

***Better Customer Experience:*** Real time information for customer relating to shipping dates and product availability.

***Better Decision Making – Demand Management:*** Demand planning faces drawbacks such as the lack of reliable data. RFID comes to produce accurate information related to the inventory of finished goods and services, work in progress and in transit stages with reliable due dates.

***Security, Privacy and Integrity:*** Security and privacy refers to tracking and inventorying solutions. Some organizations use RFID models that include digital signing of tag data in order to provide integrity assurance.

RFID Technology seems to reach its potential economies of scale in the global supply chain. RFID implementation has experienced an annual growth rate every year that passes. Since the year 2000, rapid growth in the market for RFID is creating the economies of scale necessary to bring costs down to the point where RFID tags will soon be competitive with printed barcodes (Hunt et al. 2007).

Apart from the advantages, some disadvantages also occur in the technology of RFID. As a growing technology, there are some points that need to be addressed and analyzed.

***Dead Areas and Orientation Problems:*** RFID works similar to a cell phone or a wireless network. Signals may be weak in certain areas and read rates might be poor that will not align well with the reader.

***Security Concerns:*** RFID is not a line-of-sight technology like bar-coding and new security issues could develop. If RFID will be used for high-security operations such as payment methods, fraud is always a possibility.

***Ghost Tags:*** The problem that might occur in multiple tags is that a tag can be read that does not exist.

***Proximity Issues:*** The RFID tags, if are placed on metal or liquid objects, are very difficult to be read well.

***High Cost:*** The technology of RFID is approximately new so the components of equipment might be expensive. Furthermore, software and trained personnel is needed to install, operate and train the employees.

***Unread Tags:*** The reading of multiple tags at the same time is sometimes risky because some tags might be overlapped.

***Vulnerable to Damage:*** Water, static discharge or high-powered magnetic surges may cause damage to the tags.

These advantages and disadvantages allows us to suggest that RFID technology is the tool to support successful supply chain management procedures only if the use is correct and careful. Supply chain management area has a lot of perspectives itself and the technology is the tool to be used for the effectiveness and efficiency of supply chain management.

The appearance of RFID technology can influence dramatically the way that supply chain is managed. As a new technology is rather simple and supports the automation of procedures through the supply chain (Jung et al., 2007).

Due to many logistics and supply chain applications, Radio Frequency Identification seems to be taken as an important technology tool (Srivastava, 2004; Angeles, 2005; Smith, 2005).

Nowadays, RFID has a great deal of interest in academic area and researchers focus on the technology specifics and the impact on supply chain issues as well as cost and time savings (Donovan, 2003; Kärkkäinen, 2003; Kunii, 2003; Niemeyer & Pak, 2003; Davis & Luehlefig,2004; Srivastava, 2004; Angeles, 2005; Smith, 2005).

Most organizations are trying to achieve a competitive advantage through innovations and new technologies. Porter (1990) depicts the new ways of doing things.

Davis and Luehlefig (2004), point that the implementation of RFID Technology is infancy to most organizations. As a result, they must adopt the technology as an innovative process.

## 6.1 Past RFID Applications in Supply Chain in Greece

An interesting research conducted in 2005 by Bouchounas, and it is worth to present some of the results appeared. They implemented a research on Greek organizations in the area of Logistics and pointed that 65, 62% of organizations are willing to contribute to a pilot project of RFID technology. From the other side only 12, 1% of organizations are not interested at all in such an investment. The major problem that Greek logistics organizations face is that with a 23, 3% percent, they do not have the efficient use of resources and information. A percentage of 17, 9% of organizations cannot predict customer's demands. The major factors that affect the implementation of RFID technology in Greek organizations are shown at the table below.

	IMPORTANCE		
	High	Medium	Low
Compatibility issues, current information systems & infrastructure	85,7%	10,7%	3,6%
Implementation cost	80%	16%	4%
100% reliability	79,3%	13,8%	6,9%
Motivation from government	78,9%	14,2%	6,9%
Compatibility issues between readers and tags from different customers	75%	14,3%	10,7%
Lack of success case studies in Greece	51,8%	33,3%	14,9%
Uncertainty of Return on Investment	39,3%	32,2%	28,5%

**Table 1: Factors that Affect the Adoption of RFID in Greece**

Source: Bouchounas, 2005

Compatibility issues, current information systems and infrastructure are the most important factors that organizations need to update in order to implement technologies and systems that are compatible to new technologies. It is worth to point that economical factors are the major factors that drawback organizations to follow

technological innovations. In contrast with all issues presented above, Greece is expecting to follow up with RFID technology (Bouchounas et al., 2005).

Even if the research was conducted some years ago it is proper to conduct a similar research in order to compare the findings and make further critical evaluation.

RFID technology will soon become the potential to all Greek organizations and will realize the benefits that will provide through their supply chain area. Customers will also benefit from this technology. Global positioning systems, transportation, logistics and other areas will provide to customers the best result expected.

## **6.2 RFID in Greece**

“To perform our research regarding RFID Technology in the Supply Chain Management area we used internet based libraries to search and evaluate papers issued in the last *five* years. An extended literature review took place to make us able to create the categories considered necessary to be studied in particular. We explored, identified and finally classified top technology journal articles. The preliminary results of this classification were to select from this broad area to study the articles issued the last five years, to form RFID key areas of interest and finally to reveal the use in Supply Chain Management field. As an outcome we selected as our primary data two hundred and fifty two (**252**) articles. The research on the literature showed that most of publications refer to the area of Computer Science, Engineering, Business Management and Accounting. It is clear that RFID technology is increasing, promising and controversial and is the area of study that researchers want to study in order to provide new challenges. Furthermore, many organisations have already adopted this technology in order to gain a competitive advantage.

The research continued in order to find and select the publications written in the Greek environment. Greece is a country that faces serious economic crisis and most organisations try to find ways in order to survive in such a crucial environment. Publications written are very few for Greece but they might increase too rapidly.” (Peppas and Moschuris, 2013)

Table two shows the number of publications written for the RFID adoption in Greece.

<b>JOURNAL</b>	<b>NUMBER OF PUBLICATIONS</b>
Information Systems Management	<i>1</i>
European Journal of Information Systems	<i>1</i>
Computers and Electronics in Agriculture	<i>1</i>
International Journal of Electronic Customer Relationship Management	<i>1</i>
Proceedings of the ACM Conference on Computer and Communications Security	<i>1</i>

**Table 2:** Journals (Peppas and Moschuris, 2013)

“It is clear that publications written for the Greek area of interest are very few but promising to the future. An extended search showed that Greek organisations in the area of Supply Chain seek to adopt RFID technology to their operations.

Greek organisations, due to economic crisis, are trying to find ways for competitive advantage and become strong market players. In this situation, RFID technology can be regarded as the tool for success and growth. Competitive pressure is increasing and Greek organisations seek to find ways of adopting new and innovative technologies in order to increase their efficiency of their business processes.

The competition in mature markets is strong so organisations require not only to optimise cost structures, efficiency and products on excellent quality, but also to communicate and cooperate with business partners all over the world and of course with potential customers.

RFID technology is a promising technology for the Greek market and soon organisations will take advantage on this technology and adopt it.

As it is revealed through our research, the articles that are referring to RFID technology in the area of Supply Chain according to different categories are shown below at table 3.” (Peppas and Moschuris, 2013)

We collected conference papers, articles and articles in press to show the investigations in RFID.



<b>Count of Year</b>	<b>Column Labels</b>					
<b>Categories</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>Grand Total</b>
Conference Papers	23	29	34	36	07	129
Articles	17	28	32	21	22	120
Articles in Press	0	0	1	0	2	3
<b>TOTAL</b>	<b>40</b>	<b>57</b>	<b>67</b>	<b>57</b>	<b>31</b>	<b>252</b>

**Table 3:** Articles' Statistical Elaboration (Peppa, Moschuris, 2013)

“From the above table it is clear that most publications were written in the year 2010. From the sixty seven publications, thirty four were conference papers that depicted the importance of RFID technology in Supply Chain Management Area. Case studies also appeared to be of high importance. Studies in different industries showed the high interest of RFID technology in organizations. There is no doubt that RFID is the key for success to most organizations.” (Peppa and Moschuris, 2013)

In 2010 we collected a number of studies that show the high interest in adopting RFID technology in different industries.

Schapanow et al., (2010), defined some specific levels of security and added value of privacy to customers through a case study at pharmaceutical industry. Xi et al., (2010) examined an experiment in the Hub express business in a well-known logistics company in China. The results from their research showed a high throughput. They investigated the information sharing, the saving on cost of labor and time and an investigated the best transparency procedures through the supply chain area. A new architecture was proposed by Zhao et al., (2006), that implemented in the supply chain logistics management system. He resulted to better measures as far as performance and scalability methods that are used through the supply chain.

Kribach et al., (2010) developed a generic FlexRFID middleware. This examination followed for better results in the Supply Chain area. They worked through a computing lab in order to prepare and finally offer to enterprises the FlexRFID technology. This technology improves the inventory control, the asset management procedure, the work in process and finally the flows of tracking shipments procedures. Two basic components of the development of RFID were introduced by Chuang and

Baert et al, (2011). First component included an analysis of differences between potential and actual key benefits. The second component included the performance of a two-dimensional expectation perception analysis (EPA). The empirical data found from their research were collected from specific companies located in Taiwan. This specific country (Taiwan) was also appeared in a research of Wang et al., (2010) that an experiment took place for about 640 times. This experiment included the key performance indicators. These performance indicators had to deal with the total inventory cost, the turnover percentage rate and the bullwhip effect. The research resulted to an enabled R-SCIARIMA supply chain model. This model was the best in practice by reducing the total inventory cost by 35.43% and increases the inventory turnover rate by 61, 36%.

Ting et al., (2010) made an interesting research on marking the prospect of adopting RFID technology in pharmaceutical supply chain information and transmission procedure. Similar case study appears on Barchetti et al., (2010) research, which diagnosed the key performance indicators (KPIs) for tracing the impact of standards like RFID, EPCglobal and ebXML on the pharmaceutical supply chain area. RFID technology use in Post-consumer monitoring and ordering of medical supplies were examined by Swartz et al., (2010). Practical experiences are presented by Barchetti et al., (2010) based on the item level for tracing products in the pharmaceutical supply chain area.

Another case study was founded by Schutzbank and White (2010). He used RFID technology in a short-lived environment of flowers at “Daniel’s Flowers” shop in Manhattan New York. As a conclusion the company gained a lot of money through the use of RFID technology by controlling their inventory.

Similar research was done by Vecchi and Brennan (2010) that generated generous cost benefits to the grocery retailers. Grocery retailers were also in Wang (2010), analysis and research that developed a methodology to model food quality deterioration. The assumption was to maximize the profits of food retailers’ through a pricing approach that was based on the identification of the features of food quality.

Quetti and Pigni (2010), focused on a Silk-textile Italian cluster of Como. They presented the RFID technology as an innovative technique to improve product traceability through the supply chain and also to validate the products origins with the label of “Made in Italy”. Another aspect was presented. This aspect was the “Italian Fast Moving Consumer Goods (FMCG)”. This aspect carried quantitative and

qualitative information and data that rose to the cutback of the bullwhip effect that affects the economic profits of the whole FMCG supply chain (Bottani et al., (2010). Zhang et al., (2010), examined and analyzed the ERP system legislation, in the automotive supply chain. The RFID technology as far as the information tracking system was also investigated. The scope of the case study was to show the benefits of RFID technology in Green Supply Chain area in automotive industry.

Kim and Garrison (2010) investigated South Korean retailers in order to identify organizational characteristics that result to RFID adoption. Furthermore, they collected data from 278 organizations and analyzed them in order to show the organizational needs, perceived factors and organizational readiness.

Through the research, a collection of case studies selected from the publications written in RFID technology, in order to separate the different industries that adopt and evaluate Radio Frequency Identification Technology to organizations.

