

Managing Supply Chains Using Business Intelligence

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Abstract

Organizations are deploying business intelligence (BI) systems to enable analysis of data assets for establishing management decisions. Corporate data captured using enterprise systems (ESs) are leveraged through BI to evaluate digital information for deploying business strategies. This study investigates use of BI in organizations for managing supply chain operations. The current BI practices of manufacturing firms are evaluated for transforming transactional data captured through ESs into organizational knowledge in pursuit of realizing supply chain goals. Findings from a case study reveals that although manufacturing firms have identified business analytic as one of the major necessities for organizational effectiveness, these companies often lack clarity in aligning key measurable against their business processes to utilize vital ES data. This results in underutilization of BI tools and the data assets for establishing business decisions. However, more and more companies are now deploying BI strategies for impromptu decision making in managing supply chains.

Keywords

Business intelligence (BI), enterprise system (ES), supply chain management (SCM).

INTRODUCTION

In the past two decades, business intelligence (BI) and the related field of data analytics have emerged increasingly important in both management practice and academic research (Chen et al. 2012). BI systems have been implemented by many organizations to create and manage information spontaneously that enable prompt responses to challenges faced through analytical evaluations (Elbashir et al. 2008; Ramakrishnan et al. 2012). Organizational business strategies are supported through BI systems, also referred to as “data-driven DSS” (Power 2007). The BI process includes extraction, transformation, and loading (ETL) as essential components of data management for integrating and converting enterprise-wide data into actionable knowledge. The process is supported through drill-down and database queries as well as assessments using online analytical processing (OLAP) features. Enterprise system (ES) vendors such as SAP, Oracle and Microsoft have incorporated these processes and technologies into their BI platforms which are supplied as part of their ES applications or off-the-shelf add-ons (Sallam et al. 2011). Built-in tools for reporting business performance such as scorecards and dashboards assist in visual analysis of different indicators and measurable. Additionally, data warehousing and statistical tools are used for classification, clustering and segmentation of data as well as predictive modeling and regression analysis for different analytical requirements.

Although, the importance of BI has been realized, little research has been conducted to examine these practices and evaluate the business value realized from their implementations (Elbashir et al. 2008). BI research suggests that without a clear business driven need identification, the BI initiatives “rarely produce substantial impact on business” (Yeoh and Koronios 2010, p. 31). One of the key goals for a manufacturing organization is to achieve sustained competitive advantage through effective supply chain management (SCM) processes. Recent research has also suggested that evaluating strategic decision-making capability in managing supply chain operations can assist to provide new insights on a firm’s ability to succeed in competition (Priem and Swink 2012). This study looks into these gaps in the context of BI solutions to investigate the *BI practices that are most critical to the successful transformation of data towards implementing strategic decisions in supply chain operations?*

The study is conducted through interviews with management staff of a large electronics manufacturing company that has deployed BI to understand their data transformation practices and implementation of strategic supply chain decisions. Thus, a major contribution of this paper is to determine the impact of BI systems in implementation of SCM strategies. Insights from the users in industry who are actively engaged in managing supply chain operations and regularly using data through BI for decision making are shared in this study.

The next section reviews existing literature to provide a broad perspective on BI and discusses the relationship between business strategy and IT strategy in identifying the need for an IT infrastructure that can satisfy the organizational needs to achieve business goals. Next, the research methodology explains the design and data

collection process of the study. The empirical findings from the case study are next presented. Finally, the results are summarized and suggestions for future research are offered.

BUSINESS INTELLIGENCE

BI systems have emerged as one of the key applications in firms to provide “useful insight, support decision making, and drive organizational performance” (Ramakrishnan et al. 2012, p. 486). These systems enable analysis of critical business information by leveraging large data infrastructure investments such as ESs made by organizations. BI systems have “potential to realize the substantial value” residing in the organization’s data assets (Elbashir et al. 2008, p. 135). Having pervaded in several industries including manufacturing, telecommunications, finance and banking, insurance, and retail, the implementations have achieved a mixed result – successes (e.g., Continental Airlines and First American Corporation to improve customer loyalty and improve ROI) as well as failures in other companies that have not been able to improve performance or increase profit after their BI deployment (Gessner and Volonino 2005). One of the key factors for achieving success in a BI implementation is concerned with “providing clean, consistent, high quality, and integrated data” (Ramakrishnan et al. 2012, 486). A successful implementation however, creates the ability in an organization to comprehend, think abstractly, innovate, solve problems, predict, plan, and reason. It can lead to improved data consistency based on data integration, a higher level of interactivity, easier querying and analysis, and faster access to information. It enables a firm to “learn in ways that increase organizational knowledge, inform decision processes, enable effective actions, and help establish and achieve business goals” (Popovic et al. 2012, p.729).

