INFORMATION TECHNOLOGY AND DEMAND-DRIVEN SUPPLY CHAINS

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ABSTRACT

Information technology is vital to supply chain management in the areas of integration and information sharing. Demand-Driven is a characteristic in Lean and Agile supply chains. Based on recent developments, we suggest that there is a new demand-driven strategy emerging for supply chain management. This new form of demand-driven strategy is information technology intensive and is becoming a distinct strategy all to itself.

Introduction

Leading organizations have recognized the importance of information systems for success in managing the supply chain [6]. Taken to the ultimate application level “there is a dimension to information that enables supply and demand to be matched in multiple markets, often with tailored products, in ever-shorter time-frames” [6].

Organizations have worked on their internal integration through information technology (IT) initiatives, especially enterprise systems (ES), with some success [9]. For those that have achieved a measure of success with internal integration, they have now turned their focus externally to the supply chain [10]. “The supply chain, with all its transaction and information-intensity, offers substantial opportunity for inventory and working capital reductions. It also offers the possibility of closer relationships with suppliers and customers” [10].

Another viewpoint continues to express the desired future state. Kumar states that “Supply chain management in a dynamic, demand-driven environment requires ICT-enabled [information computer technology] connectivity, cooperation, and coordination between players within an industry (horizontal coordination) and across industry and firms (vertical coordination). … efforts to create ICT-based infrastructures to enact such coordination are currently in their beginning stages. … systems that integrate whole dynamic supply chains on the fly and provide instant visibility across the supply chain are likely to emerge. The supply chains successful in creating and using such systems are more likely to achieve competitive advantage over the ones that do not” [15, p.61]. This is a highly idealized description of how IT can be exploited.

The natural assumption is that these same leading organizations mentioned above will leverage Information Technology to achieve a competitive advantage through outstanding supply chain performance. The success as reported in the literature is somewhat sketchy. In fact much of the research indicates a lack of substantial evidence of IT-enabled supply chain success. For example, Singh, Lai and Cheng [21] quote a Capital Consulting Management Services study which reported that “fewer than 20% of companies believe SCT [supply chain technology] has shown a favorable return on investment” [21]. The authors suggest that the “low success rate” can be attributed to “a lack of alignment between SCT and organizational processes” [21].
The potential for IT-enabled supply chains is not in question. Actual successful results are the main concern based on the unfavorable results found in the literature and the scarcity of successful examples in this same literature. In this paper we will explore a variety of sources to surface some examples to begin to validate the success of IT-enabled supply chains. We also hope to document a more explicit connection between IT-enabled supply chains and the newly emerging strategy of ‘demand driven’.

**Information Technology for Supply Chain Management**

The primary benefit of implementing information technology components for supply chain management is the [real-time] sharing of information between and among supply chain members both internal and external to the organization. These IT components must be aligned with the policies, procedures, and goals of the organization and/or industry at hand in order to be successful across the entire supply chain [22]. We will provide empirical evidence that those companies which are viewed as having successful demand driven supply chains are those that have properly aligned their IT components to support their organizational objectives.

IT components for successful supply chain management range from simple information sharing applications such as e-mail, EDI, and document sharing such as Google Docs, to decision making and decision enhancing applications such as artificial intelligence/expert systems, virtual “dashboards” and/or information portals, and data warehousing/mining. We will attempt to demonstrate that those organizations that have been able to successfully integrate their IT components into both their internal and external supply chains are those who have reaped the most benefit from IT-enabled supply chain management. The following sections highlight some examples of specialized supply chain IT applications.

**The Demand Driven Model**

AMR Research has developed the Demand Driven Model which is divided into four segments: Supply, Product, Demand and Information. These are further divided into three sub-categories for each of the four major segments. The categories and sub-categories are as follows:

- **Supply**
  - Manufacturing
  - Supply Management
  - Supply Chain Execution
- **Product**
  - Innovation
  - Launch
  - Lifecycle Management
- **Demand**
  - Demand Shaping
  - Demand Sensing
  - Service Management
- **Information**
  - Sales and Operations Planning (S&OP)
  - Application Tech & Infrastructure
  - Performance Management

Source: [3]

For our purposes in this paper we are primarily interested in the Information segment and we will explore the three sub-categories for that segment in more detail.
Information Segment of Demand Driven Model
The following three sub-categories describe AMR Research’s Information segment of the demand driven model in more detail.