<b>INDUSTRY</b>	<b>No of publications</b>
Technology Industry	13
Food Industry	6
Retail Industry	5
Fashion & Textile Industry	6
Pharmaceutical & Hospital Industry	6
Forest Industry	2
Fish & Sea Industry	2
Construction Industry	1
Transpostation & Shipping Industry	7
Military Industry	1
Energy Industry	1
Separate Organisations	11
<b>TOTAL</b>	<b>61</b>

**Table 4:** Case Studies Collected in Each Industry (Peppa and Moschuris, 2013)

Authors investigated different industries in order to adopt the technology of FRID. These industries include the Food industry, the Fashion & Textile industry and at last the Pharmaceutical & Hospital Industry.

The Food industry is another industry that a lot of authors investigated. This specific industry needs a better handling of its raw materials and the finished products through its procedures. RFID technology is used in order to trace foods through the supply chain area (Kelepouris et al., 2007). Many RFID applications exist in the food industry and carry supply chain management procedures, the monitor of good and the safety of foods (Kumar et al., 2009). We should establish standards for cost effectiveness and efficiency that will lead this specific industry to success.

Fashion & textile industry is an interesting area of study. Nowadays that competition is growing; suppliers need to respond quickly on the requests from their customers. This interesting industry shows issues like long production lead time, fast response to market needs and innovations on products production lines (Bruce et al., 2004). Customers demand is very high. Customers have personalized needs as far as clothing concern and technology can play a significant role of the demand of mix and the match of various clothes that provided in a few minutes. Kwok and Wu (2009) admit and consider that RFID technology will give benefits to the fashion & textile industry. The security in information and data is also another issue that needs further investigation. It is a big challenge of using such innovative technologies. RFID technology is an effective tool in order to identify several products or services by using tags. These tags will help recognize the genuine products because it includes cryptography algorithms (Wong et al., 2006). RFID technology tags can protect from shop-lifting (Lekakos, 2007).

One of crucial industries was researched by many authors. Pharmaceutical industry is very important because of that it points peoples' life and health. Ren et al., (2012), managed a new pharmaceutical production management system that was based on the technology of RFID. They proposed a new system that was able to trace the whole pharmaceutical life cycle system. This system included the flows of raw materials, the production process, the transportation flows and finally the storage procedure. The Pharmaceutical industry and the healthcare industry are two large, complex and growing areas. RFID technology will stand as an effective tool of performance and gain a competitive advantage.

We separated the publications found by the year that they were published. In the year of 2009 we found the most publications in this innovative technology. It is worth to point that after this year publications reduced and refers to the weak economic situation in Greece. The following table shows all the publications that we found that refer to the Greek industries.

Count of Year	Column Labels					
Row Labels	2008	2009	2010	2011	2012	Grand Total
Information Systems Management					1	1
European Journal of Information Systems		1				1
Computers and Electronics in Agriculture		1				1
International Journal of Electronic Customer Relationship Management			1			1
TOTAL JOURNALS/ARTICLES BY YEAR	0	2	1	0	1	4

**Table 5:** Articles' Statistical Elaboration (Peppas and Moschuris, 2013).

In the year of 2011 we did not find any publications for the use of RFID technology in the area of supply chain management in Greece. In 2011 private sector in Greece faced huge economic problems due to economic crisis which did not allow organisations' to grow and invest. The Greek government debt in April of 2010 acted as an alarm to the private sector and to all markets.

We collected the last publications and papers that referred to the Greek retail industry and we present the main areas of studies.

Pramatari and Theotokis (2009) examined a model that spotlights on customer attitudes through technology-based services. They made an analysis of 575 total questionnaires. Questionnaires were spread into two countries. They collected from Greece (173) questionnaires and from Ireland (402). Results showed that RFID services can be shaped on multiple customers' attitudes.

Bardaki et al., (2012), presented the lessons learned through two different RFID applications. These applications were involved in the retail sector. The applications indicated to dynamic pricing of fresh products and promotions management in a floor of a supermarket.

Ampatzidis and Vougioukas (2009) presented two methods for automatically matching bins. These methods included harvested fruits with analogous trees, during the period of harvesting in orchards. The data from the GPS technology may be unavailable due to vegetation and growth. These two methods used the RFID

technology. RFID was working with an antenna that was located on the harvesting platform in order to identify the trees. They measured the yield distribution in the area with a digital scale, during the loading of the bins procedure. The implementation was executed through peach and kiwi harvesting in two separate areas in Northern Greece. They proposed that the technology with barcodes is reliable for the registration of bins without any delays in the process of harvesting. They also suggested that RFID technology was also reliable for tree detection.

Vecchi et al., (2010), proposed a framework and presented the RFID based application at several established grocery retailers. These retailers were working on short life products in Ireland and Greece. Their research proposed that the low circumstances and high ambiguity avoidance are better accepted by customers' for the use of new service technologies systems.

Chatziantoniou et al., (2010), presented a simple SQL query for evaluation of RFID. A discussion also took place for prototype called COSTES (COntinuous SpreadsheeT-like computations). This prototype implements SQL queries and rating algorithms. RFID technology can be also implemented in an in-store sales position.

IT systems are widely used in the area of supply chain management in South East Europe. Greece can be also adopted such innovative technologies for future work for its business flows and procedures. Some other countries such as Albania, Bulgaria, FYROM, Romania, Serbia and Montenegro, do have the same challenges for adopting innovative technologies. These countries differ in supply chain management procedures and operations.

Since 1980 Greece has been a member of European Union (EU). The geographical position is in a big advantage, as it communicates with the rest of South East Europe. The European Union has to provide advantages in Greece and from a macro perspective the European Union has to take advantage from countries like Greece as is history and the strategic position is strong.

# RESEARCH METHODOLOGY

## Chapter 7

### 7. Case Study – RFID Adoption in Greece

Greece is a very small country but in a great position. The RFID technology first appeared during the 5<sup>th</sup> century BC. The period from 1950 to 1973 was one of extraordinary growth for the Greek economy. Greek economy after the World War II undertook a huge reconstruction work.

The motives and the barriers for Foreign Direct Investment (FDI) alter the level of competitiveness, entrepreneurship, and the business environment. These included the market growth, the political situation, the economic growth and the social stability. During the Olympic Games in the year of 2004 Greece favored on competition and venture capital.

Greece at the moment is in a hard position of economic crisis and industries strongly believe that private investments will upgrade its economy. The private sector faces huge economic problems as unemployment is increasing. Also the business performance is very low because of the political, social and economic factors. The capital equipment, the machinery, the growth of resources and applications of technology are on pain.

We selected a small number of companies that would provide valuable information for our research. These companies were:

#### **1<sup>st</sup>: Company in the Logistics Services**

The company that we visited and made our research is the biggest Company in the logistics services in Greece. This company makes use of all application packages in the area of Supply chain management and not only. The integrated system that is working is one of the best information systems worldwide. This enterprise automates most of their business flows and procedures. Company includes facilities such as facilities of warehousing, machines with automated packing, distribution systems, high tech vehicles and reliable IT infrastructure. Company's facilities are placed in



three strategic geographic areas in Greece. The equipment of their warehouse includes:

- Back-to-back
- Radio shuttle
- Drive in / drive through
- Block-stacking

Handling materials are done by forklifts and electric pallet trucks. Security is also strong and reliable with high tech information systems for all of their operations. Company has applications for security measures, fire detection alarms, and protection of fire, high tech security cameras, fire alarm, pest control and guarded yard. IT support is also strong and they are using application packages for ERP systems, WMS, RFID, Online and Real time stock, KPIs of productivity, Navfleet and Dispatcher.

## **2<sup>nd</sup>: Trade and Telecommunication Company**

This company produces transfers and sales personal computers and telecommunication equipment for offices. The enterprise is divided into three main segments: The office products, personal computers, Digital Technology products, and Telecommunications products for many uses. In the enterprise two more segments also exist. Firstly, services sector and services of transportation. Most of the products are transported and delivered to a network of 23 stores in Bulgaria and Greece.

During 1999 the company started to invest in high tech of supply and production systems. Nowadays, this specific company is one of the leaders in Trade and telecommunication industry in Greece. This specific company uses a variety of information systems such as:

- ERP (Enterprise Resource Planning)
- CRM (Customer Relationship Management)
- BW (Business Warehousing) for preparing statistics and making forecasts of stock, sales and cost.
- WMS (Warehouse Management System) for developing a new and innovative distribution center
- HR (Human Resources) for managing the resources of the company

- RFID (Radio Frequency Identification).

### **3<sup>rd</sup>: Tobacco Company**

The enterprise is the largest tobacco company in Greece. It is working on automated procedures through its production process. It is also investing and selling its products and services worldwide. Its multiple organizational units are technologically and automated working.

The drivers for the adoption of technology are the following:

- The need to develop a modular information management and reporting system. Machine level controls had to be integrated and Enterprise Resource Planning application needed to be established and automate business flows.
- The need to invest on a high tech standard platform to forecast market trends for the Greek market and around the world.

The tobacco company shifted into to technology applications adoption for gaining business value through the real time procedures and flows of transformation.

### **4<sup>th</sup>: Dairy Products**

This company is well known for its fresh dairy products to Greek customers and not only. Their products are based on fresh raw products in respect to the Greek culture and to the Mediterranean food diet. This company is famous worldwide for its fresh daily and cheese products. The enterprise is using most of the application packages in order to automate all their internal and external business processes. The cost is reduced and therefore company has a strong competitive advantage through the marketplace.

The whole manufacturing and production line area has been equipped with innovative RFID systems and application packages. Company gathers intelligent data and processing units are also technologically working inside the factory. Real time data are collaborating and automation of procedures are working properly. Employees are trained to innovative technologies such as RFID technology and only the identified personnel are allowed to use such technologies. A complete information system and a variety of application packages are working together for better performance for effectiveness and efficiency.

## **5<sup>th</sup>: Oral Care – Personal Care Products**

This enterprise that we visited is the most profitable company in Greece in this specific industry. It is thought as a leader with a strong competitive advantage. This company is already using strong and innovative technology systems such as application packages that are integrated together in order to reduce the total cost inside and outside of the company. This company uses ERP (enterprise resource planning), SCM (supply chain management), CRM (customer relationship management), HRM (human resources management) and BI (business intelligence) application packages across the entire spectrum.

## **6<sup>th</sup>: Aluminum Processing and Trading Division**

This enterprise is one of the leaders companies' globally. In Greece is the first company of producing aluminum.

The enterprise has many advantages such as:

- The flexibility in manufacturing
- The presence globally
- The presence in the market of lithography
- The leading position in the Greek market
- The huge distribution network
- The strong strategic partnerships worldwide

The company is famous for the quality of the products and services that offer. The enterprise emphasizes to its customers satisfaction and employees human resources management. The environmental care also plays a fundamental role. The enterprise has already developed a comprehensive program for environmental management and prevention.

The production line of the enterprise includes the following features:

- Internationally competitive Products with high quality are internationally competitive (products are exported in a percentage of more than 80% to Europe, Australia and United States).

- Production units are flexible in order to offer many specialized products to different industries.
- Stock of sales helps for quick and immediate services and demands.
- Technical support exists for after sales.
- Application modules are integrated with suppliers and customers.
- Recycling of aluminum scrap

The enterprise offers a modern distribution center of products. Customer demand plays a fundamental role for the enterprise. The enterprise spreads its operations and business flows through Central and Eastern Europe and also to the Balkans area.

The above enterprise makes use of the following application modules:

- Finance (FI)
- Controlling (CO)
- Assets Management (AM)
- Sales and Distribution (SD)
- Material Management (MM)
- Production Planning and Control (PPC)
- Quality Management (QM)
- Plant Maintenance (PM)
- Human Resources and Payroll (HR)
- Project System (PS)
- Business Workflow (BW)

## **7.1 Qualitative vs. Quantitative Research**

Two main approaches exist in order to control researches. Qualitative and the quantitative approach exist. The qualitative focuses on examining phenomena and now factors entries from a close perspective. From the other hand, quantitative approach examines phenomena and new factor entries to a larger number of participants with the use of surveys.

