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# **IT Deployment Assessment: A Two-Dimensional Supply Chain Life-Cycle Management Framework for Strategic Analysis**

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## **ABSTRACT**

*This paper is to develop a framework for industries to analyze their information technology deployment efforts based on operational activities along the life-cycle of their supply chains. In particular, industries that is mature and with low profit margin will find this framework applicable. It is an accepted principle in these industries that efforts to streamline and reduce cost are easier to achieve than to increase an equal amount of revenue. The framework encompasses all aspects of operations and provides a complete and comprehensive view of the whole supply chain. The first dimension of the framework includes both product-related and logistics-related activities. These are activities that range from product design to production to materials movement and warehousing. The second dimension addresses product and supply chain specific types of characteristics, which vary by industry that will impact the use of new information technology such as RFID, WiMax, and CPFR. These characteristics include the bitability, modularity, and information intensity of the product, cost structure in relation to product versus logistics, and vertical collaboration or standardization opportunities. By reviewing the life-cycle activities with these characteristics in mind, an industry can establish an information technology platform to guide new IT implementations for the future.*

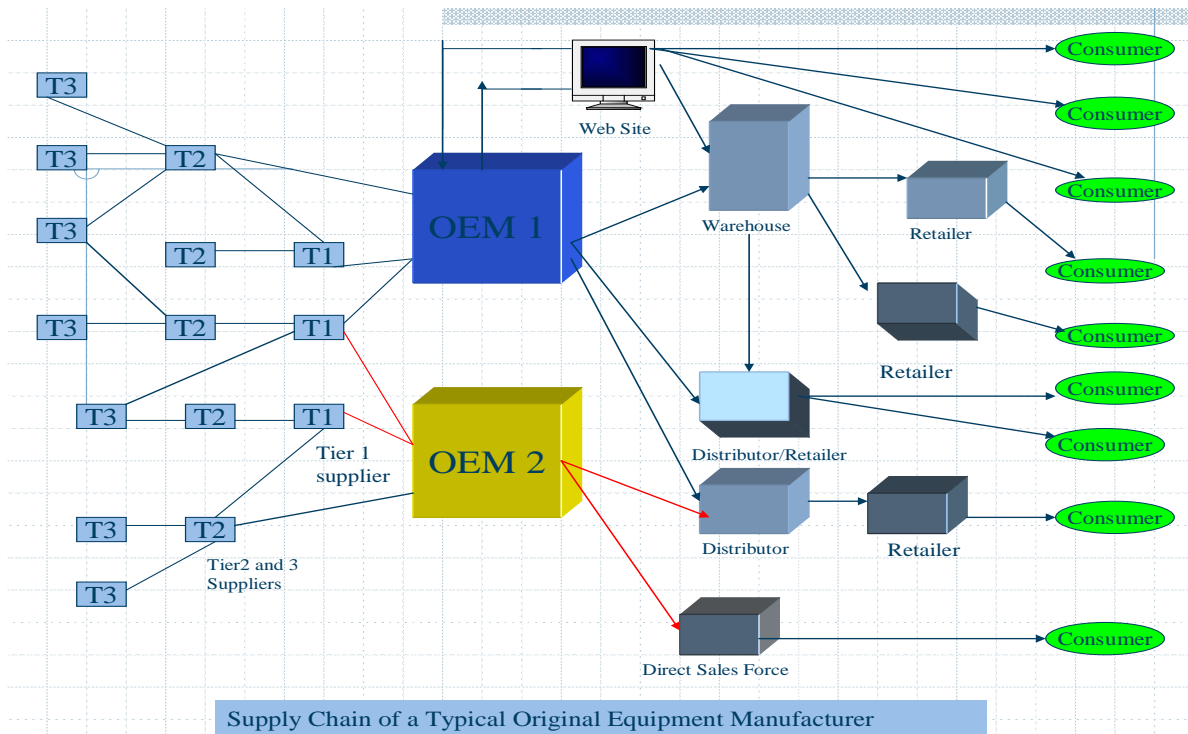
## **INTRODUCTION**

Depending on geographic location, there are many industries globally that face the difficult situation of competitive and, at times, limited growth. This is especially true in the US and Europe where population growth is rather stagnated and many industries have reached their mature stage (Anonymous, 2001). With competitive and investor pressure, it becomes imperative for these industries to transform themselves so as to be in position for the coming years (Kopczak & Johnson, 2003; Lewis, 2000). With pricing and volume growth as limiting factors, these businesses are increasingly focused on exploring opportunities to re-invent themselves and further streamline their supply chains in order to generate additional value for investors (Lewis,

