ABSTRACT

COLLABORATIVE DEVELOPMENT OF A SMALL BUSINESS EMERGENCY PLANNING MODEL

by
Arthur Henry Hendela

Small businesses, which are defined by the US Small Business Administration as entities with less than 500 employees, suffer interruptions from diverse risks such as financial events, legal situations, or severe storms exemplified by Hurricane Sandy. Proper preparations can help lessen the length of the interruption and put employees and owners back to work. Large corporations generally have large budgets available for planning, business continuity, and disaster recovery. Small businesses must decide which risks are the most important and how best to mitigate those risks using minimal resources.

This research uses a series of surveys followed by mathematical modeling to help discover risk factors, mitigating actions, and the highest return scenarios as a basis for a low-cost business continuity/disaster recovery plan. The surveys use a Delphi study format in order to rank a base list of risks and mitigating actions and to supplement those lists with ones added by the participants. Survey results are analyzed and presented back to the group for a second round of ranking and supplementing the risk/action categories. After two rounds of surveys the data is presented to an expert panel to investigate how the risks interrelate. Quantifying the interrelationships is the basis for the Cross Impact Analysis model that is able to show the relative impact of one event upon another. Once the impacts are known, a series of high valued scenarios are developed using Interpretive Structural Modeling. These high valued scenarios can be used by the small businesses as a basis for a business continuity/disaster recovery plan.

COLLABORATIVE DEVELOPMENT OF A SMALL BUSINESS EMERGENCY PLANNING MODEL

by
Arthur Henry Hendela

A Dissertation
Submitted to the Faculty of
New Jersey Institute of Technology
in Partial Fulfillment of the Requirements for the Degree of
Doctor of Philosophy in Information Systems

Department of Information Systems

May 2016

.

APPROVAL PAGE

COLLABORATIVE DEVELOPMENT OF A SMALL BUSINESS EMERGENCY PLANNING MODEL

Arthur Henry Hendela

Dr. Murray Turoff, Dissertation Advisor — Date
Distinguished Professor, Emeritus of Information Systems, NJIT

Dr. Starr Roxanne Hiltz, Dissertation Advisor — Date
Distinguished Professor, Emerita of Information Systems, NJIT

Dr. Jerry Fjermestad, Committee Member — Date
Professor, School of Business, NJIT

Dr. Julian Scher, Committee Member — Date
Associate Professor of Information Systems, Emeritus, NJIT

Dr. Thomas Wilkin, External Committee Member — Date
Assistant Professor and Chair, Department of Career and Technology Teacher Education, New York City College of Technology (CUNY)

BIOGRAPHICAL SKETCH

Author: Arthur Henry Hendela

Degree: Doctor of Philosophy

Date: May 2016

Undergraduate and Graduate Education:

- Doctor of Philosophy in Information Systems,
  New Jersey Institute of Technology, Newark, NJ, 2016

- Master of Science in Computer Science,
  New Jersey Institute of Technology, Newark, NJ, 1988

- Bachelor of Science in Chemical Engineering,
  New Jersey Institute of Technology, Newark, NJ, 1981

Major: Information Systems

Presentations and Publications:

Hendela, A., Turoff, M., & Hiltz, S. R. (2010). *Cross Impact Security Analysis Using the HACKING Game.* Paper presented at the 7th Conference on Information Systems for Crisis Response and Management, ISCRAM 2010, Seattle, WA.

Hendela, A., Yao, X., Turoff, M., Hiltz, S. R., & Chumer, M. (2006). *Virtual Emergency Preparedness Gaming: a Follow-up Study.* Paper presented at the 3rd International Conference on Information Systems for Crisis Response and Management, ISCRAM 2006, Newark, NJ.

Hendela, A. & Mendonca, D. (2004). *Innovations in Demolition: A Case Study from the Cleanup of Ground Zero.* Paper presented at the 10th Americas Conference on Information Systems, AMCIS 2004, New York, NY.

Turoff, M., Hiltz, S. R., White, C., Plotnick, L., Hendela, A., & Yao, X. (2009). The Past as the Future of Emergency Preparedness and Management. *International Journal of Information Systems for Crisis Response Management, 1*(1), 12-28.

Turoff, M., Hendela, A., Chumer, M., Yao, X., Konopka, J., Hiltz, S. R., & Yao, X. (2006). *Gaming Emergency Preparedness.* Paper presented at the 39th Annual Hawaii International Conference on System Sciences, HICCS 2006, Kauai, HI.

Yao, X., Konopka, J., Hendela, A., Chumer, M., Turoff, M., & Hiltz, S. R. (2005). *Unleash Physical Limitations: Virtual Emergency Preparedness Planning Simulation Training, Methodology and a Case Study*. Paper presented at the 11th Americas Conference on Information Systems, AMCIS 2005, Omaha, NE.

I dedicate this dissertation to my beloved family. To my wife, Vega, and my two sons, Martin and Karl, I love you more than you can imagine. You have sacrificed so much for me to achieve this life goal. I especially acknowledge my parents, Alice and Arne, who encouraged me to achieve the highest level of education.

ACKNOWLEDGMENT

I first wish to thank my dissertation committee, especially Drs. Murray Turoff and Starr Roxanne Hiltz, for their guidance and support during my years in the Ph.D. program. I also thank my other committee members, Dr. Jerry Fjermestad, Dr. Julian Scher, and Dr. Tom Wilkin for their advice and comments that have made this dissertation a better quality effort. It is an honor to have worked with all of these professors.

I thank Dr. Victor Banuls of Pablo de Olavide University for allowing me to use his CIM/CIA software. I also thank my fellow Ph.D. student, Robert Baksa, who gave me great advice on many areas of this work, especially on the presentation templates and dissertation formatting.

I thank the New Jersey State Chamber of Commerce and the members of the Meadowlands Regional Chamber of Commerce for their participation in completing the surveys. I could not have found the participants without you.

Thank you to my best friend, Jeff Miller, who helped and encouraged me through some of the difficult hours that came along the way.

Thank you to my wife, Vega, my children, Martin and Karl for their love and support during this nearly sixteen year effort interrupted by my ten eye operations and the many years of my mom's Alzheimer's care.

Last, but not least, I thank my parents, Arne and Alice Hendela who both passed away during my time pursuing this goal. They instilled in me a love of learning that has lasted a lifetime. Thank you for believing in me. Your words, Dad, ring in my ears forever. When I told you that I would pursue my Ph.D., you said, "I'm proud of you."

TABLE OF CONTENTS

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

Chapter **Page**

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

LIST OF TABLES

LIST OF TABLES
(Continued)

LIST OF TABLES
(Continued)

Table **Page**

LIST OF TABLES
(Continued)

LIST OF TABLES
(Continued)

LIST OF TABLES
(Continued)

LIST OF TABLES
(Continued)

LIST OF FIGURES

Figure **Page**

LIST OF FIGURES
(Continued)

Figure **Page**

LIST OF SYMBOLS

$\in$	is an element of a set as $a \in S$ means that a is an element in set S.

LIST OF DEFINITIONS

Antecedent	In Interpretive Structural Modeling, the antecedents are the column events found in the adjacency matrix. Antecedents influence row events known as succedents.
Business Continuity Planning (BCP)	A methodology used to create and validate a plan to maintain continuous business operations before, during, and after disasters and disruptive events.
CIA	Abbreviation for Cross Impact Analysis.
C_{ij}	The relative probability of an event occurring. A high C_{ij} indicates a combination of events that need high preparation for Worsening. A low C_{ij} shows that resources may be better allocated in other areas.
Collapse	The process of grouping events that forms a cycle in an influence diagram into a single event known as a scenario.
Event type	A high level category for an event.
Gamma (G_i)	The relative probability of occurrence due to events not specified explicitly to the Cross Impact Model.
ISM	Abbreviation for Interpretive Structural Modeling.
Model	A substitute and a simplification of a system which must be less expensive than modifying the original system or recreating it. Divided into physical models and mathematical models.
OVP	Overall Probability. This is the value of the diagonal on most C_{ij} matrices. It carries a value of 1.
P_i	The base probability of an event occurring, independent of any other event.
R_{ij}	The probability of an individual event occurring given that a particular event is certain to occur.

LIST OF DEFINITIONS

S_{ij}	The probability of an individual event occurring given that a particular event is certain to never occur.
Succedent	In Interpretive Structural Modeling, the succedents are the row events found in the adjacency matrix. Succedents are events influenced by column events known as antecedents.
Validity	Conclusions reached by the participants of the research are similar to those obtained in the real world.

CHAPTER 1

INTRODUCTION

This dissertation investigates the use of Cross Impact Analysis, in combination with Delphi techniques and Interpretive Structural Modeling, to design a Business Continuity/Disaster Recovery (BC/DR) plan for small businesses. The topic falls under the areas of Business Planning, Modeling, and Emergency Preparedness. The dissertation investigates the possibility of using Cross Impact Analysis (Turoff, 1972) in combination with Delphi techniques and Interpretive Structural Modeling (Bañuls & Turoff, 2011) to create the basis for an Emergency Preparedness/Business Continuity plan for small businesses.

Section 1.1 introduces the use of structural modeling as the foundation for the plan, a blending of Cross Impact Analysis, the Delphi technique, and Interpretative Structural Modeling as the evaluation methodology, and the high level research questions as the guide for the dissertation outcomes. Section 1.2 introduces the key research questions.

1.1 Background

Storms, such as Super Storm Sandy, which struck New Jersey in October 2012, show the weaknesses and vulnerabilities of even the best of Disaster Recovery (DR) plans. The size of the storm and the scope of its devastation were of a magnitude never seen before in the Northeast section of the United States. The massive loss of power, water and wind damage, and the lack of motor fuel all occurring concurrently showed weaknesses in the preparations made by small businesses. These losses are ones that everyone that lived through the storm experienced (Manuel, 2013). Uncovering additional loss factors and how they interrelate is complex given bounded rationality and limited knowledge (Simon, 1991).

The amount of data that can be collected from the scene of a natural disaster can be overwhelming. The ability to process this inordinate amount of information is hindered by our short term memory. Various techniques can be used to simplify the complexity and the number of the inputs (Miller, 1956). One method to reduce complexity and provide structure is to interpret information with mathematical models (Warfield, 1973).

This study gathered base information for conversion into mathematical form by asking small business owners and emergency preparedness experts how they prepared for a business interruption. The interruption might occur because of a massive storm like Sandy or other natural or man-made disasters. Once the data was collected through an online Delphi study (Turoff, 1970), the list of factors that influence the business interruption was paired. Each pairing was given to experts to determine the amount of influence that one factor had on another. The results of that pairing were put into a mathematical program to measure the influence of one on the other, a process known as Cross Impact Analysis.

A cross impact model (Dalkey, 1975; Turoff, 1972) is a model that allows the creation of an approximation that examines the interaction and evaluation of the occurrence of a set of future events. It utilizes subjective probabilities of causality of the events as developed by the subject matter experts in the domain to which it is applied.

Once the judgments of at least one expert, or the collective judgments of a group of experts (Linstone & Turoff, 1975) are determined, one may construct a structural model (Lendaris, 1980) that can be used to drive decision making.

A complete classical probability model of around ten future events would require 10 factorial (10!) times the number of combinations (Turoff, 1972). Each participant would need to estimate the influence of every possible path from one influence to another. This would include paths of length ten, paths of length nine, down to paths of directly connected events of length one. Estimating the influence probability along all paths of all lengths equates to approximately four million subjective estimations that each participant would have to make for each of the forty-five combinations that are possible when events are taken two at a time. In the cross impact approximation, the influence probability is only given for each pair of events, or n^2 estimates for n events. For the ten event model, the number of estimates is reduced to 100. This is an approximate approach similar to other matrix estimation models such as using subjective measure of association. In this method, relationships of items are estimated rather than determining all relationships possible by summing all possible combinations of 2, 3, 4,…, n-1 items at a time. The cross impact is specific to probabilities and ensures that the boundary conditions for never occurring, occurring half the time and always occurring for 0, .5, and 1.0 behave properly within the model scope. These boundary probabilities are given the values 0.0, 0.5, and 1.0, respectively. The output from the model is an internal scale of cross impact factors that relate the relative impact relationship between any two events on an interval measurement scale. In addition to the relative impact of one event on another, a composite linear measure is created that estimates the impact of events not explicitly included (Turoff, 1972).

For this study, experts were asked to first examine a trial list of all events classified as being an Initial Condition for the Emergency, the dynamic events that may occur, and then the output or result of the emergency. They were then asked to suggest edits or changes to that list. They examined the collective result and provided probability estimates into the model using the following steps:

1. Set the initial probabilities for all items to an initial value of 0.5. This represents the case where no information is available to determine the likelihood of occurrence.
2. Set the probability of a successful influence equal to 1; probability of an unsuccessful influence to 0. Successful influence is defined as an event that is likely to occur.
3. Given that an item is certain to influence the result or not to influence the result, change the initial probability of all the other items.
4. Repeat Step 3 for all the events.

In some cases the event inputs to the model are divided into three categories (Bañuls, Turoff, & Hiltz, 2013). These categories are:

1) **Initial Conditions**. These are items that are set by the nature of the disruption before any changes to the business are made to influence the amount of damage a disruption might cause. Examples are the type of emergency, such as a tornado or a flood, the scope of the destruction or the type of business undergoing the emergency.
2) **Dynamic Events**. These are factors developed via expert judgment. An initial set of events that are likely to change during an input event is based on the literature search and suggestions made by the participants.
3) **Output Events**. These are the outcomes that are hoped to be achieved from improving the emergency situation. Examples include restored electrical power, open roads to the workplace, or communications reestablished.

The experts made their estimates and asked the administrator to run the program to create the results model. The resulting cross impact factors can be used to show them an interval scale list of the relative impact different choices have on the outcome variable. Once they were satisfied with their estimates, a collective result was formed into a composite model. The same factors were compared among the experts to determine if there are any significant disagreements among the expert views and, if necessary, brought back for discussion with the expert group.