BI systems allow transformation of data based on specific needs into insightful information. Further, analysis of the information leads to action and results. BI utilizes the applied functionality of data warehouses to support extraction, evaluation, and reporting on corporate data in the different business activities through the value chain (Nicolaou 2004). The BI systems have been made available by large ES vendors such as Oracle and SAP by incorporating these tools to become part of their offering. There are some specialist mid-size BI companies such as Cognos, Crystal/Business Objects, and Hyperion/Brio that supply only the BI application as a bolt-on module to any enterprise system. Although, BI systems historically have been linked exclusively to support strategic management decisions, recently organizations have begun to further leverage these systems to support “wider business activities” such as “tactical and operational process improvements, supply chain, production and customer service” (Elbashir et al. 2008, p. 149).

BUSINESS INTELLIGENCE IN SUPPLY CHAIN MANAGEMENT

A critical component in a company’s ability to achieve competitive advantage is by using a BI approach which enhances efficiency of analytics for SCM. An executive’s reasoning abilities are enhanced using BI whilst monitoring supply chain process outcomes. BI systems integrate and consolidate information to support firms that are seeking supply chain effectiveness through vendor and customer loyalty and retention (Ranjan 2008). Several researchers have explored the business value of BI systems through analytics in supply chain (e.g., Kumar and Deshmukh 2005). Heydock (2003) has noted that by creating supply chain intelligence, opportunities to reduce costs and stimulate revenue growth are revealed, enabling firms to evaluate the complete supply chain from a customer’s perspective. The key analytics include primary drivers for supply chain processes – planning, procurement, manufacturing, logistics, and returns – to increase the efficiency within SCM. For achieving this, creating a multi-dimensional view of the supply chain by capturing transactional data, controlling and providing quick access to information with end-user view representation is essential. Supply chain performance measurement against organizational objectives identifies opportunities to increase manufacturing competences, improve vendor management, reduce costs, and optimize deliveries (Ranjan 2008). Supply chain analytics strive to provide strategic information to decision-makers in firms by applying BI to data from ESs. Information classifications range from monitoring the ability of a supply chain to deliver cost-effective products to reviewing what-if scenarios (Reddy 2003) for reorganizing key SCM processes. Excellence in SCM is achieved through implementing demand-driven just-in-time supplies, managing the warehouse and distribution facilities, providing means for planning and monitoring inventories, and tracking orders and deliveries (Taylor et al. 2004).

Recent research has found that BI plays an important role in implementing and monitoring strategies such as sustainable supply chain practices (e.g., Petrini and Pozzebon 2009). Operational staff are able to use these tools themselves and access timely and relevant information to make effective decisions. Some researchers (e.g., Horkoff et al. 2012) claim that existing BI tools typically provide data-oriented responses to queries which are difficult to relate to strategic goals and business models. Based on such organizational needs, ES vendors have incorporated the BI module and its analytical functionalities into their offering as SAP has done with Strategic Enterprise Management in conjunction with Business Information Warehouse (SEM-BW) creating the ability to provide information in real-time for current decision making (Watson et al. 2009). Some of the key

functionalities of BI tools to enable sharing of enterprise-wide information across different functional units for decision making are summarized in Table 1 (Mathrani and Mathrani 2013).