### **Qualitative Approach**

The qualitative approach describes a set of phenomenon or new factors entries in a deep comprehensive manner. An interview is the way of this approach. Interviews can

include open-ended questions or some group of people. Mostly, very few people participate with this approach. This happens because that the participants need to spend time for answering the questions and sometimes they do not want to share some of the confidential information. Interviews can be highly structured and guided and also include open-ended questions, or be less structured. This method of interviews cannot be adapted to the number of population that we want. This approach informs the practice, the theory and can be adopted on specific phenomena and situations.

### **Qualitative Approach Advantages**

Qualitative approach is using open-ended questions and interviews. This allows researchers and practitioners to understand how people are facing specific factors, outcomes and situations. Qualitative research can be thought by some people as an unreliable research. This happens because some participants may not clear understand of some situations and phenomena and give wrong answers or inappropriate information and data.

- Allow to examine new factors
- Can provide a clear view of mechanisms
- Give reliable information
- Give numerical forms apart from verbal information
- New questions may arise after completing the questionnaire

### **Limitations:**

- General population cannot be generalized
- Statistical methods are applied
- Some characteristics cannot be assessed

### **Quantitative Approach**

This approach gathers data and information in order to spotlight descriptions on a specific area to a big number of people/participants. It provides summary of characteristics across group of participants. This approach examines a large number of participants and groups apply statistical information and techniques in order to recognize all the processes of relations. It is very important to use the surveys across groups and a large number of individuals. For example, the same survey or questionnaire can be used with a group that is getting training and at the same time the questionnaire can be delivered to another group or individuals that are not getting

trained. Researchers can make comparisons of the data and information collected and determines the influence of the training that had on groups.

### **Quantitative approach advantages**

Quantitative approach has some advantages. This approach enables the generalization while using the methods of survey to a large group of people. If we interview a few people or handle to a focus group with forty matches, it should be emulated of particular cases in which the mentoring training worked. This approach could not bring evidence that is strong. Stronger support for training with success would be evidence if we use quantitative methods.

Quantitative methods can:

- Gather information and data from a large number of participant/people
- Manage in a number of group of people, that allows correlation
- Establish to a large population
- Give rating numbers and information
- Inform for policies and guidelines
- Relate variables between statistical techniques

### **Limitations:**

- This method cannot calculate new phenomena and derived factors
- This method cannot analyze if we do not have a group of control

Qualitative and quantitative methods of research grant with different approaches of new phenomena. These two approaches are highly informative, if they are used in collaboration groups. “Each approach has its benefits and detriments, and being aware of the methods used to gather information can help practitioners and policy-makers understand the extent to which research findings can be applied”. (chronicle.umbmentoring.org, 2014)

Authors started the research by using a quantitative analysis. Due to the first year of research, authors converted their research in mixed methods research. In order to create the proper questionnaire authors organized first some visits to a lot of companies in order to have a 360 view of the enterprises’ business flows and procedures and also make to the point discussions with managers and employees. Mixed research helped authors to create the specific questions to the questionnaire in order to gain the best results and make valuable assumptions.

## 7.2 Data Collection

Data collection was a very important area of investigation and we paid a lot of attention to it. This happened because the collection of these specific data would have been the basis for the results. We examined the following questions in order to receive proper and useful answers for our research:

- What specific information systems enterprises in Greece make use of?
- What is the extent of information systems use to fully automate their procedures?
- In what ways enterprises are trying to earn and access into the global marketplace?
- In what extent are these enterprises willing to adopt RFID technology and other innovative technologies?
- How important is the training and the education level of employers and employees?
- Employers and employees do they have the knowledge and experience from their previous education level?

We examined a few enterprises that are strong market players in Greece and abroad. We collected data and information in order to measure them and use them for our critical evaluation part for the adoption of RFID in these companies.

We collected specific information data from the enterprises that we visited in order to show the level of performance and the use of technology and information systems to the production level and the supply chain management level. We could finally measure in some extent how these systems can lead the enterprises to the best efficiency, effectiveness and competitive advantage. The following assessment items were introduced and analysed to the above enterprises:

Assessment item	High Importance	Low Importance	Very Low Importance
Corporate strategy regarding logistics	√		
Supplier contract terms	√		
Customer contract terms	√		
Market trends and forecasting	√		
SCM planning	√		

JIT	√		
Customer lead time		√	
Environmental activities		√	
Electronic Data Interchange	√		
Usage of bar coding	√		
Usage of applications for forecasting		√	
Decision support systems for supplier performance			√
Supply chain management applications	√		
Supplier push to adopt supply & production systems			√
Government push to adopt supply & production systems			√

**Table 6:** Assessment Items from Companies' Answers

The above table arises from the maximum of answers that we collected from the companies according to the assessment items. All enterprises operating in Greece are favored as market leaders in the industry they belong to. Each company gave an answer to the specific items. The maximum of answers in each item is shown by a tick in each category. Enterprises have to carry some of their information confidential for competitive reasons.

The PEST diagram will be also presented to show the big picture of RFID technology and how it can operate through the Greek environment. This diagram also addresses the thoughts of the political (P), economic (E), social (S) and technological (T) challenges of the RFID technology adoption in Greece. Critical evaluation analysis will also take place in order to examine, propose and explore the impact of the results founded from this research.

### 7.3 Data Analysis

The private sector in Greece shows a great interest in adopting the Radio Frequency Identification technology. A lot of enterprises maintain systems that are integrated and technological solutions in order to fully automate the internal and external business processes through the supply chain.

Some of the main solutions that are offered in the supply chain operations in Greece cover the following areas of study:

1. *Distribution Center*



Through the distribution center RFID technology will automate all material handling needs from the level of receiving and storage to the level of order picking and shipment. Wang et al., (2008), evaluated the degree of improvement by applying RFID technology to a distribution center. Results were oh high importance.

## 2. *Asset Tracking & Management*

In asset tracking and management, RFID will support the functionalities like asset search, inventory and tracking history. Oztekin et al., (2010), analyzed the trade-off between cost effectiveness and overall RFID system performance and as a result they had a valuable effect on real time information. The search time for crucial assets decreased rapidly.

## 3. *Retail & Apparel*

Retail and apparel will also be an automated process with real time data and information. Items and stock taking process will be ease of use and rapid. Bertolini et al., (2012), presented and quantified the business benefits that can be achieved through the deployment of RFID technology in the apparel and supply chain in fashion. They provided and also estimated the benefits both to strategic and operational level. As a result, they founded that RFID has the ability to provide new data that allows the increase of sales and improvement in customer satisfaction.

## 4. *Laundry Tracking*

Laundry tracking automates the process between laundry and the customers. The replenishment cycle will be fast and accurate and customer's services will be improved. The whole automated procedure has the advantage of cost and time reduction. Technology of RFID can be used to the Laundry Management System (LMS) as Van et al (2012) proposed. As an outcome they presented the reduction of power consumption, the increase of value added services, the low costs but better monitoring.

## 5. *Personnel Management*

Personnel management is very crucial as a procedure by itself. RFID technology automates processes through personnel reporting, personnel availability, resource allocation, and of course, personnel safety. Some authors introduced the system that automatically diagnoses the personnel in different situations. The system had a vital significance in improving the coal mine security management.

## 6. *Waste Collection Management*

RFID technology enables waste collection management to identify automatically waste bins assorted with weight information. Organizations can get a full cover of tracking and management needs of even the most demanding waste collection processes. Nielsen et al., (2012), demonstrated a widely distributed and semi-structured network of waste producing enterprises and waste processing enterprises by improving their operations planning by using RFID technology. RFID technology had the advantage to update and validate information in a continuous manner to bring value-added benefits to the waste collection business.

## 7. *Library Management*

Library operations are becoming the backbone of the main processes. RFID technology will transform traditional library processes to a new level. Searching, inventory, lending, returning and sorting will become contemporary globally. Zhang and Shi (2011) depicted the necessity of RFID technology of self-service book borrowing and returning system in library. RFID will replace the barcode technology and accelerate the library's self-service process.

## 8. *Patient Safety*

Patient safety is too important area as it has to do with human health. RFID technology will help the procedure for real time patient tracking, creating a link between the patient's state and the hospital's information system. Administrative tasks will become automated as well as patients' security issues will be solved. Wickboldt and Piramuthu (2012), proposed some protocols in order to identify some existing vulnerabilities.

## 9. *Document Tracking*

Tracking of documents is very crucial to organizations. Most documents are saved electronically but most times are difficult to retrieve. RFID will be the tool to search and find documents quickly in real time. A few authors, proposed an RFID-based location tracking system for distributed offices based on Session Initiation Protocol (SIP). The proposed system distributes RFID tag presence information to users through IMS (IP Multimedia Subsystem) presence enabler service. This enables real time monitoring of the observed office assets and their current presence status.

## 10. *Automatic Vehicle Identification*

Automatic tracking is another procedure that RFID technology will automate and provide a wide range of tools for further monitoring and analysis. Brandwein et al., (2012), found the optimal combination of transponder and reading device for a passive RFID system in UHF frequency band and suggested improvements.

All of the above areas are available to the Greek market in order to adopt them and automate the business processes.

The following table includes Greek enterprises that have already adopted or planning to adopt the RFID technology to their procedures and flows.

<b>ORGANIZATION NAME</b>	<b>INDUSTRY</b>	<b>LEVEL OF RFID</b>
Diakinisis	Distribution	Storage & Shipment
Plaisio Computers	Distribution - Retail	Warehouse Management
Colgate – Palmolive	Consumer Goods – Personal Products	Point-of-Purchase Promotional Management & Item Level Packaging
Olympos Dairy	Dairy	Logistics
Technological Educational Institution of Kalamata	Education	Library Services
Municipality of Korinthos - Waste Collection Management	Public Sector – Waste Management	Waste Chain
Ioakeimedes Textiles S.A.	Textile & Fashion	Warehouse Management

**Table 7:** Adoption of RFID in Greece (Peppa and Moschuris, 2013)

Diakinisis enterprise is a logistics center that belongs to the distribution sector. It is one of the largest third-party logistics providers in Greece. Enterprise “Diakinisis” has already implemented alien tags and RFID readers that have been tested on site for different RFID applications. The engineering manager “Vlasis Tsezos”, who is placed on Business effectiveness and efficiency, points out that the adoption of RFID was a strategic thinking regards to the competition in Greece. He added also that the specific system will save time, cost and labor. Employees will change the way of doing things. For example, they will no longer manually scan the barcodes used in order to check and identify all the pallets. The RFID Technology will provide “Diakinisis’s” customers with proper and detailed visibility of their goods shipped and transferred. The rest of the enterprises are planning to adopt a fully RFID technology in the near

future and at the moment they use a pilot project to check the procedures and flows. Some others are willing to participate to similar projects adoption of RFID.

We chose specific enterprises managing in Greece and we collected specific data in order to show the level of performance and the importance of RFID technology systems to those enterprises. We collected such data that will help us understand how these enterprises can be led to the best efficiency and also gain a competitive advantage through the global marketplace. Furthermore, managers were asked about the level of education and knowledge that their employees need to have.

The following assessment indicators were introduced to the above enterprises: Corporate strategy regarding logistics, market trends and forecasting, SCM planning, EDI (Electronic Data Interchange), applications usage for forecasts, decision support systems for a better supplier performance, general supply chain management applications, the level of employees' education, training of employees, cooperation with universities and support, academics cooperation, government push and support and finally the need for RFID technology to fully automate and collaborate with the existing systems all business flows and procedures.

Enterprises have to carry some of their internal processes and information confidential for competitive reasons. All the enterprises analysed, tend to be market leaders in Greece to each industry they belong. Every company was asked to answer specific questions on specific indicators.

### **7.3.1 S.W.O.T Analysis for RFID Technology in the Supply Chain Management Area in Greece**

Greece is a very small country but in a very hard position. Private and public sector are trying to get over all the drawbacks from economic crisis and finally become strong market leaders. It is worth to present an S.W.O.T Analysis of the Greek market and display all internal and external indicators that play a significant role on the adoption of supply chain and production systems in Greek enterprises.