The model is developed by any number of experts alternatively choosing probabilities for the items in the Risk and Mitigation Action event sets. When a resource, policy, or process allocation is made, the probability for that event is shifted to a value of 1. Each modeler tries to make choices to maximize the positive and minimize the negative impact events.

As the participants continue to develop the model (multiple replications) we can expect the values of the negative and positive items, always summing to 1, to exhibit one of two types of behavior:

1. The value asymptotically converges to one constant value for a given set of interactions.
2. The values oscillate in a given range during a specific iteration as the positive and negative events change in reaction to the current outcome.

The final step of our study grouped the most influential factors into a series of possible scenarios in order to help concentrate limited business resources on the highest value return. The compilation of the events for the creation of the structured model was a critical step to the creation of a useful technique known as Interpretive Structural Modeling or ISM (Bañuls & Turoff, 2011).

1.2 Study Overview

This study enables experts to establish a structural model as the basis for business continuity/disaster recovery plans. The Delphi study was run using Survey Monkey's online survey software to create a refined set of risks and actions. The CIA/ISM model software that was planned to be used was called CAEPlan which was developed by the Universidad Pablo de Olavide, Seville, Spain. This software could assist planners and small business owners to create plans in much the same way as Microsoft Excel allows financial planners to create financial plans based on their own company's financial requirements.

There are two guiding research questions that this study proposes to answer.

1) Can Delphi, Cross Impact Analysis, and Interpretive Structural Modeling be used to develop the basis for a business continuity/disaster recovery plan for small businesses?
2) How can a model based on these three techniques be designed to assist in developing the basis for a business continuity/disaster recovery plan for a small business?

According to Nicoll and Owens safety officers and management of small-to-midsize businesses (SMB) are often asked to write Emergency Response and Business Continuity plans to protect their company's staff, facilities, and infrastructure (Nicoll & Owens, 2013). The plans try to predict the impact of hazardous events occurring and then try to determine how best to respond. One method used is based on the National Fire Protection Association (NFPA) Standard on Disaster/Emergency Management and Business Continuity Programs known as NFPA 1600.

NFPA 1600 breaks down the Business Continuity process into a set of eight steps. These steps are:

1. Program management
2. Risk assessment
3. Prevention and mitigation
4. Resource management
5. Plan development
6. Training
7. Exercise and corrective actions
8. Program revision

A major step towards the creation of the plan is the determination of what risks are to be included. This dissertation emphasizes two of the mandatory components outlined by the NFPA 1600 standard. These two components are:

1) *The entity shall identify hazards and monitor those hazards and the likelihood of their occurrence*. The Delphi portion of this study will uncover hazards that may adversely affect business operations. The Cross Impact Analysis portion will apply probabilities or "likelihood" of occurrence.

2) *The analysis shall evaluate the potential effects of regional, national, or international incidents that could have cascading impacts*. The Cross Impact Analysis portion of the study will help define the interactions and potential cascading impact of events. The Interpretive Structural Modeling portion of the study will help uncover interconnected events into likely scenarios. It is from this set of high impact scenarios that the most effective use of resources can be modeled to be the basis of the plan (NFPA, 2013).

To answer the first research question, we conducted a Delphi study of small business owners and managers to create a list of risks and mitigation actions that need to be further studied. Once the Delphi uncovered the main events that concerned the business owners, an expert group was asked to assign the probability of occurrence for the base set of the most important risks and the interactions between each of them. The resulting set of probabilities was the input to the Cross Impact Analysis software that calculated the highest priority interactions. The set of high priority interactions was used as input for the Interpretive Structural Model to uncover likely scenarios. It was these scenarios that could be used as the basis for the business continuity plan.

CHAPTER 2

REVIEW OF THE LITERATURE

In order to show where the Emergency Preparedness Planning Model fits in the world of modeling, this chapter presents background material on different types of models found in the literature and how the three aspects of the approach (Delphi, CIA and ISM) have been used. The literature search is limited to areas used to conceptually build the plan model. Section 2.1 describes basic concepts in business continuity and disaster recovery. Section 2.2 describes what a disaster is. Section 2.3 frames disasters. Section 2.4 looks at the classic 1976 Turner article on a framework for disaster analysis. Section 2.5 presents the concepts behind modeling. Section 2.6 describes basic terminology for modeling. Section 2.7 describes the Delphi Method. Section 2.8 describes Cross Impact Analysis. Section 2.9 describes Interpretive Structural Modeling (ISM). Section 2.10 describes research where the Delphi Method, Cross Impact Analysis, and Interpretive Structural Modeling are combined. Section 2.11 explains Bloom's Taxonomy of Learning Objectives. Section 2.12 presents a general model of the learning process. Section 2.13 explains how Bloom's Taxonomy is used to guide the development of survey questions.

2.1 Concepts in Business Continuity and Disaster Recovery

Business Continuity (BC) and Disaster Recovery (DR) are used interchangeably, but there is a subtle difference. According to Snedaker, Business Continuity and its associated Business Continuity Planning (BCP) is "a methodology used to create and validate a plan to maintain continuous business operations before, during, and after disasters and disruptive events" (Snedaker, 2013). It has to do with managing the disruption in such a way as to minimize or eliminate the loss of revenue and to function normally.

A subset of BCP is "continuous availability" where a business has a zero-downtime requirement. Industries such as public utilities, financial institutions, and healthcare organizations must determine if the high cost of multiple redundant systems is worth the time and expense to keep an operation going without interruption. Small business entities do not usually have the wherewithal to create multiple redundancies and must determine how much downtime they can tolerate.

Disaster Recovery (DR) is a part of business continuity which deals with the immediate aftermath of an event that interrupts a business. Events such as handling hurricanes, closed roads, computer server outages, and illness in the workplace all fall into this category. DR involves stopping or minimizing the effects of the event and beginning the process to return to normalcy. It is in this transition from minimizing the effects to the return to normalcy where disaster recovery and business continuity overlap. Examples of disaster recovery include the use of backup power to keep equipment and lights going or pumping water to remove flooding from a facility.

Recovery is that process whereby the effects of a disaster are mitigated and a path to normal operation is set. There must be great urgency to implement the plan and begin the recovery. The statistics for companies not having a disaster recovery plan and delaying recovery are grim. Forty-three percent of companies that suffer a major loss never reopen. An additional fifty-one percent close within two years. Only six percent survive the loss for the long term (Sasirekha, 2013). In addition to the damage a business owner sustains, employees lose their ability to earn a living and to rebuild their own homes. Impact trickles down from the business owner to the employee to the employee's families, schools, and community activities (Smith & Sutter, 2013).

The impact of disasters on businesses, especially small businesses, has been difficult to determine, as businesses often fail from "routine," non-disaster causes. These businesses do not have the wherewithal to create detailed business continuity plans and are usually ill-prepared to recover. Federal disaster aid is used to facilitate recovery, but priority assistance is given to individuals, not businesses. This despite the findings that two-thirds of family run businesses intermingle family and business finances (Danes, Lee, & Amarapurkar, 2009).

Responses to disasters and the effect on business continuity can be daunting for any sized business. How the business is affected depends on the nature of the disaster, such as hurricane, fire, tornado, flooding, etc., the time of year, where winter cold and ice may lengthen response times, the specific area of the company that is affected, such as computer operations versus product manufacturing, and duration. A power failure that lasts only an hour is more easily prepared for than one that lasts a week (Nicoll & Owens, 2013).

Hurricane Sandy struck the New York/New Jersey area on October 29, 2012 and caused an estimated 147 fatalities and damage in twenty-four states from Florida to Maine. The damage extended as far west as Wisconsin. New Jersey and New York were hit the hardest. Only one other hurricane since 1870, the Great Hurricane of September 16, 1903, struck New Jersey directly without previously encountering land. The storm stretched even the most prepared enterprises as flooding inundated coastal communities as well as areas rarely affected by high water. To prepare for the worst, rail lines were halted, barrier islands evacuated, and power pre-emptively shut down in areas expected to shoulder the harshest forces of the storm. Wind damage was minimal compared to the flood damage which was a result of inundation, erosion, scour, and wave action (FEMA, 2013).

A property management firm based in North Plainfield, NJ that managed 90 properties in 5 states wrote about its preparations in the "Journal of Property Management." They prepared by having their properties in good condition before the storm. By "good condition," the author meant that trees were pre-trimmed and contractors were positioned to remove fallen debris as soon as possible. Despite this preparation, the firm could do little to mitigate the effects of nine days without power. When cell towers were destroyed, the company communicated with tenants via postcards. As a follow-up measure, the company is now having power generators installed at their facilities (Dobrian, 2013).

The preparation of the Business Continuity/Disaster Recovery (BC/DR) plans in the previous studies was made using checklists and discussions inside of a BC/DR committee. None used modeling techniques to try to determine the most likely scenarios or the most likely interaction between events. This dissertation research will apply mathematical modeling techniques to help small business to better prepare for disasters. The use of mathematical modeling for this purpose is perhaps the first of its kind.

2.2 Defining Disaster

The International Federation of Red Cross and Red Crescent Societies (IFRC) defines "disaster" as "a sudden, calamitous event that seriously disrupts the functioning of a community or society and causes human, material, and economic or environmental losses that exceed the community's or society's ability to cope using its own resources." The IFRC further states that disasters arise as a "combination of hazards, vulnerability, and inability to reduce the potential negative consequences of risk." Although not a true mathematical formula, the IFRC expresses the relationship between hazard, vulnerability, and capacity to respond using the following expression:

$$\text{(Hazard + Vulnerability) / Capacity = Disaster} \tag{2.1}$$

The left side of the equation shows that a disaster is related to a natural hazard, such as severe weather or another type of disruption, the social vulnerability created by a lack of preparation or other social/human factor, and the response capability of an organization or government entity to ease the suffering caused by the event. Of the three variables in the IFRC equation, capacity offers business organizations and government the greatest degree of control over the situation (J. Chen, 2011). The capacity to plan and prepare for disaster is the basis for this dissertation.

2.3 Framing Disaster

A common belief about disasters is that they are tragic events that people, communities, and organizations have little or no ability to prevent. The outside force is of such magnitude that no effective resistance can counteract it. Normal and routine behaviors of the victims are changed. Loss of life, property, and revenue seem an essential part of the disaster. Survivors suddenly feel powerless. Institutions and organizations face tasks of such enormous immediacy that, if not accomplished, survival cannot be assured. Such is the story that Harry Moore paints in his early article on disasters, “Toward a Theory of Disaster” (Moore, 1956).

Russell Dynes states that much of social life is structured and that behavior becomes routine. When crises and disasters strike, enough stress is generated that new behaviors and means to deal with the disaster take hold. Groups are created to monitor and deal with the situation. Sometimes these groups form in the midst of the disaster because of a loss of communications with upper management or other authorities. In other situations, the groups, such as fire and police departments, have formal authority to respond as they have been trained. Both the ad hoc group and the one formally charged with management of a crisis situation must make decisions with incomplete information and data. There is a great amount of uncertainty (Dynes & Quarantelli, 1977).

Uncertainty creates problems for taking necessary actions. Organizations typically resolve this problem by relying on rules of thumb, rituals, and making plans to reach a certain goal. With such an open system, members of the organization cannot know if their actions will be adequate to attain the goal. There must be a way to determine what set of problems are prudent to ignore and which ones must be faced in order to achieve the goal

(Turner, 1976). Wilensky suggests that the decision of what to ignore and what to act upon must be based on high-quality intelligence. His criteria for high-quality are that intelligence must be "clear, timely, reliable, valid, adequate, and wide ranging" (Wilensky, 1967). From the user's perspective it must be available when needed, understandable, and interpreted similarly by different users.

Wilensky's criteria were used by British officials looking to find aspects of causation for the disasters. It was found that the breakdown in intelligence was more influential to create a larger tragedy than a breakdown in control structure. Turner used these findings to create a six stage framework for the understanding of organizational failures of foresight (Turner, 1976). With better foresight, organizational and natural disasters may have been prevented or mitigated. The framework is explained in the next section.

2.4 Turner Failure of Foresight Sequence

Table 2.1 Sequence of Events Associated with a Failure of Foresight

Stage I.	**Notionally normal starting point**: (a) Initial culturally accepted beliefs about the world and its hazards. (b) Associated precautionary norms set out in laws, codes of practice, mores, and folkways.
Stage II.	**Incubation period**: the accumulation of an unnoticed set of events which are at odds with the accepted beliefs about hazards and the norms for their avoidance.
Stage III.	**Precipitating event**: forces itself to the attention and transforms general perceptions of Stage II.
Stage IV.	**Onset**: the immediate consequences of the collapse of cultural precautions become apparent.
Stage V.	**Rescue and salvage – first stage adjustment**: the immediate post-collapse situation is recognized in ad hoc adjustments which permit the work of rescue and salvage to be started.
Stage VI.	**Full cultural readjustment**: an inquiry or assessment is carried out and beliefs and precautionary norms are adjusted to fit the newly gained understanding of the world.

Turner (Turner, 1976) studied many disasters, but concentrated on three major ones to determine their common causal features. The study led to the development of a six stage sequence of events that were associated with an inability to properly prepare for a preventable situation. Turner called this a "Failure of Foresight." The events that Turner studied were the 1966 Aberfan coal slurry disaster in Wales, the 1968 train accident at Hixon level crossing in Northern England, and the 1973 fire at the Summerland summer leisure complex in Douglas, Isle of Man.

In the Aberfan disaster, 116 children and 28 adults lost their lives when a mountain of coal dust that mixed with water collapsed and engulfed a primary school, burying the victims alive (Johnes & McLean, 2001). The Hixon level crossing accident killed 11 and injured 45 when a British Railway train collided with a very long transport vehicle that was carrying heavy equipment across the tracks. The transport was too long and moved too slowly to cross the tracks ahead of the oncoming train (Ministry of Transport, 1968). The Summerland disaster killed 50 people when a leisure complex caught fire when three boys accidentally set fire to an adjacent kiosk while smoking cigarettes (Phillips, 2009). In each case there was a failure of foresight which could have prevented the disaster.

