The Effect of Supply Chain Visibility Systems on Business Processes: A Multi-Case Study Analysis

by

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Abstract

As supply chains become more global and complex, it increases the importance of end-to-end visibility into the material, information, and financial flows of a firm. This work covers various aspects of supply chain visibility such as current status, its benefits, and the benefit-enabling mechanisms, traced through multiple stages of research, including a survey, roundtable, and detailed interviews. Specifically, we developed a multi-case study analysis of supply chain visibility solutions (SCVS) and analyzed its effect on key supply chain processes.

A qualitative "with and without SCVS" framework was employed to understand the changes observed in key business processes at several companies that recently implemented SCVS. This was combined with a cross-case study analysis to evaluate the effect of SCVS on the efficiency and effectiveness dimensions of process performance. We found that SCVS has a direct positive effect on data management processes via benefit-enabling mechanisms such as automation, standardization, and better raw data. Key operational processes, such as shipment and inventory management, risk management, and procurement and partner collaboration, were affected positively by SCVS via the antecedent data management process. The strength of impact of SCVS on key operational processes varies by company characteristics and the stage of implementation of SCVS.

This research is most useful to companies considering implementing an SCVS to understand the potential benefits of SCVS and the underlying mechanisms. Managers can increase the relevance and robustness of results by extending the case-study analysis to include more companies with similar operating characteristics.

Thesis Supervisor: Dr. Jarrod Goentzel

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1. Introduction

1.1 Background and Research Question

As supply chains become more global and complex, it increases the importance of end-to-end visibility into the material, information, and financial flows of a firm. While there is no single definition of supply chain visibility (SCV), the two major themes that dominate SCV are the exchange of information for decision-making across the supply chain, and the technology that enables the process of creating visibility.

Most importantly, SCV is to be seen as a means and not an end – ideally, it ought to support decision-making by allowing companies to act on information that is accurate, timely, and holistic. Both academics and practitioners agree that increased visibility has a positive impact on decision-making, and therefore on supply chain performance. At both the systems and process level, researchers have investigated different ways in which SCV can enhance performance –for example, improved inventory management, better planning and purchasing, and a reduction in uncertainty and the "bullwhip effect" in the supply chain. On the technology front, information and communications technology (ICT) such as the control tower is also a visibility enabler. Yet, despite sophisticated technology and proliferation of SCV providers, many shippers still face challenges and uncertainties – not only during selection and implementation stages, but also later when evaluating the benefits of the implemented supply chain visibility solution (SCVS).

This thesis focuses on developing a multi-case study analysis of supply chain visibility implementation and its impact on supply chain processes. This work employs a qualitative "with and without" framework to understand the changes observed in key business processes at several companies that recently implemented SCVS. To do so, this work utilizes an exploratory theory-

building approach and conducts cross-study analysis to identify SCVS effect on processes across two performance dimensions, efficiency and effectiveness.

1.2 Thesis Scope and Structure

This research can be most useful to inform companies considering implementing SCVS (or are already in the early stages of implementation) about the potential effects on some of their business processes. The focus is on the positive impacts of SCVS and does not cover potential drawbacks, such as security concerns with respect to commercially sensitive information – since drawbacks tend to surface over time, and are also likely to be addressed by the organization's response mechanisms.

This research recognizes that changes to business processes and organizational structure at companies are the result of complex interactions that are often unique to organizations. Therefore, our findings are general in nature and not meant to be prescriptive or offer concrete guidance to companies. Also, since this research is qualitative in nature, we do not attempt to quantify SCV or degree of the impact.

The remainder of this thesis is organized as follows. Section 2 presents a summary of the literature review on the concept of SCV, its impact on processes and performance, and SCV technology. In section 3, we introduce the methods used to collect data at different stages of research. Section 4 discusses the results obtained from the survey, industry roundtable, and extensive and intensive interviews. Section 5 presents the analysis of the effects of SCVS on data management and key operational processes, the underling mechanisms, as well as managerial implications. The last section summarizes findings, identifies limitations, and proposes recommendations for further research.

2. Literature Review

This section is organized in three sections: first, we present the concept of SCV based on the definitions found in literature; next, we discuss the research on impacts of SCV on processes and performance; lastly, we provide an overview of the technologies that enable SCV.

2.1 Concept of SCV

Despite significant interest in the topic, and supply chain visibility becoming a "popular buzzword," academics recognize that there is no unique definition (e.g. Caridi, Francis, Zhang et al., Goh et al., Barrat & Oke). While presenting their definitions of SCV, different authors tend to focus on different aspects of SCV. Appendix 1 summarizes the definitions in existing academic literature and also offers examples of definitions by several research agencies and consulting companies. Goh et al. explore the terminology in detail and propose "a comprehensive definition":

> SCV is the capability of a supply chain player to have access to or to provide the required timely information/knowledge about the entities involved in the supply chain from/to relevant supply chain partners for better decision support (Goh et al., 2009).

This thesis uses this definition and focuses on a company's ability to capture and easily access relevant, timely, and accurate end-to-end supply chain data, thus providing a single version of truth in the supply chain that is used for analysis and decision-making.

SCV is increasingly viewed as essential for both short-term and long-term competitiveness of the company. Zhang et al. acknowledges importance of visibility for both tactical and strategic decision-making (2008). Tactical visibility "offers the visibility to material flows, finance flows, inventory level, availability of production capacity and resources in the supply chain," while

strategic visibility focuses on the entire organization and collaboration with supply chain partners (ibid.). This thesis considers the visibility that availability of data brings on the strategic, tactical, and operational levels. Specifically, the overall strategy and design informs tactical processes and planning, which in turn sets real-time operational and execution parameters. Output of decisions and actions on all these levels produces new data that in turn feeds back into each of these processes for decision-making.

Collaboration with partners and data exchange across the supply chain are at the center of SCV definition. Caridi points out that "visibility can be considered an enabler for strong SC relationships" (2014). In turn, collaborative relationships that involve exchange of comprehensive data between partners were found to lead to improvements in productivity, customer service, inventory and risk management, and overall marketplace performance (e.g. Bartlett et. al., Kim et. al.). However, Holcomb et al. note that sometimes there can be difficulty in establishing even internal visibility, since it is typical for firms' systems to evolve over the years and often on a functional basis leading to disconnect between various processes (2004, 2011). This research examines partner collaboration as one of the key business processes that is affected by SCV and offers insights based on in-depth interviews with shippers.

2.2 Impact of SCV on Processes and Performance

SCV, with its real-time or near real-time supply chain information, can help companies to improve operational efficiency, resource productivity, effectiveness, and customer service (Holcomb et al.,2004; Caridi, 2010). A primary goal of SCV is to improve performance of the entire company. Researchers have found that visibility positively impacts many supply chain

processes that may ultimately result in overall company performance improvement (Caridi et al., 2014; Wang and Wei, 2007).

However, SCV does not automatically lead to such improvements. Rather, McIntire proposes to treat SCV "as a vector of influence on the supply chain operation, which in turn is a vector of influence on the business outcomes" (2014). Moreover, Barrat and Oke argue that "information sharing is not directly linked to performance" (2007). The authors suggest that the company should first validate whether shared information actually provides visibility by being accurate, timely, and useful. In a positive case, this information can be used to make a more informed decision, which subsequently may lead to improved performance (ibid.). The model and findings in this research are consistent with the two-stage approach of linking information sharing with performance proposed by Barratt and Oke. The companies interviewed discussed improvements in terms of performance quality and efficiency of time and resource utilization.

Lastly, identifying the processes most impacted by visibility is a critical step for companies. This helps companies prioritize which information flows to share (Caridi, 2014). The role of improved visibility in processes within procurement, manufacturing, planning, inventory management and transportation has been studied extensively in literature. Yet, as mentioned earlier, the purpose of this work is not to establish an exhaustive list of processes positively affected by SCV and quantify the impact. Rather, it is to examine how some of the processes that are important for the company and organizational structure are improved once the SCVS is implemented.

2.3 Technology as SCV Enabler

ICTs play key role in SCV. From a practitioner's point of view, SCV initiatives are a combination of process re-engineering and technology adoption (McIntire, 2014). Extensive research documents that IT is an essential requirement for managing and improving efficiency of multi-echelon networks (Auramo et al., 2005). Moreover, Simchi-Levi et al. suggest that the objectives of IT in supply chain management are providing information availability and visibility; enabling a single point of contact for data; allowing decisions based on total supply chain information; and enabling collaboration with supply chain partners (2008). Therefore, this work considers SCVS and the technology used, from the perspective of holistic systems that create a single version of the truth by enabling companies to capture, store, analyze, share and report end-to-end supply chain data across organizational boundaries.

While technology is at the core of SCV, data management, and collaboration, it should be treated as an enabler and should not be equated with SCV itself. That is, the technology in itself is not sufficient to provide visibility – as it does not include the relational factors such as partner collaboration, corporate culture, and organizational design.

There are many initiatives on information sharing, such as sharing point-of-sale data (POS), vendor managed inventory (VMI), collaborative planning forecast and replenishment (CPFR). EDI and XML are examples of technologies that support sharing of information and inter-organizational communication, while technologies such as RFID help in tracking and tracing cargo.

In terms of holistic solutions for visibility, there are many different technology options and providers for companies to choose from. McIntire classifies technology options to acquire SCV capability into 4 groups – in-house development, off-the-shelf software, SaaS software, or a perk

from logistics service providers – and evaluates strengths and weaknesses of each, as summarized in Table 2-1.

Table 2-1: "Matrix of supply chain technology approach and business fit"

	Private Development	Off the Shelf Technology	Technology as a Service	Technology as a Perk
High Criticality of Business Needs	Good	Good	Poor	Poor
Likely Competitive Differentiator	Good	Poor	Poor	Poor
Business Needs are Mature for the Industry	Poor	Good	Good	Good
Minimal initial investment	Poor	Poor	Good	Good
Minimal long term costs	Poor	Good	Poor	Good

Source: McIntire, 2014.

Another recent development in the realm of SCV technology is cloud-based solutions and the control tower approach. Control tower is a term popular with consulting companies – Capgemini defines control tower as "a central hub with the required technology, organization and processes to capture and use supply chain data to provide enhanced visibility for short and long term decision making that is aligned with strategic objectives" (2011).

As implementation of new SCVS requires significant investment of resources and change management, companies ought to carefully evaluate benefits and costs of various technology options. Therefore, companies must first assess the current status of visibility, processes, and objectives and then identify and implement the appropriate technology that fits the nature of their business and processes the best.

For this thesis, we investigated companies at various stages of implementation and have confirmed that they use different solutions depending on their needs and objectives.

3. Research Methodology

The research undertaken is qualitative and the main method used for analysis is the case study approach. Yin defines a case study as "an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident" (2003). Case studies are considered an appropriate methodology for this research for several reasons. First, case study research is considered most appropriate when the project aims to answer "how", "what", and "why" questions. In this thesis, we primarily want to study the effect of implementation of SCVS, how it happens, and why it occurs. This project also met two other conditions for the case study methodology: that the researcher "is interested in contemporary events and does not have an ability to control or manipulate behavioral events" (Swanson & Holton, 2005).

The overall case study methodology is structured into two phases – the initial exploratory phase and the detailed investigation phase. The initial exploratory phase uses administration of an internet survey, a roundtable, and multiple short extensive interviews, to review the state of SCV practice in different industries as well as the state of technology. The detailed investigation phase uses in-depth interviews to focus the research on analyzing the impact of SCVS implementation on business processes and organizational structure. Figure 3-1 provides an overview of the research process.