Sales and Operations Planning – Sales and Operations Planning (S&OP) is described as “a critical process for matching global demand and supply” [17][18]. S&OP serves as the intersection where information flows from the demand side to the supply side of the organization’s supply chain [16]. Three primary plans are the product of the S&OP process – “the operational plan, the demand plan, and the financial plan” [17]. All three of these plans are critically important to successful performance in any supply chain.

“Originally focused on matching supply and demand, S&OP now facilitates organizational alignment between business goals and plans, while enabling quick responses to continuously changing business conditions” [13]. This statement is consistent with one of our earlier observations regarding the alignment of IT with the company’s business goals.

Application Technology & Infrastructure – One company name that appears often among the discussion of the AMR Top 25 Supply Chains is “i2 Technologies”. Not because they are one of the Top 25 but because they are a leading information technology company that assists the leading supply chain companies by providing systems and applications that dramatically improve information technology capabilities to enhance the company's supply chain.

Among the variety of applications offered by i2 Technologies are:
- Supply Management
- Inventory Management
- Demand Management
- Performance Management
- Supply Chain Planning and others

[12][14].

Performance Management – Supply chain performance management is the key to monitoring and maintaining high levels of customer service. Metrics also help to identify improvement opportunities and then validate improvements that are achieved.

Again citing the solutions from i2 Technologies, “i2 Performance Manager provides package business intelligence (analytics and reporting) for i2 solutions. Performance Manager is designed to provide a way to create a multi-perspective view of i2 planning and execution data, as well as the ability to “drill down” to a detailed level in order to do a root-cause analysis” [14].

Supply chain solutions offer the ability “for complete data visibility, frequent analytics and rapid decision making thereby ensuring that operations are consistently aligned with the financial plan” [13]. The new generation of S&OP develops the plan and assists with executing of the plan to deliver profit on a consistent and continual basis. One way that organizations employing supply chain solutions accomplish this is by “establishing performance metrics that are tied to financial metrics at each level of the organization” [13]. These examples have focused on i2 Technologies solutions but there are many other companies such as: AspenTech, ICON-SCM, Logility, Oracle and IBM [24] offering similar IT applications for supply chain management.

For one additional viewpoint from the group of solution providers we turn to IBM with the following observations. “Supply chain planning – specifically, sales and operations planning
(S&OP) – is one of the most prevalent topics in the supply chain community today”[4]. Based on
the results of the 2006 Global CEO study conducted by IBM in conjunction with ASPC, the
following observations were reported. “Supply chain leaders establish formal S&OP processes
within their supply planning organizations to create an integrated planning process while
extending the effectiveness of overall performance. More than 70 percent of the respondents
have a formal S&OP process in place” [4]. “An integrated approach among planning, logistics
and finance functions, result in higher performance but also alignment in rapidly resolving supply
chain issues” [4]. These comments give us some indication of the consistency for the objectives
when companies use S&OP and the desire to improve responsiveness to supply chain issues.

Internet Applications
In addition to the factors described by AMR Research in their detailed demand driven model we
must also consider the significant impact that the Internet has made on some company’s supply
chains. The transactions conducted on the Internet range from providing product/service
information for customer’s to processing a majority of customer orders. This will be very evident
in our discussion of successes later in the paper as described in the discussion of Cisco Systems.

Demand Driven
AMR Research has publicized the term “demand-driven supply network” in the course of their
research dating back to 2003 [5]. They also use the term within the criteria for determining the
Top 25 Supply Chains on an annual basis [1][2].

A demand-driven supply network (DDSN) “is a system of technologies and business processes
that sense and respond to real-time demand across a network of customers, suppliers and
employees” [2]. “DDSN leaders are ‘demand sensing,’ have more efforts for ‘demand shaping,’
and focus on a profitable ‘demand response’ [5].