2000). Competitively driven global businesses are swiftly capitalizing on the value of forging strong corporate alliances that achieve optimal operational efficiencies and relationships with suppliers and customers along agile supply chains. The result is synergistic mutual competitive advantages for the re-aligned participants in a synchronized supply chain as in Figure 1 (Fingar, 2000). Competencies and strategies are based in applications of information technology to achieve operational improvements and collaborative alliances that will lead to product re-design reconfiguration of the supply chain and optimization of manufacturing and logistics costs (Fingar, 2000; Mockler, 2000; Narayanan & Raman, 2004).

Throughout the 80s, 90s, and beyond, with increasing global competitive pressure, many businesses survived by recognizing the value of operational efficiency. Often time corporate strategies were focused on issues such as quality of product and customer service levels. Internal operating cost was of utmost importance. Such efforts led to successful business organizations that not only had a clear vision of the future direction of their respective industry, but were also streamlined and operationally lean. With relentless pressure by global competitors and consumers during the 90s, leading organizations recognized the need to further distance themselves from competitors.

**Figure 1: Supply chain of a typical original equipment manufacturer.**



dominating firm that essentially had the ability to facilitate various changes within the industry. The focus became the synchronization of the respective supply chain with this firm as the leading coordinator. Over the past forty years, this dominating position has shifted from manufacturers to the retailers. With this balance of power change come the need to re-focus and assess the strategies of each industry and its corresponding supply chain (Kopczak & Johnson, 2003; Mockler, 2001).

Generally, there are two tool sets that can be deployed to synchronize the supply chain. One tool set being the implementation of information technology such as RFID, WiMax, and e-commerce (Lewis, 2000). As an example, the implementation of on-line ordering system in the airline industry has reduced transaction cost by up to 80%. Another tool set is for the analysis and improvement of operations functions such as manufacturing, inventory management, procurement, and logistics. For example, the recent implementation of the continuous replenishment concept coupled with the inventory aggregation effect has transformed various retailing businesses to the lowest cycle inventory level and highest inventory turnovers in history (Homer & Thompson, 2003). But this tool set is infeasible without the use of information technology to provide the visibility of materials and information exchange for inter-organizational synchronization. It is often the combination of these two tool sets that provide organizations with the optimal level of value generation (Mockler, 2001).

The intent of this research effort is to present a two-dimensional supply chain life-cycle management framework that can be implemented by industries to analyze the potential deployment of information technology strategically (Fingar, 2000). Throughout previous implementations of information technology that affected the operation of various areas of any supply chain, most of the efforts are for addressing a narrow view of the supply chain or to resolve a specific, immediate issue. This two-dimensional supply chain life-cycle view will provide industries with a comprehensive view of most of the major categories of activities that are within the supply chain. But not all these major categories are of equal importance to a specific industry. Usually the level of importance relies on the nature of the industry that can be described by certain main characteristics of the product lines and the corresponding supply chains (Mockler, 2001). Combining the supply chain life-cycle view with the pertinent product line and supply chain characteristics allows an industry to analyze the potential impact of implementing leading-edge information technology, such as RFID and WiMax, with a macro view and establish a technology-based strategic platform for a long term horizon.

The supply chain life-cycle management dimension will first be discussed in terms of activities involved. The second dimension addressing product and supply chain characteristics will then be examined. The two dimensions are then combined so as to formulate the two-dimensional framework for information technology deployment analysis. Suggestions for implementation and a discussion of certain possible roadblocks follow. Recommendations in the form of “next steps” will then be summarized.