Table 1. Key functionalities of BI tools that assist in decision making

Purpose	BI functionalities
Business reporting	<ul style="list-style-type: none"> • Provide ability to drill down through layers of data, and do the analysis in any form (spreadsheet, charts, hyperlinks) without burdening user with technical details. • Assist in setting up of data filters, crosstabs, and user-friendly queries to answer specific questions. • Extend standard ES reports (e.g., aging analysis or order intake reports) to optimize capacity planning and improve productivity. The underpinning information and functional areas are not mutually exclusive.
Reduce information overload	<ul style="list-style-type: none"> • Aggregate/distil meaningful information, to help managers know more about their business and start looking for correlations with specific questions, since ES implementations can be overwhelming causing information overload. • Data from heterogeneous environments can be mined and presented to users on a regular basis.
Support management performance evaluation	<ul style="list-style-type: none"> • Balanced scorecards are used in conjunction with data mining to aggregate databases for performance evaluation expanding managerial analytical capabilities. • Help business managers create relevant data views to make knowledgeable decisions bringing clarity on critical information elements.
Business process simulation and scenario planning	<ul style="list-style-type: none"> • The built-in integrated reporting and dynamic query generation function allows users to extract intermediate data and assess different possible simulated outcomes. • Analytical processing can be applied to scenarios by adding experience, context, and interpretation. • Provide a point-in-time multi-view of the current progress of new initiatives, which can then be exploited to improve performance.
Add-on Features	<ul style="list-style-type: none"> • Enable organizations to identify a baseline against which standards could be defined and the information presented as a report, scorecard, or KPI, since many firms do not even know what they want to measure. • Customization with add-on features (e.g., a dashboard could provide more contextual information that helps in insightful decision making).

STRATEGIC ENTERPRISE MANAGEMENT

In the post-implementation stage, firms are looking at leveraging their ES investments at the senior-most level (Ritchie-Dunham et al. 2000). SAP, in their initiative towards satisfying this organizational need, has developed the Strategic Enterprise Management module that utilizes the balanced scorecard framework and BI for operationalizing organizational strategies. However, Ritchie-Dunham et al. (Ritchie-Dunham et al. 2000, p. 1260) state that such a strategy operationalization benefit has yet not been fully realized by enterprises with implemented BIs and this benefit is also very dependent on the end-users “thus, it is not guaranteed by the presence of balanced scorecard or BI even in combination”.

In another study, a hard-drive system manufacturer, Western Digital, has built a digital dashboard system called “real-time” with their ES as the technical backbone that includes both “sensing and responding capabilities”. This system includes a management dashboard supported by an underlying BI and data warehouse application that automates “the alerting process” and provides the means for a response through various operational indicators. These indicators include production output, inventory levels, production yields, test equipment utilization, and quality parameters that have enabled the company to increase operational efficiencies, maintain high product quality, and provide better future versions of products (Houghton et al. 2004, p. 19).

Although selecting a comprehensive data collection strategy assists in achieving BI success, a lack of strategic alignment between business and IT has been found as the reason for its failure. The relationship between business strategy, demand and application focused information system (IS) strategy, and supply oriented information technology (IT) strategy is illustrated by Ward and Peppard’s (2002, p. 41) model (Figure 1). In this model, the downward arrows originating from business strategy depict the direction for business highlighting the business needs and priorities and the upward arrows from IT strategy depict the infrastructure and services that support these business needs.

Keyes (2006, p. 242) suggests that organizations should construct a knowledge management (KM) framework based upon their choice of “organizational schemes such as balanced set of measures, benchmarking, target-setting, matrices, hierarchies, flow diagrams, and even management systems”. She states the right option is dependent on the teams’ ability to evaluate their relationships, related benefits, costs and then to measure their impact on each other and to the extent the business objectives are achieved.

