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Real time business intelligence in supply chain analytics

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Abstract

Purpose – Rapid innovation and globalization have generated tremendous opportunities and choices in the marketplace for firms and customers. Competitive pressures have led to sourcing and manufacturing on a global scale resulting in a significant increase in products. The paper tries to identify the need for real time business intelligence (BI) in supply chain analytics.

Design/methodology/approach – The paper provides argument and analysis of the advantages and hurdles in BI.

Findings – The paper focuses on the necessity to revisit the traditional BI concept that integrates and consolidates information in an organization in order to support firms that are service oriented and seeking customer loyalty and retention. Enhancing effectiveness and efficiency of supply chain analytics using a BI approach is a critical component in a company's ability to achieve its competitive advantage.

Originality/value – This paper furthers understanding of the issues surrounding the use of BI systems in supply chains.

Keywords Supply chain management, Business analysis, Information systems

Paper type Conceptual paper

1. Introduction

During the last ten years, the approach to business management across the entire globe has deeply changed. The firms have understood the importance of enforcing achievement of the goals defined by their strategy through metrics-driven management. In the twenty-first century, organizations are evolving into new forms based on knowledge and networks in response to an environment characterized by indistinct organizational boundaries and fast-paced change. Researchers Gangadharan and Swamy (2004) identify new and complex changes that are emerging which will force enterprises to operate in entirely new ways. Organizations are experiencing environmental changes characterized by indistinct organizational boundaries and fast-paced change. As a result firms need appropriate decision support infrastructures in order to face these challenges.

Firms are experiencing environmental changes resulting from the new economics of information and the increasingly dynamic and global nature of competition (Evans and Wurster, 2000; D'Aveni, 1994). Therefore, as pointed out by Dijksterhuis *et al.* (1999) organizational survival depends on the construction and integration of knowledge fostering the adaptation to the environment, as well as stimulating environmental changes through the firm's knowledge and practices. The key drivers examined by Doherty *et al.* (2003) for underlining change are the application of information technologies (IT) and systems in any organization. IT now is ubiquitous and increasingly critical part of the fabric of the modern organization, supporting its day-to-day operations and all aspects of the decision making process as well as its strategic position. Gottschalk and Berg (2007) investigated the role and effective use of information systems. As a result, Mahoney (2002) the investments in IT that enable differentiation are of ever-increasing importance.

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Several surveys including those from Gartner and Forrester report that most of the firms are interested in investing in business intelligence (BI) systems. It is to be noted that despite major investments in enterprise resource planning (ERP), supply chain management (SCM) and customer relationship management (CRM) over the last decade businesses are struggling to achieve competitive advantage. This may be due to the information captured, or not captured, by these systems. Any corporation would look forward for one goal called "right access to information quickly". Hence, the firms need to support the analysis and application of information captured in order to make operational decisions. Say for marking seasonal merchandise or providing certain recommendations to customers, firms need right access to information quickly. Implementing smarter business processes is where BI influences and impacts the bottom line and returns value to any firm.

Managing an enterprise requires access to information and efficient data management in order to monitor activities and assess performance of various business processes. It becomes challenging to understand and assess the information about the processes of an organization. This is due to the information systems that collect and process vast amount of data in various forms in organizations.

To survive in the running stream of rapidly changing, increasingly competitive global market and increasingly volatile consumer and market behavior and rapidly shortening product life cycles, business enterprises today need to (Gangadharan and Swamy, 2004) necessarily analyze accurate and timely information. This analysis can be on financial operations, customers, and products using familiar business terms, in order to gain analytical insight into business problems and opportunities. For any enterprises that are maintaining direct contact with large numbers of customers, however, a growing number of novel, channel-oriented applications (e.g. e-commerce support, call center support) create a new challenge of traditional transactional applications that have to be decoupled from channel-oriented applications to allow for sufficient flexibility of assigning access/distribution channels to products/services.

For any firm the cost reduction programs that deliver the promise through value engineering, is challenging. Any firm would look forward to use predictive modeling technique to forecast the probabilities for success in the firms' new product line. But identifying dead or obsolete stock and manage it through product aging strategies is a challenge for supply chain process. Choosing the best strategy for managing returns and making the best economic sense to recycle or refurbish defective products is always challenging for any supply chain process.

Complexities increase as the business or the environment become more dynamic, i.e. where change is a permanent feature and a factor to build into the management of the business. The key question that arises as described by Azvine *et al.* (2007a, b) is how do businesses respond to changes today and, if the nature of the business and the environment is becoming more and more dynamic, what actions can businesses take to predict and prepare for change. To accomplish this, it is essential to have a system for establishing the status of a business at any moment in time in relation to its performance objectives. An important component of this investment is in BI.

This paper analyzes the role of real time BI approach in supply chain analytical. The paper argues that in order to support firms that are service oriented and desperately seeking customer loyalty and retentions, it is necessary to revisit BI concept that integrates and consolidates information in an organization. To support the

argument, the paper presents the role of real time BI in supply chain analytics. The paper also explores the hurdles and benefits using BI. The rest of the paper is organized as follows: Section 2 describes BI and its components. Section 3 given an understanding of real time BI. Section 4 presents supply chain analytics. Section 5 describes real time BI in supply chain analytics. Section 6 concludes the paper.

2. Background: business intelligence

Adelman *et al.* (2002) describe BI as a term that encompasses a broad range of analytical software and solutions for gathering, consolidating, analyzing and providing access to information in a way that is supposed to let an enterprise's users make better business decisions. Malhotra (2000) points out BI benefits that facilitate the connections in the new-form organization, bringing real-time information to centralized repositories and support analytics that can be exploited at every horizontal and vertical level within and outside the firm. Golfareelli *et al.* (2004) brief on BI which includes effective data warehouse and also a reactive component capable of monitoring the time-critical operational processes to allow tactical and operational decision-makers to tune their actions according to the company strategy. Gangadharan and Swamy (2004) define BI as the result of in-depth analysis of detailed business data, including database and application technologies, as well as analysis practices. Gangadharan and Swamy (2004) widen the definition of BI as technically much broader tools, that includes potentially encompassing knowledge management, ERP, decision support systems and data mining.

BI includes several software for extraction, transformation and loading (ETL), data warehousing, database query and reporting (Berson *et al.*, 2002; Hall, 1999) multidimensional/online analytical processing (OLAP) data analysis, data mining and visualization.

Experts view BI in different ways. Data warehousing experts view BI as supplementary systems and is very new to them. These experts treat BI as technology platform for decision support application. To data mining experts BI is set of advanced decision support systems with data mining techniques and applications of algorithms. To statisticians BI is viewed as a forecasting and multidimensional analysis tool.

The interconnected linkage of supply chains, markets and businesses is posing a new challenge to all enterprises. The path to business insight as pointed out by Shari and Fisher (2003) follows the process of integration of data from disparate internal and external data sources, applying analysis tools and techniques to understand the information within the data, making decisions, and taking actions based on this gained insight. John (2003) argues on businesses that can achieve a true up-to-the-moment view in which the information gleaned is actually current enough to be useful in managing and executing business processes and efficiency is optimized by choosing among the best options available given the circumstances at the time, and the organization is able to respond to its best customers.

Understanding the data, transforming, and shaping the data into networked market places is a key strategy for any organization to achieve competitive advantage. The business success factor for any enterprise is finding ways to bring vast amount of data that is flowing within and across the business processes together and making sense out of the data.

BI denotes on the one hand an analytic process that transforms internal and external data into information about capabilities, market positions, activities, and goals that the

company should pursue in order to stay competitive. On the other hand, BI stands for information system concepts like OLAP, querying and reporting, or data mining that provide different methods for a flexible goal-driven analysis of business data, provided through a central data pool. BI system has emerged from the central part of this strategy for long-term sustainable success.

Traditionally, information systems have been designed to process discrete transactions in order to automate tasks such as order entry or account transactions. These systems are not designed to support users who wish to extract data at different aggregation levels and utilize advanced methods for enterprise wide data analysis. The Figure 1 shows an understanding of BI. A BI system in other words is a combination of data warehousing and decision support systems. The figure also reveals how data from disparate sources can be extracted and stored to be retrieved for analysis. The basic BI approach is shown in Figure 1. Information from supply chain, point of sales and call centers are collected and stored in a data warehouse. Using BI query reporting tools the information is analyzed for hidden useful patterns.

2.1 BI components

BI tools are widely accepted as a new middleware between transactional applications and decision support applications, thereby decoupling systems tailored to an efficient handling of business transactions from systems tailored to an efficient support of business decisions. The capabilities of BI include decision support, OLAP, statistical analysis, forecasting, and data mining.

The following are the major components that constitute BI.

2.1.1 Data warehouse. The data warehouse is the significant component of BI. It is subject oriented, integrated. The data warehouse supports the physical propagation of

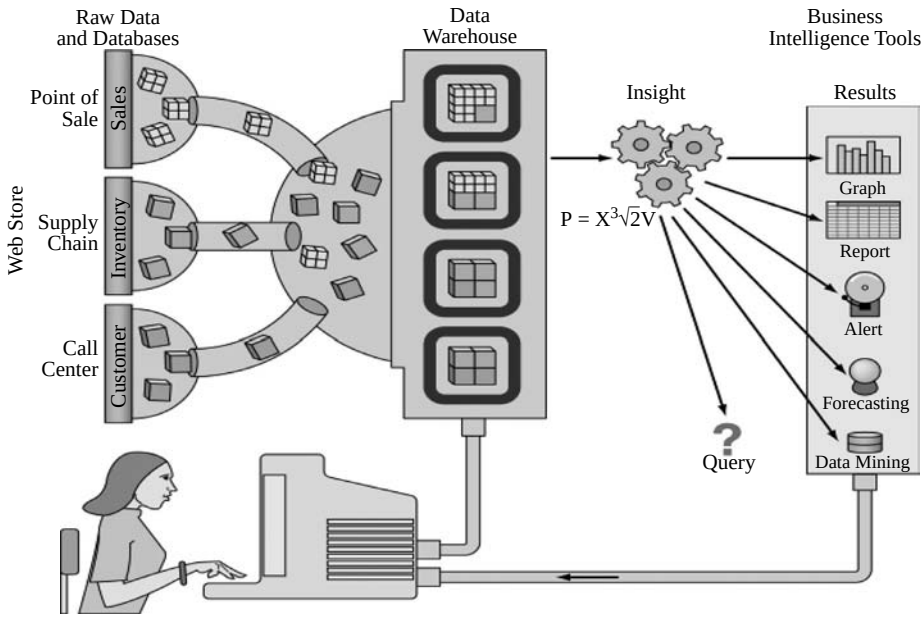


Figure 1.
A basic understanding of BI

data by handling the numerous enterprise records for integration, cleansing, aggregation and query tasks. It can also contain the operational data which can be defined as an updateable set of integrated data used for enterprise wide tactical decision-making of a particular subject area. It contains live data, not snapshots, and retains minimal history.