SWOT Analysis is a strategic planning tool that is applied by most of enterprises. SWOT analysis presents all positive and negative factors that are analysed and delivered.

**Strengths:** Applications of supply chain and production systems have been adopted by a great number of enterprises. The length of time will show stronger and better

outcomes. The organizations' profits will come by future promotions through the marketplace. Enterprises need to focus on customers' needs and therefore offer the right products or services to the lower cost. Organizations are willing to follow technology and innovations such as RFID technology.

**Weaknesses:** The most important drawback and weakness is the cost of technology systems which is very high. Enterprises need to know the Return on Investment (ROI). If Greek enterprises are able to know the ROI rate then they will be able to organize their operations, business flows and strategies. Economic crisis stands again as a drawback for enterprises to grow. Employees, employers and system users need to get trained for all these new technologies and operations and know how to use competency right.

**Opportunities:** The waterfall effect exists and stands as an opportunity to the Greek sector. A lot of enterprises have already adopted supply chain, technology systems and production systems. Some others need to follow up to this change. Revolutions in technology systems will help enterprises to grow, application packages will stand as a solution of the current business flows and procedures.

**Threats:** In Greece a lot enterprises use information system for the automation of their procedures in the supply chain management area. But a small percentage prefers doing things in the traditional way. This stands as a threat for the fully process automation. Enterprises due to economic crisis cannot afford investing on new innovative technologies. As a result is to see Greek enterprises to getting out of the market and business. The cost of implementing and training is too high for them. Unemployment is high at the moment and enterprises need to find ways to stay up to date with new information systems and technology.

### **7.3.2 PEST Analysis for RFID Technology in the Supply Chain Management Area in Greece**

Generally, PEST analysis derives from marketing concepts. Many literature studies exist on PEST analysis by identifying the external factors/issues within an environment. These external factors may have impact on specific procedures and operations through the enterprise. Zalengera et al., (2014) used PEST analysis and presented an overview of the energy situation in Malawi as well as the resources of renewable energy. Oraman, (2014), presented organic food from Turkish industry and

focused on specific drivers of the Turkish industry. Baert et al., (2011) reported the measurement of the perceived pressures and the responses that result for the food chain safety in Belgium. PEST analysis can be granted as the tool for companies when they want to order, check and analyze the specific environment indicators. This may assist on an innovative technology, a product or a service. We considered the following questions and tried to find answers in order to create a PEST analysis diagram for the adoption of RFID in Greece.

- (1) What is the political situation in Greece and how can it affect the adoption of RFID technology?
- (2) What are the common economic factors?
- (3) How important is the Greek culture through the global market?
- (4) What kind of technologies Greek companies use and how do they integrate to the global market structure?

Each letter of PEST analysis is very important. Through this specific analysis, we will explore the significance of the adoption of RFID technology in Greece and derive the importance of this specific technology.

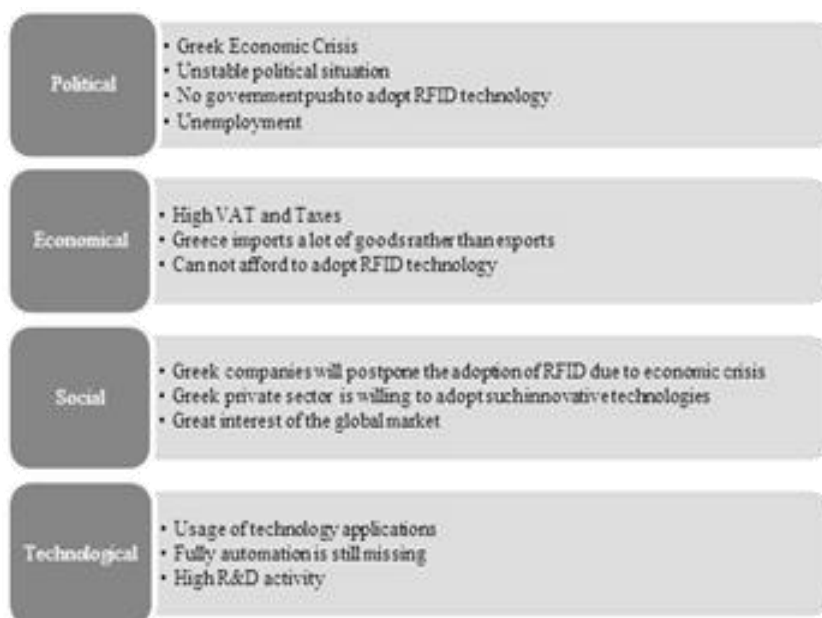
(1) Political: Political factors are very crucial for the Greek economy. Due to economic crisis, Greek enterprises are bidding to find ways action and approaches to regain their competitive advantage and become strong market leaders. RFID technology can be thought as the innovative tool for success and growth. The pressure of competitiveness is increasing and Greek enterprises need to find ways of adopting and gaining new and innovative technologies. By this way enterprises will increase the efficiency and effectiveness through their internal and external business processes. From the other hand, Greek government may impose a new tax that will change the structure of Greek organizations.

(2) Economic: Economy performance is also very important because it impacts Greece and, therefore, Greek companies. Economy can also affect the purchasing power of a consumer. Economic factors like interest rates, foreign exchange rates, inflation rate and economic growth can be disturbed and will lead to economy status change. According to Organization for Economic Cooperation and Development (OECD), economic growth remains weak. The uncertainty is related to the reform programme and liquidity conditions have undermined enterprises confidence and investment. In the future, the growth will achieve a momentum and unemployment will be reduced while exports and investment recover. The momentum reform is

renewed. The deflation will go on due to the very large degree of slack in the economy. The burden of debt will stay very high, and the fiscal sustainability will require continued restraint for a long time. The fiscal policy should aim at a small primary surplus. Tax system reforms and collection of taxes are mandatory to increase revenues. The pension reforms would help to consists of the spending. Structural reforms to barriers of competition and the investments should advance all the exports and create higher-quality jobs. The social policy remakes should aim at a fair sharing of the costs and benefits. The investments will depend on critically on a return of business confidence and on stepping up the pace of structural reform implementation. Another essential part is the good access to credits. The banking system should be stabilized by showing the high level of non-performing loans.

(3) Social: Social factors assign to cultural trends, demographics, population analytics etc. Cultural trends are very important because they can present in a way the different business strategies of Greek companies. It is worth to point that there are some Greek companies that believe that traditional ways of doing things is the best way.

(4) Technological: Technology factors assign to innovations in technology that can affect the operations of the Greek industry and the market. Automation, research and development are the most crucial factors. RFID technology is an innovative technology that will affect all procedures and operations.



**Figure18:** PEST Analysis for RFID in SCM in Greece

### **7.3.3 Balanced Scorecard Model for the Adoption of RFID Technology in the Supply Chain Management Area in Greece**

This chapter presents an extended critical analysis of the Balanced Scorecard model as far as the adoption of Radio Frequency Identification (RFID) technology concerns in the Purchasing and Supply Chain Management (SCM) area in Greece. Literature review has proven that Balanced Scorecard model can be applied to evaluate the performance of the Supply Chain. From the other hand, the use of RFID technology in SCM can lead companies' to gain efficiency, effectiveness and also achieve a competitive advantage.

The Balanced Scorecard model can help enterprises operating in Greece to examine specific variables in order to use RFID technology at the right place and time. This implementation and adoption can lead enterprises to get over the economic crisis and, therefore, become strong market leaders. Balanced Scorecard will be used by companies as a guide of measurement and managers can have a clear picture of their vision and mission of their companies.

This thesis also contributes to the knowledge of the following areas: (1) Analysis of the Balanced Scorecard Model of RFID Technology in Purchasing and SCM in Greece, the reflection of the results and lessons learned, (2) Proposals in order to get over the economic crisis, (3) Directions for further research.

The economic crisis in Greece led businesses to exist in a complex and competitive environment. Therefore, there is a great need to use a strong and effective tool that can provide better performance, effectiveness and a strong strategy. The Balanced Scorecard is a flexible performance measurement method consisted by four perspectives. First the financial, second the customer, third the internal business processes, fourth learning and finally the growth (Kaplan & Norton, 1996). The approach of Balanced Scorecard can evaluate SCM as a source of reducing cost and concerns on good financial measures. Most companies often are unable to invest and implement "effective performance measures and metrics" (Kaplan & Norton, 1996) in order to achieve a fully integrated SCM. The lack of a balanced approach and the lack of clear distinction between metrics at strategic, tactical, and operational levels can lead enterprise to unable to use the model of BSC (Gunasekaran et al., (2001); Hudson et al., (2001)).



A lot of businesses operating in Greece focus on cutting costs, reducing capacities and consolidating suppliers. Those businesses that are still alive are trying to adopt innovative approaches to safe their internal and external procedures of supply chains and create a challenging business climate.

Balanced Scorecard model can help senior managers to review the performance of their businesses quickly and prepare strategic plans that will lead businesses to excellence. The approach of the Balanced Scorecard was developed as an innovative tool for coordinating business activities to the vision and the strategy of the enterprise. This tool can improve all internal and external communications, flows and monitor the organisation's performance through strategic goals (Kaplan & Norton, 1992). SCM covers all possible processes with strong marketing decisions, customer demand, corporate business strategy and goals. SCM is an important area for information technology, information systems, innovations and investments (Bowersox and Daugherty, 1995).

RFID technology works throughout the entire supply chain processes enabling the visibility from start to finish. RFID supports better traceability and better identification of problems in the SCM area. RFID can manage the movement of materials along the supply chain. Therefore, it contributes to better supply chain efficiency, visibility and responsiveness.

### **Balanced Scorecard (BSC)**

The Balanced Scorecard method was introduced by Kaplan and Norton (1992, 1996). This method has been successfully implemented in a wide range of areas. Lipe & Salterio (2000) provide and believe that, even though the Balanced Scorecard spotlight on unique, non-financial, division-specific performance measures, stakeholders and managers still develop the performance that is based on common, financial metrics. Balanced Scorecard method has experienced an increase in popularity as a performance measurement system for translating an organization's mission into goals and measuring processes related to goal achievement. Balanced Scorecard model is one of the most well-known and accepted management tools today (Atkinson and Epstein, 2000; Frigo and Krumwiede, 2000). Balanced Scorecard can define long-term business objectives due to the impact of short-term events and,

therefore, present organization's vision in goals and objectives (Kaplan and Norton, 1996).

The Balanced Scorecard method has the advantage of balancing the financial and non-financial variables, move problem focus on financial variables, customer and business process, learning and growth variables (Banker et al., 2004).

Literature shows that Balanced Scorecard method is widely used in order to make clear each company's vision and mission by measuring all variables in each category. Lipe and Salterio (2000) came to the conclusion that all individuals will be able to make better companies' decisions by using the model of BSC. Wu (2012) used several criteria analysis tool and created strategy maps by determining causal relationships between main performance indicators. The purpose and the size of the BSC through business changes were studied by Gomes et al. (2013) and Mehrdad et al. (2013). Brignall (2002) studied BSC approach by focusing on other perspectives such as sustainability.

The Balanced Scorecard method has been successfully applied mostly as a strategic management tool and there is no confirmation that this method fails. Neely and Bourne (2000) believe that BSC method has a 70% percent of failure rate. Even though that the positive impact of managers better understand the causal relations on decision-making results is supported by empirical research (Capelo & Dias, 2009; Gary & Wood, 2011), evidence is limited for the effect of performance-measuring cockpits on decision-making outcomes.

### **Balanced Scorecard Method of RFID in Greece**

Companies operating in Greece show great interest in adopting RFID technology. Economic crisis stands as an obstacle of adopting new technologies and implementing innovations through the purchasing and supply chain. We strongly believe that if companies operating in Greece follow up a Balanced Scorecard model through their supply chain, they will soon minimize errors and mistakes and move stronger and faster through the global market.