A brief explanation of the six stages follows. A note on Stage II explains its use for our model development:

Stage I. **Notionally normal starting point**. Situations are considered "normal." The ability to cope with the world and its hazards is achieved by adherence to a set of normative prescriptions. The prescriptions regarding how to avoid hazards and their effects are embodied by laws, sets of best practices, mores, and folkways. There is no need for cultural readjustment following an unfortunate consequence involving a violation of this stage. The readjustment is made inside of the existing prescriptions to strengthen their dampening effect during the next occurrence. An example would be the strengthening of building codes to specify more fire resistant materials after fire deaths occur (Phillips, 2009).

Stage II. **Incubation period.** This is the beginning stage of the Failure of Foresight. Here, a series of events begins that accumulate into the point of disaster. Events that become the starting point for disaster fall into two categories: 1) the events are occurring without anyone's knowledge, or 2) the events are occurring, but their consequences are not fully appreciated. In the case of the Aberfan coal disaster, two events helped cause the slurry of coal dust to descend as an avalanche through the primary school. First, the pile of coal dust, known as a "tip," was created over a water spring. It was inconclusively debated during the inquiry as to whether it was known ahead of time that the spring existed below the tip site. As such it was not known if the dust pile would liquefy because of it. Historic maps of the area showed that such a spring did exist. The second event was that the village suffered under a severe rain storm. The rain water mixed with the coal dust on the top of the tip, while the spring water was mixing with the coal dust on the inside of the tip. This mixing of the solid coal dust with the water weakened the sides of the tip causing it to collapse. The mixture of solids and water, known as a slurry, rushed down to the village below and buried the primary school and many of its teachers and students (Cuoto, 1989).

It is this stage where our model will be of most use. The Delphi method will help uncover more of the unknowns of a particular scenario, while the cross impact and interpretive models will help determine the likelihood of events occurring. Cross influence of factors will be examined.

Stage III. **Precipitating event.** Stage III is where attention by outsiders is aroused. It may be the onset of a fire where the flames just become visible as in the Summerland fire, or the crashing of the train into the equipment mover as in the Hixon railroad crossing accident. In the case of the Aberfan disaster, the mixing of the water with the coal dust precipitated the disaster.

Stage IV. **Onset.** This stage is when the direct and unanticipated consequence of the failure occurs. In the case of the Aberfan disaster, the wall of coal slurry descends the mountain and crashes through the walls of the school killing 116 children and 28 adults.

Stage V. **Rescue and salvage – first stage adjustment.** The situation that was previously observed becomes a scene in a state of change and redefinition. Rapid ad hoc adjustments are made by the participants. There is recognition of the most important features of the failure. Rescue and salvage operations can begin. In the case of the Hixon crossing accident, first responders saw the derailed passenger rail cars and began to search for those in need of medical attention (Ministry of Transport, 1968). At Aberfan, townspeople and first responders quickly arrived at the site of the school. Digging began with any tools available, including bare hands.

Stage VI. **Full cultural readjustment.** When the immediate effects of the event have subsided, a more complete assessment of the incident is made. Following the assessment, cultural adjustment is made to incorporate updated beliefs and norms. The assessment may be in the form of boards of inquiry. In the case of the Hixon railroad crossing accident, the inquiry led to the installation of telephones at crossings where long transports can call before they begin to cross the tracks (Ministry of Transport, 1968).

Table 2.2 Commented Sequence of Events Associated with a Failure of Foresight

Stage	Feature	Comment
Stage I. Notionally normal starting point	Failure to comply with existing regulations	Violation of existing precautions
Stage II. Incubation period	• Rigidities of belief and perception • Decoy phenomena • Disregard of complaints from outsiders • Information difficulties and noise • Involvement of strangers • Failure to comply with discredited or out-of-date regulations • Minimizing of emergent danger	A. Events unnoticed or misunderstood because or erroneous assumptions B. Events unnoticed or misunderstood because of difficulties of handling information in complex situations C. Effective violation of precautions passing unnoticed because of cultural lag in formal precautions D. Events unnoticed or misunderstood because of a reluctance to fear the worst outcome
Stage III. Precipitating event		
Stage IV. Onset		
Stage V. Rescue and salvage		
Stage VI. Full cultural readjustment	Definition of new, well-structured problems and appropriate precautions in inquiries following the disaster	The establishment of a new level of precautions and expectations

Table 2.2 shows Turner's analysis of the three incidents in relation to the six stages. In Stages I, II, and VI Turner was able to find common ground between the incidents for which he made additional comments (Turner, 1976). In both Stage I and II, there was a failure to comply with regulations. We will discuss this point only once

during the explanation of Stage I. Turner made no comments on Stages III, IV, and V which are covered in Table 2.1.

Stage I. **Failure to comply with existing regulations**. In Stage II this item is listed as "Failure to comply with discredited or out-of-date regulations." At the time of the Aberfan disaster there were few regulations regarding tip safety. At Hixon, new regulations were buried in a technical report distributed to police stations, but were left unread. In the case of Summerland, there were examples of non-compliance with existing regulations. Regulations were either not known, or there was a feeling of "what can be gotten away with?" All was not the participants fault. In the Stage II case, some regulations had become so out of date that technical, social, and cultural compliance was difficult or impossible. For example, traditional theater regulations could not be applied to the open space, multi-story performance area in Summerland. Existing regulations were for enclosed theaters with fixed seats, not an open atrium area with moveable seats. An example of "what can be gotten away with" is the wording in the original architect's proposal that the building would be covered in a "glass-like" material. This wording gave the building review board the sense that the outer walls of the leisure complex would, in fact, be glass, or something very similar. The new material, Oraglas, was lighter than normal glass and could easily be molded into new and interesting shapes for the façade. Unfortunately the fire properties of Oraglas were significantly worse than other materials. Two months after the fire, during October 1973, the Lancashire County Council staged a demonstration where three model buildings made of different materials were set on fire at the same time. The Oraglas building burned down the fastest. The outer skin of the United States pavilion from the Montreal 1967 Expo burned in 1976. That building, known as the Biosphere, was also skinned with Oraglas (Phillips, 2009).

Stage II. These are the Stage II discussion points:

a. Rigidities of belief and perception. Turner comments that part of the effectiveness of an organization stems from the development of cultures that are related to the tasks and work environment where those tasks are performed. Where standard procedures can create operational consistency, they can also create collective blindness to important issues (Turner, 1976). A vicious, self-reinforcing circle is created (Gouldner, 1954). In the case of Abferan, it was a widely held belief by overseers and management that there were no underground springs where the fatal Tip Number 7 was created. During the board of inquiry it was discovered that the oversight commission, known as the National Coal Board, ignored local knowledge that a spring was underneath the coal tip that collapsed. Since there was a similar disaster that also occurred in Wales in 1939, the Cilfynydd flow slide, ignorance of such a problem was unfathomable (Bentley, Davies, & Gallup, 1998). The Cilfynydd tip was also built over a spring. Despite past precedence for a disaster of this magnitude, the head of the National Coal Board, Lord Robens, was able to use political pressure to save his job (Johnes & McLean, 2001).

b. Decoy phenomena. Another common theme within the investigation reports was that time spent on a well understood problem took away resources from determining the hazard involved with the actual disaster. For example, the crossing at Hixon was discussed between officials of the transport company and the maker of the transformer that was being hauled. The discussions centered on whether overhead wires might cause an electric arc with the transformer and whether the crossing was level enough to not dislodge the load from the tractor bed. No discussions were held regarding whether the slow moving transport, which only gained speeds of two miles per hour, could actually make it across the tracks before a train arrived (CMNews, 1968).

c. Disregard of complaints from outsiders. In two of the cases, Aberfan and Hixon, people who were not part of the organizations tried to warn authorities of the impending dangers. The organizational management responded by dismissing the outsiders' concerns. It was the assumption of management that they knew better about possible risks and consequences. In the case of Aberfan, the local city council was dismissed by the National Coal Board for reporting the spring under the coal tip. The road hauling company was dismissed by British Rail regarding potential problems at the new automated crossing. The response from British Rail, especially, was cited in the final accident report for its "remarkable arrogance and high handedness" (Turner, 1976).

d. Information difficulties and noise. There were various types of communication related difficulties involved with all three cases. For all three disasters, there were ambiguities regarding the warning signs, orders and procedures, and control responsibility. At Aberfan there was the disagreement of whether the underground spring existed as well as a discussion regarding the state of the tip or how much broke free during earlier slips. At Hixon, a crossing warning sign was ordered to be placed “facing traffic.” Instead of facing the oncoming cars, the sign was placed such that only the oncoming trains or cars stopped already for a train to pass could actually read the sign. At Summerland, a previous demonstration that showed the flammability of the OraGlass covering was debated as to whether the demonstrated flammability was sufficient to deny a waiver for its use on the building.

In the case of Hixon and Aberfan, top management viewed the potential problems idealistically. They assumed that the respective safety departments had a handle on any hazards and would take corrective action, if necessary. The report of how automated crossings operated was sent to the local police department, but was buried in a long technical document and went unread. At Aberfan, the mining engineers were in charge of safety. Unfortunately, they concentrated only on safety inside the mine and were less concerned about the coal spoils that were collected into the tips (Johnes & McLean, 2001). The head of the coal board finally admitted that there was a spring on maps of the area where Tip #7 was built. The excuse for continuing to build the tip was that a disaster could not be conceived of the magnitude that occurred (Cuoto, 1989).

Local personnel also were misinformed. At Hixon, the hauling vehicle was escorted by police vehicles that crossed the tracks first and then stopped.

The driver thought that the crossing by the police security guard ahead of their cargo constituted an “all clear” signal to follow immediately. As automatic crossing barriers were new, the driver also assumed that if he was on the tracks, there would be an automatic braking mechanism for the train to stop and avert disaster. The previous manual procedure had the crossing gate attendant change train signals for the train to either stop or proceed in addition to closing the road traffic gates for cars and trucks to stop (Ministry of Transport, 1968). At Aberfan, the Borough Engineer wrote to the National Coal Board (NCB) as early as 1957 to insist that based on stability concerns, the tips should not be extended. The local engineer was assured by the NCB that his concerns were being addressed (Aberfan Tribunal, 1967). At Summerland, information was available regarding the combustibility of the outer covering, but was ignored or perceived to be insignificant. Construction schedules for the leisure complex were being pushed ahead to ensure a timely opening for summer 1971 (Turner, 1976).

e. Involvement with strangers. Summerland and Hixon had their disasters exacerbated by strangers. “Strangers,” in this case, were those people at the scene of the disaster that were either untrained for an emergency situation or who were uninformed about proper procedures (Turner, 1976). Strangers, as a group were difficult to brief on procedures although some fore-knowledge could be considered common sense. The Summerland disaster would not have occurred at the time it did if not for the young boys who accidentally ignited an adjacent kiosk while smoking. The increase in congestion at the building exits and staircases was due to panicked parents trying to return inside when they were separated from their children. This type of panic was typically exhibited when there was "a perception of an immediate great threat to self and/or significant others (Gantt & Gantt, 2012)." At Hixon, the operator of the transport was a stranger in two senses. First, he was unfamiliar with the area and had never driven the route before. He was unaware ahead of time that there was a level crossing with automated gates. He was also a stranger to how the new automated gates operated and assumed that if he was on the tracks when a train approached, the train would automatically brake to a stop to avoid disaster (Ministry of Transport, 1968).

f. Failure to comply with discredited or out-of-date regulations. This area was discussed as part of Stage I observations.

g. Minimizing of emergent danger. All three inquiry reports point to a failure to see or appreciate the full magnitude of the potential danger. When hazards were recognized, the effects were underestimated. Although the Borough Engineer continually warned of a potential tip slide, the National Coal Board did not anticipate the scale of the danger which buried the school. The rubbish fire started in the kiosk at Summerland was not considered grave because the kiosk was detached from the main building. As such, the fire alarm system was not immediately activated and there was a delay in alerting the local fire department. The first call to the fire department did not come from the Summerland facility, but by a ship at sea (Turner, 1976). The closing of staffed railroad gates at Hixon crossing had included the manual setting of train signals for trains to stop or proceed. There was no connection between the new automated crossing gates and the signals given to oncoming train engineers (Ministry of Transport, 1968).

Stage VI. **Definition of new well-structured problems and appropriate precautions in inquiries following the disaster.** To the credit of all three boards of inquiry, they made recommendations based on what actually happened and not what was thought to have happened when disaster struck. The use of real facts and not assumptions eliminated many of the unknowns that were either hidden or ignored by the participants. The problem therefore became one that was well-structured by the course of the disaster and not one filled with the pre-existing ambiguity (Turner, 1976).

The size of major disasters, such as the ones that Turner used to develop his framework, or Hurricane Sandy, which will be used as the basis for this study, prevents exact recreation. Instead we must turn to modeling the events to create an understanding of what went wrong and how events interacted (Bañuls & Turoff, 2007).

2.5 Concepts in Modeling

According to Selic models have five characteristics (Selic, 2003):

1) Abstraction, where the model has reduced complexity compared to the system it represents,
2) Understandability, where the model remains in a form that is intuitive,
3) Accuracy, where the model provides a true to life representation of what is being modeled,
4) Predictiveness, where the model is able to predict interesting but non-obvious features of the system being studied, and

5) Inexpensiveness, where the model must cost significantly less to construct than the modeled system.

Limited resources available to businesses make decision-making based on modeling outputs an attractive choice. Regarding how businesses use their money, Chatterjee writes, “what [a business] invests in is based on the logic that drives the profits for a specific business” (Chatterjee, 2013). To maximize profits, the business entity must not only decide on what to make and sell, but also how to mitigate risk that can disrupt or close the business.