### **FIRST DIMENSION: SUPPLY CHAIN LIFE CYCLE STAGES AND ACTIVITIES**

In order to understand the current business environment of many of our industries, consider recent realities: relatively uncertain customer demand, increasing expectations of customers, longer lead times due to global sourcing, shorter product life cycles, continued price pressure

from downstream, and a larger variety of products due to mass-customization trends. These current realities have made it necessary for industries to re-evaluate their current practices in terms of how information technology should be deployed. The whole emphasis of the current supply chain may have shifted with the dynamics of the industry. Agility has replaced efficiency as the leading concern of supply chain strategy (Lee, 2004; Lewis, 2000). Information technology most certainly plays a critical role in achieving such fundamental shifts. The core activities of any industry can be classified in the form of stages of a supply chain life-cycle that range from product creation and production to the movement of materials to the retirement of the product line.

The two general categories of supply chain life-cycle involve product-related and logistics-related activities. Product-related activities include product design, manufacturing, and product life-cycle management activities such as new product launch, revenue/profit optimization, and end-of-life transition management. Conceptually, any re-design efforts during the life of a product are classified into product design activities. Manufacturing consists of all activities of production during the life of the product. Product life-cycle management commonly addresses activities from new product launch to the end-of-life transition to substitute product(s) (Lewis, 2000). Due to conventional practices of product design, it is common for the involvement of the suppliers in this phase. But it can still range from a cursory consultation to the complete control of the design process by the suppliers whereby the manufacturer would treat the functionality of the component like a black box. Mid-life-cycle re-design efforts often require the same type of relationship. Design collaboration with information technology is common practice in many product-complex industries. But most efforts are geared towards a B2B type of collaboration (Stockdale & Standing, 2002). But with recent enhancement and availability in connectivity, product design collaborations are now feasible at the consumer level. For example, the Saab passenger automobile manufacturing unit, through their CRM initiative, has been able to get interested consumers involved in the future design of their product line (Anonymous, 2001; Cornett & Pontier, 2002).

In production, most of the recent implementations of information technology are in the area of production efficiency and quality improvement. Efforts such as the practice of lean principles, as popularized by Toyota, are common (Anonymous, 2001; Nakayama, 2002). The role of information technology in internal production processes in the form of robotics and numerical control are relatively mature. But inter-organizational production synchronization is very complex and difficult even with elaborate information technology available. Each organization establishes its own production cycle rhythm over time and practices addressing materials (raw, WIP, and finished) inventory management typically centered at plant level (Anonymous, 2000).

Logistics-related activities include mainly planning and execution of activities in demand planning, supply planning, and fulfillment (VICS, 2004). Demand planning involves all the demand forecasting issues. Promotional activities are also considered in this category. In certain industries, significant efforts are geared towards the shaping and manipulation of demand. Activities related to such efforts are listed in this category. The role of inventory and management of activities regarding such are activities categorized in supply planning. Fulfillment activities are the most voluminous in this category. It includes most of the warehousing and movement of materials, from raw materials to work-in-process to finished

products. Decisions and activities regarding the use of distribution centers and concepts such as cross-docking and vendor-managed-inventory (VMI) are all part of this category. The roles of leading-edge information technology such as RFID tags are of critical importance in order for these types of material-movement concepts to be successful. Obtaining visibility of materials within a supply chain so that more complex collaboration can be installed has currently been the main goal for a vast number of industries. Synchronization of the whole supply chain via the use of information technology has led to logistics cost reductions consistently over 10% annually for some industries in recent years.

These two categories, product-related and logistics-related activities, together encompass all the core activities that take place within the supply chain of any industry. There are activities that span the whole life of a specific product and should be handled accordingly. It is conceivable, and at times necessary, for any industry to alter/fine-tune their information technology strategies mid-stream during the life cycle of the product, especially if the life cycle is relatively lengthy. For example, during the early stage of a new product life, an industry would more likely be concerned with acceptable lead-time and service level in order to gain market penetration and acceptance. But when the product becomes more mature and recognized the efficiency of the supply chain and the efficiency of production will normally take over in terms of priorities.