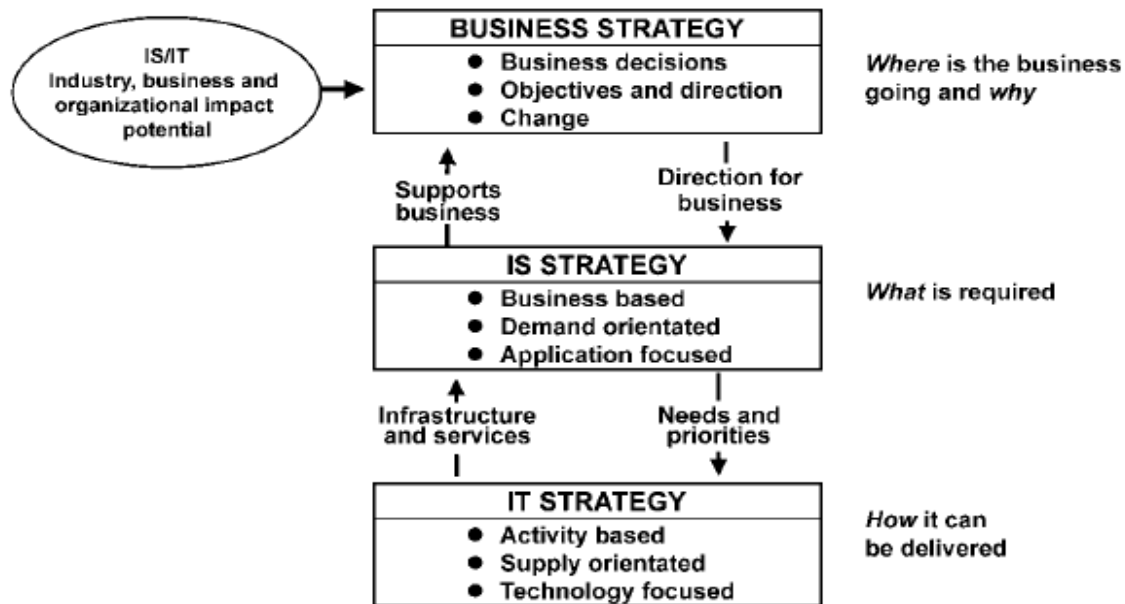


Figure 1: The relationship between business strategy and IT strategy. Source: (Ward and Peppard 2002, p. 41)

RESEARCH METHODOLOGY

The research design comprises an in-depth investigation of a large case who has implemented BI systems. Nine face-to-face semi-structured interviews were carried out with key respondents using BI. The participants included senior executives, managers, and operational staff in the organizations actively engaged in managing the BI and utilization of ES data for decision making.

The selection of the case was based on two predetermined criteria: (1) the organization is in the manufacturing sector and this is significant because the characteristics of manufacturing organizations especially motivates ES adoption (Raymond and Uwizeyemungu 2007) and (2) the case should have implemented ES and BI for at least three years and so is mature with their implementation.

The case research design utilizes a theoretical framework (Ward and Peppard's model) from the literature and establishes the study's context. Theoretical propositions have been analysed to compare the empirical findings with extant literature to answer the research question (Dube and Pare 2003). The *a priori* specification of constructs comprises the business strategy, transformation of ES data for managing supply chain operations using BI, and the outcomes, which relate to the achievement of organizational goals and objectives. In the interview, questions were asked to extract information on the most critical BI practices for the successful transformation of raw data for analytical decision making in managing supply chain operations. The results are analysed, discussed and presented in this paper.

CASE STUDY RESPONSES ON SUPPLY CHAIN PRACTICES

The study involved a large high-tech electronics manufacturing organization namely Cevon (pseudonym) who has implemented an ES including BI. Brief case description of the organization is shown in Table 2. Semi-structured interviews were conducted to understand how the firm used BI tools for supporting implementation of strategic business decisions in managing their supply chain.

Table 2. Case description of Cevon

Established	1987
Original design manufacturer	Devices for marine, in-car navigation, and fleet tracking
Employees	750 (Large)
ES	SyteLine 7, 2006
Modules	Manufacturing, Finance, BI (Cognos version 7), and Field service
Organizational growth	\$100M (03)- \$500M (07) 50% pa

Cevon Practices

Cevon has implemented a bolt-on BI application called Cognos Impromptu to their ES, SyteLine version 7 (SL7). The IT manager at Cevon opined that the BI tool is quite useful to users who need to create ad-hoc reports based on the challenges they face at any time. *“It is a great tool for generating ad-hoc reports, where there is no need for the user to go to a developer and request a new report layout because a particular column that the user wants in the report is not there”*.

The manager further stated *“when users have the ability to access the data easily they can quickly build a picture of the correct information and make better decisions. The tool helps to get required data out of the system quickly and efficiently”*. The IT manager explained that SyteLine has a lot of data in its database and it is not always presented in a user-friendly manner such as through forms and reports. Therefore, Cevon uses a bolt-on business intelligence application called Cognos Impromptu. *“This is a more user-friendly way of drilling into the specific data and presenting particular data objects with precise information that the user might be interested in looking at. For example, the user may want specific information such as information relating to a particular customer, or may only want to know the products for a particular code range, or what the value of a specific sales order was. Through this application the user can retrieve just the information required rather than all the other pieces of information that might be available in a sales order such as the delivery terms or the ship-to address, or the GST code that makes all that data irrelevant for this particular user who does not want that information.”* Therefore, rather than using the system screen to locate the relevant information which could be a tedious task, the user may use the Cognos tool to drill into the system and pull out the required information and transfer into spread sheets where even further manipulation could be done that an ES application is not very good at. For example, summing the number of records and adding up the total values.