Businesses use different analytical and modeling techniques to help determine how to make their investments. Two such techniques are opinion mining and question answering (H. Chen, Chiang, & Storey, 2012). The Delphi Method uses question and answering techniques to glean expert opinions which mold decision model inputs (Linstone & Turoff, 2011). Once expert opinions are given, other modeling techniques are available to interpret the results. Cross Impact Analysis lends itself to this type of result interpretation where interrelationships between events or other variables can be given a probability of occurrence (Turoff, 1972). Once probabilities are calculated, the most likely events can be grouped to determine the highest return on investment. The grouping of the most likely occurring events into scenarios is performed with the Interpretive Structural Modeling technique (Bañuls & Turoff, 2007). The resulting scenarios are ones that are most likely to occur and ones that will most warrant investment.

2.6 Modeling Terms

A model is a substitute and a simplification of a system which must be less expensive than modifying the original system or recreating it. Models can be divided into two broad categories, physical models and mathematical models. Physical models are smaller or larger scale copies of the object being represented (G. Gordon, 1978). For example, architects create smaller scale models to show how buildings will look once constructed. Chemists use larger scale models to show how atoms are oriented inside a particular molecule. Once physically modeled in this manner, the chemist can look for possible ways to synthesize new compounds.

Mathematical models are abstractions of a system being studied using symbolic notation (G. Gordon, 1978). This notation can take the form of mathematical equations or some graphical representation of the underlying concepts. For example, complex weather data is fed into mathematical models that use equations to predict a storm's size, path, and intensity. The output from the model is changed into graphical form and overlaid onto a map, where it can help clarify what locations may be adversely affected.

The data for this study will be generated by a Delphi process with business owners whose enterprises may be interrupted by any number of adverse events. These events include flooding, fire, illness, or technology failure. Once a set of events is determined, another survey will add probabilities to the interaction between the events using the mathematical formulae of Cross Impact Analysis. Interpretive Structural Modeling is then used to create a list of the most likely scenarios for the set of events as depicted by an interaction graph.

2.7 Delphi Method

The Delphi Method was developed in the 1950s at the RAND Corporation to obtain expert input on a particular problem while allowing the participants to remain anonymous. These expert panels are given questionnaires and participate in answering them at a time and place convenient to them. The technique is particularly useful in cases where the expert panel is dispersed over a wide geographic area (Linstone & Turoff, 2011).

Delphi has been used in many areas over the past sixty years. Several examples follow. Turoff used the technique as part of a government planning exercise to determine the likely probabilities of events ranging from a trade war between the USA and Japan to the likelihood of a Federal, State, and local revenue sharing plan through 1980 (Turoff, 1972). McFadzean used a three round Delphi study to determine a corporate strategy for information assurance and security (McFadzean, Ezingeard, & Birchall, 2011). The factors for assurance were established which allowed the company to avoid security problems rather than react to a problem and then fix a security breach. Paré applied the technique to software development in the healthcare sector to determine the most prevalent risk factors that caused project failure (Paré, Sicotte, Jaana, & Girouard, 2008). The top factors influencing development failure were:

1) Lack of a project champion,
2) Lack of commitment from upper management, and
3) Poor perceived system usefulness.

The first technology related factor was ranked at number eleven, “Poor software performance.” Nakatsu also studied risk factors involved with software project development, but in the area of off shore development (Nakatsu & Iacovou, 2009). Like the Paré study, Nakatsu found that the most important risk factor was a lack of management commitment. Unlike Paré, the next two highest ranked risk factors centered around communication difficulties. The second highest ranked factor was "Original set of requirements is miscommunicated." The third highest ranked factor was "Language barriers in project communications."

The method utilizes a series of preselected questions over several rounds where each participant may suggest additional items. After each set of questionnaires is completed, a facilitator summarizes the expert's input and then redistributes the summary with another round of questions (Linstone & Turoff, 1975). The experts can then revise their answers. The process continues for a set number of rounds.

The Delphi Method has been deemed suitable for domains that have the following properties:

- Subjective expertise and judgment inputs,
- Complex, large, multidisciplinary problems with considerable uncertainty,
- Possibility of unexpected breakthroughs,
- Causal models cannot be built or validated,
- Particularly long time frames,
- Opinions from a group where anonymity is deemed beneficial.

The Delphi Method is approved for use in studies at Virginia Commonwealth University (VCU) because of several properties not listed above. First, the method is used when subjects are spread out over several states making face to face interviews not cost effective. This is certainly the case for this study where the participants are located from

Maryland to Connecticut. Second, VCU uses the method when the participants are busy professionals who need flexibility to participate. The small business owners used in this study fit this requirement as well (Brady, 2015).

The problem of how best to prepare for disaster is certainly one of considerable complexity, the level of which is beyond the cognitive capability of a single individual. To limit this complexity and leverage other people's knowledge, the decision making process uses a group setting. The group in this study is a set of small business owners that need to create a plan to protect their most valuable investment, their business. The rounds of survey will ask these experts for their opinions regarding the business continuation risk factors they consider most important and then to assign probabilities to the events and their interactions. These small business workers and owners provide their individual expert judgment in a way that overcomes negative group effects such as bandwagon or halo effects. These effects influence groups to join in similar thoughts because of the popularity of the idea or because of impressions that one group member has towards another. The anonymity allows each person to provide their insight without this undue influence (Keller & vonderGracht, 2014). The Delphi process is used to protect participants' identities, provide controlled iteration and feedback, and to achieve group consensus (Yang, Zeng, & Zhang, 2012).

2.8 Cross Impact Analysis (CIA)

Cross impact analysis (CIA) consists of a set of related methodologies that predict the occurrence probability of a specific event and that also predict the conditional probability of a first event given a second event (Thorleuchter & vandenPoel, 2014). The method was originally developed in 1966 by Theodore Gordon and Olaf Helmer based on discussions about a simple research question, “can forecasting be based on perceptions about how future events may interact (T. Gordon, 1994)?”

The initial application of the CIA principles was a card game that Gordon and Helmer created for Kaiser Aluminum and Chemical Company called “Future.” One side of each card was marked with a single future event and an a priori probability of occurrence based on the researcher’s judgment. A die was rolled to determine if an event occurred for the given scenario. The die was an icosahedron with probabilities written on each of its twenty faces. If the probability on the die face was greater than or equal to the event probability on the card, the event was deemed to have “occurred.” When an event occurred, the card was flipped over and read. This newly revealed side of the card listed cross impact events with associated interaction effects. For example, if the role of the die determined that the event on the card occurred, then the opposite side of the card is read. This side would show the probability of another event that was written on a different card increased by 10 percent while another event written on a different card decreased by 15 percent. The game ended when all of the cards had been separated into two stacks. One stack was the set of events that occurred and the other stack were those events that did not occur. In this early incarnation of the method, the scenario was determined by random chance (T. Gordon, 1994).

Dalkey’s research proposed a process to simplify the inputs for cross impact with an elementary cross impact model. This model used relative probabilities in place of absolute probabilities and derived conditions for the consistency of the resultant matrix. To increase consistency of the estimates, an averaging technique was formulated that matched the absolute probability to the closest matching point on a line that defined a cross impact value with all consistent inputs. Dalkey noted that if the cross impact estimates were not consistent, then the calculation became more complex by including a set of cross matrix lines that themselves became averaged using a weighting method (Dalkey, 1975).

Turoff suggested that a measure of the utility of the method was the ease with which estimators could supply their estimates and how well their estimates adequately represented their world view. To that end, a simplification of input was made where events whose subjective probability of occurrence was less than or equal to 0.5 were assumed to not occur. Probabilities greater than 0.5 were judged to have occurred (Turoff, 1972).

Since this early work, CIA has been widely used to help planners forecast the future. Gray and Helmer used the approach to create California's CALTRANS transportation plan. The plan modeled the state's transportation needs through the year 2000 (Gray & Helmer, 1976). Han used CIA to help construction projects avoid cost overruns (Han & Diekmann, 2004).

The medical profession used CIA to model the intentional transmission of HIV/AIDS through risky conduct as part of the effort to quell the epidemic (Pedamallu, Ozdamar, Kropat, & Weber, 2012). Bañuls applied the approach in conjunction with the Delphi method and Interpretive Structural Modeling to develop emergency preparedness scenarios (Bañuls et al., 2013). Mamdouh has proposed the extension of the traditional use of static probabilities to include a time dimension to update the probabilities and their interaction. The addition of a Markov Chain property allows the events being studied in the future to depend only on the previous time period (Mamdouh, Saleh, & El-Hadi Ahmed, 2015).

2.9 Interpretive Structural Modeling (ISM)

Interpretive Structural Modeling (ISM) is a process that transforms unclear mental models into a visible, well-defined model that can be used in many ways (Sushil, 2012). The technique is interpretive as it uses the judgment of group members to determine how and if variables are related. It is structural in the sense that the interrelationship between variables evolves into a simplified and more organized form. It is a model as the output transforms into a graphical representation of the structure and relationships between the variables (Singh, Singh, & Sharma, 2013).

In its earliest use Warfield analyzed complex, rapidly changing societal systems (Warfield, 1973). He did this by using a process of collective exploration to increase intellectual productivity. The increase in productivity was achieved by separating the mental activity into areas that were best suited to the individual. The group decided how sets of variables interacted with one another. The output of the group process was a visual model of interaction that was more easily understood. This simplification of complexity has helped ISM's applications become more widespread.

Malone showed the application of ISM to structure personal values that created barriers to investment in a city (Malone, 1975). Borade applied ISM to supply chain management to improve Indian business performance via Vendor Managed Inventory (VMI) (Borade & Bonsad, 2012). Guo used ISM to analyze technology use motivations in students (Guo, Li, & Stevens, 2012). Ravi used ISM to determine the barriers to ecofriendly packaging in an Indian computer manufacturer (Ravi, 2015). An Indian construction company used ISM to determine the most influential factors for worker safety and environmental consciousness (Rajaprasad & Chalapathi, 2015). Whereas this study used ISM to assess risk factors for business interruption, Wu used ISM to assess risk factors in two Taiwanese, offshore pipeline projects (Wu, Yang, Chang, Chateau, & Chang, 2015). Bañuls applied the technique in combination with Cross Impact analysis to develop collaborative scenarios in Emergency Preparedness (Bañuls et al., 2013). These scenarios were used to enhance the understanding of the factors that were encountered by response teams.

In combination with Cross Impact Analysis, the approach allows researchers and practitioners, in our case small business owners and planners, to take the output of the influence graph and obtain a plausible snapshot of the future with interactions between critical events (Bañuls & Turoff, 2011).

2.10 Combining Delphi, CIA, and ISM

Combinations of the Delphi Method, Cross Impact Analysis, and Interpretive Structural Modeling have helped to simplify the prediction of future events by easing complexity. Countless studies have been performed that used one of these methods at a time. Additional results have been captured using combinations of the approaches. Some studies have used combinations of Delphi, CIA, and ISM while others have used one or more of these approaches with different mathematical analysis techniques. Valmohammadi used a literature search instead of a Delphi method to identify his factors affecting entry into e-commerce markets (Valmohammadi & Dashti, 2015). Fuzzy analysis was used to mathematically determine the priority of the barriers to entry. ISM was then used to determine the influence between the factors. Huega, Bañuls, and Turoff used a combination of CIA and ISM and a scenario generator to determine the effect of "Cause events" on "Result events" while modeling risks at a hypothetical metallurgical plant in South Europe (Huega, Bañuls, & Turoff, 2015).

Bañuls combined the Delphi Method, Cross Impact Analysis, and the Analytic Hierarchy Process to help assess the future impact of a technology portfolio and lend support to the shaping of that portfolio. Previous approaches tried to assess the impact of a particular technology one at a time. The use of expert opinion from the Delphi survey combined with the mathematical techniques afforded the opportunity to assess the impact of the technology set as a whole. Cross Impact Analysis was used to create the cross influence of one technology with another. The Analytic Hierarchy Process was used to create a hierarchy of criteria used to judge technology alternatives (Bañuls & Salmeron, 2007).

Bañuls and Turoff were the first to explore the combination of the Delphi Method, CIA, and ISM. The strength of adding ISM to the established Delphi and CIA methods was to create a graphical depiction of the high order interactions as a means to display event scenarios. The ability to see the scenarios graphically, in addition to being in a numeric table, allows decision makers to more clearly substantiate their thought process and decision (Bañuls & Turoff, 2011).

The combination of the Delphi Method, CIA, and ISM was applied to Emergency Preparedness to try to provide a tool for decision makers that can take an infinite number of future events and created a manageable number of alternatives. Given the expert input from the Delphi surveys, the use of Cross Impact Analysis gave a plausible snapshot of the future with the ability to analyze the impact of events on one another. The final output graphs simplified the mental process to create a working model that could be used to examine the consequences of assumptions with regard to preparedness, planning, and the actions taken before, during, and after an emergency. The goal of the exercise was the creation of useful details for use by responders and decision makers. These previously unknown details could make the difference between success and failure of an emergency response (Bañuls et al., 2013).

Application of the CIA-ISM approach was used to assess the impact of a series of negative events against Critical Infrastructure (CI). Infrastructure elements may be considered critical when they provide a function that is essential for routine processes and for which no rapid substitute exists. Sixteen CI elements such as "water supply undrinkable" and "No Gasoline" were selected for this assessment. Experts were asked to provide the input for the Cross Impact Analysis in a series of surveys that asked for probabilities of how each negative event interacted with each other one. Only areas with which an expert was familiar were judged. The resultant model of influences was deemed reasonable (Turoff, Bañuls, Plotnick, & Hiltz, 2014). Turoff examines the cascading effects of the critical infrastructure failures during disasters using scenario software currently under development (Turoff, Bañuls, Plotnick, Hiltz, & Huega, 2015).

