Business Continuity Planning for a U.S. Supply Chain

by

Arthur K. L. Chee  
B.A.Sc. Chemical & Biological Engineering  
University of British Columbia, 2006

Tzu-Hsueh Lee  
B.S. Finance,  
B.A. International Studies  
The Pennsylvania State University, 2011

Submitted to the Engineering Systems Division in Partial Fulfillment of the  
Requirements for the Degree of

Master of Engineering in Logistics  
at the

Massachusetts Institute of Technology  
June 2014

© 2014 Arthur K. L. Chee and Tzu-Hsuh Lee. All rights reserved.

The author hereby grants to MIT permission to reproduce and to distribute publicly paper and  
electronic copies of this document in whole or in part.

Signature redacted

Signature of Author  
Master of Engineering in Logistics Program, Engineering Systems Division  
May 16, 2014

Signature redacted

Signature of Author  
Master of Engineering in Logistics Program, Engineering Systems Division  
May 16, 2014

Certified by  
James Blayney Rice, Jr.  
Deputy Director, Center for Transportation & Logistics  
Thesis Supervisor

Signature redacted

Accepted by  
Prof. Yossi Sheffi  
Professor, Engineering Systems Division  
Professor, Civil and Environmental Engineering Department  
Director, Center for Transportation and Logistics
Business Continuity Planning for a U.S. Supply Chain

by

Arthur K. L. Chee and Tzu-Hsueh Lee

Submitted to the Engineering Systems Division
in partial fulfillment of the requirements for the degree of
Master of Engineering in Logistics

Abstract

The research objective was to provide a directional sense of some key considerations for business continuity planning (BCP) specific to a company's downstream distribution operations in the U.S. This was achieved via a two-pronged strategy comprised of quantitative and qualitative elements to complement insights gained from the literature review.

By quantitatively assessing the financial impacts arising from four hypothetical scenarios, the business impact analysis (BIA) showcased the merits of short time-to-recovery (TTR) in the event of a disruption. However, available information also appears to suggest that the estimated financial impact from carrying high-value inventory is not necessarily insignificant. Hence, a company may want to mitigate the likelihood of a scenario whereby large amounts of inventory become damaged. Qualitative information from industry participants in the study highlighted the importance of tailoring continuity plans to the unique supply chain needs of an organization.

Thesis Supervisor: James Blayney Rice, Jr
Title: Deputy Director, Center for Transportation & Logistics
ACKNOWLEDGEMENTS

I am dedicating this work and my time at MIT to my wonderful wife, lovely angels and family. I cannot thank them enough for being a part of this exciting learning adventure.

My SCM classmates and program alumni have also made this an excellent learning journey. Affiliated faculty, staff and post-docs all deserve special mention for impeccably fostering the rich interactions, opening our minds up to the many possibilities. Last, but certainly not the least, Tzu-Hsueh (Sandy), who has been an absolute pleasure to work with.

- Arthur K. L. Chee

I would like to thank all my family and friends for their support and love. I would also like to thank my colleague, Arthur Chee, for being an incredible thesis partner to work with. Finally, I appreciate the faculty and students of the SCM program for this unforgettable year in my life.

- Tzu-Hsueh Lee

We would like to thank the staff at our thesis sponsor company for making this project even possible. We are equally grateful to the many industry contacts of CTL at MIT who have been gracious in sharing with us their personal and professional insights relating to our thesis topic.

We are especially thankful to our advisor, Jim Rice, for mentoring and providing us with his knowledgeable perspectives; we could not have asked for a better learning journey than the fantastic one we had. Finally, a special thanks to Lenore Myka for patiently reading through our work and contributing to our learning over the course of the year.

- Arthur K. L. Chee & Tzu-Hsueh Lee
# TABLE OF CONTENTS

ACKNOWLEDGEMENTS .................................................................................................................. 3

TABLE OF CONTENTS ..................................................................................................................... 4

LIST OF FIGURES ........................................................................................................................... 6

LIST OF TABLES ............................................................................................................................... 7

1. BACKGROUND AND MOTIVATION ......................................................................................... 8

2. LITERATURE REVIEW .............................................................................................................. 10
   2.1 WHAT IS BUSINESS CONTINUITY PLANNING (BCP) ..................................................... 10
   2.2 BUSINESS CONTINUITY PLANNING FRAMEWORKS .................................................... 10
      2.2.1 A Comprehensive Approach for Business Continuity Planning .................................. 11
      2.2.2 An Institutional Theory Perspective of Business Continuity Planning ......................... 11
      2.2.3 Multi-Layered Planning ............................................................................................... 12
      2.2.4 Time to Recovery (TTR) ............................................................................................. 13
      2.2.5 The Importance of Third-Party Service Providers ....................................................... 14
   2.3 STRATEGIC IMPLICATIONS ............................................................................................... 14
      2.3.1 Security, Resilience and Flexibility ............................................................................. 15
      2.3.2 The Resilient Enterprise ............................................................................................. 16
      2.3.3 The Challenges of Scenario-Based Planning ............................................................... 17
   2.4 LITERATURE REVIEW SUMMARY ..................................................................................... 17

3. METHODOLOGY ....................................................................................................................... 19
   3.1 BUSINESS IMPACT ANALYSIS MODEL ........................................................................... 19
      3.1.1 Source of Data ............................................................................................................. 20
      3.1.2 Identify Impact Scenarios ......................................................................................... 20
      3.1.3 Data Cleaning and Validating .................................................................................... 21
      3.1.4 Impact Analysis ......................................................................................................... 21
         3.1.4.1 Estimation of Average U.S. Retail Pricing ............................................................... 22
         3.1.4.2 Value of Product Inventory On-Hand .................................................................. 23
         3.1.4.3 Value of Outbound Product Flows ...................................................................... 25
         3.1.4.4 Impact Analysis by Scenario .............................................................................. 25
   3.2 INDUSTRY COMPARISONS AND BENCHMARKING .......................................................... 28
      3.2.1 Participant Identification ............................................................................................ 28
      3.2.2 Interview Questionnaire ............................................................................................ 29
   3.3 LIMITATIONS ....................................................................................................................... 29

4. DATA ANALYSIS ...................................................................................................................... 31
LIST OF FIGURES

Figure 1  Monthly US$ MSRP Inventory Values, Facility A.......................... 24
Figure 2  Monthly US$ MSRP Inventory Values, Facility B.......................... 24
Figure 3  BIA for Scenario 1 at Facility A............................................. 33
Figure 4  BIA for Scenario 1 at Facility A from a disruption event occurring in the
          peak and lowest impact months of FY12/FY13.................................. 34
Figure 5  BIA for Scenario 2 at Facility A............................................. 36
Figure 6  BIA for Scenario 2 at Facility A from a disruption event occurring in the
          peak and lowest impact months of FY12/FY13.................................. 37
Figure 7  BIA for Scenario 3 at Facility A............................................. 39
Figure 8  BIA for Scenario 3 at Facility A from a disruption event occurring in the
          peak and lowest impact months of FY12/FY13.................................. 40
Figure 9  BIA for Scenario 4 at Facility A............................................. 42
Figure 10 BIA for Scenario 4 at Facility A from a disruption event occurring in the
          peak and lowest impact months of FY12/FY13.................................. 43
Figure 11 BIA for Scenario 1 at Facility B............................................. 45
Figure 12 BIA for Scenario 1 at Facility B from a disruption event occurring in the
          peak and lowest impact months of FY12/FY13.................................. 46
Figure 13 BIA for Scenario 2 at Facility B............................................. 48
Figure 14 BIA for Scenario 2 at Facility B from a disruption event occurring in the
          peak and lowest impact months of FY12/FY13.................................. 49
Figure 15 BIA for Scenario 3 at Facility B............................................. 51
Figure 16 BIA for Scenario 3 at Facility B from a disruption event occurring in the
          peak and lowest impact months of FY12/FY13.................................. 52
LIST OF TABLES

Table 1 BIA Model Input Parameters ............................................................... 19
Table 2 Average Retail Pricing for Product Categories at Facility A .................. 22
Table 3 Average Retail Pricing for Product Category at Facility B .................... 23
Table 4 BIA model input parameters for Scenario 1 at Facility A ....................... 31
Table 5 BIA model input parameters for Scenario 2 at Facility A ....................... 35
Table 6 BIA model input parameters for Scenario 3 at Facility A ....................... 38
Table 7 BIA model input parameters for Scenario 4 at Facility A ....................... 41
Table 8 BIA model input parameters for Scenario 1 at Facility B ....................... 44
Table 9 BIA model input parameters for Scenario 2 at Facility B ....................... 47
Table 10 BIA model input parameters for Scenario 3 at Facility B ..................... 50
1. BACKGROUND AND MOTIVATION

With the increase in outsourced manufacturing practices, product companies lose visibility over the supply chain. In longer supply chains that extend to various geographical regions, the entire system is exposed to more uncertainties. Furthermore, the loss in control of key processes in the system makes organizations more vulnerable to disruptive events such as natural disasters, labor disputes and economic crises.

To minimize the impact of such disruptions, firms develop business continuity plans (BCP) to prepare in advance of a disruption. The impact of a disaster can be reduced by planning out procedures and steps to resume operations before the event occurs. The longer the business operations are shut down, the greater the challenge is posed to an organization’s viability.

In the past decade, major disasters around the world severely disrupted supply chain operations and have raised the interest in business continuity. Management started to have serious discussions over the necessity and criticality of a BCP program, in order to protect their business from disruptive events. Increasing numbers of organizations realize that the risk of losing billions of dollars and resources in a short period of time threatens the sustainability of their business.

Our key research objective is to give a directional sense of key areas in BCP. We study one company as the base case by focusing primarily on its North American supply chain. In doing so, we aim to help frame various considerations that could be taken into account when developing and improving on a BCP.

We employ a two-tier approach in the study, combining both quantitative and qualitative inputs. First, we conduct a business impact analysis on the two distribution centers in the United States, in order to identify key assets and business processes in the system. Second, we seek
industry wisdom in the BCP and risk management areas by interviewing BCP and risk management professionals. With both results, we are able to provide suggestions.

Our study consists of four major components: (1) a review of a few BCP frameworks in research papers; (2) an analysis on the financial impacts of four hypothetical disruption scenarios; (3) a consolidation of interview results which reports how BCP is practiced in business environments; and (4) interpretations of the results and suggestions we have. The outcomes of this project may help companies prepare BCP to mitigate risks in their North American supply chain by offering a higher-level impact analysis and providing insights shared by various industry professionals.
2. LITERATURE REVIEW

As a result of severe natural disasters in recent years, global supply chain efforts are increasingly focused on the mitigation of risk. Under the risk management theme, business continuity planning (BCP) serves as a plan to continue operations in circumstances where capacity is lost due to a disruptive event. This chapter introduces the definition of BCP and a number of frameworks for developing BCP to gain a fundamental understanding of this area.

2.1 WHAT IS BUSINESS CONTINUITY PLANNING (BCP)

Virginia Cerullo and Michael J. Cerullo (2004) point out that business continuity planning (BCP) is implemented to mitigate major business interruptions by reducing or eliminating the impact of a disaster condition before it occurs. Barnes (2001) recognizes BCP as a capability that firms develop to recover from unanticipated disruptions in business operations. By integrating formalized procedures and resource information, companies are able to prepare and plan for operating interruptions. G.A. Zsidisin et al. (2005) view BCP as an approach to deal with unpredictable disruptions in supply chain operations, and a well-designed business continuity plan is able to help businesses minimize the impact of unexpected occurrences on the delivery of customer requirements.