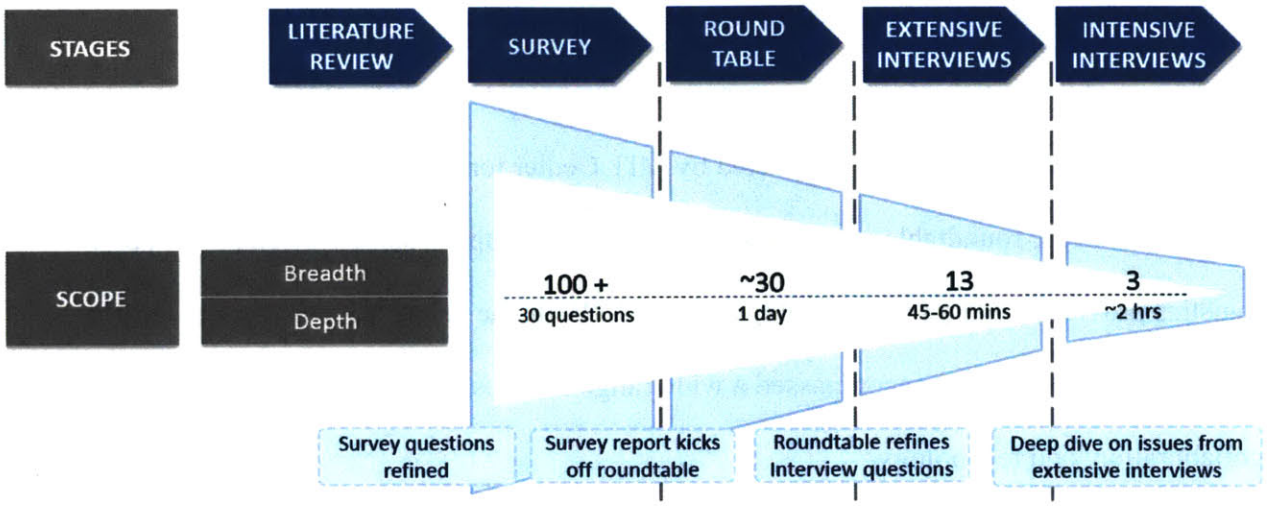

Figure 3-1: Research Design and Process

3.1 Survey

The first step was the administration of an internet survey to collect initial data on the state of current practice of SCV, in particular on how shippers obtain end-to-end visibility for their ocean bound products, and to identify the gaps in technology and processes. The survey was conducted between April 10 and April 30, 2015 and administered to approximately 4,000 companies in the MIT Center for Transportation and Logistics database. We received 160 responses, and most of the survey analysis presented in this thesis is based on a subset of 78 complete responses.

Survey questions were segmented into three categories: SCV features and benefits, current status of SCV, and visibility providers and technologies. The results of the survey were analyzed in a few different ways: descriptive analysis to understand the features and benefits of SCV; correlation analysis to identify the correlation of satisfaction with the features of SCV; cluster analyses to identify user types and patterns. The key findings of the survey analysis are summarized in the Results Section.

3.2 Becoming Location-Aware Roundtable

As part of the initial stage of the research, a roundtable to explore issues and approaches for achieving end-to-end SCV was conducted by MIT Center for Transportation & Logistics. The participants in the roundtable represented more than 30 shippers, some carriers, third-party logistics providers, and a few technology vendors. While the primary focus was on ocean visibility, the discussions encompassed a wide range of areas, including data collection, collaboration, and technology.

The roundtable discussions confirmed visibility issues experienced by the shippers that were identified by the survey, and also revealed some of the root causes. The discussion confirmed problems in data availability, timeliness, and quality, with the highest gaps in performance identified in transshipments and ocean freight in South America. For example, some shippers' containers were "rolled" to the next sailing without notice.

The roundtable also helped understand the issues in the different aspects of technology as used by each company. For example, one of the major obstacles to achieving holistic SCV stems from fragmented IT systems across multiple business units and multiple data streams that need to be consolidated. Some of the other key findings from the roundtable discussion were in the area of managing big data and exceptions, collaboration with partners, especially carriers, and evaluating benefits of SCV. The Results section will cover findings from the roundtable in detail.

3.3 Extensive Interviews

The next part of the initial exploratory phase was qualitative research interviews conducted with 13 companies, across a variety of industries. The interviews were semi-structured with the main objective to obtain a detailed understanding of the state of practice of supply chain

visibility in leading companies from a wide range of industries. Interviews were particularly useful for in-depth investigation of participants' survey responses and understanding the decision-making process behind the results.

Most of the interviewees expressed interest in being interviewed for the project in the Supply Chain Visibility Survey. Some interviewees who did not participate in the initial survey were selected based on their industry experience and specific knowledge of supply chain visibility. The companies varied significantly by size as well as maturity of supply chain visibility deployment. While the majority of interviewees were shippers, some interesting service providers such as a 3PL, a data provider, and a research & consulting company were also interviewed. Results Section provides the detailed description of industries and companies, as well as the job title of each of the interviewees. Company names are not disclosed for confidentiality purposes.

This phase of research prepared us for further in-depth interviews with the purpose of addressing narrower and more defined research questions. The insights are based on both within-case analysis and cross-case analysis and will be incorporated in the Results section of this thesis.

3.4 Intensive Interviews

Intensive interviews were utilized to conduct a detailed investigation phase of research that focused on changes in business processes and performance. This method allowed us to study in-depth systems and changes at a couple of companies. Three multinational shippers and one freight forwarder/4PL were interviewed.

This phase specifically utilizes a comparative case study method, which is characterized by a small number of cases in their real life context with the data obtained from these cases being analyzed in a qualitative manner (Dul & Hak, 2008). Interview structure was somewhat systematic and comprehensive with an outline of topics and issues. However, the researchers allowed for some variation and the tone of the interviews was fairly conversational and informal.

The research is also positivist in nature, as it is interested in facts and contains a lot of information questions. Interviews were semi-structured and characterized by different types of "what" and "how" questions, with most questions being open, simple, and neutral. The funnel model was utilized, wherein the researcher starts with broad and open-ended questions first, and as the interview progresses the questions become more specific with the detailed questions being asked last.

Phone interviews were conducted over 1 hour and interview protocol was shared with interviewees in advance in order to provide more context and make conversation more efficient. These in-depth interviews were recorded, transcribed, and summarized in two report forms – detailed bullet point notes and presentations summarizing key findings. Following the initial analysis, companies were contacted again in order to obtain any missing information or clarification and ensure the reliability of this thesis. Data triangulation was assured through the use of multiple investigators and follow ups to validate data. Finally, the data collected via intensive interviews was complemented and cross-validated with data either from previous interviews, survey responses, or notes from the roundtable, depending on the company.

The companies for intensive interviews were selected based on theoretical considerations rather than random sampling. Based on previous interviews and roundtables discussions, three shippers that have implemented advanced supply chain visibility solutions were identified as

suitable candidates for intensive interviews and case study analysis. Notably, before interviewing the shippers, the team interviewed a freight forwarder / 4PL who develops and implements control tower visibility solutions for the shippers. This interviewee's extensive, diverse, and practical expertise on SCVS helped the research team deepen their understanding of the subject and prepare the questions for the shippers.

The first interviewed shipper is a manufacturer in hi-tech industry, who is completing a transition from home-grown system to cloud-based solution. This company participated in both the survey and the exploratory stage interview. The second shipper is a heavy equipment manufacturer, who uses advance visibility system with multiple data warehouses and central data storage. This company also participated in the exploratory stage interview. The third shipper is a retail corporation that operates chains of stores. The company is proactive with respect to SCV and heavily relies on advance analytics. This shipper participated at the roundtable.

When selecting the shippers, the research team also ensured that cases met several criteria identified in academic literature. First, cases had to be exemplary instances of the phenomenon being studied that provide different perspectives. Second, the process of interest had to be "transparently observable." Lastly, two other requirements are convenience and accessibility. The selected companies for the case study were representative in several respects and have some important commonalities and differences. Specifically, all shippers recently implemented SCVS, but are in different stages of progression with respect to solution implementation. Also, while these companies represent different industries, they are all multinational, multibillion corporations with headquarters in the US. Importantly, their competitiveness strongly depends on their supply chain network and performance.

Once data was transcribed and validated, several methods of analysis were employed. The first step was within-case analysis, where each individual case analyzed separately. Each interview was structured in a "with and without" format, which compared the company's major business processes and organizational aspects both with and without the SCVS. This level of analysis highlighted which processes were most impacted, to what extent, and why.

Second level of analysis was performed through cross-case synthesis, which is based on comparison of the cases between each other and theory. All interviews were combined to observe which processes were most impacted and to what extent, and what were the most common causes.

Furthermore, the effect of SCVS implementation on the business processes was analyzed on two performance dimensions – efficiency and effectiveness. For the purpose of this thesis, effectiveness is broadly defined as the improvement in the quality of the output of the process over the quality of the inputs to the process. Efficiency, on the other hand, is treated as the amount of output of the process per unit of resource used by the process – in essence, it about quantity and reflects how the organization utilizes the resources deployed. However, establishing precise definition and quantifying these metrics for each business process are not part of this thesis' objective. Instead, impact was broadly assigned by using a high-level indicator of the extent of effect – high, medium, or low.

4. Results

In this section, we present the key findings from the survey, the roundtable, extensive interviews, and the intensive interviews. At the initial exploratory stages of the research, we identify features and benefits of SCV, the technology and solution providers, and the implications of findings for the subsequent phase of research. In the final stage of intensive case studies, we deep-dive into the systems implemented at three shippers, detailing the effects of SCVS on the various business processes. These results are analyzed in the next section to identify the insights and managerial implications.

4.1 Results from Initial Survey

Survey results were used to provide initial information on current state of SCV, kick off the roundtable conversation, and identify potential participants for extensive interviews.

The survey questions and results are primarily focused on visibility over the ocean transit leg. The survey covered the following topics: current status of SCV; the availability and quality of data; regional variations in real-time visibility; visibility at various milestones during the ocean transit; providers, technologies and communications channels used; and the features and benefits of SCV. The survey examined SCV status and capabilities at various milestones during the ocean transit: gate in, loaded on board, vessel depart, status of assets in transit, vessel arrive, container discharge, and gate out.

The results for the survey section are presented as follows: current status of SCV, technology and solutions providers, and features and benefits of SCV.

4.1.1 Current Status of SCV

The study revealed many problems in data availability, timeliness and quality. On average, participants were moderately satisfied with current ocean transit visibility. While nearly half of the respondents (45%) were less than moderately satisfied with current visibility solutions, only less than 5% of respondents were "very satisfied" with current visibility solutions.

Correlation analysis was used to identify correlations between different factors and variables. For example, a higher level of satisfaction is associated with a better access to real-time data and on-time delivery rate. Bigger companies seem to have better visibility in comparison to smaller companies. Also, European and NA exporters and importers can be distinguished by the value they place on different visibility benefits, e.g. "collaboration" is the most important benefit for European exporters, while "data improvement" is the most important for NA exporters.

Access to real-time end-to-end visibility is also at a moderate level overall, but varies by trade lane. Very few shippers have exceptional end-to-end visibility across all trade lanes. North America to Europe has the best visibility across all trade lanes, whereas South America to Asia has less visibility.

The final delivery of the cargo is reported to be mostly on time with almost a third of the shippers enjoying 90-100% average on-time delivery across all trade lanes. Notably, shippers have varying definitions of "on-time" delivery, which is very context specific. However, when delays happen there is a huge difference in receiving delay notifications depending on the trade lane. Across all trade lanes shippers typically receive either very low (0-24%) or very high (75-100%) percentage of advance notifications for delayed shipments.

Overall milestone event updates are mostly accurate across all milestones, but their availability and timeliness varies by milestone. Only around 40% of respondents receive updates

within 12 hours across all events. Very few shippers receive near real-time updates across all milestones.