The current research builds on the 2014 CI study by Turoff to uncover relationships in a set of risks and mitigating actions that small business owners can use as a foundation of a business continuity/disaster recovery plan. This process, which combines the Delphi Method, CIA, and ISM methods, will hopefully ease the planning burden on a business with limited resources. At the same time it is hoped to provide a learning experience that can lessen a disaster's effects on each individual involved with this study.

2.11 Bloom's Taxonomy of Learning Objectives

Table 2.3 Bloom's Taxonomy of Learning Objectives

A. Cognitive (or knowing domains)	• Basic Knowledge • Comprehension • Application • Analysis • Synthesis • Evaluation
B. Affective (or feeling) domain	• Receiving • Responding • Valuing • Organization of values • Internalizing values
C. Psychomotor (or doing) domain	

As the model is developed, we hope that small business owners learn to develop their plans more effectively. Learning occurs on many levels. Bloom's Cognitive Domain includes six categories that deal with attaining and developing knowledge. A brief explanation of the six categories follows (Karns, Burton, & Martin, 1983) with an explanation of how the model development uses each category:

1) **Basic Knowledge**. Simple rules, facts, terms, sequences and principles are learned through rote memory. The remembering of this type of information is considered the lowest level of learning. Knowing these terms, specific facts, concepts and principles tests the learning objectives for this category. During the Delphi process we will provide the person with a base set of events in order to

determine their interactions. This becomes the basic knowledge for the user to expand the system based on their experience and research.

2) **Comprehension**. This is the ability to grasp the material's meaning. For example summarizing a story or forecasting a trend from a set of data changes the form of the material and shows comprehension. Interpreting charts and graphs, changing word problems into mathematical equations or estimating future consequences from a set of data can test this learning objective.

   The output reports from the Cross Impact Model provide a relative impact of two events that interact. A high positive number shown in the output report indicates an event interaction that may have significant impact for developing a DR plan. Low negative numbers indicate interactions that may be less significant. In neither case can the planner merely take the output and say that the resource allocation is complete. The report provides a starting point for determining how disaster recovery resources will be allocated. The users must comprehend what these results mean in order to complete the plan.

3) **Application**. This is the ability to use new material in different and possibly real situations. These situations include applying rules, theories, and concepts. Looking for underlying assumptions and evaluating the relevancy of data can test this objective. Once the Cross Impact Model is run by the Administrator, it will be up to the planners to determine how the results will be applied in the future.

4) **Analysis**. This is the ability to decompose material into component parts. From here, its structure can be understood and relationships between the parts uncovered. Recognizing unstated assumptions, distinguishing between facts and

inferences and analyzing underlying structures in a composition of work are three ways of testing this learning objective. The Cross Impact Model, the underlying mathematics for the analysis, shows the relationship between events that may have gone unnoticed. Understanding that the results are only as good as the input to the program is part of the analysis that the planners need to perform.

5) **Synthesis**. This is the ability to put parts together into a new structure. New patterns are emphasized. Examples from this level include the creation of a speech or written composition, a research proposal, or developing a classification scheme. The output from the Interpretive Structural Model helps an individual to explore new interactions and their impact on their plans.
6) **Evaluation**. This is the ability to determine the value of material in relation to its purpose. A rigorous standard or criterion is applied. This is the highest form of the learning objectives as all other levels are contained in this one. Examples of learning objectives are the logical writing of conclusions with support by data or determining the value of a work by internal or external standards. Once the output of the model is interpreted, the final report and plan can be developed. The model creates the support material that management needs to make final disaster recovery decisions.

The Affective Domain was more difficult for Bloom to analyze. The Affective Domain is divided into degrees of acceptance and emphasizes an emotional tone where there are "internally consistent qualities of character and conscience" (Reeves, 1990). The Affective Domain is divided into five levels. The model development, use of Level 4, Organization, is explained.

1) **Receiving**. This level spans three different stages with the concept of awareness, a willingness to hear, and controlled or selective attention. Listening to others with respect or listening in the conversation to discern a speaker's name exemplifies this level.

2) **Responding**. There are three stages in this level. "Acquiescence in responding" shows the motivation required in order to take an action. This may be in the form of an invitation or suggestion from a friend to do something. Motivation is low at this stage. "Willingness to Respond" is shown, for example, when a student volunteers to actively participate in a class discussion. "Satisfaction in Response" shows an interest and a liking towards a particular subject.

3) **Valuing**. Interest in a subject builds slowly, culminating in a predisposition to act in a certain manner. There are three stages in this level. "Acceptance of a value" is attained when a subject becomes important. "Preference for a value" is shown in students when unassigned materials are being read and studied. "Commitment" is established with a high level of feeling towards a subject. There is an internal motivation to do something regarding the subject.

4) **Organization**. The distinctive characteristic of this level versus those in the Cognitive Domain is the amount of internal motivation. There are two stages in this level. "Conceptualization of a value" is where a person becomes committed to abstract thoughts and ideals. A judgment becomes the basis for further work. "Organization of a value system" is where a person develops an ethical framework in which to evaluate inputs and to set priorities of work. The model provides a basis for continued knowledge gathering. It is hoped that the use of

modeling techniques will motivate users to enhance their plans by researching outside references and providing better input for the planning process.

5) **Internalizing values**. Internalizing a concept culminates in a person being characterized by a value system. There is a consistency between the person's beliefs and their actions. There is predictability in their value choices. There are two stages in this level. The "generalized set" is the set of attitudes, beliefs, feelings, and actions that comprise a philosophy of life. There is an ethical practice and a professional commitment to a task. "Characterization" is the ultimate step in the internalization process. It is a "lived" philosophy of life.

The Psychomotor Domain refers to the use of motor skills, movement, and coordination. The Bloom research group did not create categories for this group citing a lack of experience in teaching these skills. We make no claims that development of our planning model will vary psychomotor skills in any way.

2.12 General Model of the Learning Process

Table 2.4 General Model of the Learning Process

Stage	Objectives	Tools	Methods
1.	Retention of information	Books, notes, video presentation, computer-based instruction	Lectures, Readings, presentations
2.	Organizing of knowledge	Discussions, debates, cases	Workshops, Case discussions
3.	Experiencing of procedural knowledge	Games, roles, labs	Gaming, Simulation, tutoring, on-the-job training
4.	Firming through evaluation and feedback	Tests, projects	Monitoring, grading, performance evaluation

Learning is typically understood to be gaining knowledge or acquiring and enhancing skills. To many people this implies the lowest stage of Bloom's Taxonomy where information is memorized and then repeated in response to a particular question. This is known as declarative knowledge. Procedural knowledge is that which is gained through experience. It is an ongoing process throughout one's life. The table above breaks the learning process into a series of four stages (Hsu, 1989). Each phase is addressed as part of the modeling process.

1) **Retention of information (Retention)**. This stage involves the receiving of raw information. This information may come to us through various media such as lectures or reading. When we are trying to remember facts, such as the childhood hobby of memorizing baseball player statistics from the back of bubblegum cards, this is the only phase that is necessary. The Delphi and Cross Impact Model instructions are available for the users to familiarize themselves with business continuity/disaster recovery concepts and techniques. The initial disaster events

provide a base library of knowledge suitable for use even when the model is not available.

2) **Organizing of knowledge (Organizing)**. The information that we gain during the retention phase needs to be reorganized to fit our mental model. Discussing the material with peers, participating in a workshop, or performing a case study, are ways to help reformulate the new material into a form that enhances comprehension. Once we have comprehended the information, then it is possible to relate it to new situations. This application to new situations is crucial to the success of training in the field. The model's flexibility allows users to create new event scenarios based on their personal experience and research. The added events make the modeling useful to permit organization of the information to one's own liking.

3) **Experiencing of procedural knowledge (Experiencing)**. Through the use of role-play and on-the-job training, people can begin to use the knowledge that was organized in the second stage. The difference here is that the training goes beyond the scope of mere discussion into actually performing the skill in front of a qualified instructor. As the skill is practiced, the time to perform the skill is reduced and the results become more predictable and accurate. The act of judging following the creation of a base set of event plans will enable us to refine the list.

4) **Firming through evaluation, feedback (Firming)**. The final phase of the general learning model is to provide people with feedback on their performance. The researcher will brief the planners on the quality of their performance in order to correct any habits that inhibit correct execution of the plan. This process helps

the planner to distinguish between the correct and incorrect manner of creating the plan in the context of a particular situation. What is correct in one situation may not be correct in another. Any feedback will help to firm the knowledge gained throughout the refinement of the planning model.

2.13 The Bloom Taxonomy's Role in this Study

Bloom's taxonomy will guide the development of questions and materials given to the participants. We will structure the questions and other parts of the study in a way that most learning objectives outlined in Bloom's Cognitive Domain are used. By the end of the Delphi discussion period we hope that learning has taken place with the following objectives:

1. Identify the incident we are using as the base threat.
2. Classify the risks and actions according to severity.
3. Identify roles and responsibilities used to respond to the event.
4. Identify the steps used by the organization to contain and recover from the event.
5. Recommend the high level measures to prevent or lessen the effects of future incidents.

A case description is to be given to each participant as part of their pre-study surveys. The case description uses Hurricane Sandy as its basis. Each question will be worded in such a way as to adhere to a particular Bloom level. For example, a question such as, "Who or what groups of people will be used to respond to the event?" may be considered as an Application level question (He, Yuan, & Yang, 2013). This assignment of the question to the Application level is based on the use of the word "Used." The keyword “Used” appears in the Application level in the United States Department of Agriculture (USDA) keyword/method list for using Bloom’s Taxonomy.

CHAPTER 3

MODEL DESIGN – CREATING THE PLANNING MODEL

This chapter is a detailed presentation of creating the Emergency Preparedness Planning Model. Section 3.1 develops the objectives of the model. Section 3.2 describes the components of the model that will be developed. Section 3.3 frames the model that will be developed. Section 3.4 lists the assumptions that underlie the development of the model. Section 3.5 explains the components of the model. Section 3.6 presents a diagram of how the plan model flows from initial setup though the output of the results. Section 3.7 provides an analysis and discussion of the planning model, focusing on the limitations, advantages, and disadvantages of the approach we have taken.

3.1 Model Objective

The purpose of this study is to develop a collaborative model of the conditions that small and medium sized businesses on the east coast of the United States face in trying to successfully plan for and mitigate threats that hurricanes/major storms such as Hurricane Sandy present. We use business owners, managers, and a number of professionals with Emergency Management experience. We concentrate on business owners and managers who experienced the Sandy disaster and the on-going recovery process. The Emergency Management experts were used to review the feasibility of various mitigation and preparedness options. The participants volunteered for a recently enhanced Delphi approach that enabled a large group to contribute to the development of a dynamic scenario via a process of the Delphi Method, Cross Impact Analysis (CIA), and Interpretative Structural Modeling (ISM).

The general concept of structural modeling is that a single professional or group of professionals can construct computer-based models without the necessity of knowing computer programming (Lendaris, 1980). The process gives the participants an opportunity to capture their knowledge by supplying information on the relationships between different components of the model. Cross Impact Analysis is an approach to modeling the influence that different events can have on one another. Interpretive Structural Modeling is an approach for determining relationships between goals and objectives.

The CIA approach (Turoff, 1972) uses the concept that probability changes for a given event can possibly influence the probability of other events occurring in a consistent set of events. The ISM approach (Warfield, 1973) deals with goals and objectives and uses a binary classification of having or not having an overall relationship with other goals and objectives. The CIA approach results in a directed graph where the events are nodes and the links between nodes are directed linear influence factors that can range from –infinity to +infinity. The ISM approach also generates a directed graph where each link has a value of "0" or "1." The ISM analysis of the linked nodes can produce clusters of nodes, some of which can be tied together in cyclical paths.

The result of the cross impact analysis is the development of linear factors indicating the influence of the j-th event on the i-th event known as C_{ij}. If the C_{ij} is greater than zero then the occurrence of event j influences the occurrence of event i. If C_{ij} is less than zero then the occurrence of j influences the non-occurrence of the i-th event.

The larger the absolute value of the C_{ij} value the greater the influence of event j on event i. If C_{ij} equals zero there is no relationship. The derivation of this relationship is found in the 1972 paper (Turoff) and in the 1975 Delphi Method Book (Linstone and Turoff, 1975). The result of the Cross Impact Analysis may be viewed as a graph. Events are shown as nodes with links connecting those nodes. The connecting links are directed and have values between plus and minus infinity. The result of the cross impact is the set of C_{ij} values and a set of N equations where *P(i)* is a function of the *P(j)* event for j=1 to N but excluding j=I, which is the same event.

The initial values of *P(i)* in this set of N equations are usually set to *P(i)*=0.5 for all values of *i*. The 0.5 initial value is not static, but can be modified to any value between 0.00 and 1.00 to see the resulting impact on the other calculated values. This ability to view the impact of the changes in values makes Cross Impact a very useful tool for learning about the behavior of the composite model. In addition to viewing the impacts of changed values, it is also possible to create an ordered list for any event from the highest absolute value of C_{ij} to the lowest in order to see which events have the strongest impact on making a single event occur or not occur. The C_{ij} values behave functionally like the log of the odds, which in classical probability theory, is defined as the "weight of evidence" since this function allows linear weighting of the probabilities.

The process of Interpretive Structural Modeling was created to allow people to indicate relationships among similar entities such as goals and objectives. A group would list, for example, the goals of an organization and indicate which were related to each other. The results would be a complex graph with single links between related items and no links between unrelated items. A link had a value 1 and no link had a value 0 in the N by N matrix for N entities. It was possible in this graph to automatically calculate cycles where you could leave a node and come back to it by a cyclic path if one existed. These cycles made it possible to cluster cycles and establish a hierarchy of cycles mathematically.