RFID technology is an innovative technology that is not widely used in Greece and it is hard to prove and measure. Cost implementation is high enough that managers are seriously thinking the total cost of implementation. Most managers understand the value of this technology and the benefits that are gained by RFID

technology. Greek companies pain at the following areas that we will investigate and analyze.

- Business growth: Growth in Greece is very low. RFID technology will support growth by increasing transaction volume and creating new products/services.
- Global competition: Global competition is very high and Greek companies cannot easily enter into global markets. They are not strong enough and competitive ones.
- Customer satisfaction: Greek customers' satisfaction perspective needs review. Customized customer solutions are needed.
- Innovative technologies: Technologies such as RFID need wider use by Greek companies. Greek companies pain on innovations.

Thesis authors focused on these companies that are working on the Purchasing and Supply Chain Management area in Greece. A lot of enterprises in Greece are adopting the BSC as a base of their strategic management system. Very few managers achieved to create new strategies and gain growth opportunities. A large number of methods exist in literature for the “performance measurement systems” (Bititici & Nudurupati, 2002; Chan & Qi, 2003; Chan, & Qi, 2006; Sharma et al., (2005)).

Due to economic crisis in Greece for the last years, it is worth to examine the balanced scorecard method for companies in order to show the illustration of different performance dimensions. We will consider financial and non-financial points. BSC will be used for different purposes. We will count on the benefits of BSC and will present a model that will include some elements that refer to the Project Management area. The benefits that are taken into account are the following:

- Motivation to managers and employees (Ax et. al., 2002)
- Planning and fulfilling goals (Collier, 2005)
- Long term values and goals (Collier, 2005)
- Monitoring performance (Ax et. al., 2002)

### **Methodology for BSC**

We made a quantitative research as we visited many companies in the area of Purchasing - SCM and collected 65 filled-in questionnaires by leading companies located around Athens. These companies use RFID systems partly in their supply chain and plan to expand RFID technology through their whole supply chain.

These companies already use application packages such as ERP (Enterprise Resource Planning) and the use of such application package will help them to make the best of automating their internal and external procedures through the supply chain. Economic crisis in Greece for more than eight years makes difficult for businesses to invest in new technologies and machinery. Internal factors such as customers and stakeholders do not make a step forward of paying or investing because of capital controls.

All data collected from interviews and questionnaires helped us to develop a Balanced Scorecard diagram and propose this diagram to companies operating in Greece as a key tool of pointing the vision and enable them to clarify their vision and make the best strategy. We also made a critical evaluation analysis of the Balanced Scorecard method and detected key points of adopting RFID technology in SCM area. All of the above could be a proposal of leading to supply chain innovation and process improvement.

Managers were asked key questions and tried to give answers and ideas that are included into the four perspectives of Balanced Scorecard. The following questions used as a guidance of our critical evaluation part.

1. Financial: Do you invest on new technologies?
2. Internal Business Processes: Are your internal business processes fully automated?
3. Innovation & Learning: Is your company using last technology innovations? Do you keep up-to-date your employees of these new technologies? How often your employees are getting trained?
4. Customers: Is the company focusing on the customer 100%? Are your customers satisfied? How do you measure all of the above?

Using the four perspectives mentioned below, we tried to find how they can help enterprises operating in Greece to survive, make investments on RFID technology and apply the best and suitable strategy for expanding their businesses.

- a. Financial Perspective: Improve their financial performance and be able to survive in such difficult years as economic crisis is still on the Greek map.

- b. Internal Business Perspective: Examine all of their internal and external business processes and make new plans and manage to create the best strategy that suits to each company.
- c. Innovation & Learning Perspective: Be able to make and invest on innovations such as RFID technology and become up to date to most of the new entries in technology and not only.
- d. Customer Perspective: Satisfy customers and make loyal customers despite the economic crisis.

Balanced Scorecard perspectives will show the real picture of how businesses face some of its parameters and what can be the result of following a Balanced Scorecard method in the whole supply chain.

## Chapter 8

### 8. Results

This chapter represents some of the results drawn from the interviews that took place in Greek companies. Assessment items are addressed by the results found. The following enterprises are though as market leaders in the Greek market. It is worth to point that some of them do not operate with fully automated systems. Some of their business processes and procedures are completed by the traditional way. Most of the managers believe that Greek economic crisis is an opportunity for them to expand to the global market. Economic crisis will give a push to expand to the global market.



**Figure19:** Assessment Item: Corporate Strategy regarding Logistics (Peppas et al., 2013)

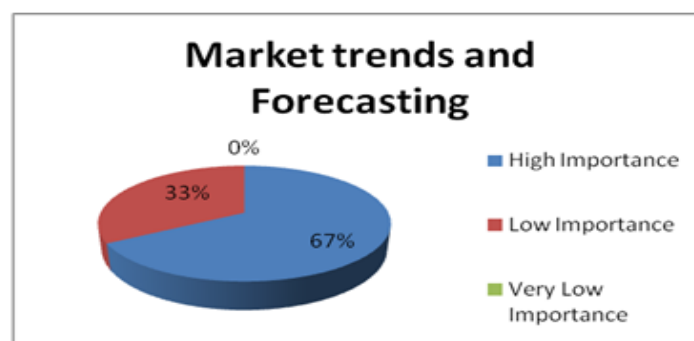
Corporate strategy is a crucial factor for the logistics area in order to define the service levels and become more effective. A percentage of 83% of enterprises are implementing a strong corporate strategy for specific product lines, countries and specific number of customers and innovative technologies. A very small percentage of 17% of the enterprises do not believe that the corporate strategy will lead them to effectiveness.



**Figure20:** SCM Planning

Most enterprises need a strong strategy for managing all of the resources and procedures depending on customer demand and changes. SCM planning, include a set of metrics in order to monitor the whole supply chain management area. Four (4) out of the six (6) enterprises are developing a set of metrics for monitoring the whole chain management area. These enterprises improve their supply chain network, they

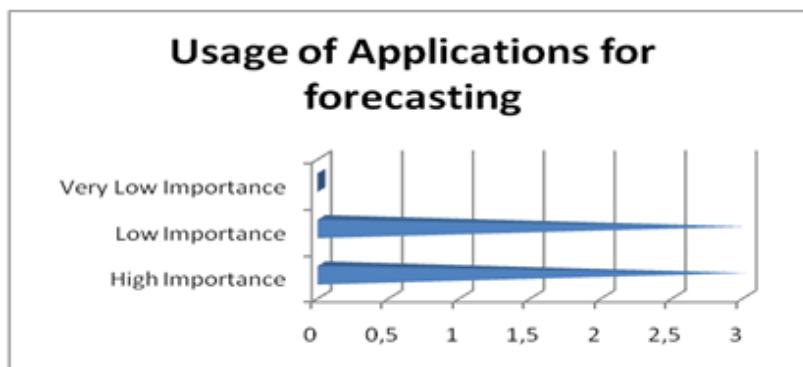
also minimize the delays and finally they reduce the general costs. A small number of the enterprises interviewed believe that planning is wasting time as far as costs, time, investments and resources.



**Figure21:** Market Trends & Forecasting

A big percentage of companies interviewed believe that, as the market changes, they need to follow up on every change. It is very important for the companies to predict when the change will occur. Enterprises believe that they need to adapt to the different changes and follow up customers and of course the market demand. Forecasting is another way to measure repeated changes and predict the profit. Enterprises need to know the customers' demand in order to be able to prepare produce the products or services needed.

Information and data flows from barcodes are transmitted through the Electronic Data Interchange systems. It is then easy for enterprises to gain the right information for all of their products through the supply chain. From the other hand, Electronic Data Interchange has a lot of standards. Therefore, if enterprises need to use this technology they should developed the specific system or application. Still some companies prefer the traditional way of doing things as far as methods of data interchange and communication concerns. It is worth to point that these enterprises are considered market leaders in Greece. SMEs in Greece do not all use Electronic Data Interchange system.



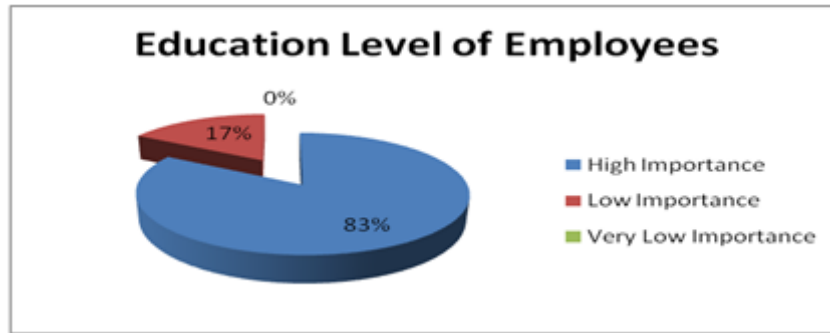
**Figure22:** Usage of Applications for Forecasting (Peppas et al., 2013)

One (1) out of the six (6) companies reviewed is using the Business Intelligence application package for forecasting. Three (3) out of the six (6) companies believe that BI applications are useful but their businesses are relied on statistical data from market research. All of the above enterprises strongly believe that forecasting is one of the best ways to predict customer demands and other crucial business procedures. The forecasts that they follow derive from the applications that they use at the moment that retrieve simple statistical reports and the information flow from the market. Still, most managers in Greece strongly believe that Business Intelligence application is a useful tool for adopting and gaining the best business strategy.

The interviews summarized that only one (1) out of six (6) enterprises makes use of the Internet Supplier Portal. This small percentage showed us that enterprises in Greece do not have the fully automated information and data change between their suppliers. This can lead to mistakes, delays and other crucial drawbacks. Most suppliers do not use the Internet Supplier Portal and the business procedures tend to have bugs and mistakes. Five (5) out of six (6) enterprises are not willing to invest in Internet Supplier Portal for the next years. Supply chain management in the Greek are includes a big number of suppliers that prefer to work on the traditional way but in some cases we show that they are still strong market players and leaders. Another point from this issue is that suppliers do not have the application packages or the proper integrated technologies in order to share information and data in real time.

Supply chain management applications are mostly based on these application packages that involve financial procedures and flows. Managers need to make fully integrations of all their applications packages that they use in order to make successful change of data and information. By gaining this integration, Greek enterprises will add value inside and outside of their businesses.





**Figure23:** Education Level of Employees (Peppas et al., 2013)

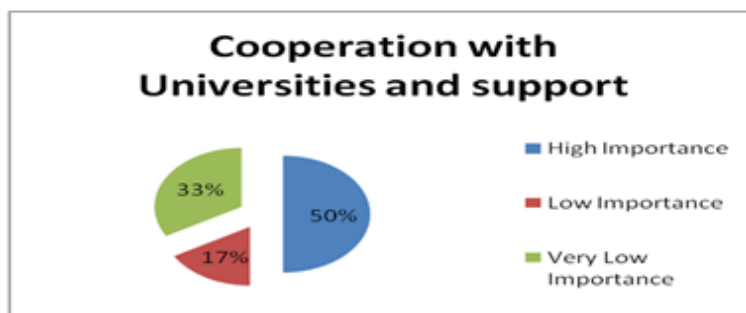
The education level of employees is another crucial part from our research. Most of employees nowadays hold a Masters' degree. The percentage here is very high which means that nine out of ten employees hold a Masters' degree (MSc in Economics, Logistics or Information Systems). Students in Greece, while finishing the university degree (undergraduate course) they move on to a Masters' degree in a special area of study. A percent of 83% which is very big agree that middle level employees such as managers and consultants need to have at least one Master's degree and several years of experience in similar positions. A lower percentage of 17% believes that is better for employees to have a university or a technical undergraduate degree and a few years of experience.