Vessel arrival and departure are the most consistent update notifications received by shippers with respect to both availability and accuracy. However, visibility when assets are in transit on water is the lowest on both metrics. Moreover, updates on the status of assets in transit take the longest time to receive (more than 24 hours). This could be either due to port-to-port transit leg being the most reliable or due to lack of appropriate technology.

4.1.2 Technology and Solutions Providers

Wide variety of communication modes and visibility solutions is available, but only a few are used. Overall awareness of software solutions for visibility is relatively low with less than 5% of shippers using integrated automated systems across all milestones. Nearly a third of all updates are still manual (phone, email) across all shipping events.

SAP and Oracle are the most well-known solutions, though their popularity may not be based purely on their visibility solutions, while INTTRA and GT Nexus are popular specialized solutions. In-house systems are quite common and in the absence of strong ROI studies, they may be hard to dislodge by the specialist software companies. Specialized tracking devices such as RFID and GPS are rarely used.

Cost concerns and complexity are the main reasons for not implementing visibility solutions, while security concerns is a secondary reason for not implementing visibility software. This might be an opportunity for better ROI modeling, as companies are struggling to quantify the cost and benefits of better end-to-end supply chain visibility.

4.1.3 Features and Benefits of SCV

Nearly 60% of respondents identified features such as exception alerts, internal and external collaboration, enhanced analytics and planning functions, continuous in-transit visibility, dynamic ETA, and event tracking as at least "very important" (highest rating being "extremely important"). More than 60% of respondents claim that "exception alerts" are "extremely important," whereas comprehensive updates such as dynamic ETA and event tracking are less important, potentially due to information overload.

Benefits of SCV were categorized as cost reduction, risk management, internal and external collaboration, performance improvement, and enhanced data for planning and decision-making. Survey results revealed that "performance improvement" and "cost reduction" are the most important benefits for the shippers. More than half the respondents see reduction in transportation cost as the source of overall cost reduction. This could be due to high expediting costs. Despite the ability of supply chain visibility to address exceptions and variability, it is surprising that risk management is least popular. The survey confirmed that shippers struggle to quantify the benefits of supply chain visibility.

Correlation and cluster analyses provided additional insights. Participants who evaluate benefits as important also rank features high. Companies that focus on cost reduction and place high importance on all features are the largest user groups. Collaboration is the most important benefit for European exporters, while data improvement is of greatest importance for North American exporters. The bigger the company the higher the perceived importance of features. It seems that there is a low correlation between volume of shipments and benefits.

4.2 Results from Roundtable

The results from the roundtable conducted in May 2015 are summarized below. They are categorized into 4 main sections: pre-requisites for SCV, technology and solutions providers, data and exception management, and benefits of SCV. The roundtable discussion was used to corroborate initial findings from the survey, expand research topics within SCV, and shape questions for extensive interviews.

4.2.1 Pre-requisites for SCV

Systematic solutions are required in order to achieve SCV and obtain its full benefits. Internally, this entails streamlining and standardizing processes across business divisions. Many roundtable participants, however, noted that this process is complicated by multiple ERP systems or different IT initiatives across divisions. One of manufacturers revealed that many of the performance problems it was having with its carriers were caused by problems in their own systems.

External factors such as issues in upstream and downstream processes also greatly affect visibility and variability. As summarized by one participant, there are many different fragmented players, different technologies, and no single standard. Therefore, collaboration with partners is crucial for achieving SCV and improving supply chain processes overall. Collaboration can help align parties' interests by sharing risks, costs, and value. For example, a shipper sharing forecasts with the carrier brings value to both parties by reducing the chance that the shipper's containers are bumped, while also improving utilization of the carrier's capacity.

4.2.2 Technology and Solutions Providers

Companies are looking for tools to process the large amounts of data generated by current technology, and convert them into actionable information in order to produce data-driven performance improvement. However, some companies emphasized that in the quest to acquire advanced SCV solutions, it is important to first assess the readiness of the supply chain. In other words, without basic pre-requisites such as reduction of internal complexity and willingness to collaborate in place, pursuing an SCVS implementation may be premature.

When discussing the current SCV solutions used, many shippers highlighted that each different technology came with its own limitations. While GPS cargo tracking technology improves in-transit visibility, it is costly and does not provide any contextual data. When it comes to information sharing, EDI messages are widely used, but can take time to reach the shipper and also provide only limited set of information.

Other challenges with respect to technology remain. Current tools and technology typically track only at the level of the entire vessel or a container, and not at the level of an individual cargo. Supplementary data such as temperature, humidity, and shock, are much harder to obtain, partly due to a lack of standards.

Four stages of track and trace functionality emerged out of the roundtable:

1. Manually calling the carrier
2. Check websites where shippers last updated the shipment status
3. Real-time information pushed to shippers
4. Event management systems that automatically trigger pre-set actions based on real-time data

Both the roundtable and survey suggested that most companies were still in stage 1 or 2 (manual checking of freight status), and there was no indication that stage 4 was successfully attained.

4.2.3 Data and Exception Management

The issue of data management received lots of attention, as participants debated where to consolidate all data streams and how to determine the right types of data that could enable action.

Shippers took one of several approaches with respect to data aggregation: third-party cloud-based platform, in-house centralized management system, and online portals. A few retailers agreed that third-party platforms provided the service of aggregating data from multiple external sources, handling data security, and performing basic analytics, such as highlighting exceptions. Another shipper manages EDI messages within a centralized PO management system, though this set up is too slow for real-time capabilities. Another option was online portals that provide data aggregation and tracking capabilities, where the shipper logs in to a single portal without the need to establish IT links with each service provider separately.

Another issue in the era of big data is finding the right balance between too much and too little data. Excessive volumes of data come with excessive costs. In particular, there are additional set-up and operating costs for the system that collects, processes, and presents the various data flows. In addition, there are also potential overhead costs due to the excessive data. Ideally, companies would prefer the capability of managing by exception, but instead they are inundated with a firehose of data that does not easily enable action.

Shippers at the roundtable found exception management to be crucial. Many companies emphasized that more information and data does not necessarily help manage shipments and exceptions, unless accompanied by the capability to drive adaptive actions. Data gaps, delays, and inaccuracies obscure the real picture of the operational situation and thereby delay adaptive actions. Predictive tools that allow anticipating disruptive events and exceptions, rather than just react to events and fix after the fact, are becoming important.

There are two different approaches that companies can take to managing exceptions. First, shippers may prefer to receive raw data from carriers and 3PLs, and analyze the data and detect problems in-house. For example, one shipper starts with identifying common performance problems and creating alerts for them. The next step for this shipper would be to codify responses to an exception, evaluate success of the response, and then to automate it. However, as one participant cautioned, "perfect" is the enemy of "good enough," and it might be best practice to focus on the business need rather than the IT functionality. For example, developing business rules for common categories of exceptions, such as the seasonal fog problem, might be more cost-effective than investing in an expensive, optimized weather-forecasting system.

A second option for shippers would be to delegate exception management to carriers and other third party providers, who would take full responsibility for door-to-door movement of the goods. This option comes down to whether shippers want transportation service as a black box service. This option requires shippers to inform providers on business rules and exception thresholds; however, shippers are typically cautious regarding sharing of detailed rules with carriers.

4.2.4 Benefits of SCV

Since companies cannot manage what they cannot see, all participants agreed that SCV is crucial to improve supply chain performance and operations. Despite evident benefits of SCV and the proliferation of solutions, shippers still need to do comprehensive cost-benefit analysis in order to evaluate if the benefits outweigh costs of a particular implementation of SCVS.

In the roundtable discussion, the benefits of SCV fell into three broad categories. First, visibility helps companies make short-term decisions such as when managing exceptions. When

deviations from the scheduled plan occur, SCV allows shippers to take timely alternate corrective actions in order to offset negative effect of the exception, thereby reducing expedited costs such as airfreight. SCV can also help lower local inventory buffers by reducing transit time variability and giving shippers more certainty about in-transit inventory. Another short-term benefit is improving compliance, especially for goods that require careful handling, such as food or pharmaceuticals. More accurate data on the contents of shipments reduces the chances of both customs penalties and physical inspections.

Second, SCV enables long-term continuous improvements in the supply chain, such as optimization of network design, reduction in buffers, and streamlining support activities. Analysis of long-running SCV data on lanes, carriers, and transit times, allows companies improve their decisions on freight allocation, modes of transportation, and inventory buffers. In the long run, SCV can also impact overhead costs by replacing manual tracking and reporting of in-transit inventory and arrival dates with automated visibility. Availability of accurate data on movement of the cargo can also facilitate more accurate billing of demurrage and detention charges.

Lastly, some participating companies saw benefits in a one-time diagnostic visibility project. Even though the picture provided by a one-time diagnostic is only a snapshot of an ever-changing landscape, it can still uncover correctable flaws in supply chain processes and operations of the company, its providers, and partners. Most importantly, a short-term diagnostic application of visibility has much lower costs than the implementation of full-time full-scale visibility solution, making it a viable option.

4.3 Results from Extensive Interviews

The results from the extensive interviews conducted between May and June 2015 are summarized below. They are categorized into 4 main sections: current status of SCV, technology and solutions providers, features and benefits of SCV, and methods to evaluate benefits of SCV. The extensive interviews contributed to the research team's understanding of how SCVS affected different companies and helped to narrow down questions and participants for the intensive interviews.

4.3.1 Companies Selected for Interviews

Most of the companies selected for the extensive interviews are large shippers with headquarters either in the US or Europe. Shippers were from a wide range of industries, including hi-tech, retail, manufacturing, and energy. In addition to shippers, we also covered SCV from the perspectives of a 3PL & freight forwarder, a research & consulting company, and an IT solutions provider. Table 4-1 provides a detailed summary of the interviewed companies.

Table 4-1: Details of Participants in Extensive Interviews

#	SC Role	Industry	HQ	Company Description	Interviewee
1	Shipper	Hi Tech	US	Multinational corporation in IT sector	Sr. Manager, Global Supply Chain Systems; IT members
2	Shipper	Electrical Equipment	France	Multinational corporation in electrical equipment sector	Manager, North America Logistics Supply Chain
3	Shipper	Retail	US	Multinational specialty retailer	Director, International Logistics
4	Shipper	Manufacturing	Australia	Multinational manufacturer, protection solutions	VP, Supply Chain
5	Shipper	Processed Food	US	Multinational food production and distribution company	Sr. Manager, International Logistics
6	Shipper	Chemical Manufacturing	US	Multinational developer and manufacturer of petroleum additives	Sr. Manager, Logistics
7	3PL / FF	Freight Forwarding	Europe	Supply chain management and freight forwarding solutions provider	Implementation Project Manager
8	IT Provider	IT	US	IT / International trade data provider	Data Scientist, CTO
9	Shipper	Manufacturing	Germany	Worldwide manufacturer of rubber flooring for commercial industry	Manager, Purchasing and material planning
10	Consulting	Research / Consulting	US	IT research and advisory firm	Research Director
11	Shipper	Manufacturing	US	Multinational manufacturer of heavy industry equipment	Innovator, Logistics' Research & Innovation; Procurement Managers
12	Shipper	Freight Forwarding	Europe	Supply chain management and freight forwarding solutions provider	Senior Director, Supply Chain Development
13	Shipper	Energy	US	Multinational corporation in oilfield services and equipment sector	Sr. Manager, Regional Logistics

4.3.2 Current Status of SCV

The interviews confirmed some previous findings from the survey and the literature review. For example, supply chain visibility is not a one-size-fit-all solution, and companies vary significantly in the maturity of their supply chain visibility systems. However, all companies recognize the growing importance of visibility into their supply chains and several common themes emerged during the in-depth conversations.

Real-time or near-real-time visibility is still rare despite the growth of technology and software solutions in the recent years. The key challenges to attaining real-time visibility and obtaining a full picture are the integration of supply chain partners into a single system and the blending or synchronization of different visibility solutions.