A blending of the two analysis approaches can be made if we expand the cross impact matrix into a 2N x 2N matrix that separates the occurrence and non-occurrence of each of the N events. Using absolute values for C_{ij}, this 2N x 2N matrix now has only positive values of C_{ij}. We can now take the highest value of C_{ij} and initially link those two events treating the link as if it had the value of 1. We then take the next highest values and continue to link events until a cycle occurs. We continue this process in like manner and look at each evolving set of clusters to see if useful relationships result. One might consider the clusters to be a reinforcing set of relationships where events in a cluster may be treated as a micro-scenario. The events in the micro-scenario no longer have to be treated as separate events but as one grouped cluster. This clustering reduces the complexity of the larger event set and makes possible decisions more obvious. The cluster also makes the use of resources more efficient. For example, if some events represent investments in resources we would hope to stop the clustering before more than one investment event enters the cluster. This avoids duplicate expenditure of limited resources. As we go to lower values of C_{ij} there may be some degree of disagreement by the collaborators about the strength of the influence factor. In cases like this we wish to follow up with the contributors as to why a disagreement exists (Bañuls & Turoff, 2011).

Both approaches being merged together reduce the problem being modeled to a matrix representation where the number of possible relationships is proportional to NxN for N events. This NxN relationship makes it feasible to gather a sufficient number of estimates for each relationship. In the Delphi Process we are using (Bañuls & Turoff, 2011; Linstone & Turoff, 1975), one asks professionals to only make estimates for relationships with which they are familiar. A very recent analysis performed by Turoff, Bañuls, Plotnick, and Hiltz involved 240 relationship estimates that required twenty estimators to complete (Turoff et al., 2014).

In order for business owners and managers to better plan, prepare for, and respond to future disasters like Hurricane Sandy, we will be seeking in the planned Delphi to determine:

1. The most important specific threats and risks to small businesses in areas of the Northeast United States vulnerable to major storms and hurricanes.
2. The possible precautions and preparedness actions on the part of business owners and managers. The group members will rank order the action by projected benefit versus relative feasibility.
3. Related policies and actions that can be taken by state and local governments in the same areas.

All of the above are risks or actions which can be represented as potential events to make up a scenario. Our contributors will see their items expressed as events and they will be asked to rate their relative importance.

An initial list of all three items was obtained from both current literature on Sandy and other related incidents such as the Great New England Hurricane of 1938 (Scotti, 2003). It also included many reports and news items on the problems of business recovery from Sandy. As detailed in Chapter 2, we made use of the Turner framework to help uncover the “failure of foresight” where the lessons learned from the disasters such as the 1938 hurricane were all but forgotten by the time Hurricane Sandy struck New

Jersey (Turoff, Hiltz, Bañuls, & vandenEede, 2013). Even at the time that the Turner article was written, lessons from past disasters were forgotten. As one example, the disaster at Aberfan, Wales in 1966 was in part caused by building the coal tip over a fresh water spring turning the coal into a mud slurry avalanche. A similar accident occurred in 1939 in Cilfyndd, Wales where another coal tip turned into a coal slurry avalanche (Bentley et al., 1998). The lessons were documented, but either forgotten or ignored.

This compilation from both current literature and some news sources will be presented to the invited contributors. We asked them first to contribute any additional options not on the initial lists. We also asked them to rate the desirability in terms of potential benefits and feasibility of the initial list of preparedness actions and mitigation policies. These government policies included such things as land use regulations. For example, changes in land use regulations that helped promote urban sprawl, also contributed to increased flooding (Sohl & Ohl, 2012). Additional factors such as the crumbling American infrastructure were included to examine their influence (Kemp, 2008). The current infrastructure grade given to the United States by the American Society of Civil Engineers (ASCE) is D+ (American Society of Civil Engineers, 2013). The ASCE bases its grade on an evaluation of aviation, bridges, dams, levees, and twelve other categories. We also interview potential respondents to help generate part of the material we needed. This investigator has become active in organizations with business members who went through the Sandy experience. These organizations include the Meadowlands Regional Chamber of Commerce and the New Jersey State Chamber of Commerce.

In doing a Delphi of this type, it is important that the respondents understand that the investigator knows the obvious things that have already appeared in the literature or news. We do not want the participants to waste time educating the investigator. They do want to know that they will be collaborating with a peer group that might provide new, important insights for them as part of their planning process (Linstone & Turoff, 1975). We will also ask the respondents to suggest other participants that they know, who went through similar situations.

The second round presented the vote lists from the first round and gave everyone a chance to vote on the new items. The new items were the entries in the free text boxes that appeared in each category in the first round survey.

Based on the entries in the first two rounds of material we gathered, we were prepared to do a very short third round to investigate any strong disagreements among the contributors. Disagreements are very important products of typical Delphi exercises. When one collects professionals from the "same" professional areas there can be some unusual disagreements. Those disagreements can be very important to explore and reach an understanding of what rationales underlie the disagreements. Questions on feasibility usually lead to some significant disagreements. A third round was not necessary as no new items were suggested.

It is not unusual during the Delphi process for professionals in the same discipline to disagree about specific areas. A literature search made during a 1970 Delphi conducted by the National Materials Advisory Board of the National Academy of Science and Engineering (Goldstein, 1975) on the future of the Steel and Ferroalloy Industry determined that only about nine variables in the Steel and Ferroalloys area were regularly reported every year. Nine variables provided very little insight into the nature of the current industry, let alone trying to project its future. The Office of Emergency Preparedness was called in to conduct the project. Over 40 planners in the industry representing 40 different companies participated.

Three of these planners were invited to a three day workgroup to try to prepare a simplified flow diagram of materials used by the industry. The diagram showed 25 process flow links from raw materials to finished forms of steel, including all the Ferroalloys collected for emergencies in the National Stockpile of strategic materials. The nine reported flows were filled in for the prior year and the diagram was sent to the 37 other planners asking them to fill in the missing 16 flows. Estimating the previous year's material flow before looking at the future of this industry was thought to be a great accomplishment. The other participants did not do what was asked. More than 20 of them attempted to redo the diagram because they felt it was not a good simplification of the industry even though three of the planners who developed the original diagram came from very large companies. Disagreements abounded yielding much more insight into the planning process.

Another example of how disagreement can yield additional insights is a recent model on how Critical Infrastructures relate to one another in a disaster situation. The Critical Infrastructures model was built using sixteen dynamic events occurring during the time period of the disaster. The model showed two hundred forty relationships between the sixteen events with one hundred eighty-five showing some amount of disagreement. The resulting distribution of the estimates made by 7 knowledgeable professionals had the following distribution of the relationships (Turoff et al., 2014):

Table 3.1 Summary of Disagreements and Conflicts

Number of .5 choices	Disagreement (majority>+1)	Conflict (tie to +1 out of 7	Consensus	Total
0	0	0	29	29
1	54	1	0	55
2	21	31	0	52
3	13	40	0	53
4	23	1	0	24
5	1	0	0	1
Unanimous	0	0	26	26
Total	112	73	55	240

Table 3.1 shows the summary of the disagreements and conflicts that occurred during the Critical Infrastructure study. A probability of an interaction between events is given 0.5 if no relationship exists between them. Consensus is assumed when a majority of those voting for a relationship agreed. The first column is the number of "no relationship" choices out of seven participants responding. "No relationship" is defined as a probability of 0.50. Not everyone votes on all items, as they are told to only vote on areas they feel confident. The results in Table 3.1 have been augmented to twenty respondents. The number of strong conflicts with the augmented results is still in the range of ninety relationships. Strong conflict relationships have a smaller influence factor when determining the ISM results and relationships. Figure 3.1 shows the resultant ISM influence graph of the events.

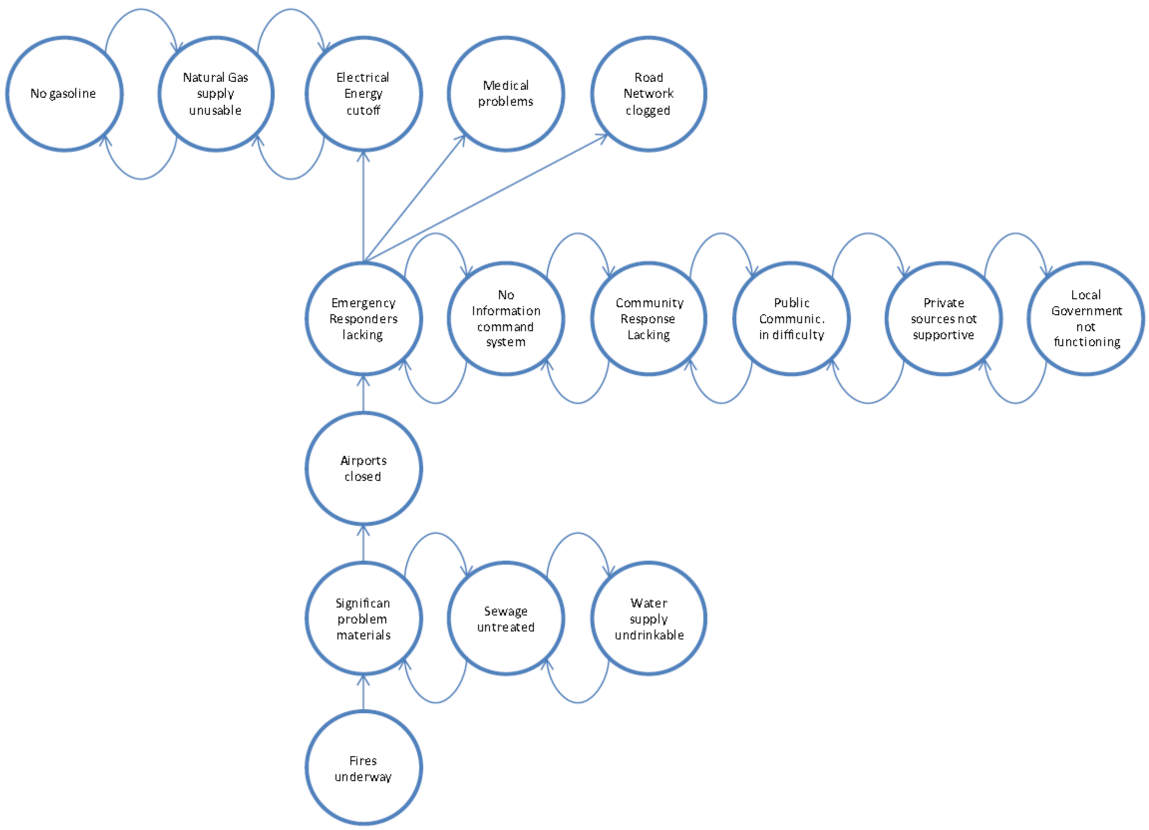

Figure 3.1 CIA – ISM diagram.

3.2 Components of the Model

A CIA model has three types of events. They all are given an initial probability of .5 which is the zero point of probability. At 0.5 there is an equal chance of an event occurring or not occurring. There is also no assumption of influence over other events.

The first type of event is the initial conditions at the start of the period during which the disaster happens. These are things that reflect significant aspects of possible mitigation or preparedness that are the results of actual investments in infrastructure such as reinforcing dams or the enacting of new policies such as improving building codes to minimize water damage. These initial condition events can influence the probability of the dynamic events or the outcome events. The dynamic events are the ones that can change values of probability based on the initial conditions and can influence outcome events during the period between the start of the disaster until the beginning of recovery operations. The outcome events are the ones that have a final value of probability based upon the changes to the other types of events. In a recent article (Bañuls et al., 2013) about the impact of a dirty bomb in an urban area, eighteen total events are divided into four initial, ten dynamic, and four outcome events. These events are shown in Tables 3.2a, 3.2b, and 3.2c.

Table 3.2a Events of the Dirty Bomb Scenario-Initial Conditions

No.	Event	Description
IC1	Decontamination Preparedness	There are enough trained people, hand held detectors, and portable decontamination units to equip responder units and to decontaminate at least 1000 people per hour.
IC2	Bomb Assessment	The equipment brought to any bomb explosion site by the police includes a radiation detector as a standard requirement.
IC3	Bomb Recognition	Firemen are trained to recognize indictors of a bomb-generated explosion.
IC4	Public Trust	The public trusts the decisions of the local leadership and will follow their requests for public behavior in emergencies.

Table 3.2b Events of the Dirty Bomb Scenario-Dynamic Events

No.	Event	Description
DE1	Bomb Recognition	A fireman with training recognizes bomb fragments within the first hour after the explosion.
DE2	Medical Recognition	A medical responder has demanded a radiation detector within the first hour after the explosion.
DE3	Threat Recognition	There is recognition of a radiation threat in the first four hours of the event.
DE4	Military Control	The military under national government command takes charge of the situation within the first 12 hours.
DE5	Center Cleared	The shopping center is cleared of all non-injured individuals within the first hour.
DE6	Official Recognition	The leadership of the city and province declare a province-wide emergency by the fourth hour after the explosion to all other local and national government bodies.
DE7	Containment Action	A containment effort for everyone in the possible contamination area is undertaken by the third hour by police and other emergency personnel.
DE8	Leadership Disagreement	The city leadership does not agree to notify the public immediately upon determining there is a radiation contamination problem.
DE9	Press Leak	The public is first notified of the radiation problem by a radio/TV reporter who is leaked the information by some unknown person.
DE10	Makeshift Decontamination	Makeshift/make-do decontamination centers are set up and made operational beginning in the fifth hour and stretching over the next twelve hours.
DE11	Public Panic	There is a rush to leave the city by any means possible as public panic sets in.
DE12	Non-Responders	A significant number of trained people refuse to carry out the decontamination procedures because there is no protective clothing and accessories for them to wear and use.
DE13	Internal Contamination	Emergency medical treatment facilities are set up by the military for holding people with internal contamination for treatment.
DE14	Public Refusal	Many people refuse to wait in lines for contamination checks and leave the holding area without permission.