The sales order forecasting process is one of the key processes for managing the supply chain at Cevon. The process begins with a business plan. The executive management creates a budget in consultation with the regions and the operations team, and finalizes the business plan. The operations and supply chain (O&SC) manager explained that a few years ago at one time, the factory had been receiving fewer orders than the regional forecasts and the company had not been meeting the budget. There was not a lot of visibility of that information. The operations team started pulling reports using BI and realized there was no way they would be able to meet the budget because there were no orders in the system and the forecasts that existed were way too large. There was too much buffer in the system which was not being turned into firm orders. Therefore, what was happening, *“purchasing was ordering truckloads of materials for products that were not going to be built. The warehouse was just getting full of raw material and inventory that was not being transformed into finished product. There was a stage where the warehouse had to be extended and components had to be stored in the covered car park area across the road. Three hundred pallets of stock were sent to the BAX Global warehouse as well, who are the company freight forwarders, for storage at their facility near the airport incurring additional monthly storage cost. We resorted to a revised sales and operations planning process with the help of BI and the situation changed”*.

How this happened is explained next. Orders for Cevon were mainly made up out of confirmed and forecasted orders received from subsidiaries. The aim was to have all orders for the next three months firmed up and forecasts reviewed for the subsequent three months with the customers. Cevon started generating a six monthly forward order status report by region using BI. This also became the founding point of the company's manufacturing rolling plan. The forward order status report was emailed to all the subsidiaries and regions with a request to firm up the next three months demand and review the following three months forecast based on the inventories and their market requirements. This process was repeated each month through the BI system, which helped to streamline the demand planning with subsidiaries. As a result, the materials and capacity plans were updated regularly in SyteLine and adjustments to the procurement and manufacturing plans were automated through the manufacturing resource planning (MRP) system. This new planning process has not only improved inventories, but also the factory capacity and production planning leading to improved delivery performance and customer service.

The outputs of the planning process at Cevon result in creation of a production plan that specifies items required for production in the next four weeks. The supply quantity is indicated against the job numbers related to each item. The added value of the production plan is based on the daily production quantity and by week, that is based on customer requirements and line capacity. The requirements are grouped by Line/Family/Work Center and Item. According to the O&SC manager *“the production plan is created by means of a BI report which is transferred into an Excel spread sheet. The main issue with the earlier production plan was that it did not communicate any order priorities to the production units. Given its weekly buckets, it did happen regularly that the shortages occurred between levels, slowing down production”*.

The O&SC manager further explained that the BOM was not always 100% accurate. Certain areas were flagged as being weak such as the final packing level BOM often contributing to stoppages in production. *“With BI, the planning process improvements include a) planning and providing requirements per item/per time bucket based on demand, b) it is now possible to schedule certain parts of the business by minimizing the set up through grouping by family, and c) the planners are able to capacity plan forecasted orders and assess the need to add capacity from the feedback from regions.”*

Cevon’s purchasing has two separate functional areas. The sourcing function, which is strategic, and the buying function, that is execution focused. In both of these areas there is a further split into electronic and non-electronic parts. Purchased parts are managed through the BI routines and the inventory management program. The purchasing manager stated that *“the inventory management program is a process which deals with consignment stock working towards a vendor managed inventory system. The sourcing function identifies and negotiates with potential suppliers. Once the supplier has been established as a Cevon supplier and a vendor account opened in SyteLine, the buying function takes over. All of these processes are managed using BI for critical decision making”*.

A number of SL7 subsystems are used in the purchasing function at Cevon such as lead-free database, tooling data, tracking of goods expected to arrive with tracking numbers, and amounts payable. These subsystems are relevant to the purchasing function with information extracted through BI in the format desirable to the user. The newly created “lead-free” database maintained within SL7 provides specific information on parts to ensure compliance to the RoHS (lead-free) standards based on the RoHS regulation, which restricts use of certain hazardous substances in electronic products. The database provides information from the manufacturer determining whether the part is RoHS compliant or not and establishing traceability. A new tools database is created as part of fixed asset register to track the company assets and depreciate them within the finance module. This forms part of resources, which is linked to “assets” in the fixed assets register. Another subsystem introduced in purchasing is the tracking of goods expected to arrive with tracking numbers. This forms part of the standard goods receipt functionality in SL7 executed in inwards goods. The revised “amounts payables” subsystem used in purchasing, forms part of the accounts payable in the finance module. The accounts payable subsystem provides the visibility of the amount due to vendors at any point in time. The data for decision making is extracted from all of these subsystems using BI and analysed for prompt actions.