Information on just the ETA is no longer sufficient. The goal of a well-functioning system now is to connect not only all sources of data into one system, but also to match the different shipping references used by various actors, such as purchase orders, bills of lading, or the container number. Moreover, visibility is required not only of the physical location of the cargo, but also for the financial, information, and documentation flows.

Data quality and format compatibility are both essential in order to attain supply chain visibility, irrespective of the sophistication of the software. Multiple interviewees reported that data inconsistencies in both format and rules are a significant challenge to data interpretation and reporting. Interviewees noted that there are almost always "multiple versions of the truth" for any shipment. This is especially true for systems using EDI for milestone reporting. Selecting the most appropriate "version" is an on-going challenge that technology does not seem to address.

4.3.3 Technology and Solutions Providers

In terms of visibility solutions, the interviewed shippers and forwarders use a wide range of software and technology solutions to attain visibility into their shipments. Many companies indicated the use of a combination of solutions and methods instead of a single, standardized mechanism for ocean freight visibility.

Shippers seem to have three routes with respect to visibility: (1) build their own in-house visibility system (customized), (2) implement cloud-based solution like GT Nexus, or (3) use a platform developed by a freight forwarder or 3PL. The traditional software trade-off debate between customized / in-house vs. standard / Commercial-Off-The-Shelf (COTS) systems is front and center for visibility solutions as well. All solutions have their certain advantages and limitations and most of them require both significant up front capital investment and time to fine-

tune the system architecture. Therefore, shippers should carefully evaluate the different approaches to software and select the solution that works the best for them, and is consistent with their supply chain needs and goals.

Despite a growing number of software solutions on the market, 3PL offerings remain a relevant intermediary for many shippers. While many companies reported that visibility becomes worse when they book via 3PL than when they book directly with an ocean carrier, they also acknowledged that 3PLs fill the gap between the shippers' expectations and the ocean carrier's capabilities with respect to visibility. Even when the 3PL is not an intermediary link to book with the ocean carrier on the shipper's behalf, the 3PL has the unique capability to bring all other pieces together. Recently, more and more 3PLs are acting as a 4PL and offer control tower solutions or sell their internal visibility capabilities to external partners.

Ocean carriers are also increasingly becoming key players in supply chain visibility. A recent development is that carriers are trying to differentiate themselves based on visibility service. Some shippers reported that they have strict scorecards to evaluate carrier performance and observed varying levels of visibility service from different carriers. Other shippers observed significant performance deterioration when working with niche carriers and on shipments involving transshipments.

While survey results indicated that on-time delivery and notification availability vary by carrier and by lane, interviews reported that they vary also by port conditions. Moreover, lead times at ports are typically the most variable in the end-to-end ocean-shipping journey, making visibility at ports quite valuable. This is partly due to widespread port congestions because of port infrastructure lagging behind proliferation of large post-Panamax vessels. In an extreme

case, the recent 2014/15 disruption of the West Coast ports in the US caused shippers to lose visibility almost entirely, over a long and uncertain period of time.

As per both the survey results and the interviews, EDI emerged as a commonly used technology, even though it has certain limitations. The primary challenge for EDI is its lack of timeliness. However, some forwarders noted that the processing speed largely depends on the logic that is embedded in the systems of customers and providers. If the logic is well aligned, EDI should not be a stumbling block.

Both shippers and carriers alike revealed that continuous real-time status updates may not be ideal for high volume shippers, since real-time status updates slow down the system. Therefore, some companies prefer to work with raw data and static updates that are sent a few times per day rather than more complex real-time systems. Also, a lower frequency of updates may reduce costs and thereby be more efficient in terms of outcomes obtained per dollar invested. However, as a general rule, the frequency of updates preferred by shippers depends on the value associated with the decisions that they make with the data.

Similarly to survey results, very few companies reported using GPS or Satellite devices as the technology behind the tracking feature of visibility systems. These technologies are considered to be an incomplete answer to visibility problems since they have limitations such as lack of context beyond cargo location. Also, cheaper alternatives such as websites like MarineTraffic.com can replace some of their key functions. The few firms that use GPS devices, use them on high-value products over high-risk lanes where the needs and benefits are the greatest.

4.3.4 Features and Benefits of SCV

One of the central topics in the interviews was the various benefits of visibility and the evaluation of ROI for visibility. While companies agree that supply chain visibility is important for their businesses, many still struggle to quantify the benefits, and come up with a meaningful ROI. Overall, expected supply chain visibility benefits appear to be similar across different regions and industries.

Benefits play a key role on operational, tactical, and strategic levels. Several companies mentioned that responsive decision-making and timely corrective action are the key benefits of operational visibility. Visibility at the purchase order level allows for consolidation and optimization of loads, thereby and increasing container utilization. In general, greater automation in the tracking process and reduction in manual entries help shippers reduce error.

Benefits at the tactical level focus on better data quality and reliability, which in turn open up potential improvements in planning and execution. For companies with high holding costs, better data can lead to significant savings in inventory by reducing variability, providing more insight into lead times, and improving company's overall control over inventory. Some shippers also use better supply chain visibility to monitor the performance of service providers that in turn allows them to make adjustments and reduce transit times by identifying better routes and carriers, thus improving overall supply chain design.

At the strategic level, some shippers identified improved customer service as one of the key benefits of visibility. Improved visibility also helps reduce silos within the organization and enhances strategic decision-making. Also, as risk management becomes more important for mature organizations, the value that supply chain visibility provides towards managing risk is becoming more significant.

4.3.5 Methods to Evaluate Effect of SCV

Two main methods are observed to quantify the benefits of visibility. Some shippers use aggregate cost-benefit analysis, while others use profitability metrics for each individual visibility component. The various components used are automation, standardized data format for all partners, efficiency in man hours by eliminating manual tasks, additional data availability and analysis capability, and quicker decision-making. We observe that as operations become more efficient, companies are more likely to focus on profitability metrics, and perform comparative "before vs. after" analysis (or "without vs. with" SCVS) to evaluate the margins that each customer or shipment generates.

Overall, the savings realized from supply chain visibility depend on the maturity of the company's visibility capability. For companies stuck on the basic transactional point of view of visibility (managing only where and when cargo should be shipped), the KPIs used do not have strong financial effect. More sophisticated levels of visibility in a company allows it to focus on KPIs that reveal waste in the system and thus improve efficiency and translate it into savings. However, this is not easily done and many shippers struggle to translate visibility into actual savings and are at best able to only address obvious short-term costs.

4.4 Results from Intensive Case Studies

The results from the intensive interviews conducted between September and October 2015 are summarized below. The section starts with an overview of the companies and their existing systems and then presents findings on the effect of SCVS implementation on key business processes at each company.

4.4.1 Company and System Description

A. Shipper 1

Company Description: The first shipper is a multinational corporation in the IT sector, and is a manufacturer and also a provider of consulting and cloud computing services. The company is headquartered in the US and reported revenues of more than $100 billion in 2014. The research team conducted one brief 30 minutes interview with the senior manager in global supply chain network design division, which was followed by an in-depth hour-long interview with him and four other managers / directors from supply chain, logistics services, and supply chain architecture and development.

System Description: The company has been working on the implementation of a cloud platform since 2012 with a focus on logistics visibility and transportation management. Currently, the old system is still in the process of being phased out and being replaced by the new SCVS. The old system covered all modes of transportation and received status updates and information from ERP. The information from the old system was then fed into application modules to create visibility for customers.

The new SCVS is currently used mainly for ocean shipments, but will be extended for air and ground transportation as well in the near future. The solution is viewed as a single central platform that will be used both internally and externally by logistics partners who provide services and execute operations in different regions. The new SCVS is expected to cover a wide range of processes, such as inventory transfer, carrier evaluation, and customer ETA updates, though it currently has only limited functionality from an operations perspective (Figure 4-1).

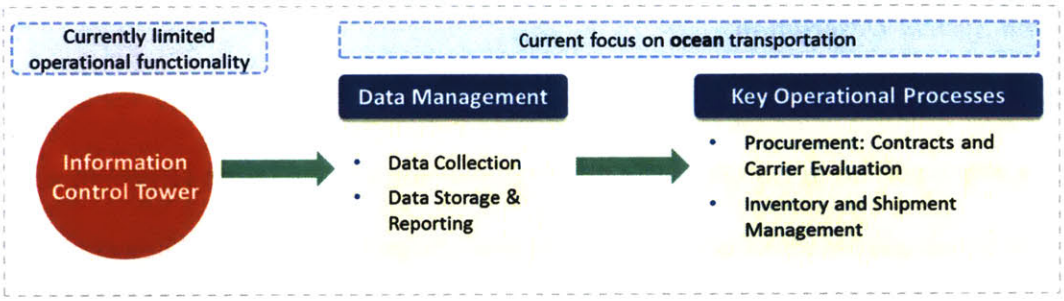

Figure 4-1: Scheme of the current SCV system at Shipper 1

Benefits sought from SCVS: The primary concern that prompted the company towards implementation of the new solution was poor data quality due to complexity and the lack of standardization on a large scale. The new SCVS has already shown improvement in the company's data quality, reducing complexity, and driving the company closer towards industry standards. The interviewees felt that had the company possessed data of good quality, they might not need a platform of this type.

Shipper 1 feels that internal complexity reduction and having a leaner system are both pre-requisites and also potential benefits of the SCVS implementation. Specifically, the company emphasized that implementation of the new solution involved significant business process re-engineering and change management, in particular working to manage the company's organization culture and obtaining stakeholder buy-in.

B. Shipper 2

Company Description: The second shipper is a multinational manufacturer of industry equipment. The company is headquartered in the US and reported revenues over $50 billion in 2014. The research team interviewed a global technology leader, who is directly involved in the development of the supply chain visibility system.

System Description: The current system has been evolving over the years. The current interface was prototyped approximately three years ago, and is now in the production phase. The solution comprises multiple systems and providers, including a proprietary homegrown system that serves as a visibility interface (Figure 4-2). Data is received from approximately 40 different satellite data warehouses and stored in a format-neutral "central data warehouse." The data in the centralized warehouse is compatible with the different applications and is used to create visibility and generate reports.

The visibility system is created and evolves with the goal to provide one integrated view into the health of the company. The system design supports holistic view and departure from transactional data towards considering all elements in the context of entire network performance.

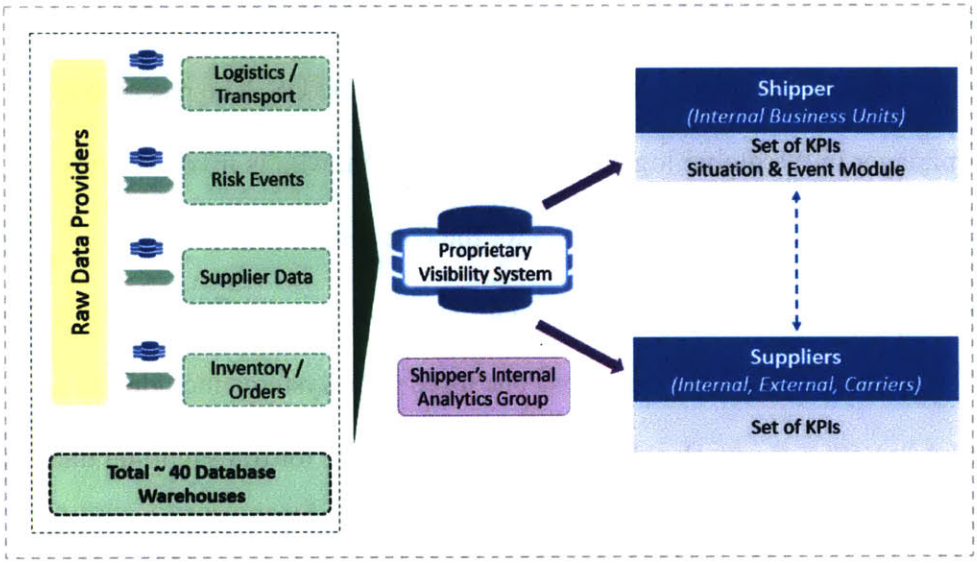

Figure 4-2: Scheme of the current SCV system at Shipper 2

Benefits sought from SCVS: Shipper 2 has developed a significant portion of the system without presenting a formal business case, since management was of the opinion that the potential benefits of the system massively out-weighed the cost. Moreover, the presence of a

supplier-related issue for which SCVS was seen as the solution, prompted the company to take a "let's go ahead and get it done" approach. Therefore, supplier management is at the center of this system. In addition, the shipper also sought to create a coordinated view across multiple aspects of logistics.