**Figure24:** Employees Training (Peppas et al., 2013)

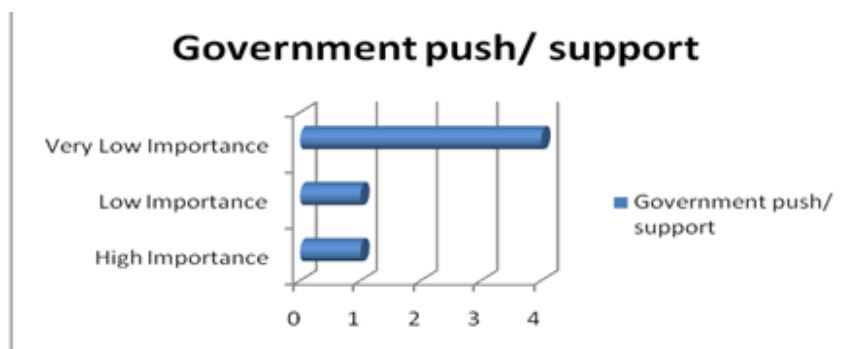
Through the interviews and the questionnaires collected managers were asked about the importance of the training issue of their employees. All of them believe that training is very crucial for employees and they make a strong effort of this. Employers also pointed that employees need further training as far as innovative technologies concern, and more specifically of RFID technology. Apart from the degrees that employees hold, they need a better preparation on working on such technologies. Employees need a further training and support. The employees that hold strong

degrees are giving value to a more academic content rather than the experience part of working.



**Figure25:** Cooperation with Universities, Academics and Support (Peppas et al., 2013)

Fifty percent (50%) of managers showed a great interest in cooperating with academics and universities in order to reverse the knowledge and the practice of RFID systems and on innovative technologies. Experiences in theoretical and empirical data and information will make the strong collaboration between the academics and the private sector in Greece. Managers from the enterprises also proposed that it is very important for the students to earn theoretical background and practical experience in specific areas of technologies. A lower percentage of managers believe that the experience comes better from internal business training rather than the collaboration with universities.

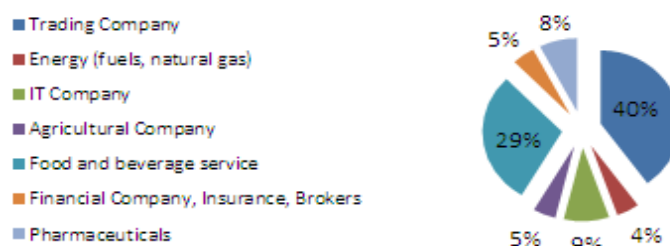


**Figure26:** Government Push/Support (Peppas et al., 2013)

The table above shows that government push is too low as far as the adoption of RFID technology concerns. Companies need economical help from the government and cost packages for developing new and innovative technologies. Government push strongly appears through the public sector through the different ministries. Due to economic crisis, Greek private sector is in a very weak position as far as the business strategy

and getting into global markets. Greek enterprises give a strong fight to stay in the market and keep a position as a strong market player into the Global Market without the government push or support.

A list of inference on PEST analysis was established in light of the business environment of Greek companies. Each one of the elements will be presented according to the Greek reality. We collected data from different types of companies for which SCM is crucial for their everyday business procedures. The following figure shows the types of companies that gave answers through the questionnaire.



**Figure27:** Companies that Answered the Questionnaire

It is worth pointing out that forty five (45) out of sixty five (65) companies belong to the food & beverage companies and trading companies. This is due to the fact that a large number of companies in Greece belong to food and beverage industry. Therefore, most of the products are imported and transferred from one place to another. The following table provides information concerning the size of enterprises (number of employees).

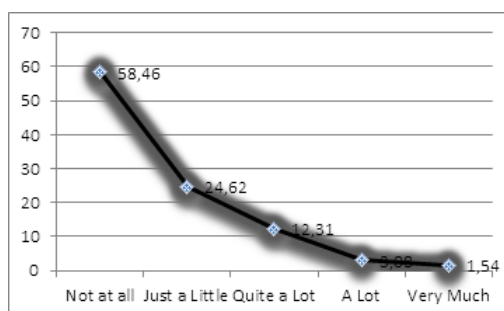
Less than 20 employees	From 20 to 50 employees	From 50 to 100 employees	From 100 to 200 employees	Morethan 200 employees	Total number of companies
4	5	6	18	32	65

**Table8:** Sample Profile of Greek Companies

Through the analysis of the collected data the following inferences were made.

*Political:* The conditions are very difficult for Greece as far as the Euro zone concerns and the International Monetary Fund (IMF). Due to economic crisis and the political situation in Greece, the government does not consider RFID technology to be an important element of supply chain management. Government officials need immediate recognition and promotion for innovative technologies and information

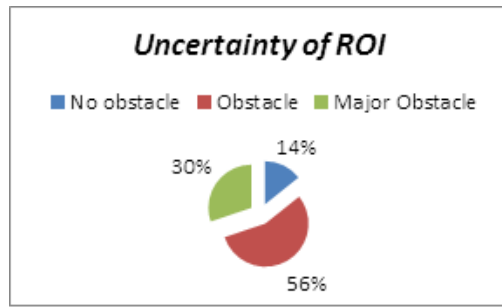
systems. However, the technology of RFID is complicated and requires much time and money. Return on investment will be shown over a long term. A long-term policy is needed in order to be perfect in every district. We collected range of data from a question answered by sixty five (65) companies in Greece that referred to the Greek government push as far as the adoption of RFID technology concerns. There is no funding by the Greek government to adopt such innovative technologies or companies are not aware of such funding packages. The following diagram shows the trend of Greek companies that believe that government push exists.



**Figure28:** Government Push of Adopting RFID Technology in SCM

It is worth pointing out that a large percentage of Greek companies (59%) strongly believes that the Greek government does not encourage companies to adopt RFID technology. During the interviews, production managers or warehouse managers pointed that the Greek government’s position is very difficult due to the economic crisis and they believe that in the future there is a hope of funding such innovative technologies.

*Economic:* The tags and the readers that are mainly used for RFID technology are crucial and at the same time very expensive. According to the survey and interviews’ results, most companies are unwilling to pay for more than 30% of the cost of retrofitting. An effective financing policy has not yet been formed. Without an economic motivation policy, companies will not be able to adopt RFID technology. A long-term reward mechanism or subsidy policy should be immediately implemented. Another factor that should be mentioned is the one of Return on Investment (ROI) metric mechanism. The following diagram represents the views of production managers referring to the level of adopting RFID technology to their enterprises and whether the cost of investment and the cost of maintenance and support prevent them to fully adopt RFID technology in their supply chain area.



**Figure29:** Uncertainty of Return on Investment

Production managers and warehouse managers pay attention to the cost of new investments in their companies. A percentage of 56%, which is very high, believe that they need to know the return of their investments. Long term investments seem to have a high risk metric that Greek companies might not afford at this moment of time. From the other hand, Greek enterprises realize that all the advantages of adopting such technologies are very crucial and important. The following table depicts the crucial advantages and profits of RFID technology in supply chain area as production and warehouse managers mentioned according to their answers.

	Much	A Lot	Lot	Little	Not at all
Improve Product Availability	11	26	21	7	0
Reduce Operating Costs	13	26	15	0	11
Invasion to Global Market	21	15	13	13	3
Improve Product Deliverables	20	16	14	15	0
Transparency	26	15	13	11	0
Improve Supply Chain Management	24	14	16	11	0
Improve Human Resource Management	14	20	14	14	3
Increase Sales Performance	14	16	16	15	4
Track and Trace	40	17	8	0	0

**Table9:** RFID Benefits in Greek Companies

RFID benefits are of high interest. Greek companies are willing to enter to global markets and become strong market players. Product deliverables need to get better and of high quality. Transparency is another aspect that Greek companies prefer as a standard in everyday business procedures. 24 out of 65 enterprises believe that the technology of RFID will help them to improve their supply chain management procedures. Human resources procedures also seem to have a better application with the adoption of such innovative technology. Track and trace of products or services is also another factor that Greek businesses need and are willing to improve in order to automate all internal and external procedures. It is worth to point that if Greek companies fully adopt RFID technology with all the existing application packages they use, they will be one huge step forward of strong competition in the global market. The following diagram presents the trend of supply chain management procedures. RFID technology, with the integration with all other application packages that enterprises use, will point and push to the fully automated systems of the supply chain management area. Full automation will minimize mistakes and delays through the supply chain and leads to business profits and effectiveness.

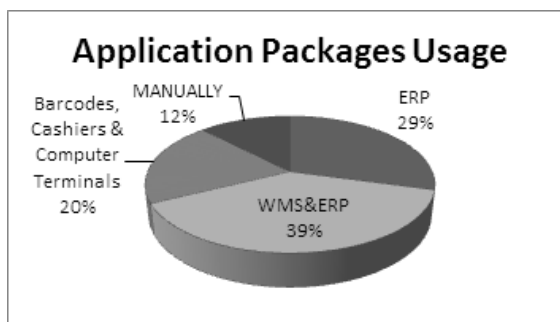


**Figure30:** Supply Chain Management Area Trend

*Social:* 70% of the companies in the Greek private sector are willing or have already adopted innovative technologies. The remaining percent (30%) of companies believe that the traditional way of doing things/business is better. Technology sector in Greece excels at capturing, analyzing, and sharing data. Companies that use innovative technologies add value to the social sector. Most companies in Greek private sector have a strong information capacity that can help social sector to understand the needs and the benefits. Therefore, most Greek companies can respond to global market challenges.

*Technological:* A successful implementation of an RFID system will be achieved by utilizing not only advanced and innovative technologies and products, but also state-of-the-art methods of appraisal and construction. However, Greek's ability to

successfully implement fully RFID systems lags behind that of well-developed countries. The technical part of RFID systems is that RFID has been developed by different manufactures with different ways of technology. Global standards should be unique for all countries. Another issue is that RFID systems make use of the “electromagnetic spectrum” and this means that are relatively easy to box by using energy at the right frequency. The following figure shows the use of application packages in Greek companies.



**Figure31:** Packages Usage

The highest percentage refers to the Greek companies that already have and use Warehouse Management Systems and Enterprise Resource Planning Application. This means that their business processes and procedures are automated. An RFID system is easier to be implemented in these companies.

### **BSC Model Results & Discussion**

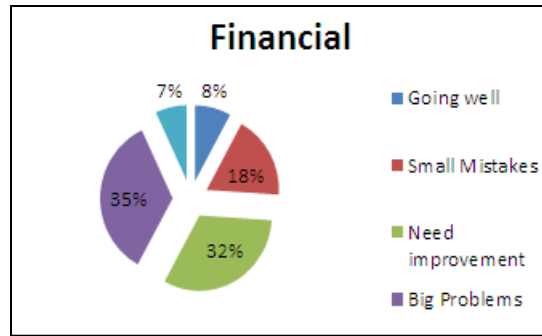
We collected specific data from the companies visited and from the filled in questionnaires in order to present performance level and the meaning of RFID technology systems that will show to the companies the best effectiveness and efficiency and achieve the best competitive advantage. The following assessment items/performance indicators were introduced to the managers. Managers were asked to rate each indicator from 1 to 6 scale according to the level of failure that they face.

<b>Financial</b>	<b>Internal Business Processes</b>	<b>Customers</b>	<b>Innovation, Learning &amp; Growth</b>
ROI rate	Service systems flexibility	Products and services range	Order entry methods
Delivery performance	Supplier lead time	Delivery performance	Product development cycle time
Supplier cost saving	Product development cycle time	Urgent deliveries performance	Flexibility on customers' needs
Delivery cost	Purchase order cycle time	Personalized goods	New technologies entries
Information cost	Total inventory cost	Quality of delivered goods	Products and services range
Technology cost	Delivery frequency	Order lead time	Suppliers' procedures

**Table10:** Balanced Scorecard Indicators for Greek companies

*Financial:* Financial issues are very important and very crucial for Greek companies as a percentage of 35% faces issues regarding all indicators in the financial area. ROI rate is a crucial rate that makes companies to hesitate to make big steps as far as investments is concerned. Delivery performance and supplier cost saving are having similar number of answers as 24 companies confront serious problems in delivery performance and 25 companies into supplier cost saving. Delivery, information and technology cost also is very high and companies are trying to find solutions that will increase their revenues and reduce the costs. RFID technology can appear as solution on these problems as companies should invest on such innovative technology but will gain the return on investment soon and gain a place into the global market. The following diagram shows the average percentage of the answers referring to financial issues.