2.2 BUSINESS CONTINUITY PLANNING FRAMEWORKS

The sections that follow summarize some of the various approaches to formulating business continuity plans that have been suggested in literature.
2.2.1 A Comprehensive Approach for Business Continuity Planning

In their paper on a comprehensive approach to BCP, Virginia Cerullo and Michael J. Cerullo (2004) list three major elements in the business continuity planning process: (1) identify major risks of business interruption, in both the internal and external contexts; (2) develop a plan to mitigate or reduce the impact of the identified risk; and (3) train employees and test the plan to ensure that the plan is effective.

The paper emphasizes the importance of integrating BCP and IT security plans since firms are more linked to other players in the business environment, and IT infrastructure failure contributes to both internal and external causes of business disruptions.

2.2.2 An Institutional Theory Perspective of Business Continuity Planning

In the research findings of G.A. Zsidisin et al. (2005), a four-stage BCP framework for upstream supply chain activities was developed. The first stage is creating internal awareness of risk exposures in supply chains and realizing potential consequences of disruptions. After risks are recognized internally, firms can drive this awareness out into upstream and downstream of the supply chain in order to manage external risks. The second stage in BCP is to prevent supply discontinuity by reducing the likelihood and/or the impact of supply chain disruptions. There are four key processes in this stage: risk identification, risk assessment, risk treatment and risk monitoring. The third task in the framework is remediating risk occurrence. Firms need to first identify the resources needed and then develop a standard procedure in order to recover from operational disruption and minimize the impacts on the business. The final step in the continuity planning is fostering knowledge management, in which firms learn from experiences of past disruptions.
According to G.A. Zsidisin et al. (2005), there are two issues managers should focus on when developing a business continuity plan for the supply chain. The first task is creating tools to support the first two stages of the BCP framework: enhance awareness in supply chain risks and prevent operating disruptions. Secondly, managers should develop metrics for BCP that capture, communicate and monitor the supply chain risks and the financial impact of such risks. The argument of Virginia Cerullo and Michael J. Cerullo (2004) further supports the concept of a heightened level of awareness along with the idea of communicating risk through appropriate metrics. They also believe that training a disaster recovery team and developing a test methodology are essential to create an effective BCP to address critical risks. Finley (2006) suggests that a BCP should be reviewed and tested on an annual basis.

2.2.3 Multi-Layered Planning

There are few who would argue against the general opinion that IT functions lead most other functions within an organization when it comes to maturity of continuity or even disaster recovery plans. Much of this phenomenon can probably be attributed to the widespread acceptance of the high-value nature of data networks, especially given the Age of Information in which business entities operate in today. In a manner that reflects multi-layered plans practiced in IT (Robb, 2005) and advocated for supply chain networks (Rice and Caniato, 2003; Sheffi, 2005), Glendon (2013) points to the 3Cs of contingency planning, continuity capability, and crisis response as layers of defense within an established business continuity plan.

According to Glendon (2013), the 3Cs are broadly applicable to predictable scenarios (e.g. annual winter weather related events) whose impacts are generally understood, or otherwise even unknown. In order to better illustrate his point, Glendon used the analogy of a factory which operates in a flood-prone region. He described this factory as having flood contingency plans that
might be effective in dealing with a 1-in-20 year, but not necessarily a 1-in-100 year flooding event (p. 46). Extending this analogy, Glendon rationalized continuity capability plans as being able to fill the void in those unlikely yet severe circumstances of disruption, entailing the prioritization of resources and processes to have production switched over to other factories. Decisive intervention by executive management becomes necessary in the most unlikely of circumstances that all alternate factory locations or points of manufacture alluded to in the aforementioned analogy are impaired at the same time.

2.2.4 Time to Recovery (TTR)

While small-scale, common supply chain disruptions such as poor supplier performance and human errors are easily managed using traditional risk management methods, disruption events with low probability of occurrence but high impact are challenging to quantify. Therefore, Simchi-Levi, Schmidt, and Wei (2014) constructed a mathematical model to help assess the financial and operational impact of critical node failure resulting from disruptive events in varying severity.

A key input to the model was time to recovery (TTR), defined as “the time it would take for a particular node to be restored to full functionality after a disruption” (p. 98). The node can be any supplier facility, warehousing facility or a transportation hub. TTR under various scenarios can be calculated through surveying an organization's suppliers to gather key data around location, products, lead-time, cost of loss, mitigation strategies, etc. Combining TTR information, bill-of-material data, operational and financial measures, inventory levels and demand forecasts for each product, the model allows firms to recognize their risk areas in details.
2.2.5 The Importance of Third-Party Service Providers

The complexity of modern supply chains with their emphasis on operational efficiencies and cost competitiveness have resulted in the outsourcing of a significant amount of operational capabilities to third-party entities (and their sub-contractors) located domestically, as well as overseas. Hence, Skelton (2007) emphasizes that companies must go beyond the superficial understanding of their supply chain in order to establish effective business continuity plans. He stresses that a thorough understanding of the supply chain can only be attained through deep engagement with, and audits of, direct as well as indirect stakeholders in the continuum of activities that define the supply chain. Examples of such inclusive engagements include regular desktop exercises and testing of established BCP to assess the hypothetical capability of all constituents in the supply chain. Marshall (2007) takes this argument further by detailing how a principal company could develop a vendor BCP risk assessment program to facilitate collaborative resolution on gaps in continuity practices, as well as to aid in decisions about vendor relationships.

2.3 STRATEGIC IMPLICATIONS

Business continuity planning could encompass strategic operational aspects which would greatly strengthen a business case when it comes to financial and resource allocation decisions within the company. As such, it is possible for business continuity planning to go from its typical defensive set-up against the likelihood of a disruptive event, to being a catalyst for attaining competitive advantage in the marketplace.
2.3.1 Security, Resilience and Flexibility

Rice and Caniato (2003) introduced the concepts of security and resilience as important attributes of Business Continuity Planning (BCP) for supply chain networks. While their study showcased how companies may be able to strengthen either one of the attributes independently of the other, it also highlighted the criticality for both aspects to be satisfactorily considered and incorporated as part of BCP, especially in the face of the post 9/11 operating environment.

There is, however, no one-size-fits-all level of security recommended for all companies because different businesses operating in different industries are inherently exposed to different types and levels of security threats. It is noted that the key security facets under consideration—physical, information and freight—are organized into basic and advanced measures. For instance, in terms of freight security, inspection serves as a basic response and radio-frequency identification (RFID) technology was considered an advanced response. Organizations with less exposure to security threats could very well be sufficiently protected through the adoption of basic security measures (Rice and Caniato, 2003).

Similarly, several ways of attaining supply chain resilience are suggested based on the various types of failure modes that can be expected. These methods are built around the themes of redundancy or flexibility, each with their own unique business cost and service level characteristics as they are inherently different in nature. While redundancy involves maintaining a predetermined level of operational capability prior to the onset of need, through deliberate investments in capital equipment, back-up operational capacity, or both, flexibility on the other hand involves the redeployment of some capacity in the existing supply chain network to compensate for a capacity shortfall within the network for any reason. Again, there is no single desired level of resilience recommended for all companies. Every company would ultimately have
to arrive at what it deems the right mix of security, redundancy and flexibility options befitting of its particular business or industry operating environment (Rice and Tenney, 2007).

2.3.2 The Resilient Enterprise

According to Sheffi and Rice (2005), “building a resilient enterprise should be a strategic initiative that changes the way a company operates and that increases its competitiveness” (p. 41). While acknowledging the role that redundancy has in every continuity plan, the authors stress that flexibility represents additional benefits that can actually confer competitive advantages to a company’s day-to-day operations. In other words, the gains to be had need not be contingent on actual disruption occurrence, which would have been the case for increased redundancy as part of any BCP. Hence, the business case for increasing the flexibility of a company’s supply chain is fundamentally more compelling.

Sheffi and Rice (2005, p. 48) cite the example of a company making the decision to supplement its low-cost offshore supplier with a supplier that is based domestically in order to increase its ability to react to changes in the market. Such market changes could be due not only to disruptions at the offshore supplier, but also brought on by any unexpected increase in demand for the company’s product, especially in the case of new product launches. Therefore, the company is in a better position from a BCP standpoint in terms of increased levels of resilience from investments in flexible operations, but also poised to capitalize on opportunities for increased sales.

In “The Resilient Enterprise: Overcoming Vulnerability for Competitive Advantage,” Yossi Sheffi (2005) provides countless other examples of how companies can build flexibility into their supply chains not only for risk mitigation purposes, but also to create competitive advantage in an increasingly complex marketplace. By first applying the Vulnerability Framework in establishing
the relative risks that a company's supply chain is predisposed to given its unique business environment and operating requirements, managers are provided with a platform from which to better communicate and formulate strategic business continuity plans that are not just grounded in the defensive mitigation of risks.

2.3.3 The Challenges of Scenario-Based Planning

In his paper entitled “Only as Strong as the Weakest Link,” Rice (2011) acknowledges that there are invariably an inordinate number of scenarios which could result in a disruption to a company's business. While there is merit to scenario-specific analysis, a helpful technique to incorporate into business continuity plans is to distil the outcomes of the many possible disruptive events into the six possible “failure modes” that might affect a supply chain. In other words, a company would be in a much better state of preparedness by thinking in terms of its readiness for the relative impacts of the six different “failure modes” to its operations, rather than trying to establish plans for every possible disruption scenario. The six different ways in which a supply chain can be impaired by any disruptive event are: (1) capacity to acquire materials, (2) capacity to ship or transport, (3) capacity to communicate, (4) capacity to convert, (5) capacity to use human resources, and (6) capacity to tap financial flows.

2.4 LITERATURE REVIEW SUMMARY

The key responsibility of business continuity professionals, or those that drive business continuity planning on behalf of their organizations, lies in ensuring that plans established are actionable in times of need. While there are merits to having accountability for continuity planning anchored in the various business units or functions within an organization, it has been suggested that an overall plan exists which maps out key dependencies across the businesses to facilitate management
clarity and oversight. The ultimate success underlying allocation of resources to, as well as the relative readiness of, business continuity plans is frequently thought of as being dependent on its relevancy to the priorities of C-suite executives leading the business corporation (Kite and Zucca, 2007).

Limited research still exists on BCP for downstream distribution systems in a supply chain. Most papers discuss an end-to-end risk assessment of the supply chain as part of BCP, while G.A. Zsidisin et al. (2005) specifically advocate for upstream supply-side considerations. Generally speaking, mainstream business continuity planning is a rather complex paradox in that while organizations want to prevent disruptive events from impacting their businesses, it also represents a pure cost to supply chain operations especially when viewed in terms of redundancy measures. In light of the lack of literature on downstream BCP, we look to elucidate how BCP might apply specifically to the downstream segment of a supply chain.
3. METHODOLOGY

We study one company as the base case by focusing primarily on its North American supply chain. In order to help frame various considerations that could be taken into account when developing and improving on a BCP, the study will encompass both quantitative and qualitative elements.

The quantitative element takes the form of a business impact analysis, whereby the financial impact on the company was calculated given a certain scenario occurring at each of its two North American distribution facilities. The qualitative element is comprised of a series of interviews conducted with BCP and risk management professionals across various industries. The methodology employed in each of the elements is covered in detail within sections 3.1 and 3.2.