There is a recognition that some KPIs are easier to measure and translate into financial impact than others. For example, inventory turns and expediting costs are easy to track and translate into financial impact, while impact of higher collaboration is hard to capture. Therefore, the primary investment justification mechanism was based on inventory calculations, which evaluated the benefit of reducing inventory by a certain percentage over a certain period of time.

C. Shipper 3

Company Description: The third shipper is a multinational retail corporation with large number of stores worldwide. The company is also headquartered in the US. The research team interviewed a senior manager in the global logistics systems division, who is involved in developing advanced analytics and visibility solutions for the company.

System Description: Most of the current systems and tools that create visibility have been in use by the company for approximately 12-18 months. The three main systems include an interface for ocean carriers with a six-week rolling forecast, a database for transactional data, and internal visibility systems. The internal visibility system has software tools that blend data of different formats and also analyze it to be used for PO and inventory management. The output can be transformed into different formats and used for custom visualization through various other software.

Visibility creation is seen as a multi-step process for shipper 3, where the company receives data from various sources, analyzes it, and uses it to create visibility and manage its supply chain (Figure 4-3). The first step is to identify business processes and the data needed to support them. Next, data aggregation is done by the third party providers, such as 4PL or cloud platform providers, who act as data warehouses. In addition to data aggregation, the providers enforce contractual data requirements and manage data methodology for obtaining the data. The providers also help leverage technology to capture all types of data even from supply chain participants who still provide data manually.

Finally, the company's data division works with internal and external "customers" to understand their data needs and create customized visibility. Internal visibility management system creates customized layer on top of the data to present data in a manner that customer would like to see or understands it. Company systems are set to create full visibility by cross-referencing different pieces of data.

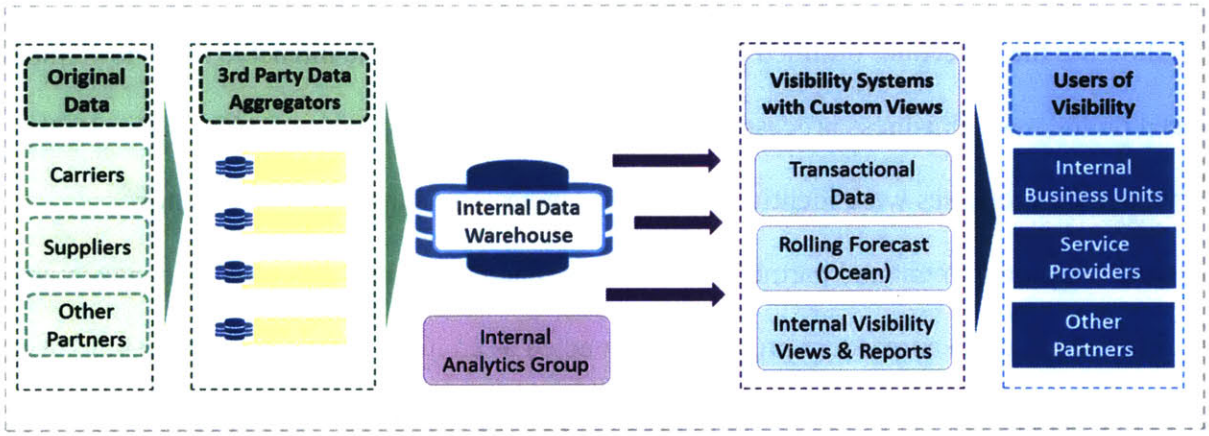

Figure 4-3: Scheme of the current SCV system at Shipper 3

Benefits sought from SCVS: Shipper 3 evaluates benefits both in terms of monetary savings, which for supply chain processes are primarily based on cost or cycle time reduction, as well as intangible benefits such as collaboration.

One of the primary mechanisms for realizing financial impact is through inventory reduction by reducing variability in shipments. The new SCVS tool assesses the true cycle time in the supply chain based on origin-destination, type of cargo, seasonality, etc. This helps manage and reduce variability and lead time, which in turn reduces replenishment cycle and takes inventory dollars out of the network.

For intangible benefits, the analytics group in the company provides comprehensive information to operators, who use it to improve the supply chain. By offering better processes and better visibility to operators, the system enables them to focus on important issues and exceptions.

4.4.2 Key Processes Identified in Intensive Interviews

Following the procedure outlined in the methodology section, the intensive interviews phase focused on the major business processes affected by the implementation of SCVS. During the interviews, the processes were identified as data management, shipment and inventory management, procurement and partner collaboration, and risk management. Data management process emerged as an antecedent process, which acted as an input and enabler to the key operational processes.

Each business process is further broken down into sub-categories of supply chain processes, which vary across companies (Table 4-2).

Table 4-2: List of Key Business Processes and Sub-Processes

Key Business Processes
Data management (Antecedent Process)
Data collection & storage
Data Analysis
Metrics and Reporting
Key Operational Processes
Shipment and Inventory Management
Shipment planning and inventory policy
Tracking & Tracing Cargo
Cargo ownership transfer
Procurement and Partner Collaboration
Partner collaboration
Performance evaluation of carrier / supplier
Carrier / supplier nomination and contract negotiations
Risk Management
Event monitoring & exception management
Response and contingency planning
Documentation & Compliance

The data management process includes data collection and storage, data analysis, and metrics & reporting. During the interviews, data management emerged as the process that was directly and to the largest degree affected by the implementation of SCVS. In turn, the changes to other processes were mainly the result of enhanced data management rather than a direct result of new SCVS. Therefore, we analyze data management as an antecedent process.

Inventory & Shipment Management includes tracking and tracing cargo (especially for ocean shipments), cargo ownership transfer, shipment planning and cargo consolidation, and lead time policy review and adjustment. Interviewees differ in the emphasis they place on the various sub-processes.

Procurement and partner collaboration includes partner collaboration, carrier nominations and contract negotiation, and carrier and supplier performance evaluation. All interviewed companies reported greater collaboration with their supply chain partners after SCVS implementation.

Risk management includes exception and variability management, event monitoring, response and contingency planning, and documentation and compliance. The interviewed companies were found to be at different stages of utilizing SCV for risk management.

4.4.3 Capturing the Effect of SCVS on Key Business Processes

The data collected from each interview was organized by process, and the effect of SCVS on each process was captured using the "with and without" framework (Figure 4-4). Specifically, the framework compares the characteristics of each process, both without SCVS (before implementation) and with SCVS (after implementation).

The performance of the processes, both with and without SCVS, is based on the outputs over the inputs and measured on both the efficiency and effectiveness dimensions (as defined earlier in the methodology section). The effect of SCVS on any process is given by the difference in performance between with and without SCVS.

Major findings that emerged during the interviews are summarized in a separate table for each company. This framework of results forms the basis for the analysis in the next section.

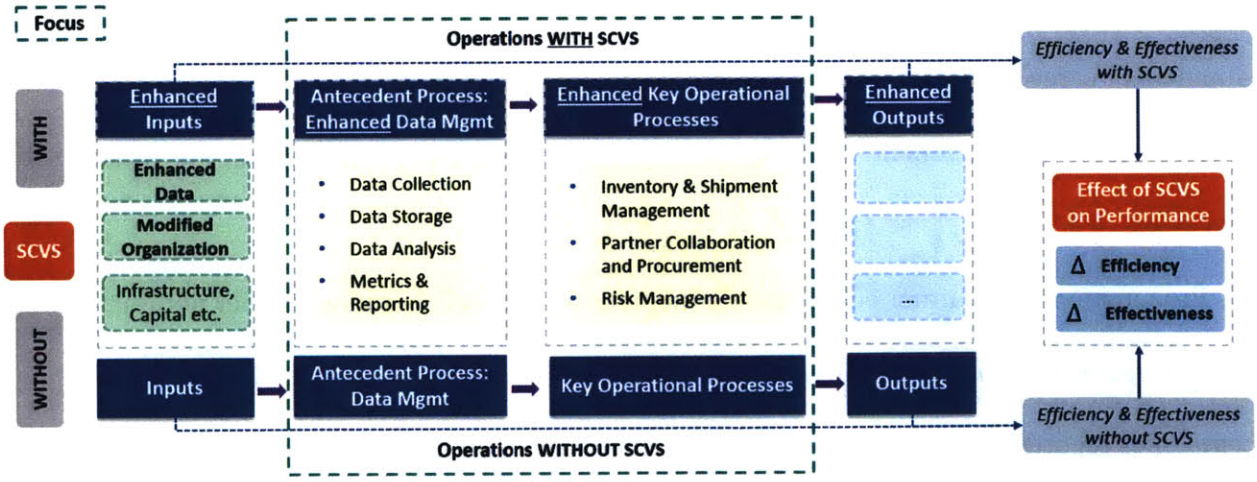

Figure 4-4: Framework for Assessing Effect of SCVS

4.4.3.1 "With and Without" Results for Shipper 1

A. Data Management

The new system with SCVS has allowed shipper 1 to change the way they manage data and "discover a lot about the data that they receive." The company has a lot of internal complexity and a deeply embedded culture of customization based on user needs. Thus, the original system was extensively customized to meet the specific needs of each user, leading to a multitude of unique processes for different business units. This had a significant negative impact on data quality. Moreover, as employees changed positions, eventually often nobody knew how exactly the system was customized. The new platform, on the other hand, is more about standardization. Management has set clear expectations that changing one piece affects all customers, thus customization is done more carefully.

Becoming a data "owner" and changing data collection process was another important transformation for the company. Before SCVS implementation the company had to ask logistics providers and carriers to provide updates and relevant shipment information. Thus, process of data collection was semi-manual with data coming in a variety of formats, often resulting in "apples to oranges" comparison. After implementation, this need to inquire multiple sources every time for different pieces of data was largely eliminated, as now the company has direct access to shipment information stored on a single platform. With the process of data collection being automated, data receipt is timelier and the company sees a more complete picture on the shipments. Format inconsistency, data entry mistakes, and manual tasks associated with original data collection method have decreased.

On a higher level, the new system facilitates "one version of the truth" and consensus within organization as everyone makes decisions based on the same data. Previously, arguments within company were not about overall validity of recommendations that business units make, but rather

were about underlying data used for analysis. It was common for business units to ask each other such questions as "where did you get data," "can we trust your data," and "how come my data is different," which would delay reaching the consensus and making decisions.

Also, the company being a large complex organization, the new solution provides an important tool to make global divisions to work in a consistent way. Moreover, moving from a legacy system to a commonly used cloud platform, provides an opportunity to align with industry standards and benchmark.

The new system has also altered how reporting is done in company 1. The shipper historically relied on the main report that covered various aspects of ocean shipments coming into Americas. It had approximately sixty different pieces of information and was used by many functions, including planning and finance, all of which wanted to include different information. After detailed evaluation and surveying stakeholders what the information is used for and why, the report was reduced to the major fifty data fields that were actually used. Thus, the improved report in the new SCVS provided better and more detailed information.