Demand Driven in Practice
There are examples where the description “demand driven” is associated with various supply
chain strategies, thus it is possible to be both demand driven and lean. It is also possible to be
both demand driven and agile. We propose a third alternative where it is possible to be demand
driven without being any one of several other dominant strategies in the supply chain literature.
First we will discuss demand driven combined with other strategies and lead up to the discussion
of demand driven as a stand alone strategy.

Lean – A ‘lean’ organization can be said to be demand driven. But there are many lean
characteristics that focus on waste in other areas and do not have a direct linkage to demand. The
ideal lean environment is one where there is “predictable demand” [7] which also means that
responsiveness is not a primary characteristic of lean.

We will use AMR’s Top 25 Supply Chains as our main examples throughout the paper. From
that list we can point to Dell Computer and Toyota as example companies that describe
themselves (or are described by others) as Lean [27]. By virtue of being in the Top 25 list the
companies have also been identified as having a “demand driven supply network” (or DDSN) by
AMR Research [1][2].

Agile – Agile is another supply chain strategy where IT-enabled processes are critical for success.
Several characteristics are present in the “agile supply chain” [7]. “The agile supply chain is
market sensitive. … The use of information technology to share data between buyers and
suppliers is … creating a virtual supply chain. … Shared information between supply chain
partners can only be fully leveraged through process integration. … The idea of the supply chain
as a confederation of partners linked together as a network provides the fourth ingredient of agility” [7]. To shorten those four elements, they are market sensitivity, the virtual nature of the supply chain, process integration and the network based arrangement of supply chain partners. IT plays an important role but there are other aspects to the Agile supply chain such as contingency planning and risk management which do not depend heavily upon IT.

Nokia is one example company among the Top 25 that has been described as Agile [12] in a publication other than the AMR Research materials. This gives us an example for this combination of Agile [12] and demand driven [1][2][20].

**AMR’s Top 25**

Related to the Top 25 Supply Chains AMR states: “The report identifies the top 25 manufacturers and retailers that exhibit superior supply chain capabilities and performance. Supply chain leaders are able to shape demand, instantly respond to market changes, and crush their competitors. According to AMR Research benchmarking data, leaders carry 15% less inventory, are 60% faster-to-market, and complete 17% more perfect orders. These advantages separate predators from prey” [1].

The criteria for selection to the Top 25 list are as follows: “The first component of the ranking is publicly available financial data and is weighted at 60% of the total score, with return on assets and inventory turns each accounting for 25%, and trailing 12 months growth accounting for 10%. The second component of the ranking is AMR Research’s opinion, which is weighted at 40% of the total score. The opinion component is based on a structured voting methodology across AMR Research’s team of analysts” [1].

For 2008, the voting has now incorporated “peer opinion” as 20% of the score while the voting by AMR panelists has been reduced to 20% from 40% [2]. The Top 5 Companies in the Top 25 for four years are listed in Table 1.

**Table 1. AMR Research Top 25 Supply Chains (Top 10 only)**

<table>
<thead>
<tr>
<th>Rank</th>
<th>2004</th>
<th>2005</th>
<th>2007</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dell</td>
<td>Dell</td>
<td>Nokia</td>
<td>Apple</td>
</tr>
<tr>
<td>2</td>
<td>Nokia</td>
<td>Procter &amp; Gamble</td>
<td>Apple</td>
<td>Nokia</td>
</tr>
<tr>
<td>3</td>
<td>Procter &amp; Gamble</td>
<td>IBM</td>
<td>Procter &amp; Gamble</td>
<td>Dell</td>
</tr>
<tr>
<td>4</td>
<td>IBM</td>
<td>Nokia</td>
<td>IBM</td>
<td>Procter &amp; Gamble</td>
</tr>
<tr>
<td>5</td>
<td>Wal-Mart Stores</td>
<td>Toyota Motor</td>
<td>Toyota Motor</td>
<td>IBM</td>
</tr>
<tr>
<td>6</td>
<td>Toyota Motor</td>
<td>Johnson &amp; Johnson</td>
<td>Wal-Mart Stores</td>
<td>Wal-Mart Stores</td>
</tr>
<tr>
<td>7</td>
<td>Johnson &amp; Johnson</td>
<td>Samsung Electronics</td>
<td>Anheuser-Busch</td>
<td>Toyota Motor</td>
</tr>
<tr>
<td>8</td>
<td>Johnson Controls</td>
<td>Wal-Mart Stores</td>
<td>Tesco</td>
<td>Cisco Systems</td>
</tr>
<tr>
<td>9</td>
<td>Tesco</td>
<td>Tesco</td>
<td>Best Buy</td>
<td>Samsung Electronics</td>
</tr>
<tr>
<td>10</td>
<td>PepsiCo</td>
<td>Johnson Controls</td>
<td>Samsung Electronics</td>
<td>Anheuser-Busch</td>
</tr>
</tbody>
</table>