2.1.2 Data sources. Data sources can be operational databases, historical data, external data for example, from market research companies or from the internet), or information from the already existing data warehouse environment. The data sources can be relational databases or any other data structure that supports the line of business applications. They also can reside on many different platforms and can contain structured information, such as tables or spreadsheets, or unstructured information, such as plaintext files or pictures and other multimedia information.

2.1.3 Data mart. A data mart as described by Inmon (1999) is a collection of subject areas organized for decision support based on the needs of a given department. Finance has their data mart, marketing has theirs, and sales have theirs and so on. And the data mart for marketing only faintly resembles anyone else's data mart. Perhaps, most importantly (Inmon, 1999) the individual departments own the hardware, software, data and programs that constitute the data mart. Each department has its own interpretation of what a data mart should look like and each department's data mart is peculiar to and specific to its own needs. Similar to data warehouses, data marts contain operational data that helps business experts to strategize based on analyses of past trends and experiences. The key difference is that the creation of a data mart is predicated on a specific, predefined need for a certain grouping and configuration of select data. There can be multiple data marts inside an enterprise. A data mart can support a particular business function, business process or business unit.

2.1.4 Query and reporting tools. OLAP provides multidimensional, summarized views of business data and is used for reporting, analysis, modeling and planning for optimizing the business. OLAP techniques and tools can be used to work with data warehouses or data marts designed for sophisticated enterprise intelligence systems. These systems process queries required to discover trends and analyze critical factors. Reporting software generates aggregated views of data to keep the management informed about the state of their business. Other BI tools are used to store and analyze data, such as data mining and data warehouses; decision support systems and forecasting; document warehouses and document management; knowledge management; mapping, information visualization, and dash boarding; management information systems, geographic information systems; trend analysis; software as a service.

2.2 Traditional BI systems

The main key to successful BI system is consolidating data from the many different enterprise operational systems into an enterprise data warehouse. Very few organizations have a full-fledged enterprise data warehouse. This is due to the vast scope of effort towards consolidating the entire enterprise data.

Berson *et al.* (2002) emphasize on emerging highly dynamic business environment and point that only the most competitive enterprises will achieve sustained market success. The organizations will distinguish themselves by the capability to leverage information about their market place, customers, and operations to capitalize on the business opportunities.

Moss and Atre (2003) describe BI as seamless integration of operational front-office applications with operational back-office applications. Gangadharan and Swamy (2004) define BI as an enterprise architecture for an integrated collection of operational as well as decision support applications and databases, which provides the business community easy access to their business data and allows them to make accurate business decisions. The firms can make better decisions, right decisions in particular on their customers, suppliers, employees, logistics, infrastructure and gather, store, access and analyze huge amounts of records only with BI.

Current data warehousing and BI approaches are widely accepted as a middleware layer for state-of-the-art decision support systems (Seufert and Schiefer, 2005). However, they do not provide sufficient support in dealing with the upcoming challenges, such as real-time and closed loop decision making (Seufert and Schiefer, 2005).

There are established research results on decision support systems (Tushman and Nadler, 1978; Eckerson, 1998; Gray and Watson, 1998; Simon, 1960; Sprague, 1980; Weiner, 1948; Silver, 1991) and information processing theory. Davenport (1993) describes various issues on re-engineering in process innovation.

Any new-form organization now a days experience is the value chain-set of primary secondary activities that create value for customers. Denison (1997) examines several critical activities related to value chain. Without effective BI to target process-oriented organizations for supporting is not possible.

Companies have to redesign their business processes for effectively managing and controlling business. It is of great importance resulting for new requirements for decision support. For enabling effective business performance and identifying opportunities for enhancing the business, collecting and reconciling all operational data related to business processes is essential. This operational data from different business processes need to be collected, integrated and prepared for analytical decision-making. This analytical decision-making is essential and required for integration of decision for any management. The components for an effective BI architecture requires a well developed data warehouse, an effective data mart and meta data management, analytical tools like data mining and OLAP and other query reporting tools (Figure 2).

A complete, mission-critical BI technology includes not only BI, data warehouse management, and data integration software, but also a robust hardware foundation

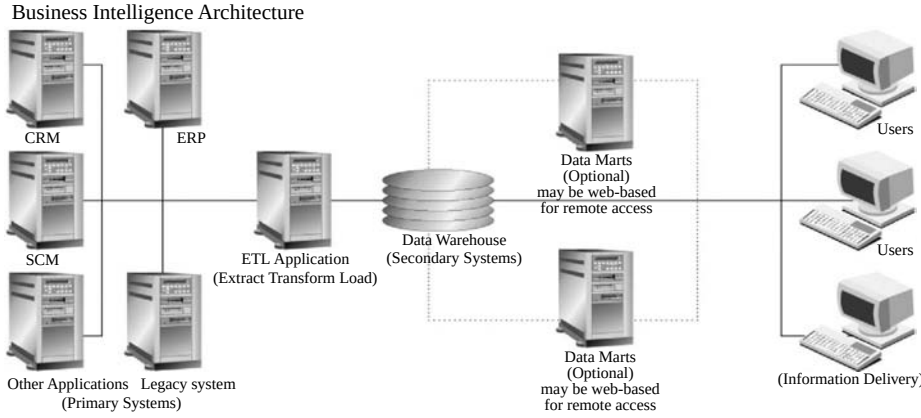


Figure 2.
Traditional BI architecture

that can support scalability both from the data and user perspectives. Information from various sources like ERP, SCM, CRM are collected and loaded through extract transform applications into the data warehouse as a central data repository (Figure 2).

Williams and Williams (2004) stress on achieving business value by using traditional data warehousing and BI tools. Grigoria *et al.* (2004) mention that management information systems are targeted only for traditional reporting and not utilized for measuring the performance of business processes.

Geishecker (2002) and Moncla and Arents-Gregory (2003) explore on providing closed loop support that interlinks strategy formulation, process design and execution for BI. In order to achieve competitive advantage, companies strive towards reducing the time needed to react to relevant business operations. By organizing and deploying BI as per the organization's own characteristics, the complete value of the data stored throughout the enterprise can be unleashed.

2.3 Real time BI

When it comes to extensive data analysis, BI is used to produce the information that is necessary to decide and take appropriate actions. Addressing this, real-time decision support gained great attention. Concepts such as active warehousing, real-time analytics (Brobst and Ballinger, 2000; Raden, 2003) and real-time warehousing became hot topics of interest to firms. Real-time decision support provides suggestions of how to speed up the flow of information in order to achieve competitive advantage. BI systems frequently have been accused by corporates for not getting results to users in a timely manner. This may be due to data-integration problems. However, new BI approaches can process the information quickly enough to make such decisions. For example, in hotel management and information systems, BI can be used to analyze customers' input and make hotel, car rental, and other offers to them when they are on the business' web site or when they visit again in the future.

The traditional BI discussed in Section 2.2 does not proactively respond to situations and take critical timely business decisions in real time.

Nevertheless, it is becoming essential nowadays that not only is the analysis done on real-time data, but also actions in response to analysis results can be performed in real time and instantaneously change parameters of business processes.

Nguyen Manh *et al.* (2005) introduced an enhanced BI architecture that covers the complete process to sense, interpret, predict, automate and respond to business environments and thereby aims to decrease the reaction time needed for business decisions. Nguyen Manh *et al.* (2005) proposed an event-driven IT infrastructure to operate BI applications which enable real-time analytics across corporate business processes, notifies the business of actionable recommendations or automatically triggers business operations, and effectively closing the gap between BI systems and business processes. Seufert and Schiefer (2005) suggested an architecture for enhanced BI that aims to increase the value of BI by reducing action time and interlinking business processes into decision making.

Azvine *et al.* (2005) discuss the issues and problems of current BI systems and then outlines our vision of future real-time BI. In large organizations, IT departments have had to gather information from multiple databases (heterogeneous data bases) such as those in accounting programs and enterprise-resource-planning applications and normalize it into a single view in a time-consuming, frequently manual process.

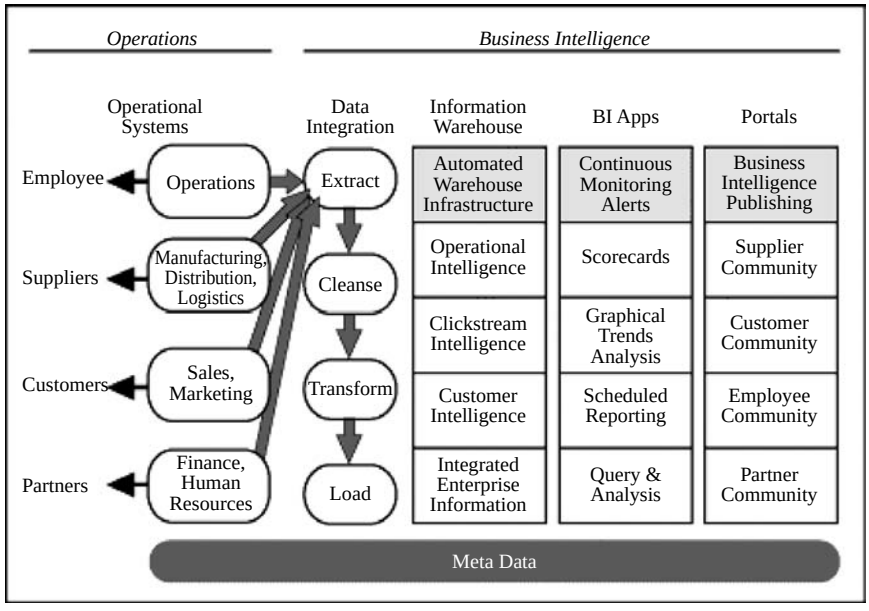
Many operational decisions (e.g. promotion effectiveness, customer retention, key account information) (Schulte, 2000) need actual yet integrated and subject-oriented data in or near real-time. Viitanen and Pirttimaki (2006) examine a case that considers BI as a strategically integrated tool.