As per the O&SC manager, since 1993, the European Economic Community has required that certain additional information is tracked at the item level including delivery terms, nature of transaction code, commodity code, origin, unit weight in kilograms, and consignment number. These are easily tracked using the BI and promptly reported. Reports such as purchase orders (POs) due, POs cost variance, item stock on-hand, and POs freight costs are made available through BI. The purchasing manager opined *“earlier most buyers had their own spread sheets by which they maintained the expected date of arrival for purchased items. With BI, the buyers can now extract information against the purchase order lines and do not need to maintain separate spread sheets”*.

The dispatch process at Cevon involves a picking list detailing orders expected to be shipped in the coming week. This is followed by the manual picking of products. The O&SC manager explained that the main process step is the customer order shipping. *“Here a very large number of serial numbers are involved. This was a tedious process with a lot of mismatch in the serial number processing earlier. After BI, traceability of serial numbers has become smooth which resolved the earlier mismatch issues.”* The extraction and transmission of the shipment information to the customers has become a very simple process using BI providing the speed and visibility that the customers wanted. Some of the BI queries and reports regularly used by the dispatch staff are serial numbers query, warehouse query, item serial number report, due for shipping and ship to report, and customer invoice report.

Cevon has been utilizing BI information to provide a view of organizational performance as projected through a balanced scorecard. The scorecard highlights the company’s objectives and provides the metrics that direct the company towards achieving those objectives. This includes benchmarking the KPIs and monitoring performance against the benchmark on an ongoing basis. Decisions are then taken based on the analyses, interpretations, and the knowledge outcomes. According to the O&SC manager, the interesting features from the scorecard were to know for example, what the budget was for the next six months, what were the firm orders, the planned orders, what were the gaps, where were the gaps coming from, and from which regions. *“So that the gaps could be taken up with those regions to ask for example, they had forecast for two million dollars and already had firm orders of 1.6 million, so where was the balance four hundred thousand going to come from. Those sorts of things, to make sure that the budgets are being met and providing visibility to all concerned especially the salespersons in the regions to make them aware of the status. And, all of this information was captured via BI”*.

Furthermore, the respondent implied that if the right data are retrieved and the noise eliminated then correct decision making becomes a lot easier because the objects that are disrupting the picture have been removed. This

allows for clear and accurate decision-making. Analytic modelling is performed using external systems such as BI where the extracted data are transferred into spread sheets for analysis. Cevon uses analytic outputs such as list reports *"list customer orders that are overdue, list customers with account receivables greater than sixty days, list overdue account payables to vendors, list overdue purchase orders, or list the orders of forecasted sales for next month are some of the list reports used for analytical decision making to achieve results"*. The analytical assessments help to establish metrics using a number of different performance indicators. *"We're looking at KPIs from 'order-to-cash', so that KPIs from every business process between taking an order from a customer, delivering the goods and collecting the money can be clubbed together in a one page document which would really be a statement of how the business is performing at any point in time. The true benefits of this are not from knowing any one week's performance but from knowing week on week whether the performance is getting better or worse. This is where such analytical information gets beneficial if the effect of changes is evaluated to understand whether the changes have actually been worthwhile."* The scorecards can provide the reassurance that the kind of changes the company is doing are actually resulting in measurable benefits.

The O&SC manager further explained that different people are interested in different types of KPIs in different areas. *"The system is being used to be analytical in terms of being able to know whether the company is getting better in particular areas or worse. Or what is the result of making a process change. Maybe, change in a particular process needs to be analysed to see whether it is having a positive effect on a range of KPIs or a negative effect."*

The respondent further noted that although the information was accessible through the BI module, people had to depend on the few users with BI licenses, which was always a problem since those people always appeared to be quite busy. Getting a custom BI report would always involve a bit of a delay depending on who was asking for the report. It would help to have a person or a function where a BI person who knows the data structure can do the custom reports through BI for all users. Put it in a format that can be brought into Excel and then the users can do the manipulation themselves. To leverage BI technology, the system must be well integrated and tied to the middleware of the ES, so that the users have the ability to drill into the core information to extract the underlying data. Ideally, providing the training and the tools to users would be the best so that they have the ability to extract and create information themselves.