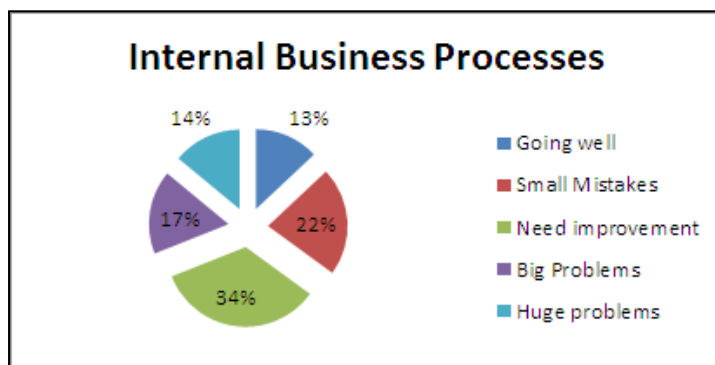




**Figure32:** Financial results

*Internal Business Processes:* Internal business processes in companies need to be improved as a percentage of 34% answered that all indicators that were examined have many disadvantages. From the other hand, 13% of companies answered that are happy with their internal business processes as they are up to date regarding their business systems, operations and stability. They are also satisfied by their product leadership strategy. It is worth to point that regarding in service systems flexibility, 40% of enterprises presented huge problems. Managers pointed the importance of flexibility as it is considered as a critical success factor for businesses. There is the need of implementing of innovative business models that will have in common comparative and long-term relationships between suppliers and customers. Supplier lead time is another important indicator that managers answered according to their companies. A percentage of 57%, which is very high, assumed that supplier lead time needs many improvements and corrections. Only 10 out of 65 companies answered that they need no changes and supplier lead time is almost perfect. Managers explained that the key for supplier lead time is forecasting. They need a system to track every purchase order, date of the order is placed, pickup, arrival, and close date. Managers assumed that they need to track the data in real time forecast to use for their orders. “Product development cycle time” and “purchase order cycle time” still need some improvements. 43% of the companies need a better way of their product development and a cycle time and 22% for a “purchase order cycle time”. Total inventory cost is high enough to keep companies outside the global competition. A percentage of 31% face problems of inflation, price changes, rate of demand, and stock. Delivery frequency concerns the leveling of demand in the whole supply chain. Greek companies are still trying hard to increase delivery frequency in order to reduce the stock held. By the time forecasting is facing some gaps it is difficult for the companies to increase the delivery frequency. 19 out of 65 companies are using forecasting tools but they need to focus more on customers’ needs. RFID technology

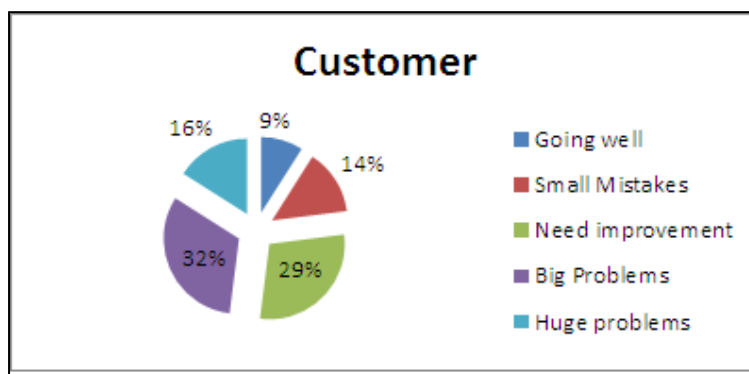
can lead companies to better handle their internal business processes by minimizing the time of supplier lead time, “product development cycle time”, purchase order cycle time and total inventory cost. Companies will then have a 360 degrees view of all their internal business processes and data will reused for forecasting and long term investments. The following figure shows the average percentage of all indicators in internal business processes.



**Figure33:** Internal Business Processes results

*Customers:* The analysis of the indicators shows that Greek companies pain as far as the customers are concerned. A percentage of 32% shows that Greek companies need to reconsider the way of customers’ procedures. More specifically, the products and services range have a high percentage of failures. 29 out of 65 companies mentioned that delivery performance needs improvement in many areas. For example, they want to minimize delivery mistakes, damaged products and reduce the delivery time. Only 6% answered that delivery performance is working great. Such companies are international companies that follow specific standards and most information systems are the same with the other companies that are working together. Urgent deliveries performance is still a big drawback to Greek companies. 30 out of 65 companies face problems. Production managers mentioned that a strong leadership is missing that will lead to capacity analysis, right productivity and production control, procurement and product delivery responsibility. Managers also mentioned that manufacturers should optimize the robustness of their processes by the use of systems failure analysis process and manufacturers should understand the whole procurement process by focusing on lead times, monitoring the procurement performance in order to assure supplier commitments and deliveries. Another indicator that should be discussed is the one of the personalized products. 52% of companies need to change their machinery or expand the existing one. Machinery and production line is not the proper of differentiating similar products. Therefore personalized goods are offered by a very tiny number of companies in Greece. Managers mentioned that they want to

invest on new machinery but economic crisis stands as a huge obstacle. The quality of delivered goods seems to have a great percentage of improvement as well. 8 out of 65 companies need no changes but 7 out of 65 companies face problems. Time stands as a problem as a lot of companies cannot respond directly to deliveries. Managers explained that if they get to know better their customers they can create long term plans of deliveries and be able to react on time. Order lead time also has some gaps that need to be fixed. This is the response of 27 out of the 65 companies asked. Managers pointed that they have to better understand market behavior that will fit to customers' needs and therefore increasing the level of communication. Only 13% of the companies managed to have excellent order lead time. RFID technology can be used as an innovative tool in customer area as customers can be informed in real time for their delivered products. The software application of RFID can rewrite all information and data of products and therefore prepare forecasts and predict future customer demand. The quality of delivered goods will also become strong and gain customer loyalty. The following figure shows the average percentage from all indicators in the area of customers.



**Figure34:** Customer results

*Innovation, Learning & Growth:* Taking into account the average percentage from all indicators, it is worth to point that Greek companies face many obstacles as far as the innovation, learning and growth area is concerned. 26% of companies in Greece face big problems and need to change or reorganize their existing systems or procedures in this area. From the other hand a percentage of 14% is doing well in the area of innovation, learning and growth. The companies that refer to the 14% are those which most of their suppliers are from abroad and also their stakeholders are from other countries. The order entry methods in these companies need improvement by the biggest percentage of 20%. Seven out of 65 companies are going well and need no more changes. This small percentage refers to these companies that use application

packages such as ERP or SCM that are fully integrated and all procedures are fully automated. The rest of the companies pointed that they already have some application packages but are not integrated with the other systems that companies have. In this situation they do not have automated procedures and some data may be lost or damaged. A small percentage of 11% answered that the application packages they use have different methods from the ones that they use so the whole procedure is done mostly by hand and telephone. In average the product development cycle time needs improvement. Companies need to develop new products or services but the cost stands as a huge obstacle. Only 7% of companies spend on new machinery and line production methods that help them to enter into the global market. Greek companies need to invest on new machinery and develop personalized products for their customers. Flexibility on customers' needs is also a pain on Greek companies. Almost half of the companies need to change the way of their procedures and focus more on their customers. A drawback here is that economic crisis cannot let them focus on their customers' needs and they only try to survive into the Greek market. As far as the new technologies entries, Greek companies face different kind of problems in order to synchronize and automate their internal and external business processes. Existing internal applications are not fully integrated and as a result they cannot invest on new ones. Their target is to integrate all internal systems and then invest on new and innovative technologies. 23 out of 65 companies need to change or fix their internal information systems. Other 23 companies need to change their internal systems and use high tech application packages. In products and services range only 10% of companies are doing well and need no changes. It is worth to point that 35% of companies face small mistakes in this area and hope to minimize these mistakes in the near future. Suppliers' procedures are another pain that Greek companies face. Here, big problems appear to be in their internal and external procedures. The application packages that the suppliers use are different from the ones that the companies use. Tracking systems are not working as they wished. 33 out of 65 companies face big problems in their suppliers' procedures. They pointed that they need a system that will show the whole picture from the time they order a product until they receive it and sell it to their customers. Some companies invested in application packages that refer to supplier portal but still they have problems to face. In innovation, learning and growth RFID technology will fit as an innovative solution that will improve the business strategy. This innovative technology is able to lead to a greater process of effectiveness in a lot of tasks (receiving goods/services, putting

away, picking and transferring goods or services). The following figure shows the average percentage of all the indicators in innovation learning and growth that companies answered.

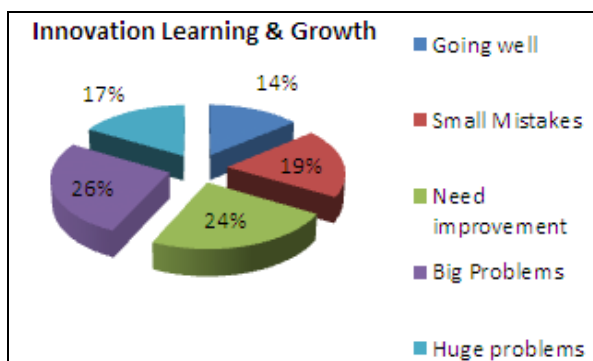


Figure35: Innovation Learning & Growth results

## 8.1 Processing the results

### 8.1.1 Introduction to TEB Model for Added Value for RFID in SCM in Greece

The following figure depicts the model that revealed from the research.

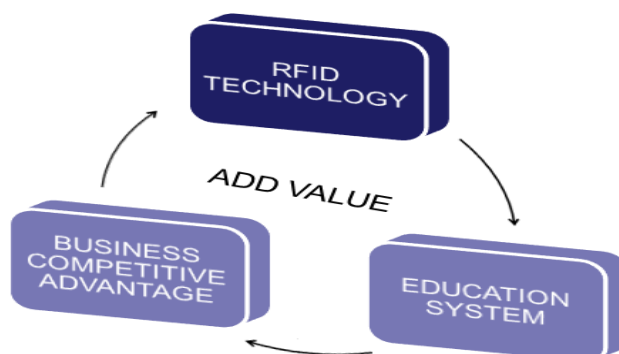


Figure36: Three Models Collaboration

In order to add value, the technology of RFID needs to be implemented and integrated with Greek Education System and the Greek Ministry of education. After adopting RFID technology into the Education system in Greece and more specifically in Greek universities, well-educated students and experienced students will collaborate with business professionals to work on the best and suitable strategy and practices on RFID technology in Greece. Businesses can totally support RFID technology systems in collaboration with their existing systems and work on the automation of all their internal and external business processes.

Engineering education is another area that can follow up on such innovations and work on the adoption of RFID systems to the supply chain management area. Engineer academics will target on the focus on such technologies and implement new problem solving area methods that will organize all businesses procedures. Therefore, businesses will be able to stay competitive with a strong market strategy in the global market.

Engineers' construction will design a new development of information that include and extensive analysis of the requirements needed and they can select the best selection criteria and concepts in these problem solving areas. Models, Process Models or Meta-Models could be then implemented in order to produce a strong analysis of the RFID technology framework and the supply chain management area. Furthermore, new, strong and innovative modules and systems could be also implemented for a better collaboration between RFID technology and supply chain applications area. New implementations, skills, theory and solving methods could be also developed in order to perform as a strong weapon for all enterprises to finally gain a competitive advantage through the marketplace.

From the other hand, university academics can follow up of all the above technologies and give strong and experienced knowledge and skills to their students in order to increase their professional potential and act as strong leaders. Engineering curriculum may implement a strong comprehensive analysis with examples from real life with enterprises that have already adopted the RFID technology and lead to a high vocational education. Training processes are mandatory for all the participants that will gain the excellence from engineering professionals' visits to the universities that would give visions and missions to the students in order to work on RFID technology. Practical exercises and activities will then take place for an excellent professional work in all areas discussed.