The primary goal of real time BI is to meld analytics with management functions so that analytics become an integral part of how managers and employee teams perform their job (Figure 3). Information is collected from several operation systems for data integration. Note the different applications of BI emerging from query analysis to score card management. Hence, successful implementation of real time BI needs to focus first on specific business needs (i.e. SCM, customer churn detection and reduction, etc.).

New service-oriented-architecture tools provide interfaces to various data types, which helps integrate data sources so that multiple applications can read them. BI's real-time capabilities can make it easier for companies to work directly with customers. A customer might be on the phone or an e-commerce web site for only a few minutes, which limits the time and amount of information a company has to make sales-related decisions.

Real time BI system does the process of delivering information about business operations with minimum latency. This means delivering information in a range from milliseconds to a few seconds after the business event. While traditional BI presents historical information to users for analysis, real time BI compares current business events with historical patterns to detect problems or opportunities automatically. This automated analysis capability enables corrective actions to be initiated and or business rules to be adjusted to optimize business processes.

All real time BI systems have some latency, but the goal is to minimize the time from the business event happening to a corrective action or notification being initiated.



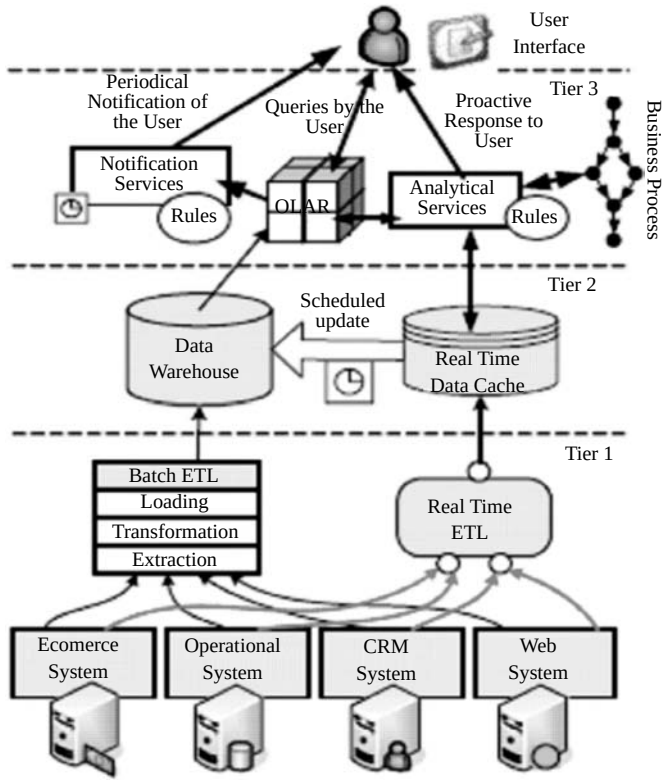
Source: Robinson (2002)

Figure 3.
BI infrastructure

Real time BI technologies are designed to reduce latencies to as close to zero as possible. Traditional BI and business activity monitoring by comparison only seek to reduce data latency and do not address latency since some processes are governed by manual processes.

Robinson (2002) evaluated the completeness and adequacy of BI infrastructures based on the information available from: effective data integration process, continuous monitoring processes, automated information delivery process, fully automated warehouse administration infrastructure, availability of information on standardized dimension such as customer, product and geography, higher end-user acceptance. The BI infrastructure adopted from (Robinson, 2002) is presented as a three tier frame in Figure 4. Real time ETL tools collects the operational data from different heterogeneous sources for centralized data integration in real time. The business rules are analyzed in tier 3 through query and reporting tools in real time.

Nguyen Manh *et al.* (2005) proposed an approach to real time BI based on service-oriented architecture (Figure 4). As organizations seek to incorporate intelligence into business operations, a robust infrastructure is necessary to meet mission-critical requirements for high scalability, availability, and performance (Nguyen Manh *et al.*, 2005). Azvine *et al.* (2007a, b) proposed a real time BI architecture for an adaptive enterprise.



Source: Nguyen Manh *et al.* (2005)

Figure 4.
Real time BI architecture

The concept of service-oriented architecture has been the buzz in the business technology area. These service-oriented architecture tools provide various interfaces to various heterogeneous types of data in any organization and integrate various data sources so that multiple applications can have access to these data. Several service-oriented architecture adapters and interfaces have been developed for integrating and accessing various heterogeneous data sources. Lawton (2006) provides information on these type of adapters that enables Google One-Box search appliance to tract in real time data stored in more than 85 types of data bases and generated by more than 150 transaction types. Lawton (2006) further adds that vendors like Cognos, Information Builders, and SAS are working with Google to use the Google One Box with real time BI systems.

3. Supply chain analytics

The concept of supply chain analytics promise to extract and generate meaningful information for decision makers in the enterprise from the enormous amounts of data generated and captured by supply chain systems.

For configuring supply chain functions data collected across the supply chain is crunched, numbers are analyzed, and information is generated for decision makers. Technologies ranging from mainframe-based multidimensional spreadsheets to PC-based statistical analysis tools are used for supply chain systems' analysis. The biggest challenge any enterprises face today is building these supply chain-based analysis of aggregating data from multiple sources.

Limited ability to raise prices, high-customer expectations and low levels of loyalty have led to increased challenges in already competitive market for all retail organizations (Taylor *et al.*, 2004). The retailers are looking forward to supply chain analytics to reduce cost and improve customer service. The retail organizations can expect a better and effective supply chain analytic only by defining the analytical needs of enterprise and a well-defined key metrics for organizational strategy.

The hype surrounding both ERP, SCM and CRM have led many firms to believe that these systems improve business processes and customer services and also provide enterprise reporting and analytics. But the fact is ERP and CRM systems are integrated across enterprise information infrastructure and functions on their respective modules. Both the systems do not follow the integrated business rules and definitions and function in their individual domains. The traditional transactional systems are not designed to support efficient enterprise reporting and business analytics. Hence, it is well understood that SCM alone cannot deliver the expected value at right time in an organization. Clearly a BI systems needs to draw information from all operational systems. Hence, BI and SCM requirements need to be developed simultaneously.

Taylor *et al.* (2004) explore the issues on SCM and BI in an organization. Many retailers are now turning towards advanced SCM systems in an attempt to reduce costs and improve customer service. Taylor *et al.* (2004) describe that SCM sells on the promise of just in time (JIT), demand driven supply, providing the functionality to plan and monitor inventory levels, track orders and shipments and manage warehouse and distribution facilities.

Supply chain analytics provides a broad view of an entire supply chain to reveal full product and component. It is implemented for strategic decision making. It reveals opportunities for cost reduction and stimulates revenue growth. It generally maintains historical data and enables an understanding of total cost. Drill down and roll up

operations yield figures to reveal what caused the performance level. Ordering products, global outsourcing, and web-based buying and selling, JIT manufacturing are the major key business drivers for supply chain analytics.

Lee and Kim (2007) proposed a methodology for the development of new business based on technical systems. Sivakumar, 2006 discusses on supply chain intelligence in organizations to derive better operational efficiency by giving key performance indicators (KPI) for supply chain managed firm. Kumar and Deshmukh (2005) explore the business value of BI through supply chain analytics.

Several vendors like SAS, business objects provide supply chain analytical solutions. Heydock (2003) point out on supply chain intelligence which reveals opportunities to reduce costs and stimulate revenue growth by enabling companies to understand the entire supply chain from the customer's perspective.

Heydock (2003) describes this new initiative for providing the capability to extract sense and analyze information about a supply chain. Supply chain using BI enhances an executive's ability to reason through business outcomes. Supply chain analytics include planning sourcing, making and delivery of supply using analytics.

Supply chain analytics provides a single view across supply chain and includes prepackaged KPI, analytics. It also helps an organization on the primary drivers behind supply chain processes-planning, procurement, manufacturing, logistics, and returns. An organization therefore can analyze and act to increase the supply chain efficiency. Supply chain analytics addresses measuring supply chain performance against goals and over time, identifies opportunities to reduce costs, improves supplier management, increases manufacturing efficiency and optimizes delivery.

For storing pre-aggregated information, controlling end-user access to the information, providing fast access into information and representing the end-user view and multi dimensional view of the supply chain system is essential.

Both vendors and users of supply chain have become enamored with operational BI. The real time BI can be pushed to enhance supply chains. BI analysis will be in line to a business process such as identifying unusual supplier activity that might require a change in pricing or manufacturing schedules or noting higher than expected sales activity of lower margin products that may indicate a problem in sales or distribution. Several vendors foresee BI as powerful engine that hooks into all sorts of processes and work flows to monitor anomalies and changes in trends in supply chain. BI is foreseen to automate adjustments in stead of alerting people. In other words BI can be treated as a layer that sits across all application layers. This can be interpreted as adding BI functionality to all applications that require attention to the results of the processes executed. There is no ERP report to roll up a cross process for viewing customer profitability. Applications that monitor certain processes may be immediately useful for certain managers who use these SCM applications but these processes also need to be monitored by BI tools that works across multiple platforms.

4. Real time BI in supply chain analytics

There are various proven research results on supply chain framework (Kinder, 2003), supply chain performance (Li *et al.*, 1997), supplier selections (Lee *et al.*, 2001; Kraljic, 1983; Choi and Hartley, 1996) supplier evaluations (Ghodsypour and O'Brien, 1998; Hausman, 2003), supply chain practices (Kinder, 2003; Cavinato, 2002; Sarkis and Talluri, 2002; Sabath and Fontanella, 2002).

As mentioned in Section 2.3, The hype surrounding both ERP, SCM and CRM have led many firms to believe that these systems improve business processes and customer services and also provide enterprise reporting and analytics. But the fact is ERP and CRM systems are integrated across enterprise information infrastructure and functions on their respective modules. Hence, it is well understood that SCM alone cannot deliver the expected value at right time in an organization. Clearly a BI systems needs to draw information from all operational systems.

Data have been critical to decision support. Rapid innovation and globalization have generated tremendous opportunities and choices in the market places for consumers and companies alike. Competitive pressures have led to sourcing and manufacturing on a global scale resulting in a significant increase in product offerings. When businesses grow more complex so do the supply chains. The managers need tools that generate the insight that leads to smarter.