Overall, the company seeks to migrate from reporting perspective and replace legacy processes. Employees are encouraged to shift away from exclusively relying on static reports towards using new SCVS in a more dynamic way now that the system has this capability. At the same time this shift in reporting culture is expected to drive adoption of the new SCVS.

B. Shipment and Inventory Management

Shipper 1 has improved its tracking and tracing capabilities after SCVS implementation. In particular, it has achieved better visibility on water by accessing live GPS updates, status alerts, and better information on shipment arrival. Before, the company had to rely on turnaround time and the most certain milestone it had – container departure from the port, as a basis for

estimating other milestones and doing transactions. Importantly, newly acquired in-transit visibility allows the company to control inventory transfer point. While before cargo ownership was typically transferred when ship leaves the port, now the company can use different milestones as a basis for inventory transfer point, such as arrival to destination port or entry into international waters. This change in inventory ownership transfer point has resulted in significant inventory cost reduction for the company.

Shipper 1 sees high potential of improved tracking & tracking processes in a wide range of areas across transportation modes, but currently they are still in the early stage pilot and need more time to fully take advantage of it. Load consolidation and container utilization is another focus area offering big saving opportunity.

C. Procurement and Partner Collaboration

Shipper 1 continues to manage its partner relationships directly as before, but noted that quest for data quality is a driver of collaboration with the control tower solution provider, logistics providers, and ODMs.

Procurement department overall uses a combination of old and new tools, as old internal system is still responsible for end-to-end coverage. However, new SCVS has significantly impacted business processes in ocean transportation. The system acts as platform for logistics and transportation providers for pricing bidding and other related information, while internally it also provides visibility into carrier nomination history and business allocation to service providers.

The company now have fully informed KPIs and complete documentation and data on both rates and accept/decline ratio, while before there were only incomplete transaction records that were not accessible by all divisions. For example, now the company has full historical visibility

into situations when procurement team received good rates from carrier, but carrier did not allocate any space for company's cargo. This additional easily accessible information on freight cost and nominations allows the company to optimize its ocean transportation spend and supplier portfolios.

D. Risk Management

Shipper 1 has not yet actively used new SCVS for risk management, but the system helps to pre-define parameters and thus better manage exceptions. Specifically, better visibility into processes allows to define expectations, for example on how shipment moves, and thus fine-tune exception management processes, such as on-route changes and contingency planning.

Table 4-3: Summary of "With and Without" Results for Shipper 1

Key Processes (Shipper 1)	Process *without* SCV	Process *with* SCV	Effect of SCV on Process
Data management (Antecedent Process)			
Data collection & storage	- Via 3rd party - Manual / semi-manual execution - Data at multiple locations and in different formats - Limited data	- Own data - Automated receipt - Multiple sources feeding into single platform - More data available	- Timely data without need to make external inquiry - Reduction in manual jobs - Easy to access and use data - More complete picture of the suplly chain
Metrics and Reporting	- Inconsistent data and formats across reports and functions - Non-standard metrics - Static report - Has to be requested	- Consistent format and data used across organization - Standardized metrics - Dynamic data - Readily accessible	- Improved data quality - Consistent with industry standards - Complexity reduction - Ease of comparison
Key Operational Processes			
Shipment and Inventory Management			
Tracking & Tracing Cargo	- Limited on-water visibility - Manual sporadic updates - Multiple information sources	- Extensive visibility with live tracking & status updates - Automated / semi-manual - Single source & platform	- Timely and accurate location data - Milestones validation - Ability to provide updates to partners
Cargo ownership transfer	- Poor visibility into container location in-transit leads to cargo ownership transfer when cargo leaves port	- Extensive visibility into container location allows for ownership transfer at different milestones	- Significant cost savings
Shipment planning and inventory policy	- Limited consolidation leading to sub-optimal container utilization - Inventory policy and planning with limited data	- Visibility increases consolidation and container utilization - Inventory policy and planning done in-house with more comprehensive data	- Optimized consolidation leads to higher container utilization ("big & easy" saving opportunities) - Improved inventory management
Procurement & Partner Collaboration			
Partner collaboration	- Limited collaboration - System too complex to easily add new provders to the system	- SCV forces higher levels of collaboration - Easy to add new providers to the system	- More overall collaboration with providers and ODMs - Reduced time, effort to add partners to system - Reduced cost for partners to do business with shipper
Performance evaluation of carrier / supplier	- Limited record of communication / transaction data	- Full documentation in a centralized location	- Extensive capabilities to evaluate and track performance - More informed KPIs
Carrier / supplier nomination and contract negotiations	- Semi-manual process - Contract negotiation based on limited data	- More automation for ocean segment - Based on fully-informed KPIs	- Better contracts - Fully-informed decisions - More optimized cargo allocation to carriers

4.4.3.2 "With and Without" Results for Shipper 2

A. Data Management

The shipper's system tracks data quality metrics, such as data accuracy and coverage / availability. The central piece of the SCVS, however, is a closely monitored set of KPIs used for every element in a supply base and accessible by both internal and external suppliers. These KPIs cover not only timeliness of shipping out and delivering, but also metrics related to expediting, inventory, demand, payment, and collaboration.

The metrics have very detailed categorization, for example company tracks late, early, and without notification shipments. KPIs provide good indication of supply network performance problems on transportation side. Moreover, interface is designed like a diagnostic tree – if high level metrics are not right, an employee can easily drill into details of each KPI to investigate the issue at a much deeper level.

The company realizes that they deal with a complex network of choices on a daily basis, thus in a new SCVS all metrics are tied together and designed to catch tradeoffs and inefficiencies. For example, the company does not just want inventory situation to improve, it wants it to improve in a right way and not at the expense of KPIs in other areas.

The shipper has also leveraged data and process standardization with the implemented visibility system. Standard data format and business rules facilitate interpretation and decision-making. For example, rates calculation can be based on different terms and rules, and definition of "on-time delivery" can mean different things to different partners. The SCVS helps to establish clear data requirements and manage partner and supplier expectations.

B. Shipment and Inventory Management

Shipper 2 has high holding cost, so even a small improvement in inventory management can have a significant direct impact on financial performance. The system allows to closely monitor and take into account inventory turns at the company and its suppliers. Reducing uncertainty and variability looking forward through better visibility and processes helps to reduce inventory.

The company also has better capability to live track inventory with more advanced SCVS. Tracking and tracing, which is mostly automated with exception for high priority cargo, helps to make decisions and fine-tune network. Also, accumulating this type of historical data allows to do more advance analysis, for example on closing probability window vs. distance. In addition, accurate port arrival information allows to better prepare and synchronize inland port-to-door delivery, especially for over-dimensional break bulk and ro-ro cargo.

The company currently receives good reports on ocean milestones and events from the third party visibility provider. The interviewees, however, consider information on physical location of cargo in transit and milestones not as important as velocity and time frame parameters, such as days until arrival and deviation from schedule. While traditional data transfer mechanisms, such as EDI, do not provide this information, new system is supposed to address this shortcoming. However, even the new system currently has blind spot in terms of reporting velocity and live updates on location and dynamic ETA. The promised live update service from third party provider does not work consistently, as it largely depends on the carrier and the lack of standards in this area further contributes to the problem. This can prevent the company from acting in advance and taking proactive approach to fix problems.

C. Procurement and Partner Collaboration

Shipper 2 places a strong emphasis on collaboration with suppliers and the new visibility system reflects this. Majority of company's suppliers (more than $15 billion of spend) are already connected to the visibility system and the company progressively moves towards connecting entire supplier base. The company provides system access and training to its suppliers. Notably, both internal and external suppliers have access to the same interface and KPI information as the company.

Moreover, now performance tracking and evaluation is primarily used to support the collaborative work towards mutual goals rather than for punitive purposes. The company wants their suppliers to achieve overall improvement rather than improve one metric at the expense of another. The portal helps to monitor this type of tradeoffs, as it provides full visibility into all KPIs that are interconnected.

Importantly, the company reports metrics for both sides, tracking not only supplier performance, but also its own actions that have impact on the network. For example, one of the KPIs tracks change in company's demand, which in turn affects parameters for the supplier and thus may impact its performance. Also, "collaboration" KPI demonstrates what percentage of time either party deviated from the original plan.

The system also helps to keep track of carrier acceptance / consignment rates. More importantly, the company is shifting the conversation with ocean carriers from port-to-port transit time to more a holistic one that covers carrier's consistency in departing and delivering on schedule and its impact on inventory stock that they carry. For example, carrier can be perfect on port-to-port time, but still negatively affect inventory metrics because of delayed discharge at the port. The SCVS not only helps the company to collaborate with carriers as with providers of ocean service, but also places the interaction in the context of overall company performance.

The new system has a positive impact in several ways. First, everyone operates off the same definitions and knows exactly how each metric, such as on-time delivery, is calculated. While suppliers' performance have always been measured by the company, only now suppliers have full visibility into exactly the same information as the company. This helps to create one version of the truth and eliminates previously relevant argument of "my KPI vs. your KPI." In addition, new system helps suppliers to understand their role in a larger system. This facilitates the process of the company and supplier agreeing on what and how to improve together.

Moreover, the portal allows to create additional supplier metrics by tracking how suppliers interact with the system (e.g. how often they use portal, which information they use the most, etc.). This is closely monitored by newly created analytics group within supply network space and allows to provide additional feedback to the suppliers. As a result of all of the above, the company reported ratio of supplier KPI improvement with visibility vs. without visibility as 4:1 on all 9 metrics.

D. Risk Management

SCVS helps shipper 2 to be more proactive in risk management, enabling managers to detect and deal with disruptions. The company specifically implemented "situation and event" feature for active risk management globally. The feature demonstrates all types of past, current, and anticipated events that can disrupt the transportation and supplier network along with calculations of anticipated impact and potentially affected shipments or parts. Company's system receives updates from external sources on a wide range of events, such as natural disasters, storms, fire alarms, and police calls. It also allows to project time before running out, inventory levels, consumption rate, and time to replenish. The information is provided both on high level and local level with an option to drill down into granular details. This information not only

triggers internal system to look into event and evaluate the impact, but is also tied to suppliers' KPIs.

This type of visibility allows the shipper to take proactive approach. For example, the company closely monitored West Coast port strike situation and was able to re-plan most of ocean traffic to avoid delays. From operations stand point, the company typically does not re-route shipments in transit, but rather changes the strategy going forward on handling next orders.

Better visibility also allows reduction in expensive expediting, especially airfreight. Full visibility and as a result better situation control, prevents over-reaction and allows the company to focus on more strategic issues rather than "firefighting."