3.1 BUSINESS IMPACT ANALYSIS MODEL

Business impact analysis (BIA) seeks to assess, at a high-level, the costs and loss in revenue if business operations at a downstream distribution node were to be disrupted for a certain amount of time. Our BIA model for distribution facilities allows for the following input parameters to be taken into account as part of the study:

<table>
<thead>
<tr>
<th>Description of Input Parameter</th>
<th>Units of Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contingency warehouse monthly rental</td>
<td>$/SqFt.</td>
</tr>
<tr>
<td>Contingency warehouse space required</td>
<td>SqFt.</td>
</tr>
<tr>
<td>Total monthly rental cost of contingency Material Handling Equipment (MHE)</td>
<td>$/month</td>
</tr>
<tr>
<td>Percent of damaged inventory stock</td>
<td>%</td>
</tr>
<tr>
<td>Percent revenue from wholesale customers</td>
<td>%</td>
</tr>
<tr>
<td>Percent revenue from retail store customers</td>
<td>%</td>
</tr>
<tr>
<td>Percent revenue from e-commerce customers</td>
<td>%</td>
</tr>
<tr>
<td>Amount of inventory held by e-commerce fulfilment ctr.</td>
<td>Days</td>
</tr>
<tr>
<td>---------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Amount of inventory held by retail store customers</td>
<td>Days</td>
</tr>
<tr>
<td>Amount of inventory held by wholesale customers</td>
<td>Days</td>
</tr>
<tr>
<td>Average COGS / Average MSRP</td>
<td>Dimensionless</td>
</tr>
</tbody>
</table>

3.1.1 Source of Data

Historical sales and inventory management data, over a period of two years, were obtained for the two major distribution facilities that are within the scope of the study. The datasets would be sufficiently representative of some of the characteristics that are inherent of the company's business operations at each of the two facilities due to varying levels of demand for product.

3.1.2 Identify Impact Scenarios

Impact analysis was conducted using four different scenarios. These scenarios were representative of a few extreme outcomes of disruption events in which damage was severe and obvious. The following were the four scenarios:

*Scenario 1: The facility was rendered inaccessible*

*Scenario 2: The facility was accessible, but 50% of the merchandise was damaged*

*Scenario 3: Data center failure*

*Scenario 4: E-commerce global contact center breakdown.*

The above scenarios were outcomes of disruption events rather than being specific to the nature or type of disruption event. We chose to analyze the impact on the company based on the disruption outcomes to avoid an analysis which was dependent on the specificity of a disruption event.
3.1.3 Data Cleaning and Validating

Three sets of data were available for our study: inventory positions at both facilities, outbound and inbound data at both facilities, and the manufacturer's suggested retail price (MSRP) information for the Japanese market. While we were provided with inbound and outbound data for a two-year time period, we had to work with inventory positions limited to a period of six months.

The next step of the business impact analysis was to clean up the data and extract useful information for the study. We initialized the process by applying a formula to the dataset:

\[
\text{Initial inventory (month 1)} + \text{Inbound (month 1)} - \text{Outbound (month 1)} = \text{Ending inventory (month 1)}. \tag{1}
\]

Due to the limitations of the dataset, we negated the use of inbound data in our analysis by matching-up inbound shipments to outbound shipments on a month-to-month basis since it would not be unreasonable to expect stock replenishment of goods sold. We also utilized the average of the six months of inventory positions to be representative of the monthly inventory positions over the two-year time frame; this would be relevant for Scenario 2.

3.1.4 Impact Analysis

With cleaned and organized inventory information, we were able to apply the four scenarios we identified to the dataset. However, the financial impact had to be presented in a U.S. business environment for the purpose of our study. Hence, the impact analysis needed to be framed in terms of U.S. dollars by first deriving an estimate of U.S. retail pricing for goods sold based on the Japanese retail MSRP information dataset.
3.1.4.1 Estimation of Average U.S. Retail Pricing

An estimate of the equivalent U.S. dollar retail pricing was determined based on the following guidelines: (a) Japanese retail pricing tended to be higher than that in Hong Kong, and (b) Hong Kong retail pricing was in turn higher than in the U.S. With these guidelines, the following general pricing relationships were utilized in the estimation of U.S. dollar retail pricing.

Japan retail price = HK retail price + 30% markup  
(2)

HK retail price = U.S. retail price + 15% markup  
(3)

Since international currency exchange rates are known to fluctuate, the general prevailing rates quoted by Citibank N.A. on April 2, 2014 were assumed to be representative:

1 HK dollar = 13.38 Japanese Yen

1 U.S. dollar = 7.76 HK dollar

As the original dataset had not included information for product categories “Bravo,” “Echo,” and “Golf,” an estimate of their retail pricing had to be derived from the following assumptions:

Pricing for Bravo = 80% x (Average Retail Pricing for Hotel and Juliet)  
(4)

Pricing for Echo = 110% x (Pricing for Juliet)  
(5)

Pricing for Golf = 90% x (Pricing for Juliet)  
(6)

Tables 2 and 3 provide a line item summary by product category of the eventual estimated average U.S. dollar retail pricing.

Table 2  Average Retail Pricing for Product Categories at Facility A

<table>
<thead>
<tr>
<th>Product Category</th>
<th>Japanese Yen</th>
<th>HKD</th>
<th>USD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpha</td>
<td>8684.38</td>
<td>499.27</td>
<td>55.95</td>
</tr>
<tr>
<td>Bravo</td>
<td>39172.00</td>
<td>2252.04</td>
<td>252.36</td>
</tr>
<tr>
<td>Charlie</td>
<td>301697.94</td>
<td>17344.94</td>
<td>1943.63</td>
</tr>
<tr>
<td>Delta</td>
<td>12285.06</td>
<td>706.28</td>
<td>79.14</td>
</tr>
<tr>
<td>Product Category</td>
<td>Japanese Yen</td>
<td>HKD</td>
<td>USD</td>
</tr>
<tr>
<td>------------------</td>
<td>---------------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>Kilo</td>
<td>26098.19</td>
<td>1500.41</td>
<td>168.13</td>
</tr>
</tbody>
</table>

### 3.1.4.2 Value of Product Inventory On-Hand

Utilizing the estimated average U.S. retail pricing, the amount of inventory dollars within the confines of the distribution facilities was calculated from the following:

\[
\text{Total Inventory Retail Value} = \text{Retail Unit Pricing} \times \text{Product QTY}
\]

(7)

Based on the six-month data on initial inventory positions provided for FY12, the total inventory retail dollars at Facility A and B are shown in Figures 1 and 2 respectively.
Figure 1  Monthly US$ MSRP Inventory Values, Facility A

Figure 2  Monthly US$ MSRP Inventory Values, Facility B
3.1.4.3 Value of Outbound Product Flows

Product flows, especially those relating to outbound shipments, are indicative of the relative health of a company’s revenue stream. Hence, particular focus is given to the historical quantity of outbound shipments based on data available for FY12 and FY13. The following general equation describes the value of outbound product flows, in terms of retail dollars that may be lost, due to any disruption of outbound shipments:

\[ \text{Value of Outbound Product Flows} = \text{Retail Unit Pricing} \times \text{Outbound Shipment QTY} \]  

(8)

3.1.4.4 Impact Analysis by Scenario

With the aforementioned definitions of the value of product inventory on-hand and the value of outbound product flows, BIA was then conducted for the two distribution facilities experiencing each of the four hypothetical scenarios.

Scenario 1: The facility was rendered inaccessible

When a facility was rendered inaccessible due to a disruption event, one might expect both inbound and outbound shipments at the facility to come to a halt. In defining this particular scenario, the assumption was that there was no damage to physical inventories already at the facility. Hence, the financial impact from Scenario 1 is comprised of (a) the lost revenue from disrupted shipments to customers, and (b) the additional rental costs from operating out of a third-party location for the period of time necessary before regular operations at the facility can be restored. This duration of time taken to restore full accessibility to the facility for resumption of normal operations after the occurrence of a disruption event is defined as TTR.

We assume that lost revenue from disrupted shipments to customers occurs only after the
customer has stocked-out from depletion of its inventory on-hand. As for the additional costs of operating out of a third-party location, the assumption made is that the costs begin to accrue immediately after the occurrence of the disruption event up until the disrupted facility is restored with full accessibility as well as the resumption of normal operations. Hence, the financial impact on the company due to Scenario 1 is generally defined in mathematical terms as:

\[
\text{Scenario 1 Financial Impact} = [(\text{Per Day Revenue Lost from Disrupted Customer Shipments}) \times (\text{Days TTR} - \text{Customer Inventory Days On Hand})] + [(\text{Daily Rental Costs at 3rd Party Location}) \times \text{Days TTR}]
\] (9)

where Per Day Revenue is lost only when Days TTR > Customer Inv. Days On Hand.

**Scenario 2: The facility was accessible, but 50% of the merchandise was damaged**

This particular scenario is defined as the circumstance whereby the facility remains accessible, although 50% of the inventory on-hand is taken as damaged. Since accessibility to the facility is not in question, it is assumed that regular outbound shipment of undamaged goods is able to resume after the disruption event. Hence, the financial impact from Scenario 2 is comprised of (a) the value of inventory on-hand that was damaged, and (b) the lost revenue from the consequent disruption of product shipments to customers. The duration of time taken by the facility to replace damaged product in order for the resumption of those product shipments to customers after the disruption event is defined as TTR.

Lost revenue from the consequent disruption of product shipments to customers due to damaged goods at the facility occurs only after the customer has stocked-out from depletion of its inventory on-hand. Hence, the financial impact on the company due to Scenario 2 is generally defined in mathematical terms as:

\[
\text{Scenario 2 Financial Impact} = (\text{Cost of Damaged Merchandise}) + [(\text{Per Day Revenue Lost from Disrupted Customer Shipments Due to Damaged Inventory}) \times (\text{Days TTR} - \text{Customer Inventory Days On Hand})]
\]
Inventory Days On Hand)

where Per Day Revenue is lost only when Days TTR > Customer Inv. Days On Hand.

Scenario 3: Data center failure

Scenario 3 involves the failure of a data center which is central to all information processing and transactions relevant to the company’s operations at the facility. Given such a circumstance, it is assumed that all inbound and outbound shipments are only able to occur at a much lower level of productivity since workers have to resort to manual processes when the computer systems are malfunctioning. In this case, TTR is the duration of time taken for IT to restore the company’s data center operations to enable the resumption of regular productivity levels in outbound shipment processing. It is however also important to note that it may be possible that no customer shipments could be made manually at all.

During the data center failure, revenue is lost by the company only after the customer has stocked-out from the depletion of its inventory on-hand. Hence, the financial impact on the company due to Scenario 3 is generally defined in mathematical terms as:

\[ \text{Scenario 3 Financial impact} = (\text{Per Day Revenue Lost from Reduced Productivity Levels in Outbound Shipment Processing}) \times (\text{Days TTR} - \text{Customer Inventory Days On Hand}) \]

where reduced productivity impacts only when Days TTR > Customer Inv. Days On Hand.

Scenario 4: E-commerce global contact center breakdown.

The final scenario involves the failure of the company’s global contact center which impacts its e-commerce business activities. In this case, all physical inventory remains in saleable condition, however outbound shipments that are due to e-commerce activities, estimated at 30% of total outbound shipments, are disrupted. The magnitude of financial impact due to a disruption of the organization’s global contact center is hence given by:
Scenario 4 Financial impact = (Per Day Revenue Lost from Disrupted Outbound E-Commerce Shipments) x (Days TTR – Inventory Days On Hand at E-Commerce Fulfillment Center)

where Per Day Revenue is lost only when Days TTR > Inv. Days On Hand at Fulfillment Center.