The term BI comprises OLAP, data mining, data warehousing, visualization and query reporting tools. A decade ago BI used to monitor changes in source systems, extract the changed data, perform necessary transformation and put the data for loading in the warehouse. Note that not all data were real time. But real time analysis of data helps firms move to what is called as "zero latency" or real time enterprise. Though real time BI involves changes in various technologies what really makes different and significant is how the scope and importance of BI is viewed at. Real time BI impacts current business decisions and current business processes.

Traditional BI systems consist of a back-end database, a front-end-user interface, software that processes the information to produce the BI itself, and a reporting system. Several varied sectors like manufacturers, electronic commence businesses, telecommunication providers, airlines, retailers, health systems, financial services, bioinformatics and hotels use BI for customer support, market research, segmenting, product profitability, inventory and distribution analysis, statistical analysis, multi-dimensional reports, detecting fraud detection, etc.

Robinson (2002) evaluated the completeness and adequacy of BI infrastructures based on the information available from effective data integration process, continuous monitoring processes, automated information delivery process, fully automated warehouse administration infrastructure, availability of information on standardized dimension such as customer, product and geography, higher end-user acceptance.

Companies still fee that BI has technology-related complexities and usable only by technically savvy specialists. They also feel that BI is expensive. BI takes a long time to yield correct analysis. The firms want these analyses in real time for short-term projects. The tradition BI may not do this but a real time BI environment certainly comes into rescue.

The focus of SCM systems is to provide operational and transactional efficiencies in the fields of manufacturing, sourcing and distribution within an organization and across its supply chain. Applying the concepts of BI to data from SCM systems, supply chain analytics seek to provide strategic information to decision makers in organizations. Information categories range from what-if scenarios (Reddy, 2003) for reconfiguring key functions in sourcing, manufacturing, and distribution to measuring the ability of a supply chain to produce cost-effective products.

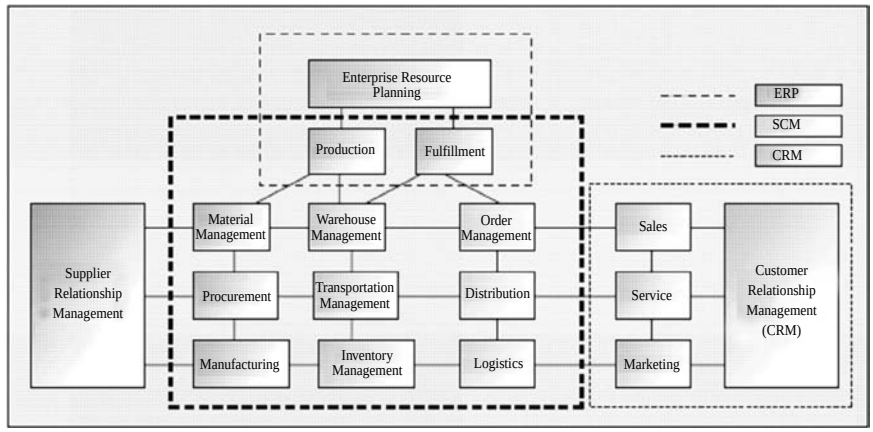
The SCM sells on the promise of JIT, demand driven supply, providing the functionality to plan and monitor inventory levels, track orders and shipments and

manage warehouse and distribution facilities (Taylor *et al.*, 2004). But SCM systems have to ensure that right items are in stock always so that inventory levels can be reduced. The existing SCM, ERP and CRM systems' attempts to have enhanced enterprise reporting and analytics for improved return on investment (ROI) did not result in anticipated way. This paved way for supply chain analytics in real time.

Real time BI in SCM requires the ability to analyze products, processes, components, and materials. This demands a data integration infrastructure. Supply chain analytics analyses the products, processes, components and materials. Hence, an integrated infrastructure that extracts, transforms and loads the data from multiple sources like ERP, SCM, CRM, customer data, supplier data, product data, manufacturing data, quality management data, shop floor manufacturing data, legacy system data, online web-based SCM data, demographic market places-based data and marketing data from third party data suppliers is required for a successful supply chain analytics.

Figure 5 shows an understanding of the role of ERP, SCM and CRM in any enterprise. The data sources can be from like ERP, SCM, CRM, customer, supplier, product manufacturing/testing, quality management, shop floor manufacturing, legacy system, data from online industry trading exchanges, market places and auction, demographics and marketing data purchased from third party data suppliers, etc. Real time BI in SCM requires tighter integration of manufacturing into analytics. And, information resulting from the integration is critical to the identification of design issues and costs through out the product life cycle.

As more and more customers look for web-based purchases, the transactions representing these business activities become accessible readily to the business for improved analytics and better business decisions. Customer loyalty is driven by product quality and price and as well as new set of criteria such as product choice, service quality and ease of access. Every one is aware that the business decisions are growing at an unprecedented pace. The complexity of these decisions also increases as the diversity and volume of data grow. Customer demographic data, business transactions, seasonal ebbs and flows, supplier data and inventory levels all have to be carefully coordinated to enable real time business decisions.



Source: Krishnamurthy (2006)

Figure 5.
Data sources integrated for real time BI

To build real time BI in SCM application, it requires many data sources to be integrated (Figure 5). The data sources that companies are integrating to support their real time BI in SCM, ERP, data from suppliers, legacy systems, SCM systems, and CRM systems (Figure 5) data from shop floor systems and product manufacturing/testing applications is also vital for feeding real time BI. The companies are not using data from online industry exchanges and marketplaces widely.

There fore, the bottom line is that real time BI in supply chain requires a data integration architecture that will support supply chain analytics applications with the ability to extract, transform, cleanse, and integrate data from a variety of data sources. Many of these sources can be difficult to reach; while everyone now knows the difficulty associated with retrieving ERP and legacy systems data, other sources can be even more difficult to access. For instance, shop floor manufacturing data can be especially difficult to collect because many of these systems use proprietary application interfaces and data formats. Figure 6 shows the role of BI in an enterprise. The traditional data life cycle includes data warehouses and data marts.

An example: consider a firm ABC that manufactures broad range of products. It wants to track the resellers and retail sales channels. The company incorporates mobile devices, bar code scanners to store the information for every item about its location and status of current method of transportation. This enhances better monitoring, synchronizes and optimizes the process flows. The real time BI continuously analyses the data and calculates the key critical indicators that provide value. The key business drivers for this corporate is meeting the reporting requirements over a large geographically dispersed users database, tracking customer orders and replacing multiple non integrated legacy applications. The company requires a standard format in real time to improve the data quality and resolve conflicting terminology because

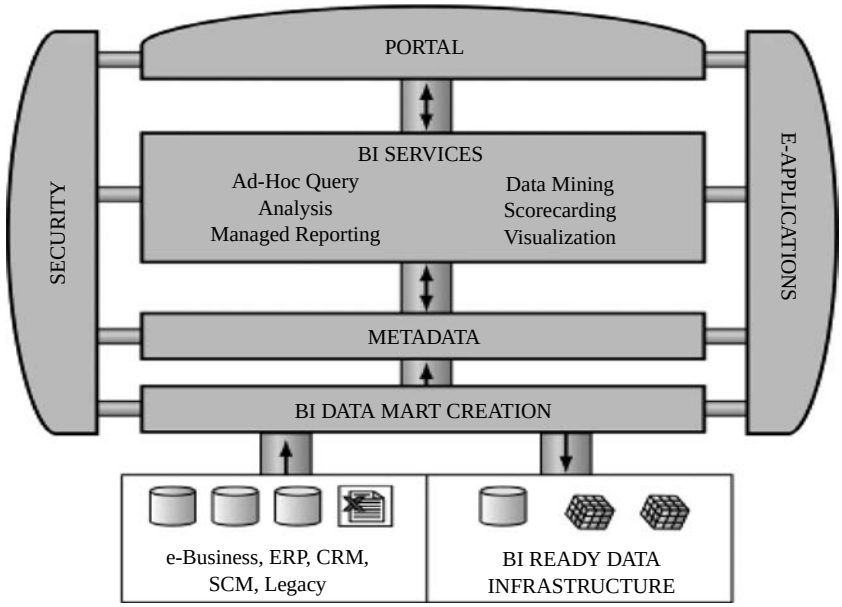


Figure 6.
BI services in real time in an enterprise

there are several business conflicting rules for reporting and analysis across region. The real time data warehouse refreshes minute to minute and seconds to seconds. The documentation for the existing reporting solutions in gathering requirements for key process indicators is essential. Here, real time BI comes to rescue.

The real time BI continuously analyses the data and calculates the key critical indicators that provide value. The value can be interpretation of essential business information such as current transportation time for shipping, transportation cost, utilization of any transportation vehicle, etc. In addition, real time BI detects early situations for planning and coordination of the logistics such as delay of freight or loading the freight into a wrong container. In such critical cases BI makes arrangements in order to deliver the goods timely by changing the transportation route or changing the method of transportation. The route can be choosing a more direct transportation route to the customer and or through express-transport services. In case of failure of delivery, the real time BI automatically sends the notification to the customer with an estimate of delay in shipping.

In this example, the real time BI reacts in near real time to changes in the business environment. Events from various sources (vehicles, distribution centers, contractors, customers) are received and unified (event transformation) in order to assess the current state of the business environment. Certain event patterns describe a business situation (e.g. a truck is stuck in a traffic jam) that is automatically discovered by real time BI (situation discovery). A business situation triggers the invocation of analytical services in order to forecast whether a shipment is going to be late (analytical processing). Based on the analytical results a rule decides (decision making) whether the transportation route should be adjusted, or whether the customers should be notified about the shipment delay. The real time BI instantaneously initiates and executes the appropriate actions (response management) based on the outcome of the decision rule.

A global real time data warehouse, real time data mart for storing historical and summary data at different levels is required. An efficient OLAP interface with secured real time architecture is necessary. The reports are refreshed every minute in various time zones. This enhances the real time reporting for supply chain analytics. The enterprise can have real time based 360-degree view of its reseller business. For planning and forecasting based on product distribution, optimizing sales distribution, analyzing key inventory measures real time BI in supply chain analytics is necessary. This paves for a centralized data base for reporting data and accommodating rapid delivery of solution enhancements. The end-users will benefit from improved analytical flexibility and better performance for creating, delivering and viewing supply chain analytics.