## **SECOND DIMENSION: SUPPLY CHAIN & PRODUCT CHARACTERISTICS**

The second dimension of the framework examines the key characteristics that are either supply chain-focused, product-focused, or both. These are characteristics that potentially could have major implications regarding the deployment of information technology that would enhance performance in the corresponding activities within the supply chain life-cycle. They are categorized into six categories: bitability of product; total product/logistics cost structure; information intensity; vertical supply chain collaboration feasibility; benefits of standardization; modularity of product and process.

Bitability of product defines to what extent the product(s) of the industry under evaluation is susceptible to being digitized. For example, a can of soft drink would not have high level of bitability but on the other hand a book would have a high bitability index. Products can be rated into high, medium, and low bitability level.

Total product/logistics cost structure is the consideration given to the balance between the product cost versus the logistics cost of the product(s) in the industry. This can be expressed in percentage form or range of percentages. The purpose of this category is to ensure that a cost-benefit consideration is included in the strategic evaluation of any potential information technology deployment. In certain industries, such as automobile, the cost incurred with the production of an automobile is so high in comparison to the cost of all the logistics activities that it would be rather ineffective to invest into the reduction of logistics cost as compare to the production cost (Anonymous, 2001; Cornette & Pontier, 2002; Nakayama, 2002). But it needs to be pointed out that this does not imply no analysis is worthwhile because in today's competitive business environment, any savings/efficiency is of value. But usually industries are faced with limited resources and only certain amount of attention can be expended and should be utilized selectively.

Information intensity is a measurement of the amount of information surrounding the specific product(s) of the studied industry. As contrast to the bitability of product, which defines the potential digitization of the product itself, information intensity is measuring the information about the product, the selling activities, the fulfillment, and any other activities. For example, an automobile will have minimal bitability rating, but it would rate high in terms of information intensity. Comparatively, a book would have rather high bitability rating but low in terms of information intensity. Information intensity can be rated into high, medium, or low.

In evaluating the deployment of information technology on the supply chain for any industry, one has to examine the structure of the supply chain and understand the materials flow dynamics (Stockdale & Standing, 2002). Obviously for certain industries, their supply chain is aligned in such a way that the use of information technology for collaboration is a great deal more beneficial than others. Factors that are important for this evaluation are the number of levels in the supply chain, the movements of materials, the sensitivity of timeliness, and customer desired service levels. There are industries whereby the basis of competition is the efficiency of their supply chains such as the general discount merchandizing industry dominated by Wal-mart. Of course, in this category, vertical collaboration among buyers and suppliers are the assumed model. This is probably the most complex category of the six. But in order to stay in line with the other categories, it is appropriate to rate industries by high, medium, or low.

Standardization is most effective in industries where it is not just prudent for vertical partners to standardize but as much for horizontal competitors to benefit from such efforts. For example, it would be most important for those involved in the financial industry to standardize many of their transactions even among competitors. It is inconceivable for banks otherwise. One can not imagine ATM machines that are incompatible. On the other hand, it is of no value for competing restaurants to synchronize their menus. Scoring in this category can also be accomplished via high, medium or low (Mockler, 2001).

Modularity can be separated into either modularity of the product or modularity of the process involved in producing the product. Product modularity allows suppliers and customers to collaborate in the joint design of the product and independent production. The roles of suppliers and customers can be re-sequenced and re-positioned via collaboration. Otherwise it would be impractical. Process modularity allows suppliers and customers to collaborate in the joint production of the product. It also allows for the potential delaying of product differentiation through the practice of postponement. As in most situations, there can be overlaps between the two types of modularity. For example, in the process of producing integrated circuits, IC chips, of Intel, the production process can not be modularized. So it is infeasible for Intel to invest into the separation of production of majority of their products. On the other hand, computer printers are very much feasible to be modularized, both product and process. Manufacturers like HP can definitely entertain the notion of having retailers participate in the process of producing the computer printers, like the installation of the power supply unit or load language-specific type of software. But this would require significant amount of data coupling in order to be effective. For the sake of comparison, it is appropriate for this category to be rated as *yes* or *no* on both product modularity and process modularity. It is a simplification that can be remedied in more detailed analysis. Modularity, or lack of such feature, has tremendous impact on the use of information technology particularly in information exchange.

For a given industry, one can gauge the general levels of where majority of the players in that specific industry are at in terms of the six categories describing the broad characteristics related to the supply chain and product(s) of that industry.