Sources: [1][2][19]

From these lists we will identify other examples where “demand driven” is the main strategy and also appears to be a stand alone strategy separate from either Lean or Agile.

**Examples of Success**

Samsung Electronics – Samsung has been rated as #10 in 2007 and #9 in 2008 in the AMR Top 25 Supply Chains. “Samsung’s processes leverage technology brilliantly” [23]. “The company’s [Samsung’s] outstanding use of sales and operations planning (S&OP) and forecasting allowed its
supply chain to set aggressive pre-stocking inventory targets in advance of the holiday season, helping to lift volumes” [26].

Technology also played a major role in other performance accomplishments. “Samsung moved to the No. 1 position in the US mobile handset market during 3Q08. In a period in which US consumer spending is volatile, Samsung’s supply chain helped grow its shipments by 6.2%” [26]. “Samsung now owns 22.4% of the market and is No. 1 in the world’s largest handset market, due in most part to the supply chain leadership” [26].

Also note that while Samsung ranks among the Top 10 Supply Chains, Sony Electronics does not appear in the Top 25 or even the Top 50 Supply Chains. Sony’s financial performance is the primary reason given for their absence from the list [11].

Cisco Systems – Leading technology companies are naturally expected to also lead in the use of technology in the supply chain. Cisco Systems lives up to this expectation but has accomplished a high degree of success despite some stumbles along the way. The major stumble occurred in 2001 when Cisco found itself holding $2.5 billion in inventory that it could not sell and ultimately wrote that amount off [21]. This was the result of unfounded optimism about the market on the part of Cisco’s CEO John Chambers and led to Cisco’s first ever decline in revenues for the first quarter of 2001 [6].

From that lesson, Cisco took control of their supply chain and did so through extensive use of technology. Cisco’s efforts are viewed as an outstanding example of “business transformation … using Internet technology to integrate its core processes and culture.” These are some of the results that indicate Cisco’s leadership in supply chain management and their ability to leverage the Internet:

- “90 percent of orders [are] taken online.
- Monthly online sales exceed $1 billion.
- 82 percent of support calls [are] now resolved over the Internet.
- Customer satisfaction has increased significantly” [21].

As further evidence, Cisco also won the 2008 Supply Chain Innovation Award given by the Council of Supply Chain Management Professionals (CSCMP) in cooperation with Global Logistics & Supply Chain Strategies magazine [2]. Cisco was evaluated based on a case study about their efforts to improve performance in their reverse logistics segment of the supply chain. “Cisco has been working collaboratively with partners to eliminate waste from the reverse logistics process. … Cisco reduced capital investment in inventory and eliminated waste by sharing forecasts and streamlining business processes to the mutual benefit of Cisco and its partners” according to comments by Mike Burkett, AMR Research analyst [2]. Information sharing and the associated information systems appear to be a key element for this achievement and recognition.

Nokia – Nokia excels at speed-to-market for new product introductions. To deliver their new products they utilize rapid-response manufacturing and quick ship logistics [16]. In each
instance, information technology plays a key role. “As a pioneer in value chain strategy, Nokia has led in supplier development, S&OP, and collaborative product development” [23]. A similar comment accompanied the 2008 Top 25 list: Nokia “Leads the way in supplier collaboration practices, design for supply chain and embedded innovation” [25].