5. Real time BI: benefits and hurdles

BI is a boon to any enterprise as BI pulls together large quantities of real time information from disparate heterogeneous systems and distills them into focused views of the business. BI's new real-time capabilities can even make it easier for companies to work directly with customers. A customer might be on the phone or an e-commerce web site for only a few minutes, which limits the time and amount of information a company has to make sales-related decisions. However, new BI approaches can process the information quickly enough to make such decisions.

Any organizations who successfully integrate BI into a business process can achieve a significant return on investment. This is the most arguable statement. Some organizations may view it differently. The cost of deploying a large data warehouse to support a BI system is still high for many organizations. Now calculating BI systems' return on investment is difficult because BI provide business-related insights rather than direct links to sales or cost savings. What will happen to those firms with tight budgets? Such firms might decide to cutback on such expenditures.

A study reports (Eastwood *et al.*, 2005) that a BI implementation generates a median five-year return on investment (ROI) of 112 percent with a mean payback of 1.6 years on average costs of $4.5 million. Of the organizations included in the study, 54 percent had an ROI of 101 percent or more. The largest class of benefit was due to "business process enhancement," where BI was applied to operational decisions in areas such as logistics (Eastwood *et al.*, 2005) call centers, fraud detection, and marketing campaign management.

Yet BI benefits do not come without effort. From an organizational perspective, the business units affected by the BI project must be intimately involved and committed to the project. Likewise, management must have an in-depth understanding of its business processes and a clearly defined set of goals to be achieved. Finally, the technology platform for BI must be capable of delivering information on demand, at the point of an operational decision, in a cost-effective manner. The real payback for BI applications as pointed out by Gangadharan and Swamy (2004) comes from the BI hidden in the organization's data, which can only be discovered with data mining tools. In addition, the success of BI depends on training and support on BI tools.

Firms are of thought that BI does not integrate with their CRM and ERP applications. Vendors also used to offer BI systems only as stand-alone products that did not always integrate well with other corporate software such as CRM and financial applications (Lawton, 2006). Owing to this, firms are denied the opportunity to analyze the valuable information in these applications.

The author is of opinion that ERP integrates information pertaining to firm's internal processes while SCM processes and monitors firm's external information. Integrating them and giving a correct relevant business decision based on bundles of very large volumes of both internal and external data is possible only with BI.

Nevertheless, BI faces numerous ongoing challenges to future success, such as implementation cost and complexity. BI systems frequently consist of multiple elements that do not integrate well together, including best of-breed components from different vendors. Organizations want BI systems that are cheap, fast, easy to install and use, low maintenance, sated with help functions, and keeps the users happy and off the back of IT. It is very difficult to find such one.

The biggest challenge is the users' ability to determine how to take action based on the results of BI analysis in an organization.

The author also feels that there are no such widely implemented benchmarked BI standards for any firm. This exacerbated limitation has caused firms to consider BI as complex systems. Traditional BI has been slow at gathering and analyzing data. This makes the short-term and day-to-day decision making unsuitable. BI products and their interfaces have also been more complex than most applications need and require too much technical sophistication for most employees to set up and use effectively. Most of the tools have rich functionality that is only appropriate for about 5 percent of a company's employees.

Data integration, defining business and end-user requirements, and organizational issues (e.g. getting different departments and groups to function/collaborate cohesively based on related metrics, etc.) are (Sivakumar, 2006) the three most difficult issues companies are experiencing with supply chain analytical application development.

Another shortcoming in BI is the data marts required to store the amounts of data that is necessary for BI operations are too expensive for most firms. A terabyte-sized data mart cost $5 million five years ago. But today the use of inexpensive open source software as well as proprietary software and hardware that are less costly than in the past has reduced data marts' prices (Lawton, 2006).

A BI system might not be able to make informed decisions based on the information but can present users with organized, analyzed data. For example, knowing that older males buy more of a product does not necessarily tell the vendor what it must do to increase sales.

Although BI tools are easier to use, companies still need a technically savvy team to deploy the data warehouse that integrates all their information into one place. The team also must create applications to access the information and decide which data sets within the warehouse will be most useful.

BI technology will always entail complex deployment and data preparation and is not easy to link directly to either reducing costs or increasing revenue. Any firm should not expect a tool to produce value on its own, it may be difficult for that to happen at least in case of BI.

Real time BI for supply chain analytics reduce decision cycle processes. It responds to market and customer demand in hours and in minutes not in weeks. Measuring and monitoring supply chain activities interactively to respond to timely decision are possible in real time BI.

The companies should use their general enterprise real time data warehouse for their supply chain analytics. According to a Gartner report, 57 percent of companies said their organizations were using their general corporate or enterprise data warehouses (Sivakumar, 2006) to support their supply chain analytical applications, as opposed to 43 percent who were using a separate data warehouse intended specifically for supply chain analytics.

Using real time data warehouse will allow consolidation of all supply chain-related information with all other corporate data. This consolidated view offers the optimum capabilities for enterprise data analysis and reporting. The drawback to this approach is that it typically requires a considerable undertaking in which redesigning the enterprise data warehouse to incorporate supply chain models and reporting processes is essential.

6. Conclusion

BI refers to the use of technology to collect and effectively use information to improve business potency. An ideal BI system gives an organization's employees, partners, and suppliers easy access to the information they need to effectively do their jobs, and the ability to analyze and easily share this information with others. BI provides critical insight that helps organizations make informed decisions. It facilitates scrutinizing every aspect of business operations to find new revenue or squeeze out additional cost savings by supplying decision support information.

Business transactions, customer demographics, seasonal flows, supplier data and inventory levels all have to be carefully coordinated to enable real time BI enabled

supply chain solutions. We have presented in this paper real time and traditional BI. The approach to real time BI in supply chain analytics is described. The advantages of real time BI is also discussed. We believe that supply chain analytics using real time BI in organizations will derive better operational efficiency and KPI for any organization in SCM.

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Relationship between Business Intelligence and Supply Chain Management for Marketing Decisions

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Abstract The companies that apply the concept of business intelligence in their marketing decisions in some of the following ways were included in this study: at the level of the entire system or specific marketing strategy of companies (e.g. marketing department, research development, commercial, etc.), apply business intelligence only in certain marketing processes or projects, used in business from the technology and platform for data warehouse, data mining, OLAP tools, using advanced analytical techniques of simulation and visualization applications. Variables examined were categorized into four groups: business intelligence, supply chain management, information visibility and integration. Factor analysis was used to facilitate the connection of these groups of variables, i.e. reduction of number of variables. Then, we tested the correlation between the newly formed variables. There was a significant statistical correlation between business intelligence, supply chain management, information visibility and integration among the partners in the production chain. ANOVA was conducted to compare differences in the mean values of variables in relation to the activity, size and legal form. This paper will analyze the relationship between business intelligence and supply chain management for strategic and tactic marketing decisions.

Keywords Business Intelligence, Supply Chain Management, Factor Analysis, Correlation, Marketing Decisions

1. Introduction

In the context of this research business intelligence is seen as a concept of conscious, organized, continuous, legal and legitimate gathering, analyzing and using data and information for strategic and tactics marketing decisions. It is carried out using information technology, but also in other ways. It is aimed to collect the relevant knowledge about customers, suppliers, competitors, and other market factors that directly or indirectly affect the company's business, and to support marketing managers in making strategic and tactic decisions. The purpose of this study was to capture the companies that apply the concept of business intelligence in their business. While researching on the orientation on supply chain and supply chain management, companies selected were those which have been able to confirm that they have at least one link in the supply chain in order to be included in the sample. Also, they were supposed to be active when applying business intelligence for marketing function.

2. Sample Selection and Questionnaire

For the purpose of this paper the most interesting empirical statistical research involve survey sampling. The questionnaire was verified by several professors from Faculty of Economics in Split and Zagreb, Faculty of Social Sciences in Zagreb as well as practitioners of business intelligence.

Before the final definition of the survey, pilot study was conducted by the interviewer to test questions on a smaller number of respondents. The purpose of this pre-testing was confirmation of the basic assumptions of the proposed model, validation of the research instrument and remove the ambiguity. In addition to the implementation, the purpose was to determine its clarity and appropriateness for the research. The method of data collection was via internet.

321 enterprises responded to the questionnaire. Given that the intention was to investigate those companies that apply business intelligence in their marketing work, prior to processing we exempt companies that replied to the questionnaire's last assertion of business intelligence ("In your enterprise business intelligence is not yet systematically organized"). There were 25 companies as such. In addition to these companies, the exempted were three who had not responded to this question, which means that the usable responses was 293, and the response was achieved by 29.3%. As expected response rate for online surveys is variable, in the case of 30% of companies it is considered to be acceptable.

The main instrument for the implementation of this study

was a questionnaire consisting of closed questions with multiple choice answers that involve using a Likert scale with five degrees of intensity. Likert scale attitude is based on the assumption that every statement/particles on the scale has equal importance and weight in terms of how much reflects the attitude toward a particular issue or problem. The survey participants have to chose the answer from 1 = strongly disagree to 5 = strongly agree. For the purposes of this research, a measurement of the perception of respondents was employed. This was chosen for two reasons: (1) the effects of the use of business intelligence are intangible or qualitative, which are not suitable for the objective measurement, (2) most of the information by their nature confidential or strategic, is therefore not suitable for publication. Studies have shown that managerial assessment and management estimates do not differ significantly from the objective values obtained from external sources.

3. Creating Variables Related To Business Intelligence

Claims related to business intelligence are grouped into five groups. Internal consistency was examined using Cronbach's alpha. The first group includes claims related to the sources and reliability of data and information. There is at the beginning of a total of eight variables. Crobach's alpha was calculated to examine internal consistency and it was concluded that one variable should be dropped. Thereafter obtained a satisfactory size Cronbach's alpha (0.715).The second group includes claims related to access to data and information. There were four claims. Cronbach's alpha was 0.77.

The third group of variables is made of claims relating to advanced analytics. There were also four claims. Cronbach's alpha was 0.778.

The fourth group includes claims related to intuition and time and consists of five claims. Cronbach's alpha was 0.765.

The fifth group consists of claims related to the organization of business intelligence and consists of five claims of which one is expelled because of internal inconsistencies. Cronbach's alpha was 0.64.

After testing the internal consistency, factor analysis was performed in order to create five latent variables to facilitate handling in the later stage of analysis. All the results were satisfactory in accordance with the requirements of factor analysis. Main indicators considered about the validity of factor analysis were: Kaiser-Meyer-Olkin measure of sampling adequacy, Bartlett's test of sphericity, Kaiser's criterion on the size of eigenvalues and the percentage of variance explained. Factor loadings were all greater than 0.5, which is very satisfactory.