3.2 INDUSTRY COMPARISONS AND BENCHMARKING

The qualitative element of our study involved interviewing BCP and risk management professionals to gather valuable insights from across various industries, including CPG, medical, logistics, service and manufacturing organizations.

During the initial stages of developing a questionnaire, both in-person interviews and written surveys were being considered. However, after developing several versions of the questionnaire, it was decided that an in-person/phone interview approach would better allow us to achieve our key research objective, which was to provide a directional sense of key areas in BCP.

3.2.1 Participant Identification

Efforts were made to identify and invite BCP and supply chain risk management professionals to participate in our study. MIT Center for Transportation and Logistics (CTL) was approached to assist with providing a quick shortlist of industry contacts with the requisite knowledge and experience in the areas of risk management and business continuity planning.

We reached out to 17 professionals working in various organizations across industries. Several of these invitees had direct experience with business continuity planning and risk management, while others saw need to delegate our invites to colleagues whom they thought were better able to speak with us. In total, we had favorable responses from eight invitees.
Of the eight study participants, all had experience with risk management and six had direct experience with business continuity planning. The eight participants related their experiences across 11 industries, either from their previous or current place-of-employment.

3.2.2. Interview Questionnaire

A series of questions was designed to help us understand business continuity management within the context of the study participant’s experience. The questionnaire consisted of four parts: product attributes and demand patterns, supply chain set-ups, business continuity plans, and wrap-up questions.

The first part of the questionnaire aimed at understanding the main objective in the supply chain to create business value, as well as the key procedures and critical assets in the business to protect. In the second part, we looked at the supply chain design of the organization to identify critical nodes and links in the system. The supply chain set-up was based on the key attributes of the business, which were identified in the first part of the questionnaire. Next, we examined the specific business continuity planning for the organization, including what the development process was, which parties were involved in decision-making and what resources were invested. In this section, we also asked for past experiences in disruptions, if any, and what were the responses and lessons learned. Finally, we closed the discussion by providing an opportunity for respondents to bring up anything important they thought was not covered.

3.3 LIMITATIONS

Quantitative BIA was only able to establish rough estimates of financial impact on the company based on high-level data along with a number of assumptions forming the base case of the analysis for each impact scenario.
As for the qualitative element of our study, the primary limitation of the interview approach was the duration of the interviews and the limited number of participants. With more interviewees and longer time for discussion, we may have had a more thorough understanding of the BCP practices for different industries. In addition, all of the participants had experience with risk management or business continuity planning, and thus the results may not be representative of industry norms.
4. DATA ANALYSIS

We begin our quantitative analysis by applying our BIA model (see 3.1 Business Impact Analysis Model) to available data. The resulting estimated financial impacts at the two facilities due to each of the four hypothetical scenarios are presented in 4.1 Business Impact Analysis.

Qualitative analysis based on interviews conducted with the eight study participants from industry are presented in 4.2 Interview Results.

4.1 BUSINESS IMPACT ANALYSIS

4.1.1 Business Impact Analysis for Facility A

Scenario 1: The facility was rendered inaccessible

The following table lists input parameters utilized in the BIA model:

<table>
<thead>
<tr>
<th>Description of Input Parameter</th>
<th>Scenario 1 Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contingency warehouse monthly rental [$/sq. ft.]</td>
<td>$ 5.00</td>
</tr>
<tr>
<td>Contingency warehouse space required [sq. ft.]</td>
<td>500,000</td>
</tr>
<tr>
<td>Total monthly rental cost of contingency Material Handling Equipment (MHE) [$/month]</td>
<td>$ 50,000</td>
</tr>
<tr>
<td>% Revenue from wholesale customers</td>
<td>50%</td>
</tr>
<tr>
<td>% Revenue from retail store customers</td>
<td>20%</td>
</tr>
<tr>
<td>% Revenue from E-commerce</td>
<td>30%</td>
</tr>
<tr>
<td>Days inventory held by E-commerce fulfilment ctr.</td>
<td>7</td>
</tr>
<tr>
<td>Days inventory held by retail store customers</td>
<td>14</td>
</tr>
<tr>
<td>Days inventory held by wholesale customers</td>
<td>20</td>
</tr>
<tr>
<td>TTR (days)</td>
<td>10 or 30 days</td>
</tr>
</tbody>
</table>

In Scenario 1, shipments to customers out of Facility A cannot occur when the facility has
been rendered inaccessible. The company is assumed to have activated its contingency plan of operating out of a third-party location while efforts are being made to restore accessibility to Facility A. Therefore, our analysis of financial impact from Scenario 1 takes into consideration (a) the lost revenue from disrupted shipments to customers, and (b) the additional costs associated with rent of capital assets to operate out of the third-party facility.

Lost revenue from disrupted shipments occurs only after the customer has stocked-out from depletion of its inventory on-hand. This has been taken into account by our BIA model for each of the three main customer segments served by Facility A, namely: wholesale, retail and e-commerce. As for the additional costs associated with rent of capital assets, the costs are assumed to accrue immediately after the occurrence of the disruption event.

TTR in Scenario 1 at Facility A is defined as the duration of time taken to restore full accessibility to the facility for resumption of normal operations after the occurrence of the disruption event. As an initial baseline for comparison, we seek to quantify the financial impact resulting from a short TTR of 10 days, as well as that for a relatively longer TTR of 30 days. Based on the BIA model input parameters utilized for Scenario 1 at Facility A, Figure 3 below was obtained which provides a graphical representation of the estimated financial impacts, which varies by the month in which the disruption occurs, when TTR is 10 days versus 30 days.
Estimated financial impact at Facility A is observed to peak in the month of March FY12. The occurrence of a disruption event in the month of December FY12 instead would, however, result in the least financial impact on the company. When analyzed as a function of TTR, the peak and lowest financial impact months are illustrated by Figure 4 below.
The above graph allows us to recognize that the financial impact due to a disruption event occurring in March FY12 is more sensitive to TTR than that due to a disruption event occurring in December FY12. Additionally, it may be in the interest of the company to establish, as part of its BCP, a TTR goal of 20 days as financial repercussions from the disruption event increases at the greatest rate after 20 days.

Scenario 2: The facility was accessible, but 50% of the merchandise was damaged

The following table lists input parameters utilized in the BIA model:
Table 5  BIA model input parameters for Scenario 2 at Facility A

<table>
<thead>
<tr>
<th>Description of Input Parameter</th>
<th>Scenario 2 Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Revenue from wholesale customers</td>
<td>50%</td>
</tr>
<tr>
<td>% Revenue from retail store customers</td>
<td>20%</td>
</tr>
<tr>
<td>% Revenue from E-commerce</td>
<td>30%</td>
</tr>
<tr>
<td>Days inventory held by E-commerce fulfilment ctr.</td>
<td>7</td>
</tr>
<tr>
<td>Days inventory held by retail store customers</td>
<td>14</td>
</tr>
<tr>
<td>Days inventory held by wholesale customers</td>
<td>20</td>
</tr>
<tr>
<td>Amount of merchandise damaged</td>
<td>50%</td>
</tr>
<tr>
<td>Average COGS / Average MSRP</td>
<td>0.70</td>
</tr>
<tr>
<td>TTR (days)</td>
<td>10 or 30 days</td>
</tr>
</tbody>
</table>

In Scenario 2, accessibility to Facility A is not in question. Hence, it is assumed that regular outbound shipment of undamaged goods is able to resume after the disruption event. Financial impact from Scenario 2 would therefore be comprised of (a) the value, at cost, of inventory on-hand that was damaged, and (b) the lost revenue from the consequent disruption of product shipments to customers. The duration of time taken by the facility to replace damaged product in order for the resumption of those product shipments to customers after occurrence of the disruption event is defined as TTR. As an initial baseline for comparison, we seek to quantify the financial impact resulting from a short TTR of 10 days, as well as that for a relatively longer TTR of 30 days.

Lost revenue, from not being able to ship product that has become damaged, occurs only after the customer has stocked-out from depletion of its inventory on-hand. This is taken into account by our BIA model for each of the three main customer segments served by Facility A, namely: wholesale, retail and e-commerce.

Based on the BIA model input parameters utilized for Scenario 2 at Facility A, Figure 5 below was obtained which provides a graphical representation of the estimated financial impacts.
on Facility A, which varies by month in which the disruption occurs, when TTR is 10 days versus 30 days.

Figure 5  BIA for Scenario 2 at Facility A

Scenario 2 financial impact at Facility A is observed to peak in the month of March FY12. The occurrence of a disruption event in the month of December FY12 instead would, however, result in the least financial impact on the company. When analyzed as a function of TTR, the peak and lowest financial impact months are illustrated by Figure 6 below.
Figure 6  BIA for Scenario 2 at Facility A from a disruption event occurring in the peak and lowest impact months of FY12/FY13

The above graph allows us to recognize that the financial impact suffered from having to write-off damaged goods is not insignificant; it amounts to nearly $1 billion. Additionally, the financial impact from a disruption event occurring in March FY12 is more sensitive to TTR than that due to a disruption event occurring in December FY12. Since financial repercussions from the disruption event increases at the greatest rate after 20 days has elapsed, a company may choose to establish, as part of its BCP, a TTR goal of 20 days.

Scenario 3: Data center failure
The following table lists input parameters utilized in the BIA model:

Table 6  BIA model input parameters for Scenario 3 at Facility A

<table>
<thead>
<tr>
<th>Description of Input Parameter</th>
<th>Scenario 3 Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Revenue from wholesale customers</td>
<td>50%</td>
</tr>
<tr>
<td>% Revenue from retail store customers</td>
<td>20%</td>
</tr>
<tr>
<td>% Revenue from E-commerce</td>
<td>30%</td>
</tr>
<tr>
<td>Days inventory held by E-commerce fulfilment ctr.</td>
<td>7</td>
</tr>
<tr>
<td>Days inventory held by retail store customers</td>
<td>14</td>
</tr>
<tr>
<td>Days inventory held by wholesale customers</td>
<td>20</td>
</tr>
<tr>
<td>Outbound shipment productivity lost</td>
<td>40%</td>
</tr>
<tr>
<td>TTR (days)</td>
<td>10 or 30 days</td>
</tr>
</tbody>
</table>

In Scenario 3, it is assumed that all shipment operations at Facility A are able to continue, but at a much lower level of productivity since workers have to resort to manual processes when the computer systems are malfunctioning. TTR in Scenario 3 is therefore defined as the duration of time taken for IT to restore the company's data center operations to enable the resumption of regular productivity levels in outbound shipment processing. As an initial baseline for comparison, we seek to quantify the financial impact resulting from a short TTR of 10 days, as well as that for a relatively longer TTR of 30 days.

Based on the BIA model input parameters utilized for Scenario 3, Figure 7 below provides a graphical representation of the estimated financial impacts at Facility A, which varies by month in which the disruption occurs, when TTR is 10 days versus 30 days.
Scenario 3 financial impact at Facility A is observed to peak in the month of March FY12. The occurrence of a disruption event in the month of December FY12 instead would, however, result in the least financial impact on the company. When analyzed as a function of TTR, the peak and lowest financial impact months are illustrated by Figure 8 below.
Figure 8  BIA for Scenario 3 at Facility A from a disruption event occurring in the peak and lowest impact months of FY12/FY13

The above graph allows us to recognize that the financial impact, due to a disruption event, is more sensitive to TTR in March FY12 than in December FY12. Additionally, it may be in the interest of the company to establish, as part of its BCP, a TTR goal of 20 days as financial repercussions from the disruption event increases at the greatest rate after 20 days has elapsed.