However, at different times the BI administrator at Cevon has been asked to help produce information that is used for some KPIs. *"It has only been a matter of establishing what that indicator is and what drives that indicator which really is the vital thing. Once that is established, the required information is easily retrieved out of the system, measured, and monitored. In reality, this is the area which is the most complex. Organizations fail to identify the areas which really need assessment. For example, portfolio management...In our PAC [program approval committee] review meeting, most of the times our team is not clear where the organization is creating value and where it is not. We then simply follow the usual market-pull, technology-push, or the cost reduction objectives of the organization without really a proper technical or financial assessment."*

DISCUSSION

The findings highlight the organizational practices and the capabilities offered by BI tools to extract and analyse enterprise-wide data, and assist in establishing strategic decisions in managing supply chain operations. There are many areas where managements need to establish business decisions in supply chain operations by assessing the different day-to-day scenarios, reviewing vital information and metrics captured through BI tools. Reporting techniques such as KPIs and balanced scorecards are used to monitor performance and assess future actions. The BI tools help in providing such information timely enabling a proactive response to the constantly changing business environment.

Given the risks and significance of managing supply chain operations, this study has highlighted the utility of BI tools in mapping decisions throughout the operational processes. Various organizational user participants have answered the research question, *which BI practices are most critical to the successful transformation of data towards implementing strategic decisions in supply chain operations*. A summary of BI practices that enable transformation of data and strategic decision making within supply chain operations are: (1) analysis of current state of operations in managing the supply chain, (2) creation of user-friendly customized reports based on SCM needs, (3) align business strategy with operational SCM strategy for day-to-day monitoring, (4) simulation of different supply chain scenarios to implement strategic management decisions, (5) inform management on key metrics and measurable within SCM through dynamic on-line queries, and (6) data transfer into other platforms (e.g., Excel) for further analyses. These capabilities assist business managers in understanding critical process variations in unstable supply chain situations, knowledgeably strategize distribution of resources, and implement immediate actions. The study results highlight that the BI tools are used in supply chain operations to provide support in key functional areas such as: (1) development of budgets and business plans, (2) forecasting sales and

planning operations, (3) procurement of materials, logistics and inventory management, (4) production, quality control, dispatch and return of products, and (5) performance and financial management.

A model that establishes relationship between BI practices and its support in key functional areas of SCM is developed based on the case study findings and presented in Figure 2.

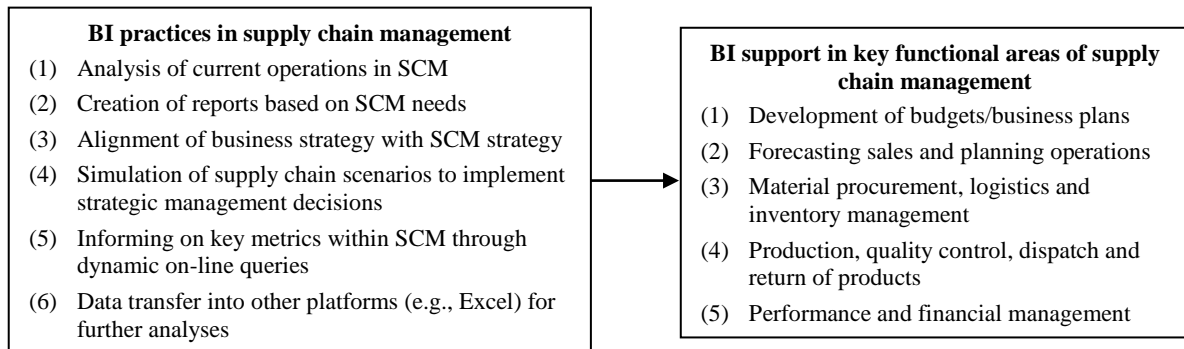


Figure 2: The relationship between BI practices and its support in key functional areas of supply chain management

In the case of Cevon, the business strategy was defined by the company management and the goals were aligned to the overall organizational activities. The company had their IT infrastructure and BI support aligned to their business needs to achieve valid outcomes from their BI investment. These findings are consistent with Ward and Peppard's (2002) model (Figure 1), which illustrates the importance of a clear business strategy and setting of objectives in guiding and comprehending the business requirements leading to deployment of relevant IT tools to support the realization of business goals. An emphasis on determination of clear goals and objectives at the project outset is an important factor for ES implementation success (Plant and Willcocks 2006).