IBM – IBM is unique because they have appeared in the top five of the Top 25 Supply Chains each of the four years as released by AMR Research [1][2][20]. They are also a provider of supply chain applications/solutions [4]. The summary comment from AMR acknowledges that IBM is a “Pioneer in supply chain management with a track record of sharing its learnings” [25].

The four companies presented here are just a sampling of the demand driven companies that are among the AMR Top 25 Supply Chains. Table 2 provides a brief summary for these four companies showing the financial measures used by AMR Research in determining the Top 25 Supply Chain rankings.

**Table 2. Financial Performance for Four Companies**

<table>
<thead>
<tr>
<th>2007 Top 25 Performance (2006 Fiscal Year)</th>
<th>Ranking</th>
<th>ROA</th>
<th>Inventory Turns</th>
<th>Revenue Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nokia</td>
<td>1</td>
<td>19.0%</td>
<td>17.9</td>
<td>20.2%</td>
</tr>
<tr>
<td>IBM</td>
<td>4</td>
<td>9.2%</td>
<td>18.9</td>
<td>0.3%</td>
</tr>
<tr>
<td>Samsung Electronics</td>
<td>10</td>
<td>13.7%</td>
<td>13.2</td>
<td>6.3%</td>
</tr>
<tr>
<td>Cisco Systems</td>
<td>11</td>
<td>12.9%</td>
<td>7.1</td>
<td>14.5%</td>
</tr>
</tbody>
</table>

Source: [23]

Old Dominion Freight Lines – We offer one example of supply chain success that does not appear in the AMR Top 25 list. Founded in Richmond, Virginia in 1934, Old Dominion Freight Lines (ODFL) has grown from a one-truck operation between Richmond and Norfolk to a super-regional carrier with over 4000 trucks and 15,000 trailers serving 44 states. They have positioned themselves as a worldwide solutions provider in single-source value added transportation services. Supply chain visibility and information sharing is critical to the success of ODFL and the company has considerable investment in information technology [8].

The various IT components embraced by ODFL include a customer management portal known as a “shipping dashboard” (odfl4me.com) for real-time order tracking and confirmation as well as significant investment in freight processing technology, operations technology, and freight transaction management systems to allow for the optimization of freight flow [8]. The company uses various third-party IT solutions providers such as Brainware, Inc. for automated document processing such as invoices and payload documentation. Drivers carry handheld devices in their trucks thus allowing route changes, road conditions, and customer interactions to be available in real time. The result is a dynamic and interactive supply chain for both the customer and ODFL which can react quickly to demand-driven changes [8].

**Future Research**

This paper represents a first attempt to explore Demand Driven in a very explicit manner and was suggested by prior research by one of the authors [19]. The authors feel that the “Demand Driven” strategy has not been thoroughly researched and is limited primarily to the publications from AMR Research. Companies utilizing the Demand Driven approach need to be explored in
greater depth to create a better understanding of the successful approaches. In this paper we have focused on IT as one of the main elements that we believe contributes to the success of those companies with a DDSN. Future research can expand upon this and consider other factors in combination with IT.

Summary
Some of the research for this paper indicates that Demand Driven either overlaps or is partially embedded within both Lean and Agile. When we add the AMR Research viewpoint, Demand Driven does appear to be separate due to the intense information technology applications that are utilized by companies with successful DDSNs. We believe that the evidence in this paper suggests that the success of DDSN is clearly enabled by information technology more so than the Lean or Agile successes.

At this time, the broader literature does not indicate a clearly distinct Demand Driven strategy that can be separated from Lean and/or Agile. But based on the AMR Research materials [1][2][5] we believe that there is a growing distinction among companies that subscribe to the DDSN approach. Companies employing the DDSN strategy are dealing more directly with the end customer, a significant number are consumer product companies, and they have utilized leading edge technology applications in an optimal way to enhance their DDSN capabilities. We believe that this trend will continue and that DDSN (or Demand Driven) will become a more prominent strategy going forward.

REFERENCES
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