Scenario 4: E-commerce global contact center breakdown

The following table is a summary listing of input parameters utilized in the BIA model:
Table 7  BIA model input parameters for Scenario 4 at Facility A

<table>
<thead>
<tr>
<th>Description of Input Parameter</th>
<th>Scenario 4 Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Revenue lost due to disruption of E-commerce</td>
<td>30%</td>
</tr>
<tr>
<td>Days inventory held by E-commerce fulfillment ctr.</td>
<td>7</td>
</tr>
<tr>
<td>TTR (days)</td>
<td>10 or 30 days</td>
</tr>
</tbody>
</table>

In Scenario 4, a breakdown of the company’s global contact center impacts only its e-commerce activities. TTR in Scenario 4 is therefore defined as the duration of time taken for the resumption of E-commerce outbound shipments to the company’s E-commerce fulfillment center. As an initial baseline for comparison, we seek to quantify the financial impact resulting from a short TTR of 10 days, as well as that for a relatively longer TTR of 30 days.

Based on the BIA model input parameters utilized for Scenario 4, Figure 9 below provides a graphical representation of the estimated financial impacts at Facility A, which varies by month in which the disruption event occurs, when TTR is 10 days versus 30 days.
Scenario 4 financial impact at Facility A is observed to peak in the month of March FY12. The occurrence of a disruption event in the month of December FY12 instead would, however, result in the least financial impact on the company. When analyzed as a function of TTR, the peak and lowest financial impact months are illustrated by Figure 10 below.
The above graph allows us to recognize that the financial impact, due to a disruption event, is more sensitive to TTR in March FY12 than in December FY12. Additionally, it may be in the interest of the company to establish, as part of its BCP, a TTR goal of 7 days in order not to suffer any financial impact from the breakdown of its global contact center.

4.1.2 Business Impact Analysis for Facility B

The same analysis that was done for Facility A is repeated for Facility B.

Scenario 1: The facility was rendered inaccessible
The following table lists input parameters utilized in the BIA model:

<table>
<thead>
<tr>
<th>Description of Input Parameter for Facility B</th>
<th>Scenario 1 Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contingency warehouse monthly rental [$/sq. ft.]</td>
<td>$ 5.00</td>
</tr>
<tr>
<td>Contingency warehouse space required [sq. ft.]</td>
<td>500,000</td>
</tr>
<tr>
<td>Total monthly rental cost of contingency Material Handling Equipment (MHE) [$/month]</td>
<td>$ 50,000</td>
</tr>
<tr>
<td>% Revenue from wholesale customers</td>
<td>100%</td>
</tr>
<tr>
<td>% Revenue from retail store customers</td>
<td>0%</td>
</tr>
<tr>
<td>% Revenue from E-commerce</td>
<td>0%</td>
</tr>
<tr>
<td>Days inventory held by E-commerce fulfilment ctr.</td>
<td>7</td>
</tr>
<tr>
<td>TTR (days)</td>
<td>10 or 30 days</td>
</tr>
</tbody>
</table>

As was the case for Facility A, shipments out of Facility B cannot occur when it has been rendered inaccessible. The company is only able to re-route inbound product flow to a contingency, third-party distribution facility in order to continue on with shipping these products to customers. Hence, our analysis of financial impact from Scenario 1 takes into consideration (a) the lost revenue from disrupted customer shipments due to an inaccessible Facility B, and (b) the additional costs associated with rent of capital assets to operate out of the contingency third-party warehouse.

Since Facility B, unlike Facility A, serves only wholesale customers, our BIA model requires the input parameters to be updated to state that zero percent of revenue is derived from e-commerce and retail store customers. As was our previous analysis for Facility A, TTR for Scenario 1 at Facility B is also defined as the duration of time taken to restore full accessibility to the facility for resumption of normal operations after the occurrence of the disruption event. As an initial baseline for comparison, we seek to quantify the financial impact resulting from a short TTR of 10 days, as well as that for a relatively longer TTR of 30 days.
Based on the BIA model input parameters utilized for Scenario 1 at Facility B, Figure 11 below was obtained which provides a graphical representation of the estimated financial impacts at Facility B, which vary by month in which the disruption event occurs, when TTR is 10 days versus 30 days.

10 Vs. 30 days TTR
BIA for Scenario 1 @ Facility B

Figure 11 BIA for Scenario 1 at Facility B

It is noted that when TTR is 10 days, the financial impact to the company of $850k is due only to the additional cost of renting capital assets to operate out of the third-party distribution facility. This is explained by the fact that Facility B has yet to experience any loss in revenue.
since their wholesale customers have not run out of inventory on-hand given that these customers were assumed to carry 20 days' worth of inventory on-hand. When TTR is extended to 30 days, it is observed that the estimated financial impact at Facility B peaks in the month of June FY13. The occurrence of a disruption event in the month of May FY12 instead would, however, result in the least financial impact on the company. When analyzed as a function of TTR, the peak and lowest financial impact months are illustrated by Figure 12 below.

![BIA for Scenario 1 @ Facility B](image)

**Figure 12 BIA for Scenario 1 at Facility B from a disruption event occurring in the peak and lowest impact months of FY12/FY13**

From the above graph of how financial impact varies with TTR, we are able to recognize that the company may want to establish, as part of its BCP, a TTR goal of 20 days. Beyond the
20 days TTR duration, financial impact increases rapidly due to the accumulation of revenue losses with each additional day that Facility B is still not able to serve its wholesale customers. It can also be seen that financial repercussions are more sensitive to TTR duration during the peak sales month of June FY13.

**Scenario 2: The facility was accessible, but 50% of the merchandise was damaged**

The following table lists input parameters utilized in the BIA model:

<table>
<thead>
<tr>
<th>Description of Input Parameter</th>
<th>Scenario 2 Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Revenue from wholesale customers</td>
<td>100%</td>
</tr>
<tr>
<td>% Revenue from retail store customers</td>
<td>0%</td>
</tr>
<tr>
<td>% Revenue from E-commerce</td>
<td>0%</td>
</tr>
<tr>
<td>Days inventory held by wholesale customers</td>
<td>20</td>
</tr>
<tr>
<td>Amount of merchandise damaged</td>
<td>50%</td>
</tr>
<tr>
<td>Average COGS / Average MSRP</td>
<td>0.70</td>
</tr>
<tr>
<td>TTR (days)</td>
<td>10 or 30 days</td>
</tr>
</tbody>
</table>

Aside from taking into account that Facility B serves only wholesale customers, our BIA model is now also specified with the amount of goods that have become damaged as part of Scenario 2, as well as the dimensionless ratio of COGS to MSRP. Financial impact from Scenario 2 at Facility B is therefore comprised of (a) the value, at cost, of inventory on-hand that was damaged, and (b) the lost revenue from the consequent disruption of product shipments to customers.

TTR in Scenario 2 at Facility B is defined as the duration of time taken by the facility to replace damaged product in order for the resumption of disrupted product shipments to customers. As an initial baseline for comparison, we seek to quantify the financial impact resulting from a short TTR of 10 days, as well as that for a relatively longer TTR of 30 days. Based on the BIA model input parameters utilized for Scenario 2 at Facility B, Figure 13 below
was obtained which provides a graphical representation of the estimated financial impacts at Facility B, which vary by month in which the disruption event occurs, when TTR is 10 days versus 30 days.

![Graph: 10 Vs. 30 days TTR BIA for Scenario 2 @ Facility B]

It is observed that at TTR of 10 days, the financial impact of $128.2 million suffered at Facility B is due entirely to the write-off in value of damaged goods. When TTR is extended to 30 days, financial impact at Facility B is observed to peak in the month of June FY13. The occurrence of a disruption event in the month of May FY12 instead would, however, result in the least financial impact on the company. When analyzed as a function of TTR, the peak and lowest
financial impact months are illustrated by Figure 14 below.

Figure 14 BIA for Scenario 2 at Facility B from a disruption event occurring in the peak and lowest impact months of FY12/FY13.

When TTR is extended to 45 days, it is noted that overall financial impact on the company would have increased by around 26% or 16% from the baseline of $128.2 million, depending on whether the disruption event occurred in the peak or lowest month of sales (i.e. June FY13 or May FY12). This analysis allows us to recognize that the value of goods damaged is significant, and that the financial impact is more sensitive to TTR during a peak sales month. While it may be reasonable to establish a TTR goal of 20 days as part of BCP, significant financial impact could be avoided by mitigating any likelihood of a situation whereby large amounts of goods
become damaged.

Scenario 3: Data center failure

The following table lists input parameters utilized in the BIA model:

<table>
<thead>
<tr>
<th>Description of Input Parameter</th>
<th>Scenario 3 Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Revenue from wholesale customers</td>
<td>100%</td>
</tr>
<tr>
<td>% Revenue from retail store customers</td>
<td>0%</td>
</tr>
<tr>
<td>% Revenue from E-commerce</td>
<td>0%</td>
</tr>
<tr>
<td>Days inventory held by wholesale customers</td>
<td>20</td>
</tr>
<tr>
<td>Outbound shipment productivity lost</td>
<td>40%</td>
</tr>
<tr>
<td>TTR (days)</td>
<td>10 or 30 days</td>
</tr>
</tbody>
</table>

As was the case for Facility A, shipment operations at Facility B are able to continue, but at a much lower level of productivity since workers have to resort to manual processes when computer systems are malfunctioning. Our BIA model takes into account this lost productivity as well as the case where all of Facility B’s operations serve only wholesale customers.

TTR in Scenario 3 at Facility B is defined as the duration of time taken for IT to restore the company’s data center operations to enable the resumption of regular productivity levels in outbound shipment processing. As an initial baseline for comparison, we seek to quantify the financial impact resulting from a short TTR of 10 days, as well as that for a relatively longer TTR of 30 days. Financial impact from Scenario 3 at Facility B is therefore the revenue lost due to reduced productivity levels in outbound shipments to customers caused by data center failure; this loss in revenue begins when wholesale customers have depleted their inventory on-hand.

Based on the BIA model input parameters utilized for Scenario 3 at Facility B, Figure 15 below provides a graphical representation of the estimated financial impacts at Facility B, which
vary by month in which the disruption event occurs, when TTR is 10 days versus 30 days.

From the above, it can be seen that when TTR is 10 days, the company suffers zero financial impact according to our model because wholesale customers have not stocked-out from having 20 days' worth of inventory on-hand. When TTR is extended to 30 days, the financial impact at Facility B is observed to peak in the month of June FY13. The occurrence of a disruption event in the month of May FY12 instead would, however, result in the least financial impact on the company. When analyzed as a function of TTR, the peak and lowest financial impact months are illustrated by Figure 16 below.
This analysis allows us to recognize that the financial impact, due to a disruption event, is more sensitive to TTR in June FY13 than in May FY12. Additionally, it may be in the interest of the company to establish, as part of its BCP, a TTR goal of 20 days to avoid any financial impact arising from a data center failure.

Scenario 4: E-commerce global contact center breakdown

Since Facility B serves only wholesale customers, the breakdown of the company’s global contact center would not have any financial repercussions on Facility B.
4.2 INTERVIEW RESULTS

We had nine interview calls with eight industry participants selected from MIT CTL's contacts. Of the eight interviews for this study, we gathered data on 11 industries based on the respondents' previous and current experience with business continuity planning. The industries discussed were various types of consumer products, technology, apparel manufacturing, transportation, chemicals, medical supplies, and telecommunication. We had a chance to schedule multiple calls with the participants to make sure we had enough time to discuss all of the following topics in detail. During the calls, we gathered industry insights on business continuity planning by going through the questionnaire we developed for this study. The questionnaire consisted of four parts: product attributes and demand patterns, supply chain characteristics, business continuity planning and wrap up questions (see 7. Appendix).