4. Creating Variables Related to Supply Chain Management

Claims relating to the management of the supply chain are grouped into five dimensions. The first dimension is related to agility and had four claims. Cronbach's alpha was 0.894. The second dimension was related to the adaptability and had three claims. Cronbach's alpha was 0.817. The third dimension is related to the alignment and had three claims. Cronbach's alpha was 0.732. The fourth dimension is related to the proactivity and consisted of four variables. Cronbach's alpha was 0.900. The fifth dimension was related to the performance and consisted of six statements. Cronbach's alpha was 0.896.

After testing the internal consistency, the factor analysis was performed in order to create five latent variables in order to facilitate handling in the later stage of analysis. All the results were satisfactory in accordance with the requirements of factor analysis. Take the same indicators on the validity of the factor analysis and the creation of variables related to business intelligence.

5. Business Intelligence, Supply Chain Management and Marketing Decisions

Making strategic marketing decisions represents a specific phase in marketing management. A research has shown that different models are used in practice for this purpose . According to the findings of the research, the most complex phase in making marketing decisions is linked to strategy implementation. A prerequisite of the effective marketing strategy considers different criteria which should be fulfilled– accuracy, measurability and applicability of information. Also, the important aspect is the suitability of information which is used in existing marketing information system of a company. Companies that satisfy those criteria make promptly decisions to eliminate market risks which also indicate the control role of Business Intelligence, through Supply Chain Management (SCM) at the tactical and strategic level. The basic hypothesis of the research is: Correlation concept of business intelligence and supply chain management is significant in making marketing decisions in order to preserve and strengthen marketing position.

Business Intelligence in Supply Chain Management contributes to the differentiation of the business entity. Market differentiation assumes constant collection of information of competitors' supply. Making strategic and tactical marketing decisions based on the application of Business Intelligence in the management of SCM is more efficient and responsible. Moreover, tools of the marketing mix should be adapted in accordance with strategies for making marketing decisions which are already mentioned above. The research has shown that making marketing decisions, based on Business Intelligence, is generally conducted through four phases. The first phase considers company's environmental analysis. The second phase includes defining frames of the final marketing decision. In

the third phase correction decisions are made according to the feedback. In the fourth phase, consequences of the final marketing decision are estimated. In this process, Business Intelligence displays critical and strategic factors associated with key marketing business variables. Subsequently, the influence of the same factors on the marketing variables is estimated.

Marketing decision making should perform the function of maximizing the perception of the value of business entity market supply. The efficiency of data collection and analysis of competition in this sense are the imperative. Some authors define this process as market mechanism (Kotler) – *Competitor Intelligence System*. The already mentioned research suggests that CIS should be adjusted to the company and the environment in which it operates. Positive experiences indicate a convenience of Business Intelligence analysis for making marketing decisions through five levels:

1. Early warning intelligence related to unusual market events;
2. Intelligence as a support for making strategic marketing decisions;
3. Intelligence as a support in tactical and operational decisions;
4. Evaluation of competitors;
5. Intelligence as a support in planning and making marketing strategies

Although, Herring (1999.) is the first one who, according to the results of the conducted research, formed important intelligence application areas for making marketing decisions, in this approach access stratification through multiple platforms is evident. The research conducted for the purpose of this study confirmed that relevant information about consumers, competitors, potential partners, suppliers and other influential groups is the first and the last line in defending market position. As a result, Business Intelligence protocol in making marketing decisions should be adjusted according to the table 1:

Table 1. Recommended Business Intelligence protocol in making marketing decision

1.	Estimation of tactical and strategic competitor's marketing activities.
2.	Estimation of competitor's marketing programs.
3.	Guidelines for improving own marketing plan.
4.	Decisions related to the market development.
5.	Guidelines for improving a global image.
6.	Guidelines for shaping competitive marketing strategy.
7.	Simulations and evaluation of the implementation of the new marketing decision.

Source: Author of this work, according to conducted research, 2013.

6. Correlation between Business Intelligence and Supply Chain Management important for marketing decisions

After reducing the number of variables in the business intelligence and supply chain management investigated the association between latent variables related to business intelligence and supply chain management. The following matrix of Pearson's correlation coefficients was obtained in the table 2:

Table 2. Correlation between business intelligence and supply chain management

		SCM Agility	SCM Adaptability	SCM Alignment	SCM Proactivity	SCM Performance
BI Reliability of data and information	Pearson Correlation	0.400**	0.465**	0.321**	0.287**	0.429**
	Sig. (1-tailed)	0.000	0.000	0.000	0.000	0.000
	N	270	275	270	273	270
BI Access to data and information	Pearson Correlation	0.330**	0.330**	0.211**	0.201**	0.252**
	Sig. (1-tailed)	0.000	0.000	0.000	0.000	0.000
	N	283	289	283	285	280
BI Advanced analytics	Pearson Correlation	0.247**	0.380**	0.162**	0.397**	0.295**
	Sig. (1-tailed)	0.000	0.000	0.004	0.000	0.000
	N	274	280	274	278	273
BI Intuition and time	Pearson Correlation	0.420**	0.473**	0.313**	0.296**	0.402**
	Sig. (1-tailed)	0.000	0.000	0.000	0.000	0.000
	N	282	288	282	285	280
Organization of BI	Pearson Correlation	0.308**	0.333**	0.235**	0.242**	0.265**
	Sig. (1-tailed)	0.000	0.000	0.000	0.000	0.000
	N	276	282	275	280	275
**. Correlation is significant at the 0.01 level (1-tailed).						

As can be discerned from the table above, in all cases there is a statistically significant correlation between variables that are related to business intelligence and variables related to supply chain management ($p < 0.001$). It may also be noted that the correlation coefficients are not very large.

7. One-Way Anova of Business Intelligence With Respect to Activity, Employment and Legal Form of the Company

It has been investigated the difference in the arithmetic means of business intelligence through one-way analysis of variance in relation to the sort of business of the company, number of employees, and legal form. Statistically significant differences in mean of business intelligence were obtained only when analyzing the activity of the company. It is shown in the Table 3:

Table 3. Analysis of variance of business intelligence with respect to the activity of the company

Variable	Significance
Source and reliability of data and information	0.013
Access to data and information	0.080
Advanced analytics	0.061
Intuition and time	0.927
Organization of business intelligence	0.967

Companies in the field of banking and finance, telecommunications and business services sectors have significantly more developed business intelligence in relation to companies related to the industrial production, trade, tourism and construction. These differences were found in the first three groups of questions related to business intelligence and were statistically significant.

As regards the number of employees and legal form of companies, there was no statistically significant difference regarding the application of the concept of business intelligence, and thus these results are not displayed.

Table 4. Analysis of variance of supply chain management regarding the activity of the company

Variable	Significance
Agility	0.007
Adaptability	0.062
Alignment	0.001
Pro activeness	0.394
Performance	0.002

8. One-Way Anova of Supply Chain Management With Respect to Activity, Employment and Legal Form of the Company

As can be seen from the table 4, above, all variables were statistically significant difference except pro activeness. As with business intelligence, better results were achieved in companies in financial services, telecommunications and business services. As with business intelligence, there was no statistically significant difference considering number of employees and legal form of enterprise, and thus these results are not displayed.

9. Conclusion

The research has shown that different approaches of Business Intelligence application for making marketing decisions through Supply Chain Management are used in practice. In each approach analysed above, the most complex phase is making decisions for marketing strategy implementation. It is necessary to ensure accuracy, measurability and applicability of information based on which marketing decisions are made. Companies that are included in the sample and which accomplish these criteria take prompt measures to eliminate market risks.

Business Intelligence in management of SCM contributes to the differentiation of a business entity. The research has shown that making marketing decisions based on Business Intelligence implementation in SCM management is efficient and business responsible. Making marketing decisions has to be in the function of maximizing perception of the value of business entity market supply.

The aim of the main hypothesis was to investigate the correlation concept of business intelligence and supply chain management, in the context of making marketing decision. Aggregate correlation coefficients show statistically significant correlation between the actual two sets of variables. Correlations dimensions that constitute the observed variables indicate some interesting elements:

- Quality of sources and reliability of data and information is effectively connected with better agility, adaptability and better performance of the companies analyzed;
- Use of intuition and time improvements based on the use of business intelligence is effectively connected with better agility, adaptability and better performance;
- Widespread use of advanced analytics is actually associated with better adaptability and greater supply chain pro activeness of the companies analyzed.

With the exception of the correlation between advanced analytics and compliance which is defined as low, all other mutual correlations are strong and statistically significant, so we can conclude that there is a positive correlation between

the use of business intelligence and efficient supply chain management. It can be concluded that the relationship between business intelligence and supply chain management should be strengthened in order to maximize the correlation coefficients in the practical sense.

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Business Intelligence during times of crisis: Adoption and usage of ERP systems by SMEs

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Abstract

Adoption of Enterprise Resource Planning (ERP) systems is considered to be one of the most important technological and organizational innovation in modem enterprises and SMEs, that promote knowledge diffusion, and sound business decision making processes. Notwithstanding the importance of information and knowledge management, especially during periods of crisis, most small and medium-sized enterprises (SMEs) still underestimate the application and the dynamics of Business Intelligence in their decision-making processes when adopting and implementing ERP systems and their marketing oriented subsystems such as Customer Relationship Management (CRM). In this paper ERP systems adoption and implementation by SMEs in the region of Western Macedonia is examined. Special attention is given to the critical factors affecting adoption of ERPs by SMEs and the business intelligence potential of implementing and using ERP during a period of crisis. The factors identified are related with the economic and organizational characteristics of the SMEs surveyed. Our results indicate that although SMEs recognize the advantages and benefits gained by the application of these systems, especially in managing and summarizing heterogenous data, still the business intelligence capabilities of ERP systems are underutilized, as managers do not take advantage of the knowledge and experience gained from using them. The paper concludes with proposals for further research on the implementation of ERP systems and the expansion of business intelligence usage by SMEs.

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1. Introduction

Enterprise resource planning (ERP) became a key strategic tool, for all firms operating in nowadays competitive and globalized economy (Sakas et al, 2014; Marinagi et al., 2014). ERP applications and their Business Intelligence capabilities have been transforming the way organizations conduct business and operations, by dramatically improving financial transparency, marketing and customer services, supply chain and operations management, human resources management, by integrating all resources and information in a single platform. Business Intelligence tools provide the techniques and solutions that help managers to fully analyze and understand complex business situations, and simplify decision making processes that is of crucial importance in periods of financial and economic crisis as the one SMEs are currently in (Dekoulou & Trivellas, 2014; Trivellas & Santouridis, 2013; 2013a).