Table 4-4: Summary of "With and Without" Results for Shipper 2

Key Processes (Shipper 2)	Process *without* SCV	Process *with* SCV	Effect of SCV on Process
Data management (Antecedent Process)			
Data collection & storage	- Time-consuming to collect all data for evaluation	- Quick access to all data - More data available for decision-making	- Facilitates faster and informed decision-making
Data analysis & reporting	- Based on transactional data - Takes time to perform limited analytics	- Data in the context of entire network provides integrated view across multiple dimensions - Data is in standard format and standard business rules are being applied - New functions within analytics group analyze additional data	- Holistic approach to metrics and visibility - Facilitates interpretation & decision-making - Heps understand why system behaves in a certain way - New organizational capabilities, e.g. a new analytics group was formed
Key Operational Processes			
Shipment and Inventory Management			
Track & Trace	- Insufficient live-tracking capability	- Improved, though not perfect live tracking of inventory	- Helps make decisions and fine-tune network
Shipment and inventory planning	- Basic inventory planning capability - Lack of visbility into internal and external inventory turns	- System allows to project inventory levels, consumption rate, replenishment time - Close monitoring and incorporation of inventory turns at the shipper and its suppliers	- Helps to reduce uncertainty and variability looking forward, thereby reducing inventory
Procurement and Partner Collaboration			
Partner collaboration	- Suppliers are not connected to the shipper's system - Limited ability to collaborate holistically	- Majority of suppliers connected to shipper's system - Common platform supports close collaboration	- Suppliers have better understanding of the requirements and the overall network - Supplier performance improves dramatically once they use the system - Collaboration increased
Performance evaluation of carrier / supplier	- Limited number of KPIs and limited ability to monitor supplier performance - Different definitions and metrics used by different parties, since suppliers don't have access to KPI data	- Set of comprehensive KPIs tracks actions and performance of both suppliers & the shipper - Covers both high-level information and lower level details - Suppliers have access to the same KPI data as shipper	- Integrated, holistic metrics with insights into entire enterprise performance - "One version of the truth": suppliers and shipper work with the same data and definitions
Carrier / supplier nominations and contract negotiation	- Purchasing based purely on lower cost	- Purchasing dept. evaluates all relevant supplier data and impact on the entire network on multiple dimensions	- Holistic purchasing strategy - New goals and metrics for purchasing function
Risk Management			
Event monitoring & exception management	- No defined process for monitoring events that may disrupt network - No single platform available to store event data	- Single system with data on past, current, and anticipated events that may disrupt network and their potential impact	- Enables proactive approach with contingency planning done in advance - Allows altering strategies for future shipments - Minimizes impact of disruptive events - Less expediting costs such as airfreight
Response and contingency planning	- Limited ability to do proactive contingency planning	- Incoming data on events alerts the system	

4.4.3.3 "With and Without" Results for Shipper 3

A. Data Management

SCVS system in company 3 helps to create analytics and metrics that are needed by customers and end users. Data management and analysis largely relied on Excel in the past. Analysts used to spend significant part of their work day pulling data, uploading it in Excel, filtering and interpreting. Moving away from Excel towards more automated tools to aggregate and analyze large amount of data has allowed to perform a more detailed analysis.

After system implementation, analysts now have to work with small percentage of relevant data and can start with managing exceptions rather than spending half of the day trying to get from 100% of data to small percent of important data. Significantly, new tools allow to perform analysis and make decisions based on all data, while before the system could only process data sample that is not necessarily a representative dataset. This new capability allows to answer questions that have never been asked before and change the way business units make decisions.

The primary prerequisite for visibility is obtaining managed data that is clean, accurate, and contractually stipulated. The company wants the best data in all areas of business and sets contractual expectations about data timelessness and accuracy. While the company's system is set up such that it is the sole owner of the data, it recognizes that sometimes the party that is the closest to the data is better placed to deal with that data. For example, ocean carriers are perceived to be in the best position to provide data on cargo during ocean transit.

The company has also focused on getting their providers and partners to manage and provide data in a standardized way. In particular, before many partner companies used to transfer data manually and in a variety of formats (e.g. email or flat file). As part of the effort to improve visibility and data systems, the company required and helped its partners to transition to EDI

with automated transfer. This transition not only provided the company with better data, but also helped many of their partners to modernize with respect to data standards, which helped to move forward larger business community.

B. Shipment and Inventory Management

Shipper 3 has visibility across various event milestones (when factory booked cargo, when it was loaded, etc.) and currently reviews all international cargo coming to the US, with plans to extend coverage to other regions as well. In addition to this, it also allows to see how long it takes on average for a distribution node to unload and receive product into computer system, moving it from in-transit state to inventory state.

The new SCVS and data management tools also enabled shipper 3 to improve its inventory policy decision-making process. Process of reviewing and adjusting lead times has been in place for about 20 years, but the availability of data to benchmark supply chain effectiveness and ability to do a quarterly review based on comprehensive data has been in place for international piece for only a year. Previously, adjustments were not made on a routine basis, but only when a significant event or variation occurred. It was more of an ad hoc process based on "tribal knowledge" using spreadsheet analysis that took time, which was largely due to the lack of data to support tool on the required level.

The system has supported implementation of a holistic process with recommendations being made based on data analysis and reviewed by key stakeholders before final policy adjustments. The company now has both more data and systematic powerful tools that enable quicker and easier analysis. As a result, the company is able to make inventory policy and particularly lead time adjustments quarterly. In this case, availability and usability of data helps to effectively use

it to manage supply chain. As a result, it helped to improve internal metrics in the past year – for example, percentage of on time arrival went from 45-55% to within 97%.

C. Procurement and Partner Collaboration

The system in company 3 allows to scorecard carriers based on more data and advise them on their performance relative to other carriers. Thanks to holistic data system and visibility into end-to-end network, the company often has better data on carrier performance and shipments (e.g. on-time reliability, offload rates, etc.) than carriers themselves. The feedback from the shipper helps carriers to identify issues within their network and improve.

In terms of carrier nomination, SCVS with more data and well-informed metrics helps to evaluate and make business decisions on whether to utilize carrier for a certain business or not. For annual ocean contracts, procurement team is now armed with a complete set of metrics on how carriers perform overtime.

As mentioned in the section on data management, company 3 also worked with its service providers and partners to foster transition to automated data transfer in a standardized format. While the participation rate in the first year was less than expected, since many partner companies did not want to invest in new technology, in the long run it is expected to benefit all parties.

D. Risk Management

Shipper 3 uses visibility to manage variability due to both seasonal known events and unexpected disruptive events. The company tracks seasonal weather events globally and either develops mitigation strategy or creates a window where supply chain becomes more extended to

account for variability. For disruptive events the system helps to get quick visibility into potentially affected shipments – their location, POs, and expected impact.

On a daily basis, the new SCVS helps to manage exceptions, in particular shipments that fall out of arrival range. Before the system was not capturing reason behind late or early arrival, so the exception went either unexplained or analysts had to spend time to determine reasons. The new system has reason coding built behind exceptions, which allows to quickly address them and plan better for future shipments.

While compliance improvement was not one of the goals when implementing new system, additional data naturally helps company 3 with documentation and compliance. First, visibility and clean data from partners helps to kick off processes within customs compliance realm. Second, the system helps to manage safety and health regulations, in particular for perishable cargo, as now the company has quick access to detailed information on pick up time, location, temperature, packing and can associate it with POs.

Table 4-5: Summary of "With and Without" Results for Shipper 3

Key Processes (Shipper 3)	Process *without* SCV	Process *with* SCV	Effect of SCV on Process
Data management (Antecedent Process)			
Data collection	- Data exchanged in various formats manually	- Data transferred automatically in standardized EDI format	- Better, standardized data for both the shipper and partners
Data analysis	- Analysis based on small data samples - Spreadsheet based analysis	- Consider and process comprehensive data - Replaced spreadsheets with more powerful tools	- Able to do more detailed analysis on full data - Eliminated many day-to-day tasks related to data analysis, allowing focus on exception management and process improvement
Key Operational Processes			
Shipment and Inventory Management			
Track & Trace	- Limited visibilty on only a few milestones	- Visibility into all major milestones	- Know how long it takes to move inventory from in-transit to in-stock state
Lead time review and policy adjustment	- Lead time adjustment done on ad hoc basis when large variation noticed or big event occurs - Process based more on "tribal knowledge" and spreadsheet analysis	- Routine lead time adjustment on a quarterly basis - Standardized process supported by data and powerful analytics tools	- Lead time analysis done faster and in a more systematic way - Availability and usability of data helps to create more holistic process to create inventory policy - Informed recommendations based on data has helped improve performance metrics
Procurement and Partner Collaboration			
Partner collaboration	- Data exchanged in various formats manually	- Partners required to transfer data automatically in a standard EDI format	- Helped partners modernize their data management systems
Performance evaluation of carrier / supplier	- Less informed metrics based on limited or sub-optimal data	- More data that is easier to process - Performance tracking over time - Ability to tie metrics from different partners / shipping legs together	- Able to create complete set of fully-informed metrics & holistic view of the system - Fully informed scorecard & benchmark system for carrier evaluation - Partners are provided with detailed holistic feedback - Carrier selection & ocean contracts are based on fully-informed metrics
Risk Management			
Exception management	- System didn't capture reason behind shipment falling out of arrival range	- Reason coding behind exceptions implemented	- Able to quickly find and address reasons behind exceptions
Variability management & contingency planning	- Limited and sup-optimal data to support the contingency-planning process	- For known & seasonal events system allows to better track & evaluate variability - For unexpected disruptive events, able to quickly associate all pieces of information from different sources	- More prepared to mitigate variability - Able to create full picture on particular unit of cargo - Better & faster visibility into cargo affected by disruptive events
Documentation & Compliance	- Limited and sup-optimal data to support the compliance process	- More data of higher quality & better access to support compliance processes	- Clean and timely data helps to manage compliance & documentation more effectively

5. Analysis

In this section we analyze the results observed in the previous section to develop insights and implications.

The framework proposed in the results section identified data management as an antecedent process to the operational processes. Therefore, we utilize slightly different approaches to analyze the effects of SCVS on data management vs. key operational processes. For the antecedent data management processes, we analyze the effect of SCVS on process performance across two dimensions – efficiency and effectiveness; and for the key operational processes, we analyze the consolidated effect of SCVS on business performance.

SCVS affects data management processes and key operational processes via enabling factors. Enabling factors are the mechanism by which these processes are improved, thereby providing the benefit of implementing an SCVS.

As an example, shipper 2 acquired many companies over the last few years, which significantly increased the complexity of the supply chain network. Total spend for logistics and transportation approximately doubled over the last 8 years. However, despite added complexity and volume, the company did not have to add more staff to manage everything moving on the network – which was due to increased efficiencies. Therefore, the effect on performance for shipper 2 is "high" under "efficiency" and enabled by such factors as "better tools" and "better data."

The rest of the analysis section first describes analysis for data management process; then analyzes the effect of SCVS on key operational process at both the individual company level and at the aggregate level; and finally, presents a summary of insights and implications.

5.1 Analysis of the Effect of SCVS on Data Management Processes

The various enabling factors for improving the data management processes that emerged during conversations with the companies are listed in Table 5-1.

Table 5-1: Enabling Factor Mechanisms

Enabling Factors	Description
Automation	Transformation of manual tasks in the process into a more automated mode
Centralization	Single platform for data storage and availability in a central location as opposed to multiple platforms and many locations
Internal standardization	Standardization of data and processes within the organization
External standarization	Alignment of the company's data standards and processes with industry standards and best practices
Better data	Improved availability and/or quality of relevant data
Better tools	Improved tools to manage the available data and other processes
On-demand access	Easy access to readily available information

Table 5-2 provides a summary of the effect of SCVS on the various data management processes, with its corresponding enabling factors. Since the effect of SCVS on the various data management processes was somewhat consistent across companies, we do not break out the effect across each company. However, we aggregate the magnitude of the observed effect across all interviewed companies, in order to provide a sense for which data management processes are affected the most, and which enabling factors are more common. The aggregated analysis allows us to infer the likelihood of expected effects on various data management processes and the enabling factors in any new SCVS implementation.

Table 5-2: Effect of SCVS on Process Performance

Data Management Processes	Effect of SCVS on Process Performance			
	Efficiency		Effectiveness	
	Enabling Factors	Effect	Enabling Factors	Effect
Data collection & storage	Automation Centralization Internal standardization	High	External standarization	High
Data Analysis	Better tools On-demand access	High	Better data Better tools	High
Metrics and Reporting	On-demand access Internal standardization	Med	Internal standardization External standarization	High

The effect of SCVS on the data management processes was generally high for all processes on both the efficiency and effectiveness dimensions. This is because better data performance is one of the key benefits of SCVS, which has a direct and primary impact on the data management processes.