The technology of RFID can be adapted by many sciences in schools and universities such as Computer Science, Economics and Business, Maritime management, Industrial Management, etc. The technology of RFID can be integrated and developed in a lab that could help all students to examine, explore and learn the specific technology. The result would be the gain of critical evaluation and development skills that students will gain and therefore develop new ideas referring on this technology. An RFID lab could work as a strong exploration tool for all students. New ideas and new proposals can be derived from an RFID lab that could result to further and deeper

researches as well as innovative solutions for all businesses. Engineering education can play a significant role on the share of valuable knowledge and skills to create future engineers professionals. The re-growth of small countries like Greece will help to overcome all difficulties and get over the economic crisis.

### 8.1.2 Introduction to the 2IT Government Business Model

Another aspect that should be mentioned is the poor transmission of innovative technologies through the Greek market. Companies are not informed by the government or an institution about new and innovative technologies. After completing the interviews and gathering data from the questionnaires, we came to a proposal as far as keeping up-to-date all Greek companies in the private sector for new and innovative technologies. The following figure shows the proposed model to the Greek government in order to fully support and inform Greek companies in the private sector. A new business model named 2IT government business model is proposed.



Figure37: 2IT Government Business Model

The Ministry of Finance, Development and Tourism can be responsible for informing about new and innovative technologies to the Greek private sector companies. We suggest a strong integration between Greek government and companies in the private sector.

**Informing** refers to the knowledge and experience that employees from the Ministry can gain from different sources (seminars, conferences, internal business meetings in different countries etc.).

**Training** can then take place to Greek companies in order to get to know and work on new technologies and follow the market changes.

**Implementing** is the stage that both employees from the government and employees from Greek companies work together until the new technology or the new project become a part of the existing systems of the company and work normally together.

Testing is the last part of the 2IT Government Business Model that includes all the final tests of the new technology adoption and ensures the success of the project. All four parts of the new model include specific indicators.

### **8.1.3 A Unique BSC Model for RFID in Greece**

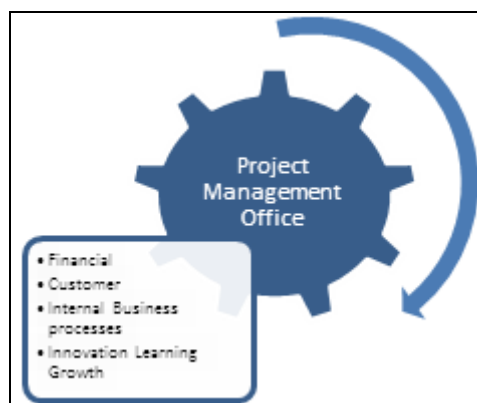
The data collected from the interviews and the questionnaires helped us to draw the Balanced Scorecard Model that suits to most of the businesses in the SCM area. This model can be used as a manual for businesses to better understand their internal business processes and draw their vision and mission. Balanced Scorecard Method can also be considered as the tool for businesses operating in Greece to:

- Produce revenues, cover expenses and provide reserves for the future
- Attract new customers and keep the existing ones
- Deliver products or services on time and at the right place
- Minimize mistakes
- Prepare an effective and efficient distribution system
- Offer high quality and cost effective products or services
- Maintain infrastructure needed for long-term growth
- Maintain staff competence
- Incorporate innovation management to the company

After completing the results of the questionnaires and pointing the key parts of discussions by the interviews, we came to a unique Balanced Scorecard Model that included the Project Management (PM) Perspectives. The following figure shows the new model that requires the creation of a new team or department of the companies that need to improve the indicators of the balanced scorecard. The new model will stand as a Project Management Office through the Balanced Scorecard Indicators. This new office will stand as a deliverance of gaps that arise to Greek companies. The Project Management Office will work through the performance, functions and types that will lead companies to success. Experienced project managers will work through the PM office in order to find ways for Greek companies to invest in new and innovative technologies such as RFID technology and then minimize the mistakes and disadvantages of all the procedures. Greek companies have to realize that they will invest to a new department but will gain a long term investment and a competitive advantage through the global market. The new model includes all four perspectives



through the Balanced Scorecard method and an umbrella of the Project Management Office that will fit to all perspectives.



**Figure38:** Balanced Scorecard for RFID in SCM area in Greece

Balanced Scorecard method can help enterprises operating in Greece to clear some of their current internal business processes and make the right changes that will lead them to expansion to the global market. These enterprises will then focus on the investment on innovations and technology. Supply chain innovation, better internal business processes and improvement of organizational performance will be the key of the success.

## **8.2 Reflection of the Results & Critical Evaluation**

The data collected from the interviews and the questionnaires was the basis for determining the most critical and important issues and drivers, as presented below, of adopting RFID technology in the supply chain management area in Greece. Global competition is very high and competition between companies is increasing. Companies need to produce goods and services according to new customer personalized needs arising in the global market. Companies need to gain an advantageous position in the global competitive environment by determining right strategies and creating different values. The increasing productivity and profitability gains new markets and improves existing market shares that are reached through innovation activities.

Greek companies need to develop innovative skills, gain sustainable abilities, and upgrade their performances. Therefore, they need to make innovations in order to stay in the global market. We found that Greek employees are well-educated and with technical skills in order to produce new goods and services and create new developed

methods. The huge obstacle is the economic crisis that prevents companies to invest capital and money for innovations. In the global competitive environment, organizational and managerial innovations are the keys to success for companies. New ideas should be raised and implemented. While creativity and innovation become the main capital of companies, getting success at indefinite and flexible market conditions is only possible with innovations (Bozkurt and Kirit, 2000). New ideas should be raised and implemented.

To compete in global market conditions and, therefore, get over the economic crisis, Greek companies need to:

- Create innovations with strategic priority
- Implement innovations starting from a product, service or just an idea
- Monitor global changes
- Make fast decisions and respond quickly to market changes
- Limit bureaucracy
- Work as a team and exchange ideas
- Reward employees ideas
- Use technology
- Incorporate innovation management to the company.

Greek companies should pay attention on customers' demand and, more specifically, to factors such as price, quality, lead time, and variety of products that make supply chain management more important for manufacturing organizations. Greek companies need to create new market opportunities and produce new goods and services. In order for Greek companies to reach customers' demand, they should focus on nowadays customers' demand and prefer the correct product or service at the right time, the right price and at the right place. RFID technology can improve application performance based on data provided by the companies' system (Wang et al., 2013). Greek companies can change the whole operating approach, enhance their management level, improve their operating efficiency, and optimize network asset costs. IT asset management is an important component of datacenter operation with potential legal and financial implications. High value IT assets provide automation of business controls based on events generated by an assets' move (Calio et al., 2011).

Greek companies do not work only on the traditional R&D but also on the acquisition of new equipment. Prahalad and Hamel (1990) depict and show the importance of integrating technology assets. These assets can develop the core competencies of the organization, stating that "core competencies are the collective

learning in the organization, especially how to coordinate diverse production skills and integrate multiple streams of technologies.” From the other hand, a lot of enterprises face difficulties on blending the several flows of science or technologies. These compose their culture into new, higher-order capabilities (Hamel and Prahalad, 1994). A percentage of 85% of the Greek companies identifies the importance of RFID technology, but also assumes that the top management will be able to identify all of the streams of technology that are important to the company.

European countries can no longer blossom without a strong long-run development strategy as it used before 2007 (Capello et al., 2015). The economic contraction that begun in 2007–2008 exposed the limitations associated with these development processes (Pavlatos and Kostakis, 2015). Economic crisis might affect management accounting and the use of its practices within the organizations. Greece is affected by the economic crisis in a very hard way. Still there is a hope for Greek companies to adopt innovative technologies for their procedures and their business operations and, therefore, minimize their costs. The adoption of such innovative technologies will lead Greek companies stronger to the global market and get over the economic crisis.

Production managers in Greece believe that RFID technology is a tool of efficiency and effectiveness and return on investment is not that far. Economic crisis is working as an obstacle for companies for investing in innovative technologies. Greece is a small country but in a very strategic geographical position. This is an asset for Greece in order to backing and support the whole supply chain management area, from raw materials stage, to production, distribution, warehousing till the phase of the end customers.

### **8.3 Limitations and Future Research Directions**

RFID technology has been already used by many companies operating in Greece since 2005. The specific adoption had decreased since the economic crisis in Greece appeared. A lot of companies slowed down the research and development part and, therefore, stopped to adopt innovative technologies such as Radio Frequency Identification. Collins et al. (2010) assert that RFID technology is a disruptive technology to transform supply chain into a more efficient system.

The findings show a definite view of Greek companies to use RFID technology innovative systems and gain efficiency, effectiveness and of course gain a competitive

advantage through to the Global Market place. Greek manufacturing enterprises and companies in the logistics area, that implement RFID and supply systems, collaborate to all technology applications through the different departments inside and outside of the enterprises. Well educated employees work hard day by day to keep up with technology changes. Still the fully automation is missing from most of the companies but there is a big interest to adopt all of the systems in the future.

Our findings were only based on an analysis of the data collected from the interviews done and some questions selected from the questionnaire. It is useful to justify these findings by gathering all of the data from questions and data gathered from the questionnaires from the companies that are operating in Greece and perform more advanced statistical analysis.

Finally, this study has some inherent limitations. Data have been collected from only one country. A study spanning across various countries would strengthen the generalization of findings. It is worth to point that all the managers that were interviewed shared internal company's information with us, but all companies have some confidential information and data that managers are not allowed to share with. Another important limitation of the study refers to the answered questionnaires. Questionnaires were delivered in two ways Door-to Door and by email. The questionnaires received by email were impersonal which means that participants did not have contact with us and as a result it was difficult for us to make further contacts with managers and prepare more interviews.

Future research directions include:

- The expansion of Balanced Scorecard model in SCM area in Greece. The combination of project management issues and balanced scorecard model will give new directions of theoretical and practical approaches in companies' performance, functions and procedures that lead to success and added value.
- The preparation of a detailed report of the 2IT government business model that was introduced in this study, and shares it with Greek government.
- The analysis of the three models collaboration (TEB model) that will add value to companies and become strong market leaders. TEB model can be adopted by many countries and not only Greece.

## Chapter 9

### 9. Conclusion

The RFID technology adoption in Supply Chain Management has drilled in the IT industry and set as a target to provide solutions that will grow its extension and excellence.

The technological progress nowadays is emerging of international standards. Adopting an RFID system, each company gains many advantages through its procedures and processes. However, a few factors still present a challenge like high cost, customer concern or tag orientation. RFID technology promises the development of future applications in the supply chain management area.

Companies benefit from this technology and as a result they increase supply chain efficiency and responsiveness, productivity, inventory visibility, accuracy and reduce logistics, labour and error costs. RFID can be used to all kinds of logistics operations, such as inventory control, shipping and receiving and asset management, as well as to manufacturing and retailing. The implementation of an RFD system requires a large initial investment and careful planning in order to consider the various issues companies face when rolling out the technology.

RFID technology has been attractive in numerous contexts and for many companies, and many of them prefer to start with pilot projects and ROI analysis in order to evaluate the future cost and profits.

Greek academic area shows a great interest in researching the technology of RFID. From the other hand, Greek organisations with strong business strategy and vision have already adopted on RFID technology or they participate to a pilot project in order to gain competitive advantage and therefore insert into global marketplace.

Companies pay millions of dollars/euros in order to reach the highest point of leadership and strategy. Companies pay attention on improving with several ways their supply chain performance. It is worth to adopt and operate such innovative systems in order to gain a competitive advantage and create a higher/stronger position to the global market. The use of such innovative technologies like RFID technology and systems will push organizations to identify and reorganize main and potential problem areas and issues that they may confront through the supply chain. The big challenge for Greece is to adopt such technologies and therefore overcome the

economic crisis. Economic crisis lead Greece to very low and slow growth. Therefore, companies should take this period as an opportunity to do things differently. Greek organizations can focus on innovation and growth. Costs will be reduced, they will increase market share and new products or services will be revealed. Greek companies need to take into account to become more efficient and therefore add more value. Business strategy and plans need to be in a high priority.

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