### **THE TWO-DIMENSIONAL SUPPLY CHAIN LIFE-CYCLE MANAGEMENT FRAMEWORK**

The two-dimensional framework can be constructed by setting up the categories in each dimension in a matrix form as in Figure 2. This will allow any industry to evaluate each of the stages involved in the supply chain life-cycle of any product line against the characteristics that present the most impacts in relationship to the deployment of new information technology. A critical benefit of this evaluation is that most of the core activities involved in the design, planning, execution, and management of a specific product line are considered, together with the logistics materials movement and warehousing. It allows for a comprehensive view of these activities in conjunction with the major characteristics of the product line and its corresponding supply chain. For the past decades of information technology deployment in business performance enhancement, a significant percentage of the gains are in these operational activities.

In the areas of information technology deployment in addressing operational activities, the most common applications are in communications/information sharing, utilizing the Internet as a communication platform. When opportunities are available for multiple collaboration efforts, Supply Web and Portals are most common used (Stockdale & Standing, 2002). On the other hand, for B2B, one-to-one type of collaboration, organizations such as Voluntary Interindustry Commerce Standards, VICS, has developed the Collaborative Planning Forecasting and Replenishment, or CPFR, model (VICS, 2004). The CPFR model has been in its second major revision and is being deployed by major companies such as Wal-mart, Sears, Henkel, and others. No doubt it is still in its experimental stage but it has generated significant performance enhancement operationally for these companies through logistics cost reductions and value generation. In addition, the use of new information technology such as RFID tags, CRM, WiMax, and other wireless technology will move into mainstream applications in the near future in various industries. These information technologies are needed in order to provide visibility, connectivity, and collaboration for both upstream and downstream organizations in any supply chain. With such a revised information technology platform, the current goal of agility in the supply chain of many industries can be obtained with desirable results (Lee, 2004).



Figure 2: Two-dimensional supply chain life-cycle management framework.

		Supply Chain Life-Cycle					
		Product-related			Logistics-related		
		Product Design	Manu- facturing	Product Life-Cycle Manage- ment	Demand Planning	Supply Planning	Fulfillment
<b>Supply Chain &amp; Product Characteristics</b>	<i>Bitability of Product</i>						On-demand deliveries
	<b>Modularity of Product &amp; Process</b>		Postponement				
	<b>Information Intensity</b>				CRM		
	<b>Cost Structure</b>			Delayed outsourcing	Vendor-Managed Inventory		
	<b>Supply Chain Collaboration</b>	Supplier collaboration			CPFR	CPFR	CPFR
	<b>Reverse Supply Chain Opportunity</b>	Built-in sensors					Product recapturing
	<b>Standardization Benefits</b>		Global sourcing			Upward substitution	
	<b>Compliance</b>	Product Liability; Intellectual Property Rights; RoHS; EPA.	ISO; Contracts; RoHS			Foreign Corrupt Practices Act	Ports Security, TSA
			<b>Supply Chain Life-Cycle</b>				

## CONCLUSION

It is the authors' opinion that a significant portion of the value generation gain for some industries is going to come from activities relating to the operation of the supply chains of those industries. By framing the activities into categories throughout the life cycle of the supply chain, one can assure that all major activities are considered. But not all industries should emphasize on the same activities due to their product and supply chain differences. Critical characteristics that impact the product and supply chain are stated in order to flush out the opportunities for those industries that can best capitalize on the use of new information technology to optimize the operation activities involve with the product line. By applying the two-dimensional supply chain life-cycle management framework to those industries, the industries can then develop a strategic platform for new information technology deployment that will help accomplish their goal of continued value generation. The authors believe that these comprehensive views will provide a solid base in dealing with new information technology such as RFID, WiMax, CRM with consumers, and CPFR, instead of isolated implementation efforts that may lead to incompatibility and inefficiency. This is critical in particular for low profit margin industries as in consumer product goods (CPG) and grocery. But for industries that are in dire conditions for re-structuring as in automobile manufacturing and airlines, this framework will provide a base for re-consideration of existing information technology as well as the leading-edge types.

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