Notwithstanding the importance of these systems, SMEs are still struggling to implement and fully leverage the advantages stemming from the use of these systems. In this paper the perceptions and attitudes of managers and users of ERP systems towards the factors affecting the successful adoption, and usage of ERP systems and their business intelligence capabilities are examined, in the region of Western Macedonia in Greece. The basic research questions addressed concern the crucial factors affecting the successful adoption and implementation of ERP systems, the advantages derived from their usage, and the importance of the Business Intelligence capabilities that are embodied in an ERP system.

The remainder of the paper is organized as follows. Section 2 offers the definitions of ERP and Business Intelligence systems and briefly revises relevant literature concerning the success factors for implementing and using these systems. Section 3 discusses the data used in the study and the methodology used. In section 4 the results are presented, and finally section 5 concludes the paper discussing the results, and offering suggestions for further study.

2. ERP and Business Intelligence in SMEs

ERP is a software-driven business management system that integrates all aspects of every-day business and operations, including marketing and sales with the usage of CRM subsystems, manufacturing, inventory management, planning, financial accounting and human resource management, helping firms run their business more efficiently, raisng the levels of customer service and satisfaction, while increasing productivity and lowering costs and inventories at the same time.

Business Intelligence is defined as systems that collect, transform, and present structured data from multiple sources (Negash, 2004) reducing the needed time to obtain relevant business information and enable their efficient use in management decision making process (Den Hamer, 2004), allowing dynamic enterprise data search, retrieval, analysis, and explanation of the needs of managerial decisions (Nofal et al., 2013). Pirttimäki (2007) describes Business Intelligence as a process that includes a series of systematic activities, being driven by the specific information needs of decision makers and the objective of achieving competitive advantage. According to Tyson (1986), Business Intelligence focuses on collecting, process and present data concerning customers, competitors, the markets, technology, product and the environment.

The advantages generated by the implementation of the ERP and Business intelligence system come from the integration between the modules in order to achieve operational and organisational goals such as improved productivity, lower costs, reliable performance, reductions in paperwork, saving time etc. (Dekoulou & Trivellas, 2014; Zuyderduyn, 2014; Trivellas & Santouridis, 2013;2013a). Said et al (2003) issues that are of critical importance for all firms especially for SMEs that operate in very competitive environments. ERP and Business intelligence systems are more successful on the ability to maintain agreements with customers with respect to the full delivery and in a timely manner (Zuyderduyn, 2014), and can communicate more effectively with customers on the progress an order (Marinagi et al., 2014). These goals can be of critical importance in periods of crisis where both firms and customers become more cost conscious and efficient utilisation of resources may become an issue of surviving or not. Understanding and fully utilizing Business Intelligence capabilities can be a daunting task for

SMEs' managers, due to the organisational characteristics and the limited resources they have at their disposal, as even large companies managers have limited understanding of those systems (Hwang, 2009).

The majority of the research focused on investigating ERP and BI but only a few attempts to integrate them (Nofal et al., 2013), a trend also highlighted by Fitriana (2011). There are three approaches in the use of Business Intelligence in the literature (Rouhani et al., 2012) depending on the goal of usage BI and the required focus, namely, the managerial approach, focusing on improving management decision making, the technical approach, and the enabling approach that focuses on value added capabilities.

In this paper the managerial approach is used to measure perceptions of managers and ERP systems users towards the advantages and implementation factors affecting the usage of ERP and Business Intelligence system. The perceived usefulness of a Business Intelligence systems and its learnability are determinants for end-user acceptance and are measures of a successful implementation (Sangar et al., 2013). High levels of the perceived advantages of using ERP systems should be positively corellated with Business Intelligence capabilities, and therefore to higher usage of these capabilities from SMEs. A longer period of time using these systems should also result in more effective usage of Business Intelligence capabilities and higher level of the perceived advantages derived from the utilization of ERP systems, due to economies of knowledge, and the need to reduce costs in crisis periods.

3. Research Methodology

The core objective of the present paper is to investigate the attitudes and perceptions of SMEs in the region of Western Macedonia, that use ERP systems and business intelligence to their everyday operation. Our main goals are to identify the main advantages that an SME can derive from the implementation and usage of an ERP system, and the business intelligence capabilities offered by ERP systems.

In order to measure the above mentioned, 37 firms of the region of Western Macedonia were examined, during April and May 2014. The majority of the firms (56.10%) are commercial firms, with 31.71% coming from the manufacturing sector, 7.32% are services firms and only 4.88% from the tourism sector. More than one out of two firms (58.54%) employ more than 20 employees, and the vast majority of the firms (80.00%) had more than 1.5 million € turnover. It is also important to note that almost all firms of the sample use ERP systems provided by Greek software firms (such as SoftOne, Singular Logic, Entersoft, etc.), and that all firms have implemented an ERP system during the last 10 years.

Managers and users of ERP systems were personally interviewed, with the use of a structured questionnaire divided in 5 sections, concerning the implementation, adoption and usage of Business intelligence capabilities of the ERP system used by the firm. All questions were taken from relevant literature hypotheses, and were presented using the Likert scale from 1 (totally disagree) to 5 (totally agree). In order to identify the relationship between the advantages yielded by the usage of ERP systems, business intelligence features and firms' characteristics, various statistical tests were employed as the non parametric test of Kruskal-Wallis, the Spearman correlation coefficient and the Kolmogorov–Smirnov non parametric test.

4. Results

SMEs have only recently began adopting ERP systems in their daily operations. The firms in the sample examined has been using ERP systems for an average of approximately 6 years with a standard deviation of 3.09 years. The main advantages identified by the respondents relate to data integration (50.00%), controlling activities (37.50%) and flexible decision making (32.50%) which are all related to business intelligence features of ERP systems. However, it is worth reporting that contribution to cost reduction (10%) was considered as the less important advantage of implementing the ERP system in the company, despite the fact that during crisis periods, reducing cost is of essence for SMEs. On the other hands the main disadvantages and deterrents for adopting ERP systems were cost of initial setup and support (36.80%) and most importantly the cost and time required for training

the personnel to handle the new system (44.70%). Good quality training makes the user comfortable with the system and it increases their expertise and knowledge (Sangar et al., 2013)

In Table 1 the factors affecting the successful adoption of ERP systems are presented. The reliability of respondents' answers has been tested, using Cronbach's alpha reliability test, for all sections of the questionnaire with values higher than 0.7, reaching 0.948 for the questions of whole the questionnaire. Specifically for the questions of Table 1 the value of Cronbach a indicator is 0.763, and the Kolmogorov-Smirnov test shows that answers do not follow the normal distribution.

Table 1. Factors affecting the successful adoption of ERP systems.

	Average	Median	S.D.	Range	D (sig.p.)
1. Communication / cooperation between the involved departments of the enterprise	4,55	5	0,833	2	D(37)=0,465, p=0,00
2. Project group skills involved in implementing of the ERP system	3,76	4	0,867	3	D(37)=0,277, p=0,00
3. Process of surveillance and evaluation of implementing ERP	3,91	4	1,01	4	D(37)=0,263, p=0,00
4. Software training/education	4,33	5	0,924	3	D(37)=0,340, p=0,00
5. Needs assessments of enterprise - system's specifications	4,21	4	0,820	3	D(37)=0,277, p=0,00
6. Clarity of objectives by the implementation of ERP	3,85	4	0,939	3	D(37)=0,291, p=0,00
7. Appropriate parameterization of software	4,55	5	0,754	2	D(37)=0,424, p=0,00
8. Suitability-sufficiency in technological infrastructure of the enterprise	4,06	4	0,827	3	D(37)=0,289, p=0,00
9. Support from the software provider	4,67	5	0,595	2	D(37)=0,440, p=0,00
10. Capability of management and personnel concerned	4,24	4	0,502	2	D(37)=0,413, p=0,00
11. Enterprise's available financial and human resources	4,06	4	0,788	2	D(37)=0,217, p=0,00
12. Personnel's training due to ERP system implementation	4,39	5	0,827	2	D(37)=0,374, p=0,00
13. Level of trust between people involved in ERP system implementation.	3,91	4	1,01	3	D(37)=0,223, p=0,00
14. Level of quality service in external technical support for the ERP implementation.	4,24	4	0,902	3	D(37)=0,284, p=0,00
Total Average:	***4,18***		***1,50***		

According to the results of the above Table, participants overall agree on the importance of the crucial factors affecting the successful implementation of an ERP system as they were reported in the relevant literature. The most important factors identified are the support of the software provider (4.67), the configuration/customization of the ERP system (4.55), and the ability of communication and cooperation between all the involved departments of the firm (4.55). Respectively the least important factor concern the composition and the skills of the group assigned to implement the project with 3.76.

The advantages of implementing and using ERP systems were thoroughly examined by 14 questions in section B of the questionnaire. Cronbach a value for the questions of Table 2 is 0.846. The overall average value for all questions is 4.10 with a standard deviation of 0.47, while answers are not normally distributed.

The advantages that are most favoured by respondents are the integration of data and information from different departments (4.68), the reliability of information assembled (4.43), and saving time (4.40). However saving

operational resources (3.60), cultivating a culture of responsibility (3.68) are valued as less important contribution of ERP systems, and effective intra-enterprise solution (3,78), raising questions concerning the strategic and organisational integration of ERP systems in the participating SMEs.

Table 2. Respondents' perceptions of advantages of implementing ERP Systems.