However, a major finding in this study is related to needs identification. Findings have revealed that although these systems are much in use currently, the organizations many a times fail to identify the key areas that need assessment, and the data that is needed for analysis. NZ organizations are still weak in clearly articulating and understanding their business needs and objectives. Despite having availability of enterprise-wide data and systems that can extract precise information, the managers sometimes fail to identify the business needs and related data to achieve objectives. This finding is consistent with (Yeoh and Koronios 2010, p. 31) who also suggest that without a clear business driven need identification, the BI initiatives "rarely produce substantial impact on business". Therefore, although technology and support through systems such as BI is accessible, the acumen to ascertain business requirements and identification of the precise data needed to address fulfilment is significant.

Study findings also reveal that BI tools have achieved a quantum leap in analytical capability and business reporting. However, these findings emphasize that in order to leverage BI technology the system must be well integrated to the middleware of the ES, so that the users can drill into the core information themselves to extract the underlying data. Therefore, the IT infrastructure and system integration play a vital role in achieving adequate results. Over-looking of IT infrastructure can impact the holistic landscape of organizational processes that involves sharing of enterprise-wide information and monitoring of business activities. Additionally, data extracted by IT specialists provides a limited picture via ad-hoc reports opposed to impromptu generation of intelligence by the business managers using BI. Providing the training and tools to users is a better strategy so that they have the ability to extract and create information themselves instead of depending on IT administrators.

This summary provides an evaluation of the case and highlights the current practices and the critical effectiveness constructs of the BI process. Managements have realized that effective utilization of BI capabilities lead to a deeper insight into the business dynamics for managing supply chain operations in global markets. The analytical process originates from the setting of organizational SCM strategy and objectives, translating into day-to-day operational targets. Once the supply chain operational goals are decided, these goals drive the organizational initiatives and processes in support of their achievement. The data are extracted and utilized, initiated through the BI process for supply chain performance monitoring and management or a functional requirement that needs information for decision making. The BI system assists in analysing extracted data for strategic decision making. The analytical processes lead to creation and utilization of knowledge in various organizational new initiatives, and process improvement programs to achieve the company's goals and strategic benefits in supply chain operations.

CONCLUSIONS AND FUTURE DIRECTION

The study has emphasized the significance of identifying needs and implementing critical BI practices to manage supply chain operations in organizations. These practices are deployed when the BI tools are used to provide vital information for resolving underlying supply chain issues and improving organizational processes. These practices assist in monitoring and measurement of critical supply chain deliverables and implementation of strategic business plans. The BI practices impact an organization's ability to realize the goals and objectives set in managing SCM processes. BI tools augment analytical metrics through measurable summary reports, graphical models, and tabular data assisting managers in execution of knowledgeable decision making.

Performance review assessments supported by an underlying BI and data warehouse application drives an effective response to achieve better strategic and operational results. To investigate opportunities and risks in operations, a BI evaluation approach allows the overall financial objectives to align to functional metrics for deploying a contingency plan based on the examination of multiple "what ifs" and use of business process simulation techniques. Assessments performed in areas of sales volume realized, customer orders received, vendor supplies accepted, inventory levels achieved, production output realized, product quality attained, and product deliveries executed lead to understanding the optimization of data flows within SCM at discrete levels for an improved operational performance. This enables the organization to enhance supply chain efficiencies, improve product quality, and timely dispatch products to customers. Furthermore, these practices help in collaboration with network partners in business such as distributors, key suppliers and customers by providing vital information such as data on inventories and in-market sales that help in aligning supply and determining demand. However, the availability of high quality and consistently integrated data is critically important to realize these supply chain operational goals. Additionally, the BI support and IT infrastructure must be aligned to the business needs of the organization.

As a rational approach to business management, BI technology provides the ability to extract relevant information from data warehouses, allowing analyses of operational performance, and distribution of results. Thus, BI practice continually leads to an ongoing process of continuous improvement in supply chain operations. Although this study was conducted in New Zealand, the findings will be of interest to organizations across different regions of the globe. Future research can replicate this study in other countries, especially utilizing the perspectives of the BI users in those countries, as well as using diverse selection criteria for organizations - small firms or different industry sector and compare findings with this study.

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