4.2.1 Part 1: Product Attributes and Demand Patterns

The first part of our research questionnaire included questions about product attributes and demand patterns. All of our respondents were able to provide an overview surrounding demand patterns as well as a product lifecycle that is characteristic of the industry in which they serve.

Understanding product life cycles helped us identify unique traits in BCP across all the respondents. For instance, it was reasonable to assume that the shorter the product life cycle, the more important TTR became in developing BCP, since an organization would not wish to miss the selling window. On the other hand, other specifications may be observed in the BCP for longer-life products. In terms of product attributes, two of the 11 industries had product lifecycles of a few months, one industry had generally one year, two industries had one to two years, two industries had one year or more, and one industry had more than two years of product...
life. Two industries owned numerous product lines whose life cycles varied from weeks to years. Finally, one industry was within the service sector and thus did not have a general product life attribute. Its service duration also varied from months to years.

Seasonality is critical in assessing the impact of a disruption, as the impact may differ according to the time in a year it happens. In addition, high volatility in demand exposes a firm to more risks since the inventory level fluctuates and increases in peak seasons. For demand patterns, two of the 11 industries experienced high seasonality while four industries had fairly consistent demand. There were also four industries that reported having high and less predictable demand patterns. Two industries had various demand patterns which depended on SKUs or were driven by the weather conditions.

In consumer oriented businesses, it is unsurprising to learn that the demand peaks were taking place around the Thanksgiving holidays, which typically kick-off the year-end season culminating with Christmas as well as New Year’s. The service organization we interviewed, however, was less predictable since demand characteristics were frequently dictated by dynamic situations unfolding domestically within United States, or internationally on the global front.

4.2.2 Part 2: Supply Chain Characteristics

The second part of our interview questionnaire consisted of inquiries about the supply chain set-up of the interviewees’ organizations. All the study participants described both the upstream and downstream supply chain activities that were representative of their industries. Inquiring about supply chain set-up helped us understand potential risk areas and facilitate further discussion around BCP that a firm developed to secure any critical factors in the system.

For upstream supply chain set-up, three of the 11 industries sourced locally in the United States, two were partially outsourced, five were primarily or 100% outsourced. One of the 11
industries was within the service sector and provided international transportation services to customers. While five industries owned multiple sources of supply, either locally or internationally, two industries had fewer sources of supply and expressed concerns over the concentration of suppliers.

In terms of downstream activities, six of the 11 industries dealt with end customers directly, three industries were majorly in the business-to-business market, and two industries had both industry customers and end consumers. Five industries reported to have more consolidated inventory locations for end products, while the other six industries did not express any specific concerns over the downstream supply chain. Three of the 11 industries also reported a single critical node in the supply chain, either in the upstream operations or distribution systems.

4.2.3 Part 3: Business Continuity Planning

Several business continuity planning practices were described by the respondents. Each organization had distinct BCP structure as different considerations were taken into account according to the industries they serve.

4.2.3.1 Considerations of Business Continuity Planning

In terms of considerations when establishing BCP, some of the key ideas included the life of the products, inventory replenishment, and ways to get back in business as soon as possible. There were other factors that should be considered in the plans, such as crisis, loss of life, damage, and safety. During the discussions, many of the interviewees focused more on resuming business and the other factors were assumed to be taken care of by other parties.
4.2.3.2 Structure of Business Continuity Planning

We asked the interviewees to describe the structure of their BCP and provide details specifically to the downstream protection; some examples of BCP practices are listed below.

One organization described its BCP practice as being structured around four key factors: personnel, facilities and critical equipment, supply chain and IT. For each location in the supply chain system, the information used and the input to the BCP was slightly different, depending on the purpose and nature of the locations. The strategy was not based on any type of scenario, but utilized an all-hazards approach when developing BCP. The plans emphasized on securing core capabilities, which were the four key factors, rather than looked into scenarios. The four main areas were weighted differently according to the functions and criticality of a facility. In addition, if the predefined minimal operational requirements could not be met, the crisis management team would step in.

Another organization practiced a two-tier approach for BCP to secure both upstream and downstream operations. The first step in the development of BCP was to build security around manufacturing and upstream activities; then in the second step, distribution systems and downstream BCP were established, forming an end-to-end continuity plan.

An example was provided for a particular product line, whose distribution systems protection was extended to upstream operations. The production for that product was make-to-order; therefore the company did not have finished goods inventory ready for customers. The respondent believed, in this case, the risks were greater in the upstream activities. The security of distribution of the product was therefore dependent on the continuity of upstream manufacturing activities. Although ensuring the continuity of downstream warehousing and distributing provided protection to activities that were closer to customers, the effectiveness of
such downstream BCP would be limited if a disruption occurred in the supply-side operations, such as circumstances in which supplier failed or manufacturing activities halted.

One respondent mentioned planning for different types of demands within an organization. As the organization interviewed had two distinct demand patterns, stable and dynamic, the BCPs were tailored to requirements in each demand pattern. Requirements were typically described in terms of capacity and timeline for transportation, and served as objectives of each continuity plan. More importantly, the ability for BCP to support dynamic requirements was established on a complex system that was able to track the locations, both domestic and international, of static and floating assets such as human resources, equipment, etc.

Some firms established BCP at the corporate level to secure operations of each function in an organization. Some firms have a corporate programs, in which planners not only established BCP for the supply chain function, but other departments within the organization such as marketing, finance, human resources, etc.

Overall, three of the eight respondents had BCP experiences focusing on the upstream activities, one emphasized more on the downstream in their BCP work, three addressed more on the end-to-end planning process in the discussion, and one respondent expressed that there was only a little work done for his organization at this point.

4.2.3.3 Business Impact Analysis

One of the common elements we found in many responses was business impact analysis or similar financial analysis. Four of the eight respondents described similar processes in which they identified possible disruptive events in the supply chain and assessed the impact of such events to their business. Various components of business impact analysis were described by the interview respondents:
A typical procedure was starting the impact analysis at a higher-level and qualitative perspective. For instance, if a disruption occurred in the area where the manufacturing site was located, what would be the impact? As manufacturing plants cannot be moved or changed, finding out where to have immediate capacity and where the largest and most profitable customers were became critical considerations. Next, quantitative approaches were taken to estimate the financial impact of disruptive events. Methods included estimating the probability of various disruptions and scenario-driven analysis. Most participants recognized the difficulty of identifying specific disruptions due to the variability. One respondent stated that identifying the probability of events was the biggest challenge to him in the planning process.

Utilized as part of a BCP, a scenario-planning approach provided intensive simulation modeling, for the purpose of discovering critical requirements to be met in each plan. Simulations were utilized for not only developing BCP, but assessing the feasibility of a BCP by testing and understanding the deficiencies in the plans under the current business environment.

A corporate-level BIA included a detailed questionnaire and face-to-face interviews with the managers in each business unit. The objective was to gather information around critical processes, financial impacts, non-financial impacts, regulatory or compliance requirements, estimated time period of tolerance in operating without automated systems, and the level of manual work. In addition, managers had to decide the time-to-recover of the business processes. The questionnaire defined four tiers of time-to-recover, in which tier one represented zero to two hours and tier four was 14 days. The key to the analysis was to acquire a realistic picture of what process fell into what time frame. With the BIA, the BCP group determined three critical things in the supply chain: human resources, continuity of the retail points, and the capability of distribution. According to the respondent, “At time of disaster, if we can recover those three things, very quickly and promptly, which is our goal, we will stay in business.”
4.2.3.4 Business Continuity Planning in Upstream Supply Chain

BCP for upstream operations was put in place to secure the continuity of manufacturing sites, due to the criticality of certain parts of the finished goods, the limited number and concentration of suppliers, or higher capital investments in the upstream supply chain.

An example of a well-defined business continuity program was illustrated; the primarily goal was to ensure the continuity of the suppliers. The objective of the BCP program was to gain visibility over the supply chain activities, including the operations of contract manufacturers and component suppliers. Customized surveys were sent to suppliers to gather critical node and processes information, and an IT platform was applied to manage the program. With the data gathered from supply chain partners, time-to-recovery was assessed at different activity levels. The recovery plans and recovery time were documented and served as a driving factor in the BCP of the firm.

According to one of the respondents, the organization he belonged to had a requirement in the contract agreements to ensure BCP or emergency response planning for the suppliers. The key was to make the suppliers think about the same type of questions that the company was thinking about. Standard requirement criteria were set for every supplier, and for single source or more risky suppliers, additional requirements were applied in the contract agreement. The importance of ensuring the continuity of logistics providers was recognized as well as well. The approach was similar plans for suppliers, in which requirements were set to raise the business continuity awareness.

4.2.3.5 Business Continuity Planning in Downstream Supply Chain

Over the course of the interviews conducted, we collected many practices and approaches. Many
of these fit as part of an overall BCP and/or response system within the particular company.

Some of the practices appeared to stand alone as useful BCP methods. These are presented here accordingly:

- The most common thought across all interviewees was building redundant routes and facilities so that products could be continually moved around while the normal routes were destructed.

- One of the plans included a short list of facilities in the region where temporary operations could be set up.

- To search for back-up third-party logistics providers, quarterly real estate surveys were conducted to research for warehousing space. The respondent clarified that there was nothing reserved or leased, but instead they build relationships with large logistics providers who had space available.

- The possibility of bulk storage was mentioned, in which inventory could be stored in railcars. With bulk storage, there would be no long-term commitment to back-up capacity.

- Public warehousing could be an option, but it would not be an ideal choice due to budget constraints.

- For securing office capacity, an organization contracted with a third-party company to bring in a mobile office trailer and 200 seats within 24 to 48 hours.

There were discussions around obtaining equipment for temporary operations:

- One respondent discussed the possibility of purchasing from the used market, where equipment was ready for use and the wait time would be shorter compared to purchasing from manufacturers.

- However, it is not likely to entirely replicate a highly-automated warehousing system; and thus the operations would be going back to a more manual and less efficient way, which
requires more people and more space to maintain the volume.

To recover the capacity of utilizing human resources, several ideas were proposed:

- One interviewee discussed how to source human resources from other operations in the organization to support their temporary operations after a disruption occurred.

- A participant mentioned that most organizations do not operate on the basis of 24-seven, 365 days a year; however, human resource needs for operations often cannot wait a day or two to be restored. He basically emphasized the critical time frame that may be necessary for people to resume their work after a disruption occurred.

- Another approach mentioned in one of the discussions was to identify key positions that were core to the operations. For example, according to a respondent who utilized this method, the personnel who were responsible for getting products, packaging, and shipping were the key positions in their warehouse. To ensure the continuity of these positions, the company did cross training to spread the skills and experience across workers in different functions.

In terms of securing transportation and logistics:

- There were cases in which downstream distributions systems were outsourced to third-party logistics companies. Some interviewed organizations incorporated 3PL in the planning process, or required their 3PL partners to have BCP in place to ensure better communication under a crisis.

- One respondent discussed how they had business relationships with leaders at the logistics and sourcing partners, who contribute to the development and preparation of business continuity planning.

Opinions towards the importance of information technology systems in the facilities were similar across nearly all participants.
• One organization had a pre-configured and ready-to-go replacement warehouse management system, which served as part of the BCP.

• A participant stated that recovery plans were developed for computer rooms in each regional distribution center.