	Average	Median	S.D.	Range	D (sig.p.)
1. Reliable information	4,43	4	0,636	2	D(37)=0,317, p=0,00
2. Data and information integration	4,68	5	0,572	2	D(37)=0,440, p=0,00
3. Productivity increase	4,15	4	0,736	2	D(37)=0,231, p=0,00
4. Improvement in quality of decisions	3,95	4	0,783	3	D(37)=0,300, p=0,00
5. Time - saving	4,40	5	0,871	3	D(37)=0,354, p=0,00
6. Cultivate Responsibility	3,68	4	0,764	3	D(37)=0,415, p=0,00
7.More effective solutions in an intra-enterprise level found	3,78	4	0,620	2	D(37)=0,317, p=0,00
8.More effective use of information sources and enterprise's data	4,25	4	0,776	2	D(37)=0,283, 2=0,00
9. Operational functions facility	4,15	4	0,622	2	D(37)=0,320, p=0,00
10.Operational resources saving	3,60	4	1,128	4	D(37)=0,203, p=0,00
11. Improvement in customers services	4,23	4	0,660	2	D(37)=0,283, p=0,00
12. Better suppliers evaluation	3,90	4	1,033	4	D(37)=0,207, p=0,00
13. Optimal inventory management and procurement (supply chain)	4,23	5	1	3	D(37)=0,331, p=0,00
14. Optimal management of human resources (personnel, payroll, etc.)	4,08	4	0,997	4	D(37)=0,245, p=0,00
Total Average:	***4,10***		***0,47***		

The relationship between the characteristics of firms and the perceptions of benefits derived by ERP implementation is tested using the non parametric test of Kruskal-Wallis as the responses are not normally distributed. The variable used is the mean value of all the responses, while the independent variables are the: a) the sector in which th firm operates, b) the number of employed personnel, and c) the sales turnover. The results are shown in Table 3.

Table 3. Results of perceptions of managers concerning advantages of ERP systems.

	Kruskal-Wallis χ^2	Df	Significance
a) Sector of activity	8,72	4	0. 033**
b) Number employed personnel	0,16	5	0. 983
c) Sales Turnover	6,93	4	0. 074

** *significant for 0.05*

According to the results of the test the perceived advantages of ERP implementation differ only across sectors with as the value of the test is $\chi^2 (3, N=37) = 8,717, p = 0,033 < 0.05$ probability. Figure 2 depicts that the firms of the sample in the service and manufacturing sector responded more uniformly, while commercial firms' perceptions of advantages of ERP implementation differ significantly.

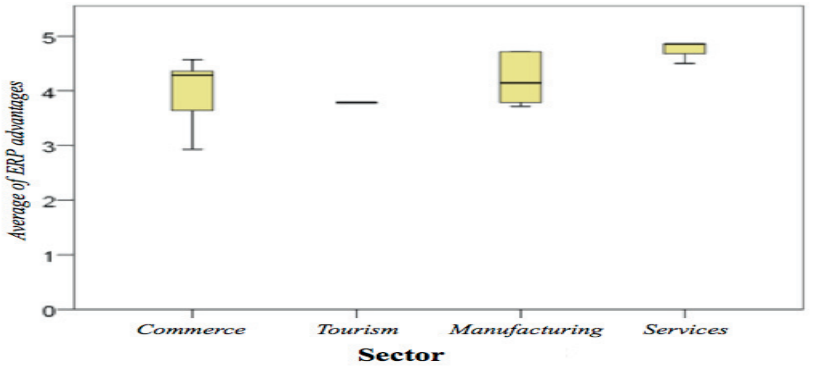

Fig. 1. ERP advantages and SMEs sectors.

Business Intelligence is the focus of the 4th section of the questionnaire examining 23 business intelligence capabilities of ERP systems. The average value for the total of the 23 variables is 3.99 with a standard deviation of 0.508. Notably 11 out of 23 variables take scores less than indicating that SMEs do not take full advantage of the business intelligence capabilities of ERP systems. Cronbach a value for the questions of Table 4 is 0.903 and the Kolmogorov-Smirnov test shows that answers do not follow normal distribution.

Table 4. Results of perceptions of managers concerning Business Intelligence capabilities, of ERP systems.

Possibility of Business Intelligence	Average	Median	S.D.	Range	D (sig.p.)*
1. Group services and tools (groupware)	3,97	4	0,706	2	D(37)=0,260, p=0,00
2. Possibilities of collaborative decision making	3,68	4	0,541	2	D(37)=0,370, p=0,00
3. Clustering of problems	4,03	4	0,875	3	D(37)=0,220, p=0,00
4. Optimization techniques	4,45	5	0,768	3	D(37)=0,343, p=0,00
5. Import/Export data from/to other systems	4,48	5	0,769	2	D(37)=0,394, p=0,00
6. Simulation models	3,55	3	0,810	3	D(37)=0,267, p=0,00
7. Simulation / risk assessment	3,74	4	1,094	4	D(37)=0,238, p=0,00
8. Treasury management tools (capital, producers, loans)	3,90	4	1,044	4	D(37)=0,247, p=0,00
9. Economic management tools (Financial Accounting)	4,42	4	0,620	2	D(37)=0,309, p=0,00
10. Investment Management Tools	3,39	4	1,174	4	D(37)=0,215, p=0,00
11. Cost-audit tools (profitability analysis, profit accounting centers)	4,19	5	1,138	4	D(37)=0,309, p=0,00
12. Property management tools	3,35	3	1,082	4	D(37)=0,215, p=0,00
13. Graphic representations	3,90	4	1,012	4	D(37)=0,309, p=0,00
14. OLAP Possibilities (Multi dimensional analysis)	4,39	5	0,715	2	D(37)=0,210, p=0,00
15. Aggregated results tools	4,68	5	0,702	2	D(37)=0,377, p=0,00
16. Entrepreneurial references (enterprise reporting)	4,42	5	0,848	3	D(37)=0,320, p=0,00
17. Data Extraction (data mining)	4,19	4	0,873	4	D(37)=0,484, p=0,00
18. Dynamic user interface (Dashboard)	4,03	4	0,836	2	D(37)=0,334, p=0,00

19. Decision making methods, using fuzzy logic	3,74	4	1,032	4	D(37)=0,283, p=0,00
20. Decision making analysis with multi-criteria	3,87	4	1,056	4	D(37)=0,231, p=0,00
21. Datawarehouses	4,13	4	0,846	3	D(37)=0,212, p=0,00
22. Applications on mobiles (mobile application), tablets	4,03	4	0,912	3	D(37)=0,247, p=0,00
23. Cloud applications systems (Web-based)	3,61	4	0,989	4	D(37)=0,278, p=0,00
Total Average:	***3,99***		***0,508***		

Business intelligence capabilities that are considered the most important are the aggregated results tools (4.68), importing/exporting data (4.48) and economic management/accounting tools (4.42), while property management tools (3.35) and investment analysis tools (3.39) are considered less important.

The link between the advantages of implementing an ERP system and the Business Intelligence capabilities in SMEs is examined in Table 5. Furthermore the correlations between ERP system implementation and their Business Intelligence capabilities, with the years of ERP usage are also investigated, using the Spearman coefficient. The more years a firm uses an ERP the more conscious should be on the advantages and capabilities it offers, due to experience and economies of knowledge.

Table 5. Results of perceptions of managers concerning Business Intelligence capabilities, of ERP systems.

Correlations	Spearman Coefficient	Significance p.
Total Average Table 2 answers vs Total Average Table 4 answers	0,738	0.000***
Total Average Table 2 answers vs Years of ERP usage	-0,022	0,892
Total Average responses Table 4 vs Years of ERP usage	-0,021	0,901

*** *significant for 0.01*

The values of the Spearman coefficient indicate that years of usage have no correlation with the perceived advantages of implementing and using an ERP system nor with the Business intelligence capabilities of the ERP system. That result may indicate the lack of economies of knowledge, and the underutilisation of the capabilities of the ERP system, resulting to poor ROI, and less efficient management and marketing decisions, that are critical in times of crisis. However, as expected the perceptions of the advantages emanating from the implementation of ERP systems are highly and positively correlated with the perceptions of business intelligence capabilities that the system delivers.

5. Conclusions

The present research aimed at investigating the perceptions and attitudes of firms using ERP systems and their Business Intelligence capability in the region of Western Macedonia in Greece. The integration of ERP systems is important for SMEs from a strategic point of view, especially due to the competition, they face in a globalised business and economic environment, where focus on cost reduction and customer needs is of outmost importance.

The sample consisted of 37 firms and respondents found more important the advantages derived from reliable data collection and consolidation, as well as saving time by automating procedures, but not saving operational resources, and cost. These results are in line with relevant findings of (Kanellou & Spathis, 2013), but are in contrast with the findings of (Said et al., 2003), (Forslund, 2010) and (HassabElnaby et al., 2012) who argued that the main benefit from adopting and implementing an ERP system is cost reduction. Similarly the Business Intelligence capabilities that are considered more important are data related, important for business reporting and date importing and exporting capabilities, about profit and non-profit organizations analysis (Nasiopoulos, Sakas, Vlachos, 2014).

Our findings raise important questions regarding the strategic intent and the reasons of adopting, implementing and finally using an ERP system by SMEs. ERP systems and their Business intelligence capabilities are not incorporated in SMEs in order to fully exploit the benefits deriving from their usage. Organizational and operational factors such as culture (Trivellas et al., 2006; 2007), strategy (Konstantopoulos et al., 2007; Reklitis et al., 2007), leadership (Trivellas & Drimoussis, 2013; Trivellas & Reklitis, 2014), learning (Dekoulou & Trivellas, 2014) and quality management (Trivellas & Santouridis, 2009), as well as strategic orientation of a firm (Reklitis & Trivellas, 2002; Trivellas, 2012) are significantly affecting the implementation and integration of sophisticated business intelligence systems (Nasiopoulos, Sakas, Vlachos, 2014). SMEs especially in times of crisis divert resources from "expensive" tasks as training and integration of new software and its capabilities divesting themselves from potential competitive advantages and losing the chance to gain core competences (Dekoulou & Trivellas, 2014). In addition, a lot of work needs to be done regarding linking ERP systems to outsourcing partners of an SME (Kutsikos & Sakas, 2014).

The results of this study can be used in the implementation of ERP systems and the usage of business intelligence features by SMEs, but also for the formulation of marketing strategies for ERP software companies focusing on SMEs. An important limitation of the study is the small sample used, that is unfortunately a common problem in conducting questionnaire research with SMEs. However, further research should focus deeper on the organisational structures of SMEs, facilitating the implementation of ERP systems, as the underutilisation of the new capabilities of these systems deprives them from well needed future growth. Moreover, scholars should examine the role of education (Santouridis et al., 2014) and HR practices in order to enhance work outcomes (Trivellas, 2011; Trivellas et al., 2013;2013a; Kakkos & Trivellas, 2011) and cultivate the necessary behavioral and emotional competencies (Trivellas & Drimoussis, 2013; Trivellas & Reklitis, 2014) for the full and every-day application of ERP systems in a safe work environment (Metallidou et al., 2014).

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