Table 3.2c Events of the Dirty Bomb Scenario-Outcome Events

No.	Event	Description
OE1	City Isolation	The total city area is quarantined from the rest of the world until contamination detection is conducted for all citizens and physical areas.
OE2	Income Loss	The sum of the costs of this event and the income loss to the city is very large in terms of the Gross National Product contribution of that city to the national income for one year.
OE3	Short term Success	About 80% of those estimated as contaminated are detected and decontaminated in the first 24 hours.
OE4	Public Trust	The public trust in local leaders after the emergency is high, so the public is cooperative and trusting in the advice and directions of the city leadership in the post-crisis stage.

Besides the resulting ISM model, it is possible to take a given event and use the results of the analysis to list the most important linear influencing factors determining the final outcome. This quickly shows what events are most influential in bringing about an outcome of the event being examined.

A similar model will be developed for this study based upon the results of the Delphi. The expert respondents were given a chance to ask about the relationships for the event set in the following way:

They were asked what they thought the real probabilities were of the events currently in the set. They were then asked to indicate which events they felt they knew something about with respect to the interactions of that event with at least some of the other events. When they actually estimated the relationship between events given that one occurs or does not occur, the impacted event will be assumed to have an initial 0.5 probability. The survey instructions indicated what they needed to assume for event *i* so that it would certainly occur or certainly not occur. They were asked to assume the opposite of their inclination in making their response. They needed to think about the maximum change or consequence and then gave a new probability for each interaction they felt they could estimate. For example, what is the probability of a bomb being recognized on the street given that there is a moderate level of Public Trust?

The ultimate result of this process was a set of equations where there was a probability for each event that could be computed from the values of the other probabilities in the set. Such a model allowed users to change the initial probability of 0.5 assigned to all the entries in the set and see how the others were affected. Therefore one could evaluate the impact of making a change in any of the initial events or investments and any of the dynamic events to see the impact on the output events. Such a model could be used as a learning tool or a decision tool depending on who was using it and for what purpose.

3.3 Framing the Model

The US Federal Emergency Management Agency (FEMA) categorizes disasters as having four phases. Those phases are:

1) **Mitigation**: This phase includes steps that reduce the vulnerability to a disaster's impact. Examples include changing building codes to fortify structures against earthquakes or changing land use regulations so that buildings are not constructed inside of a flood plain.
2) **Preparedness**: This phase focuses on understanding how a disaster might impact a business, a community, or other entities. This phase includes the planning for disasters and the education of potential victims. This is the phase on which this study will concentrate.
3) **Response:** This phase addresses the immediate needs of the disaster. These include saving lives, providing food and shelter, and implementing the plan to recover a business.
4) **Recovery:** This phase executes the restoration of all aspects of business and personal life. A stable situation and a sense of normal life are created (Martin, 2008).

FEMA describes the disaster management process in four phases, while other literature uses between four and eight phases. Almost all literature uses the basic four phases that FEMA espouses, but others split "identification" and "planning" from mitigation and preparedness into their own separate parts. Other literature adds "early warning" as a phase between preparation and response (Van der Walle, Turoff, & Hiltz, 2010). Senior European Union (EU) project officers have used the following expanded phase framework to guide disaster management:

1. **Awareness and Prevention:** This phase is where hazards are modeled and predicted, risks are assessed and e-Learning programs are administered.
2. **Preparation:** This phase is where monitoring and early warning takes place, scenarios are developed, and people are trained.
3. **Alert:** This phase utilizes Decision Support Systems (DSS) to enact a particular scenario for which emergency responders have been trained. Alarms are sounded through all media and secure telecommunication systems.
4. **Immediate Response:** Emergency telecommunications are used to create a command and control structure. Situational awareness is raised. Emergency resources are dispatched. Additional communications with the general public is initiated.
5. **Sustained Response:** Interventions are made to restore critical infrastructure functionality and to meet community and social needs.
6. **Recovery:** Lessons learned through the event are recorded. Scenarios are updated to more accurately reflect reality. Socio-economic and environmental assessments are performed. Rebuilding efforts begin.

Both FEMA's and the EU's Phase 2, Preparedness, emphasize creating plans or scenarios and educating potential victims. For our study we will blend and extend the FEMA and EU phases as follows:

1) **Mitigation**: This phase includes actual investments and policies that reduce the impacts of a disaster.

2) **Planning**: This phase focuses on planning how best to prepare for and handle an actual disaster. This is the phase on which this study will concentrate.

3) **Training**: This phase educates and rehearses responses to disaster events.

4) **Preparedness:** This phase is where monitoring and early warning takes place, scenarios are developed.

5) **Response:** This phase addresses the immediate needs of the disaster. These include saving lives, providing food and shelter, and implementing the plan to recover a business.

6) **Recovery:** This phase executes the restoration of all aspects of business and personal life. A stable situation and a sense of normal life are created (Martin, 2008).

7) **Evaluation:** A determination is made as to what went wrong and how similar situations might be avoided or mitigated.

Our model development concentrated on the planning stage. In broad terms, the model was developed using the following steps:

1) **Develop Scenario:** Write background material listing risks and possible mitigation actions.

2) **Develop Initial Surveys:** Write questions to establish base experience in developing a business continuity/disaster recovery plan.

3) **Invite Participants:** Invite participants from a variety of business organizations and contacts. The groups to be contacted include members in the Meadowlands Regional Chamber of Commerce and the New Jersey State Chamber of Commerce.

4) **Conduct Delphi Study:** Give a base list of possible risks and mitigation actions to the participants. Ask them to add or eliminate items. Ask for the reasons that participants add or eliminate items from the list. The process is repeated for two to three rounds until a consensus is reached on a final list.

5) **Conduct Cross Impact Analysis Study:** Ask a panel of expert judges to assign probabilities to the most important risks and their interactions.

6) **Create Interpretive Structural Model:** Use the results of the Cross Impact Analysis Study to create a set of ISM scenarios.

7) **Analyze Results:** Analyze and interpret the results of the data.

8) **Document Results:** Write final report.

Details of the exact questions and calculation criteria can be found in Chapter 4.

The study administrator created the base list of risks and actions, sent the participants their invites, and supported all aspects of the study.

3.4 Assumptions

The design of the model is based on several assumptions about the real world. These assumptions are:

(a) *Costs of creating a business emergency preparedness plan must be taken into account before implementing a strategy.* The cost of creating a plan and the costs to implement a plan need to be considered before a final plan is created. Resources are not infinite. A plan that is more expensive to create than the business is worth will never be implemented.

(b) *Events occur only once.* Once an event occurs, it cannot occur again. This is one of Dalkey's prime assumptions for Cross Impact Analysis. Once a particular event is evaluated, a different event must be considered to further develop the planning model.

3.5 Components of the Model

The process used for this study adds to the cross impact methods and modeling algorithms from the earlier works by Lendaris and Turoff (Lendaris, 1980)(Turoff, 1972). In addition, this process captures knowledge needed to utilize the subjective estimations of experts for the construction of a business continuity/disaster recovery plan. The CIA-ISM work by Bañuls and Turoff guides the creation of the scenarios (Bañuls & Turoff, 2011).

The process has two main benefits that we hope to confirm by this study.

1. To aid small business owners in analyzing the need for new resource investments to better prepare for business interruptions.

2. To allow business owners and planners to develop their knowledge in creating business continuity/disaster recovery plans through the preferences of experts in the field.

The emergency events and the cross impact factors will utilize survey websites to gather the information during this study. The number of participants used for the model development will be of a sufficient size to underscore the improvement possibilities. The surveys used to gather the risks, mitigating actions, and their relative probabilities are detailed in Chapter 4 and Appendices D, E, G and J.

3.6 Model Flow

The information gathering process is outlined in Table 3.3 and Figure 3.2.

Table 3.3 Business Emergency Preparedness Model Flow and Description

No.	Item	Description
1.	Develop Scenario	Write background material using business interruption as the base threat case.
2.	Develop Initial Survey	Write questions to establish base experience in developing a business continuity/disaster recovery plan.
3.	Send Invitations	Send study invitations to a list of small business owners and planners.
4.	Create Users	Create survey User ID’s and password for each accepted invitation.
5.	Take Pre-survey	Provide each participant with a baseline survey prior to inputting survey answers.
6.	Define Base Risks and Actions	Create the list of high level risk and action categories that will be used during the Delphi study.
7.	Create Delphi Surveys	Create Delphi surveys and give to each participant.
8.	Modify Risk and Action List	Change risk and action list based on the result of the Delphi study.
9.	Ask Participants for Modifications	Give participants the revised list of risks and actions for input of their relative probabilities. Give summary results of the first round.
10.	Create Interaction Survey	Create survey to capture the subjective interaction estimates for the panel of experts. The participants assign the probability of influence between pairs of events for which they are familiar.
11.	Perform Cross Impact Analysis	Enter the aggregated values of the event interactions into the Cross Impact software.
12.	Create Interpretive Structural Model	Analyze the results of the Cross Impact Analysis to form ISM scenarios.
13.	Take Post-survey	Provide each participant with a post participation survey following the entry of Cross Impact estimates.
14.	Analyze Results	Analyze the results of the model. Any needed revisions are made to the software and data.
15.	Document Results	Document the results of the project.

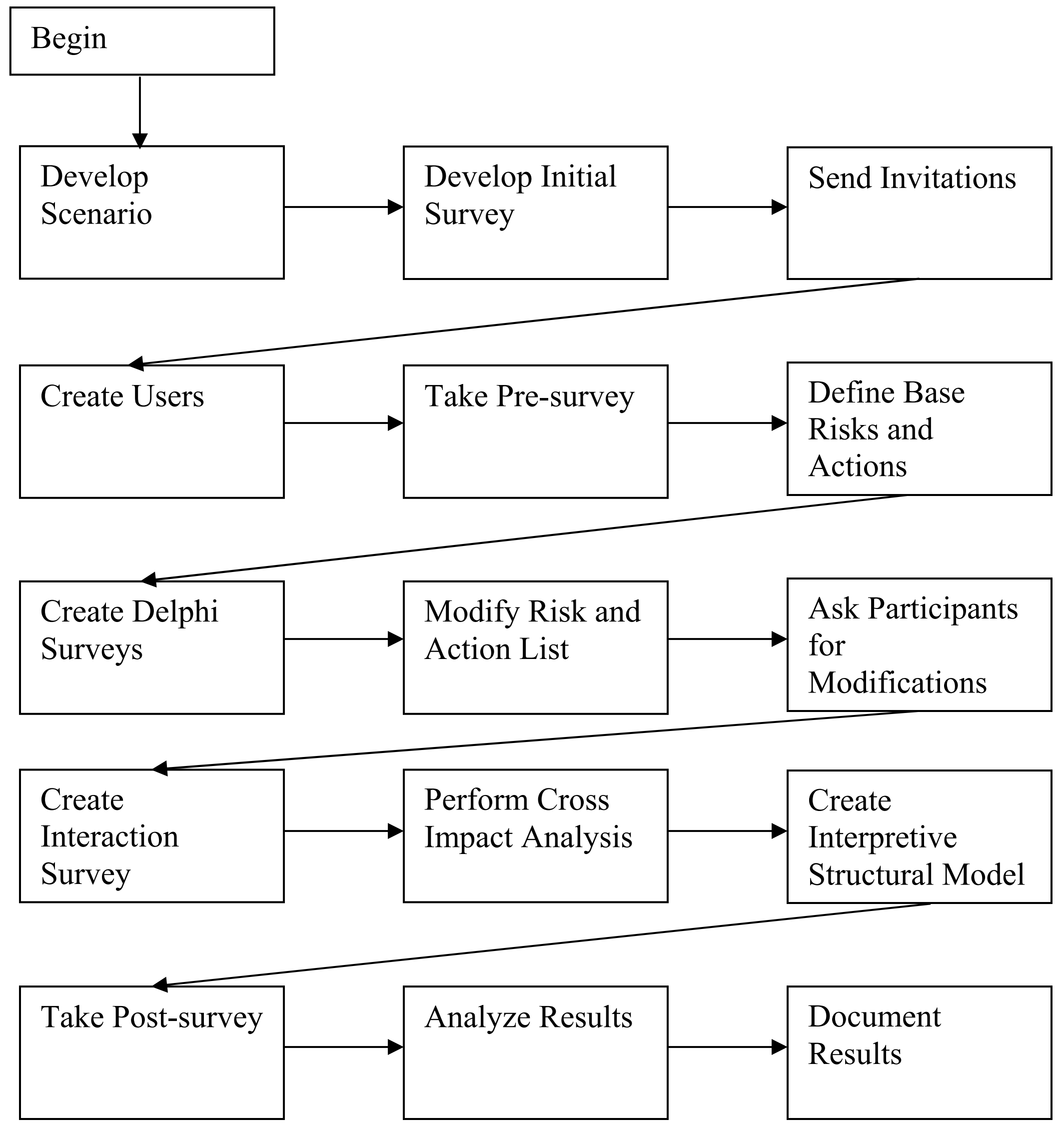

Figure 3.2 Model flow diagram.

3.7 Analysis/Discussion

This section presents a discussion of the planning model process. The discussion focuses on limitations and advantages/improvements that the model brings compared to previous approaches. The underlying planning model is described.

This study creates a new process for the creation of a small business continuity/disaster recovery plan. This new process combines the Delphi Method, Cross Impact Analysis, and Interpretive Structural Modeling to provide a basis for BC/DR plans to small businesses for the first time. According to Norman C. Dalkey, "Cross-impact analysis revises estimated probabilities of future events in terms of estimated interactions between those events" (Dalkey, 1975). Two properties define an event. First, the event can occur only once in the time frame under consideration. Second, the event may not happen at all. All the planning for a disaster may never be used. If the BC/DR plan is actually implemented, the lessons learned during the business interruption will certainly be used to prepare for another event. In this sense the event only occurs once.