• One interviewee mentioned that there were service agreements in place with all major IT suppliers. The same respondent also pointed out the key considerations of bringing in the IT providers into the planning process: “Questions around their viability, their business continuity plans, their disaster recovery plans. Do they have alternatives sites? Do they exercise their recovery plans? Can we participate in their plans? Are they prepared to participate in our exercises?”

4.2.3.6 Inventory

In terms of replenishing inventory under a crisis, ideas were brought up around how to relocate inventory by moving products in the supply chain system. For example, when a distribution center was down, the possibility of supplying from other locations or retail points was discussed. Depending on the lead-time of the products, firms also considered redundant sources of supply. The decision of how to move inventory around was based on where the customers were and how critical those customers were to the business.

For the retail industry, one interviewee mentioned that building up inventory in the systems was primarily how the company mitigated disruption risks; however, this approach brought risks of obsolescence as well. Another interviewee proposed an idea of balancing inventory between the stores across the entire network. However, the same interviewee also recognized the difficulty of such an approach in E-commerce due to the higher level of automation in warehouse systems. “There is no feasible way to recreate that automation in the short term,” said the
4.2.3.7 Reviewing Business Continuity Planning

To improve the effectiveness of BCP, tabletop exercises were conducted by many of the interviewees. The level of details covered in the exercises varied depending on the allocation of resources and the scope of the projects. Some respondents invited external key stakeholders to the discussion, including external consultants, logistics partners, and suppliers, while some remained internal exercises within the organization. However, one respondent highlighted that although the supply chain partners were invited to the planning process, nothing would be done automatically under a disruptive event. It is crucial to reach out to suppliers immediately during a crisis in order to fully understand the problem and exercise BCP.

One respondent shared his experience of utilizing internal audits to measure the business continuity program. A self-assessment questionnaire was developed to assess the maturity level of 10 to 15 aspects in implementing the business continuity program. The questions were around the existence of policies and procedures, BIA analysis, recovery plans, exercises, training and awareness programs, crisis communication, and sufficient resources to manage BCP.

4.2.3.8 Investment Decisions

In terms of how the BCP investment decisions were made, there was no common formula across organizations. Most of the respondents reported that the budget was dependent on senior management. One respondent suggested that when there was a major disruption somewhere that affected your organization or other companies in your industry, senior management paid more attention to the issue. Another respondent discussed how the estimated costs were calculated for each temporary operation in the BCP and a budget derived from the estimation.
While most interviewed organizations did not have a set budget, one interviewee stated that for some business divisions within his organization there were set budgets for BCP, and for other divisions the budget was dependent on how resources were allocated. Another view on the issue was having an established initial budget which was required to fund normal operational and BCP maintenance; and a committee would determine whether additional financial resources could be allocated based on actual parameters of an operation when the resources needed exceeded the initial expectations.

One participant reported that the budget for BCP was determined by a management team, and there was a separate budget for IT disaster recovery. The IT recovery plan cost more due to the arrangement with third-party providers.

4.2.4 Part 4: Wrap-up Questions

4.2.4.1 Key Issues in Business Continuity Planning

One of the respondents raised a concern for putting a BCP program in place. He believed that before any planning was done, it is more important to understand the true needs of the organization; otherwise the BCP developed would not be practical and relevant. A participant highlighted the cooperation between planning groups and operation teams, in which both parties contribute mutually toward BCP to strengthen the program.

Another view was the importance of decentralizing BCP so that every business unit had control over their own plans for continuity. The same participant also questioned the effectiveness of a centralized planning group who served as a full-time role in an organization as planners for business continuity.

The importance of senior management engagement was acknowledged across most of the
interviewees. As one respondent recognized, aligning all the key stakeholders in the discussion was the key struggle he experienced in BCP.

There was a discussion over the significance of senior management engagement in the early planning process where impacts and priorities were identified. Senior leadership buy-in facilitated the entire process and the involvement of the finance department encouraged more discussion.

4.2.4.2 Improving Business Continuity Planning

To improve the business continuity planning process, one respondent suggested that more analytic tools could be utilized to assess the outcomes of different disruptive events and a lot more modeling systems could be done. For instance, organizations could conduct more scenario analysis by asking themselves “what happens if we lose...”, and gain more understanding about the business by tracing manufacturing footprints and distribution systems. The results of using such tools could provide insights into the process within an organization and how the supply chain systems function. In addition, the modeling tools could make a firm more efficient, and support business continuity decisions by helping to identify potential supplies at risk or pinpoint potential locations of inventory shortages within its network of operations. This operational knowledge from modeling could help improve an organization’s capability to recover from disruptions.

Another leading practice was the constant monitoring of global events in order to be proactive in BCP and responsive to events elsewhere in the world, as the effects of an event may extend globally. An awareness and understanding of changing regulations or market landscape also helps an organization to continually improve upon its continuity plans.
5. DISCUSSION AND SUGGESTIONS

5.1 INTERPRETATION OF DATA ANALYSIS

This section presents observations made based on the review of relevant literature, the results from the business impact analysis, and the input from interview participants. We will discuss the effect of demand seasonality on financial impact, the criticality of time-to-recover, other operational impacts which had not been included in our BIA model, as well as scenario-specific considerations that may be taken into account when developing BCPs.

5.1.1 Relationship between Demand Seasonality and Financial Impacts

Facility A serves wholesale, retail and e-commerce business in the fashion apparel industry. In all four disruption scenarios for Facility A, it is observed that the magnitude of financial impact peaks in November of FY12 before a sharp decline in December. It then climbs steadily to peak again in March, before hovering at levels which are significantly higher than in the prior months of December through February, gradually attaining a peak again in November of the following year, FY13. These results do appear to suggest some correlation to the typical consumer demand sales cycle based on knowledge of the back-to-school shopping season at the beginning of Fall, which then continues on to November which kicks-off the Thanksgiving holidays; the month of March on the other hand marks the start of the spring season.

Facility B, on the other hand, serves only the wholesale market segment and carries durable goods with a much longer product lifecycle. The different nature of products and type of customers served by Facility B help to explain the different underlying demand dynamics implied by the BIA when comparing financial impacts on Facility B versus that of Facility A.
Facility B exhibited a peak in financial impact in the event of a disruption taking place in the month of September FY12 and June FY13 of the following year. Based on limited data, the underlying seasonality in end-customer product demand is not immediately evident especially since the BIA peak in FY12 does not appear to be replicated in FY13, and vice versa.

The methodology for BIA sought to assess, at a high-level, the costs and loss in revenue if business operations at a downstream distribution node were to be disrupted for a certain amount of time. Hence, the financial impacts determined from BIA would track with seasonality in product demand. With the understanding that facilities A and B are distribution warehouses, it is, however, important to note that the closeness of any expected correlation depends on the length and lead time of the supply chain that is downstream of the distribution warehouse prior to the product actually arriving in the hands of the end-customer.

As suggested by the literature and study participants from the industry, financial impact arising from demand peaks could be mitigated by adopting some form of flexible operations at any major distribution node. For example, inventory stockpiles could be level loaded to regional distribution centers, especially during peak demand seasons. In doing so, the organization is exposed to a lesser magnitude of financial impact in the event of a single point failure resulting in loss of inventoried goods. In addition, one interviewee suggested the idea of having different continuity plans for stable versus dynamic demand signals, essentially reflecting how BCPs might vary according to demand patterns or seasonality.

5.1.2 Time-to-Recover (TTR) and Other Operational Impacts

As one would expect, the results generally tell us that the estimated financial impact to an organization, in the event of a disruption, increases with the time taken by the company to fully resume its operations. Additionally, the magnitude of financial impact on a distribution node is
dependent on the amount of inventory on-hand being carried by downstream customers. When customers have a lean inventory policy, they may demand more frequent supplier shipments to avoid a stock-out event especially for a profitable product that is also in high-demand. In such a case, the larger financial impact on the supplier’s distribution node that can be expected due to a disruption of its shipments to customers justify the greater need for the company to further invest in its BCP to have its facility be able to recover its operations in a shorter period of time. The cost-benefit analysis could take a similar form as was demonstrated by our analysis of financial impact as a function of TTR (section 4.1 Business Impact Analysis). Based on the sensitivity of financial impact to TTR, a company could for example justify the level of financial resources that it may wish to allocate in order to achieve a certain target TTR.

In reality, the financial impact on an organization in the event of a disruption is arguably greater due to the consequences of other operational impacts such as an associated loss of brand reputation, asset recovery, increased human resource needs, expedite arrangements for goods, and possibly even updated transportation routing requirements. Other variables that have not been considered include the competitiveness of the marketplace in which the company operates, as well as the particular nature of the company’s product lifecycle. The company’s standing in the marketplace also brings along its own set of financial consequences whether based on higher customer expectations, or even governmental and industry requirements for regulatory compliance, especially if the organization is the sole provider of a critical product or service.

### 5.1.3 Other Scenario-specific Considerations

The following sections explore several other scenario-specific considerations that may be taken into account when developing BCPs.
5.1.3.1 Scenario 1 - Facility Rendered Inaccessible

The financial impact due to Scenario 1 was built on the assumption that there was no damage to physical inventory at the facility. However, this may not necessarily be the case. For example, if the scenario also involved merchandise being damaged, then similar BCP considerations as that described for Scenario 2 (see next section 5.1.3.2) would also apply.

Different interpretations of the scenario would invariably lead to different perspectives in BIA which influence how an organization may elect to formulate its BCP. While our analysis for Scenario 1 defined TTR as the duration of time taken to restore full accessibility to the facility for resumption of normal operations, an organization could, in reality, prioritize the restoration of say 50% of the accessibility to the primary facility instead. As an example, a company might focus its efforts only on restoring access via its largest shipment docks. In other words, partial accessibility may be deemed sufficient to facilitate a much quicker resumption of some portion of its shipment operations to reduce the magnitude of financial impact arising from an inaccessible facility. Additionally, the company may also consider activating overtime operations as part of its BCP to aid in resuming normal operations via accessibility at its largest shipment docks, which could also essentially result in a shorter TTR.

In addition to lost revenue from disrupted shipments to customers, the financial impact due to Scenario 1 also took into account the additional rental costs for capital assets in order to operate out of a third-party location. While it was assumed in our model that the third-party location was immediately available to facilitate shipments to customers of inbound products arriving after the disruption at the company’s primary facility, this may not be the case in reality. Hence, a company should not overlook the importance of asserting in its contractual arrangements, as part of BCP with external vendor partners, the key performance expectations
surrounding its ability to re-route shipments to and from an alternate location within an agreed
timeline. Such due diligence could effectively help contain some of the financial repercussions
from a disruption that renders a company’s primary facility inaccessible.

It is also important to also take into account the nature of the disruption rendering the
facility inaccessible as part of BCP arising from BIA for Scenario 1. As an example, an
earthquake that has made the facility inaccessible presents far greater challenges to recovery
operations than say the localized obstruction of shipping docks. Hence, a company may want to
consider having as part of its BCP the ability to activate flexible options such as mobile
workstations or temporary warehousing storage solutions that could be deployed in the
immediate vicinity of the primary facility, or outside the earthquake-impacted zone depending on
the specific severity of the disruption event.