Within the data collection and storage process, the commonly occurring enabling factors for improving efficiency are automation and centralization, whereas for effectiveness it is external standardization. Across all three companies, replacing manual data collection with automated process helped reduce the time employees spend on this task – freeing up time for more value added tasks and reduces errors due to manual data entry. Furthermore, centralized data storage facilitates access and reduces the time employees spend on accessing and gathering various pieces of information. Internal standardization also contributes to greater efficiency, as employees have to deal with fewer data formats on a daily basis. External standardization helps companies move closer to best practices, thus improving the quality of outputs.

The next stage of the data management process is the data analysis process. Firstly, the SCVS provides better data quality and availability across all three companies, allowing for more informed decisions, thereby impacting effectiveness. Better tools seem to impact both efficiency and effectiveness. Two companies at a later stage of SCV software implementation found that

better tools help significantly with day-to-day data analytics, allowing employees to manage only exceptions. Therefore, the SCVS helps to improve efficiency by increasing time utilization and the return on an individual's time. In terms of effectiveness, better tools which have more functionalities and greater capabilities leads to better quality outputs. Lastly, on-demand access affects efficiency by reducing cycle time for analysis to be completed, and making faster decision-making possible.

For the metrics and reporting process, the main efficiency enabling factors are on-demand access and internal standardization, while for effectiveness, they are internal and external standardization. For example, shipper 2 noted that employees can consume more information and make more decisions in the same amount of time. Here system design, in particularly on-demand access that provides all critical information fast, plays a crucial role. In particular, without SCVS, a comprehensive evaluation of a single supplier could take up to two months for one person to gather the required information, whereas it now takes only "two clicks."

Internal standardization also positively affects both the efficiency and effectiveness. It leads to rationalization of metrics and reports, which is significant for improving efficiency in companies, since they do not have to track multiple variations of metrics. This enabling factor also facilitates silo reduction and helps internal business units and external partners operate off the same metrics and reports, which can be used to make both operational, tactical, and strategic decisions. As mentioned earlier, external standardization allows for aligning with industry best practices, thereby improving the effectiveness of the process.

5.2 Analysis of the Effect of SCVS on Key Operational Processes

A slightly different approach is taken for analysis of effect of SCVS on key operational processes. First, efficiency and effectiveness are not distinguished for evaluation of operational processes, because they are closely related and hard to distinguish based on the information available. Second, most of the enablement occurs through the improvement of the antecedent data management process – therefore, we do not identify any other enabling factors separately.

Instead, based on the findings identified in the results section, we first evaluate for each company whether there was a significant (High), moderate (Medium), or marginal (Low) effect of SCVS on each key operational process. We then aggregate the results across all case studies in order to identify the typical magnitude of the effect of SCVS implementation on company performance that can be expected for a new SCVS. Table 5-3 provides a summary of the effect of SCVS on all key operational processes across all shippers, as well as aggregate effect on company performance.

Table 5-3: Effect of SCVS on Company Performance

Key Operational Processes	Effect of SCVS on Company Performance			Aggregate Effect of SCVS on Company Performance
	Shipper 1	Shipper 2	Shipper 3	
Shipment and Inventory Management				
Shipment planning and inventory policy	H	H	H	**H**
Tracking & Tracing Cargo	H	M	H	**H**
Cargo ownership transfer	H	-	-	**L**
Procurement and Partner Collaboration				
Partner collaboration	M	H	M	**M**
Performance evaluation of carrier / supplier	H	H	H	**H**
Carrier / supplier nomination & contract negotiations	H	H	L	**H**
Risk Management				
Event monitoring & exception management	L	H	H	**H**
Response and contingency planning	L	H	M	**M**
Documentation & Compliance	L	L	M	**L**

At the aggregate level across all three case studies, risk management processes seem to be slightly less affected by SCVS implementation than both shipment & inventory management and procurement & partner collaboration processes. This might partly be due to risk management being improved typically only at the more advanced stages of SCVS implementation. This is also consistent with the survey finding that the risk management category is perceived among companies as the least important benefit, since most of them are at early stages of SCVS adoption.

Within risk management, event monitoring and exception management sub-processes seem to be strongly affected by SCVS. This might be because companies are actively looking for this feature in SCVS, as confirmed by shippers' rating of exception alerts as the most important feature of SCV in the survey, which was also echoed during roundtable discussions.

At the level of each company, within the shipment and inventory management process, shipment planning and inventory policymaking was affected significantly across all companies, albeit in slightly different ways. Shipper 1 was able to improve container utilization and consolidation metrics, as well as utilize more comprehensive data to inform its inventory policy overall. Shipper 2 highlighted how more and better data on inventory metrics helps reduce uncertainty and variability. Shipper 3 is now able to utilize more data and better tools to improve lead time analysis and inventory policy overall, which is reflected by improved performance metrics.

Within the cargo tracking & tracing sub-process, shipper 1, whose system focused on ocean shipping, noted a significant improvement in its ocean transit capabilities. Shipper 3 was also able to take advantage of the improvements that SCVS offered in this area. Shipper 2, however,

found the improvements to be moderate, due to gaps in what the company needed vs. what the SCVS provided.

Shipper 1 also had significant benefit from improved performance of the cargo ownership transfer sub-process. However, due to the nature of the contractual terms with their suppliers, the other two shippers did not experience a significant impact.

Within the risk management process, SCVS had a significant effect on the event monitoring & exception management sub-process for both shipper 2 and shipper 3, but not for shipper 1. This is largely due to shipper 1 being in early stages of implementation with a focus on only a few modules of software. On the other hand, shipper 2 has recently added risk management module with extensive capabilities, including response and contingency planning, which helps shipper 2 to manage network risks more efficiently and effectively.

All sub-processes within the procurement and partner collaboration process are affected by SCVS across all cases. In particular, performance evaluation of carriers and other suppliers was significantly impacted in all interviewed companies. This is because after SCVS implementation, shippers have full data on provider's performance and therefore more informed comprehensive KPIs. Notably, shipper 2 experienced high effect of SCVS on all 3 sub-processes, reflecting the emphasis that shipper 2 places on partner collaboration and work with suppliers.

5.3 Analysis Summary and Managerial Implications

Overall, the findings from the analysis of intensive interviews have been consistent with findings from previous stages of research. The cross-study analysis shows how some processes were strongly affected by SCVS across all companies, while for other processes, the effects were varied. Data management process, being one of the primary features and targets of SCVS, has

been strongly affected across all companies via multiple enabling mechanisms. Improvements in data management enable key operational processes, which in turn can translate into superior company performance.

Among operational processes, we observed greater variability in terms of the impact. One of the reasons is that the type of company and products it ships dictates which processes are prioritized and affected more. For example, for a company shipping food products or pharmaceuticals, documentation and compliance is priority issue, and therefore the visibility solution would reflect that. On the other hand, inventory policy improvement would be a priority for company with high inventory costs.

Another factor that explains the variation in impact of SCVS on key operational processes is the stage at which the company is at with respect to solution implementation and current state of data management. If a company recently started an SCVS implementation, then we do not expect it to prioritize more advanced features of visibility such as compliance or contingency planning. For example, shipper 1 is still in the pilot stage with most of the implementation only on the ocean segment of transportation. Therefore, it has not yet seen dramatic change across business processes in terms of headcount, types of roles, effectiveness and duration.

Overall, for new SCVS implementations, we can typically expect high impact on both efficiency and effectiveness across all data management processes. For shipment & inventory management and procurement & partner collaboration processes, companies can expect significant impact, while for risk management, the effects depend on how advanced is its data management process and the stage of implementation.

6. Conclusion and Further Research

This research covered several aspects of SCV solutions, including their effect on key operational processes and antecedent processes, tracing through multiple stages of research from survey to roundtable and in depth case studies.

This work found that SCVS has a direct positive effect on efficiency and effectiveness of data management process via multiple enabling factors, such as automation, standardization, and better raw data. Key operational processes were affected by SCVS mostly indirectly via data management process. The research identified shipment and inventory management, procurement and partner collaboration, and risk management processes as operational processes that were affected by SCVS the most. However, the strength of impact on these processes, and therefore on company performance, typically vary by company characteristics and stage of implementation.

The in-depth case studies were limited to only three shippers. However, since a significant overlap in the areas of impact was observed among the three companies, we do not expect to see any substantial increase in the areas of impact with the addition of more case-studies. However, a larger dataset will provide a more robust analysis and statistical significance of the relative importance of affected processes and their enabling factors.

Furthermore, causal analysis on a larger dataset of companies varying by industry, size, and the stage of SCVS implementation could provide more specific managerial insights on what a particular company could expect when considering SCVS implementation, based on its operating characteristics.

Another area of research that would be useful to companies considering implementing SCVS is evaluation of the financial benefits of SCVS. During the various stages of research, companies repeatedly mentioned the difficulties of building a business case for SCVS implementation.

While this work attempted to evaluate the effect of SCVS at a high level by looking at process efficiency and effectiveness, it would be of interest to also quantify the financial impact of SCVS on a company, utilizing a similar "with and without" framework.

The insights developed in this thesis will help companies that are considering implementation of SCV solutions, or in early stages of implementation, to understand what type of benefits they may expect and why.

Appendix 1: Definitions of Supply Chain Visibility

Supply Chain Visibility Definition	Reference
A process of four meta-steps: capture data, integrate data, create intelligence, and interrupt decisions. Either the data being collected or the decisions being interrupted should be supply-chain oriented, and should span outside of a single organization's boundaries.	**McIntire (2014)**
SC visibility relates to the ability of the focal company, i.e. the supply chain leader, to access / share information related to the SC strategy and the operations of SC partners.	**Caridi et al. (2014)**
The ability, usefulness, usability, timeliness, trust, and accuracy to exchange information between supply chain partners.	**Pidun and Felden (2012)**
The capability of a supply chain player to have access to or to provide the required timely information/knowledge about the entities involved in the supply chain from/to relevant supply chain partners for better decision support.	**Goh et al. (2009)**
The identity, location and status of entities transiting the supply chain, captured in timely messages about events, along with the planned and actual dates/times for these events.	**Francis (2008)**
The ability to provide the latest relevant information/knowledge to all supply chain partners for collaborative decision making.	**Zhang et al. (2008)**
The extent to which actors within a SC have access to or share information which they consider as key or useful to their operations and which they consider will be of mutual benefit.	**Barratt and Oke (2007)**
The degree to which supply chain partners have on-hand information related to demand and supply for planning and control management.	**Hsiao-Lan and Wang (2007)**
The sharing of all relevant information between supply chain partners, also over echelons in the chain.	**Kaipia and Hartiala (2006)**
The ability to be alerted to exceptions in supply chain execution (sense), and enable action based on this information (respond).	**McCrea (2005)**
Capturing and analyzing supply chain data that informs decision-making, mitigates risk, and improves processes.	**Tohamy (2003)**
Visibility means that important information is readily available to those who need it, inside and outside the organization, for monitoring, controlling and changing supply chain strategy and operations, from service acquisition to delivery.	**Schoenthaler (2003)**
Direct insight into the status of orders, inventory and shipments across the supply chain.	**Bradley (2002)**
A capability that provides controlled access and transparency to accurate, timely and complete plans, events and data — transactions, content and relevant supply chain information — within and across organizations and services to support effective planning and execution of supply chain operations.	**Gartner (2015)**
The awareness of, and control over, specific information related to product orders and physical shipments, including transport and logistics activities, and the statuses of events and milestones that occur prior to and in-transit.	**Aberdeen Group (2013)**
Supply Chain Visibility is all about how organizations capture and interconnect data to extract critical supply chain execution information. It provides a single view for tracking information, material and/ or cost by monitoring key dimensions in a global supply chain, such as inventory positions or shipment in-transit status and real-time order movements in order to make informed and fact based decisions.	**Capgemini (2011)**

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