5.1.3.2 Scenario 2 - Facility Accessible, with 50% of Merchandise Damaged

In this particular scenario, TTR was defined as the amount of time it takes for the organization to
replace damaged goods in order to resume product shipments to customers after the disruption
event. No consideration was made as to whether the damaged merchandise included what might
be considered goods with exceptionally high profitability, or even finished products which were
critically needed for a scheduled product launch for which the company may be contractually
obligated to supply. Accounting for such details could actually be beneficial depending on the
specific business and operational strategy of the organization. In such an instance, our current
analysis, which is based on an aggregate perspective of financial impact from revenues lost, may
not sufficiently highlight to the organization the importance of a short TTR as part of its BCP
associated specifically with those critically or strategically needed products.

Additionally, TTR for Scenario 2 relates to the company’s ability to pull from its upstream
manufacturing source the same items that were damaged by the disruption event. Therefore, it serves to highlight the importance of expanding the mental model associated with BCP for a distribution facility to include consideration of its upstream supply chain and the associated lead times. For example, the BCP could include considerations for how well a company’s upstream product factories may be able to cope with a sudden increase in product volumes demanded in order to replace damaged goods for existing downstream customer orders, as well as to meet new customer orders, or even a contractual ship-date.

5.1.3.3 Scenario 3 - Data Center Failure

The financial impact due to Scenario 3 was based on an assumed 40% reduction in shipment productivity due to staff having to revert to manual work processes when the computer systems are malfunctioning. However, it is important to note that today’s modern business environment is so dependent on electronic data processing and information databases that it may not be inconceivable to assume all business activities coming to a standstill, or all outbound shipments to customers coming to a complete halt. This would appear to reconcile with the feedback from industry experts interviewed who have mostly indicated that IT infrastructure and data networks are the least of their current concerns as it has always been core to their respective organizations’ BCP.

TTR was defined as time taken for IT to restore the company’s data center operations to enable the resumption of regular productivity levels in outbound shipment processing. While most organizations may relate this to the duration of time for restoration of its data servers and communications links, it is also important not to overlook the software aspect of recovery operations as part of BCP. In the case of an organization that utilizes a highly-customized and proprietary version of enterprise resource planning/management software, it may wish to
consider prioritizing as part of its BCP the human resource as well as necessary expertise capable of expediting the restoration of its architected information systems. While this is probably less of an issue in today’s modern business environment involving globally-connected enterprises, it may still be a key point of consideration for small and medium-sized enterprises.

Additionally, it may also be important to take into consideration the nature of disruptions that might result in a data center failure. For example, a data center failure caused by a fire in the building which houses the data servers would have vastly different ramifications as compared to a disruption caused by relatively uncomplicated hardware or software malfunction. As such, it may be of interest to an organization to ensure the robustness of its BCP for data center failures by including broad considerations that extend beyond simple hardware and software fixes.

5.1.3.4 Scenario 4 - Breakdown of E-Commerce Global Contact Center

In our particular BIA model, the percentage of revenue that is attributed to e-commerce is set to 30%. Clearly, the more important an e-commerce distribution channel is to a company, the greater the financial impact that can be expected as a result of Scenario 4. Additionally, it may also be important to consider the role e-commerce has in the organization’s overall business strategy in the formulation of BCPs addressing e-commerce operations.

TTR was defined as the duration of time taken for the resumption of e-commerce outbound shipments to the company’s e-commerce fulfillment center. While this could entail the mere replacement of standard telecommunications hardware, it could also entail other specific requirements depending on the nature of disruption that is causing the breakdown of the global contact center just as it was the case for the data center failure of Scenario 3. As an example, if the breakdown was due to a natural disaster such as an earthquake at the location of the contact center, then it may not be sufficient for a company to have considered only hardware related
infrastructure as part of its BCP. Instead, the BCP would have benefited from the inclusion of considerations for reinstatement of the contact center at an alternate geographical location outside of the natural disaster’s range of impact. This would also entail the associated challenge of replacement staffing, or even possible consideration for short-term relocation of existing staff during the interim to facilitate short TTR in such instances.

5.1.3.5 TTR Interview Observations

When establishing BCP, major planning activities naturally surround the key nodes in the supply chain in case of single point failure. In upstream operations, the critical concerns may come from the limited capacity in the supply side due to the difficulty of searching an alternative supplier. The TTR considerations are estimated by, for instance, identifying the time to search for a back-up source if a supplier was down, and the time to resume operations at the manufacturing sites, which involves more estimation in details on the TTR of the automation systems, human resources, IT systems, or other factors that are important to that specific site.

On the other hand, downstream BCP usually considers key distributing nodes where end inventory is consolidated and stored and distributing networks where the flows of goods take place. TTR estimation in the downstream activities can be utilized to measure the time for restoration of human resource capability, warehousing and processing capacity, and IT systems, and depending on the nature of the disruptive event, the TTR may extend to the upstream activities if the event has impact on the supply side.
6. SUMMARY

Our research objective was to provide a directional sense of some key considerations for BCP by studying one company with downstream distribution operations in the U.S. This was achieved via a two-pronged strategy comprising of quantitative and qualitative elements to complement insights gained from the literature review.

While classical notions of BCP have been heavily weighted with defensive measures drawing on redundant capacity in the event of a disruption, literature has served to enrich our perspectives. Several leaders in the field of supply chain risk management have suggested that a well-architected BCP could afford a company strategic levers for competitive advantage in the marketplace. By identifying opportunities in the product flow value stream where flexibility in operations could be incorporated, a company’s BCP becomes rounded out with applications that extend beyond the mere occurrence of disruption events.

Literature also addresses the multitude of disruption scenarios which adds to the complexity faced by companies in the development of their BCPs. While some amount of scenario-based planning has merit, it has been suggested that companies could be in a much better state of readiness by thinking in terms of the six capacity “failure modes” or predictable outcomes resulting from disruption scenarios. By considering how the company is able to navigate varying levels of capacity losses, an organization is able to reduce the risk of being caught flat-footed from a BCP that is too event-specific.

Quantitative analysis involving BIA showed that financial impact from a disruption scenario tracks with seasonality in product demand. BIA also yielded perspectives on how sensitive the financial impacts, for each of the four hypothetical scenarios, are to time-to-recovery (TTR). Such perspectives help in the framing of TTR goals in the development of BCPs. Additionally,
the analysis facilitated an understanding of how financial impact from a disruption is dependent on the amount of inventory on-hand with customers downstream of the distribution facility. It is, however, important to note that our BIA may be conservative in nature due to the omission of other operational impacts or even spillover costs such as an associated loss of brand reputation from disrupted operations.

Qualitative analysis of interviews conducted revealed that actual BCP practices for downstream supply chains varied widely amongst study participants from various industries. These views reflected the different areas of concern arising from unique supply chain configurations that had to be taken into account in the planning process. This observation is in alignment with the lack of a standard BCP template in published literature. As one of the interviewees remarked, “It wasn’t like there was one template out there that you could use to fill in the blanks. Everything is so unique to each business.”

Although the results suggest that there is no one-size-fits-all BCP, we were able to identify some methods utilized by industry for the development of BCPs. For example, BIA was frequently used by study participants to highlight potential areas of risk or test the maturity of an existing BCP. Another example is the Time-to-Recover (TTR) concept mentioned by two of the leading BCP practitioners in industries as a method that helps in the identification of interdependent relationships that may be internal or external to a supply chain.
## 7. APPENDIX

### Exhibit 1 BCP Questionnaire

Prepared by: Arthur Chee & Tzu-Hsueh Lee

### Discussion Questions

<table>
<thead>
<tr>
<th>Theme</th>
<th>Time</th>
<th>Industry Name/Type</th>
</tr>
</thead>
</table>
| Product Attributes & Demand Pattern | 3 mins | Please briefly describe the characteristics of the major products in your company and the demand pattern.  
  - Product life cycle, high/low value, demand volatility, seasonality, etc |
| Downstream Supply Chain     | 3 mins | How are your downstream distribution operations organized?  
  - Concentration of inventory locations, customers, etc |
| BCP for Distribution       | 15-20 mins | Tell us more about BCPs in the distribution systems. What does the BCP look like in your critical downstream nodes?  
  - BCP for a particular building? Back-up capacity? Uniqueness?  
  - BCP for the distribution network – work with carriers / suppliers?  
  - IT systems?  
  What are some key performance indicators for your BCP?  
  Has a tabletop exercise been done before? What were your key findings?  
  How was the investment decision made? What was the calculus?  
  - Flat budget, ROI basis, probability and estimated costs, etc. |
| Back up questions for no downstream BCP | 15-20 mins | What are the most challenging things in the distribution network?  
  What are the most important things in the distribution network that you want to protect?  
  Do you have experience with disruptions in downstream activities? |
• Problem, solutions, lessons learned
  
  If your warehouse went down, how fast could you get it back running?
  • Lease, workforce, products, MHE, etc

<table>
<thead>
<tr>
<th>Things can be added to the discussion</th>
<th>* If we have time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time to recover concept</td>
<td></td>
</tr>
<tr>
<td>How was the BCP evaluated?</td>
<td></td>
</tr>
<tr>
<td>Past experience in executing BCPs</td>
<td></td>
</tr>
<tr>
<td>Improvements on the BCPs</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Wrap-up</th>
<th>Last 3 mins</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upstream business continuity vs Downstream BCPs</td>
<td></td>
</tr>
<tr>
<td>• Downstream being closer to customer, appears to be a natural concern for BCP. What are your thoughts (if your current focus has been upstream activities)?</td>
<td></td>
</tr>
<tr>
<td>Are there any other aspects of BCP which you think should have been a part of this discussion?</td>
<td></td>
</tr>
</tbody>
</table>

**Question Bank**

<table>
<thead>
<tr>
<th>Category</th>
<th>Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Justification for BCP, Business Impact Analysis</td>
<td>• Can you share with us how the budget for Continuity Plans was derived?</td>
</tr>
<tr>
<td></td>
<td>• How was risk to your distribution operations assessed to be in need of Continuity Plans?</td>
</tr>
<tr>
<td></td>
<td>• How do you assess or quantify potential losses to frame need for BCP?</td>
</tr>
<tr>
<td></td>
<td>• Physical inventory, equipment, facility losses only? Extend to include potential business revenues lost?</td>
</tr>
</tbody>
</table>

<p>| Details of Continuity Plans | • What do Continuity Plans entail for your downstream warehouse/distribution operations? |
|                           | • Could you describe what the recovery timeline is like as part of Business Continuity for your downstream distribution operations? |
|                           |   • How do you ensure that material receipts can continue to arrive as planned? |
|                           |   • What pre-arrangements exist to ensure outgoing shipments can continue? |</p>
<table>
<thead>
<tr>
<th>Disruption Experience</th>
</tr>
</thead>
</table>
| • Is your downstream BCP customized by location or applicable to all locations?  
  o How are they different? |
| • What is in-place for a loss of capacity to acquire materials? |
| • What is in-place for a loss of capacity to ship or transport? |
| • What is in-place for a loss of capacity to communicate? |
| • What is in-place for a loss of capacity to convert (or to operate)? |
| • What is in-place for a loss of capacity to use human resources? |
| • What is in-place for a loss of capacity to tap financial flows? |
| • Have you ever had to call your BCP into action? |
| • Could you describe the nature of the event and its impact to your distribution operations? |
| • How did the organization respond to the event? |
| • What % level of distribution operations was regained during activation period of your BCP? |
| • What are some of the lessons learned? |
| Continuous Improvement |
| • With the benefit of hindsight, what would you have done differently for your BCP? |
| • What areas or opportunities for improvement have you identified? |
| Product/Service Attributes |
| • Could you describe some defining attributes of your product/service? |
| • How would you characterize demand patterns served by your distribution operations? |
| • What are some key performance indicators of your distribution operations? Established BCP? |
8. REFERENCES