The Delphi Method is well suited for this study. The ability to have an open discussion regarding factors that may or may not affect a business during a disaster is paramount to the group learning that goes on during a Delphi round. The discussion centers around the base list of events as provided by the Administrator. Participants can then discuss which events should be added to the group and which ones should be removed. The final list was culled to approximately 25 top-ranked events. The top ranked events form the basis for the Cross Impact portion of the study.

Cross Impact is well suited for the analysis of the resultant event set. When considering N non-recurrent events, there is a set of 2^N outcomes or states that range from no events occurring to all events occurring. If we are in a state where a set of K events has occurred, then we can have at most N-K remaining transitions where K+1 events have occurred. In Figure 3.3, for example, there are a total of eight events, numbered (0,0,0) through (1,1,1). N is eight. If one is at the event (0,0,0), K=1, as it is the first event visited. There are N-K possible events one can visit when you leave the (0,0,0) box. In this case 8, the total number of boxes, -1, the boxes you have visited, = 7, the possible number of future boxes that you could visit. If you count the boxes to the right of (0,0,0) there are indeed seven event boxes. Once out of a particular state, the event can never occur again. For example, once a fire begins, the identical fire cannot begin again. For the total of 2^N states, the number of transition paths is given by $N2^{N-1}$. For a set of three possible events, the number of states is given by $2^3 = 8$. The number of transitions is given by $3*2^{3-1} = 3*2^2 = 3*4=12$. This is shown in the diagram below:

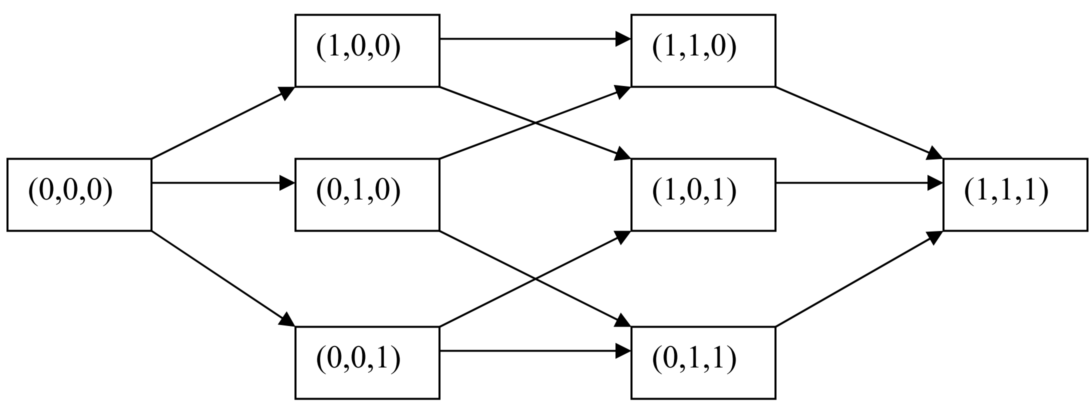

Figure 3.3 Transitions and states for three events (1,2,3) (Turoff, 1972).

As N exceeds 3 the feasibility of asking for individual event probabilities becomes impractical, if not infeasible. The cross impact method simplifies the task in two ways.

1) The number of questions is limited to N^2 for N events.

2) The two types of questions that are asked about the causal relationship are intuitive.

The questions asked of all N events are:

1) What is the probability that an event, *i*, occurs before some future point in time?

2) What is your answer to question 1 if you assume that a different event, *j*, is certain to occur?

Question 2 imposes a constraint on the transition probability estimates that the sum of all transition probabilities leaving a state where the *j-th* has not occurred is equal to 1. It must be noted that these conditional probabilities are not in the formal probability sense. They are a causal probability that provides a relative measure of the degree of causal impact that one event has upon another.

The numeric results in the following ten event model come from the 1972 paper by Turoff. It is a ten event model about the economic future of the United States developed by a young economist. He created the event set and estimated the probability relationships. Some of the positive events for a good future outcome have yet to be accomplished, e.g., greatly simplifying the United States income tax system.

Sample input is given in Table 3.4.

Table 3.4 Sample Cross Impact Data

Event i	Overall Probability P_i	$\Phi(P_i) = \ln(P_i/(1-P_i))$, For i=1 to N	Given i=1, Value of j in last two columns, R_{ij} and S_{ij}	Conditional Probability given event 1 is certain to occur, R_{ij}	Conditional Probability given event 1 is certain not to occur, S_{ij}
1	0.50 (default)	0.000	1	1.00	0.50
2	0.30	-0.847	2	0.25	0.36
3	0.60	0.405	3	0.55	0.65
4	0.50 (default)	0.000	4	0.40	0.60
5	0.40	-0.405	5	0.30	0.51
6	0.30	-0.847	6	0.40	0.22
7	0.60	0.405	7	0.55	0.65
8	0.20	-1.386	8	0.10	0.36
9	0.10	-2.197	9	0.05	0.19
10	0.60	0.405	10	0.55	0.65

NOTE: P_i values are from (Turoff, 1972), page 358. R_{ij} and S_{ij} values are from (Turoff, 1972) page 359.

The upper and lower limits of the causal probabilities, P_i's, for all i can be calculated using Equation 3.1.

$$(P_i - 1 + P_j) / P_j <= P_i <= P_i / P_j \tag{3.1}$$

Column 2 in Table 3.4 shows P_i, the overall probability estimate of an event occurring. The odds of occurring, O_i, is the ratio of the estimated probability of the event occurring to the probability of same event not occurring. The formula for O_i is given in Equation 3.2.

$$O_i = P_i / (1 - P_i) \tag{3.2}$$

The occurrence ratio, $\Phi(P_i)$, known as the "weight of evidence," is the natural log ratio of two mutually exclusive events occurring. In our case, the mutually exclusive events are the probability estimate of occurring, P_i, as given by a participant and the probability of that event not occurring as given by $(1 - P_i)$. Equation 3.3 shows the formula for the occurrence ratio.

$$\Phi_i = \Phi(P_i) = \ln(O_i) = \ln(P_i / (1 - P_i)) \tag{3.3}$$

Equation 3.3 is comprised of the sum of all of the influences of events explicitly estimated that enhance the likelihood of an event occurring or diminish the likelihood of an event from occurring plus any outside influences of other events not explicitly estimated. The influence of explicit events is known as C_{ij}. The influence of unstated events is known as G_i. Equation 3.4 shows these two influences.

$$\Phi(P_i) = \ln(P_i /(1 - P_i)) = G_i + \sum_{k \neq i}^{N} C_{ik} P_k \tag{3.4}$$

If we assume that the j-th event is certain to occur, we may define

$$R_{ij} = P_i \text{ for } P_j = 1 \tag{3.5}$$

$$\Phi(R_{ij}) = \ln(R_{ij} / (1 - R_{ij})) = G_i + \sum_{k \neq i,j}^{N} C_{ik} P_k + C_{ij} \tag{3.6}$$

Subtracting Equation 3.4 from Equation 3.6 and solving for C_{ij} yields:

$$C_{ij} = 1 / (1 - P_j) * [\Phi(R_{ij}) - \Phi(P_i)] \tag{3.7}$$

Assuming an event j is certain not to occur, we may define

$$S_{ij} = P_i \text{ for } P_j = 0 \tag{3.8}$$

Using the same technique as the derivation of R_{ij}, yields:

$$C_{ij} = 1 / (P_j) * [\Phi(P_i) - \Phi(S_{ij})] \tag{3.9}$$

Combining Equations 3.7 and 3.9 provides a way to calculate Cij as shown in Equation 3.10.

$$C_{ij} = \Phi(R_{ij}) - \Phi(S_{ij}) \tag{3.10}$$

When all C_{ij} values have been calculated, we may determine G_i using Equation 3.11.

$$G_i = \Phi(P_i) - \sum_{k \neq i}^{N} C_{ik} P_k \tag{3.11}$$

The resulting calculation for C_{ij} yields the relative impact of one event upon another. The calculation of Gamma or G_i shows the impact of other events not considered explicitly in the model. The calculation results are shown in Table 3.5 (Turoff, 1972).

Table 3.5 Sample Cross Impact Results

Event	**P_i**	**$\Phi(P_i)$, For i=1 to N**	**R_{ij}**	**$\Phi(R_{ij})$**	**S_{ij}**	**$\Phi(S_{ij})$**	**C_{ij}**	**G(1)**
1	0.50 (default)	0.000	1.00	N/A	0.50	N/A	N/A	+0.23
2	0.30	-0.847	0.25	-1.10	0.36	-0.58	-0.52	
3	0.60	0.405	0.55	0.20	0.65	0.62	-0.41	
4	0.50 (default)	0.000	0.40	-0.41	0.60	0.41	-0.81	
5	0.40	-0.405	0.30	-0.85	0.51	0.04	-0.88	
6	0.30	-0.847	0.40	-0.41	0.22	-1.27	0.88	
7	0.60	0.405	0.55	0.20	0.65	0.62	-0.41	
8	0.20	-1.386	0.10	-2.20	0.36	-0.58	-1.62	
9	0.10	-2.197	0.05	-2.94	0.19	-1.45	-1.49	
10	0.60	0.405	0.55	0.20	0.65	0.62	-0.41	

Note: Subscript i in P_i and $\Phi(P_i)$ is equal to 1 to N. Subscript i in R_{ij}, $\Phi(R_{ij})$, S_{ij}, $\Phi(S_{ij})$ is equal to 1, while subscript j varies from 1 to N. N equals 10 in this table. The G value is calculated for i = 1. The balance of this table may be found in (Turoff, 1972).

Once calculated, the output from the Cross Impact Analysis can be used by Interpretive Structural Modeling software to uncover high value scenarios. The structure of the directed graphs in the ISM output portrays the complex interactions between events. It is these high valued interactions that may act as the basis for the high valued events worthy of investment. With limited resources, small businesses must concentrate on disaster protection schemes that afford the greatest amount of protection (Sushil, 2012).

Dalkey's two properties lead to advantages and disadvantages of using this process to create a model (Dalkey, 1975).

The process is limited in several ways:

1. **Face value results**. The simplicity of receiving results may leave users, especially novice planners or new business owners, with a sense that the steps to improve their preparations for disaster should be made without interpretation. As with all tools, our process is an aid to predicting what areas should be modified to improve the plan. It is not the final word.
2. **Human estimates**. The model results are limited by the probabilities input into the system. The speed of calculation afforded by modern computers may only allow the user to misallocate resources more quickly.
3. **Non-recurring events**. Events cannot occur more than once. Once an event is selected, you may not choose it again. In the real world, a fire may re-ignite. A second storm may follow the first one causing more interruptions.
4. **Data collection fatigue**. A ten by ten matrix requires 90 conditional probabilities as well as 10 base event probabilities to be judged. As the event set increases, the number of probability estimates may become overwhelming (T. Gordon, 1994).

The limitations are counterbalanced by the advantages of using this process:

1. **Simplicity**. The underlying Delphi Study and Cross Impact Analysis algorithm are easy to use. Once events are decided and probabilities are assigned to events, interpreting results is relatively simple. Large positive numbers in the CIA results table speak to events that need more resources allocated. Large negative numbers may be interpreted as events less likely to have a negative effect on the business.

2. **Efficiency.** The process allows the users to explore interactions and their impact by adding to the base list during the Delphi process. What-if analysis can be quickly performed by changing probabilities and rerunning the mathematical model. For this study, the final model will be run by the Administrator. These results will then be used as input into the ISM software to uncover possible scenarios.

3. **Default values.** The process provides default values to help minimize the input of all probabilities. This allows the subject to concentrate on the most important interactions with which they are most familiar.

CHAPTER 4

RESEARCH APPROACH AND METHODS

This chapter describes the evaluation framework and procedures that will be followed for the creation of the BC/DR planning model. It presents how the Delphi Method, Cross Impact Analysis, and Interpretive Structural Modeling will be used in combination, the research questions, tasks for small business owners and data evaluators, survey questions, and how the model data will be processed.

4.1 The Delphi Method, Cross Impact Analysis, and Interpretive Structural Modeling

Where traditional research looks to create generalizations based on experimental results, this research aims to "produce and apply knowledge of tasks or situations in order to create effective artifacts" to improve practice (March & Smith, 1995).

To create the basis for a disaster planning model, we use small business owners, a community of practice that cuts across different types of businesses, to assist in this iterative process. It is often the case that the creation of the business continuity/disaster recovery plan falls on the owner of the business or a set of individuals that are affiliated with different organizational units or groups within a business. Each person is responsible for a different aspect of the plan grouped into a professional network.

An overview of the methods employed in this study is shown in Table 4.1. The sections that follow explain the successive use of Delphi, Cross Impact, and Interpretive Structural Modeling in more detail.

Table 4.1 Research Model Evaluation Steps with Objectives and Methods

Evaluation Step	Objective	Method
Delphi Method	Determine event set	• Surveys • Expert opinion
Cross Impact Analysis	Determine interaction probabilities of the events	• Surveys • Modeling software
Interpretive Structural Modeling	Find scenarios	Modeling software

4.2 Research Model/Framework

We use a blending of several evaluation and analysis approaches to create the basis for the BC/DR plan. The three approaches that are used are the Delphi Method, Cross Impact Analysis, and Interpretive Structural Modeling. The use of blending multiple methods to perform research is not without precedence. Vaishnavi and Kuechler's work (Vaishnavi & Kuechler, 2004) promotes the idea of using multiple methods to create artifacts when using the design science approach. The use of multiple methods blended together has been advocated as beneficial by both Mingers (Mingers, 2001) and Nunamaker (Nunamaker, Chen, & Purdin, 1991). More detail of the approaches being used is found in Chapter 3.

The model shown in Figure 4.1 depicts the steps involved in this study. At each level, information gathered in one phase will drive the next phase. At any point, a problem that is discovered will be reported to the lead researcher for consideration on how to correct it.

The following section depicts the final evaluation method for this study.

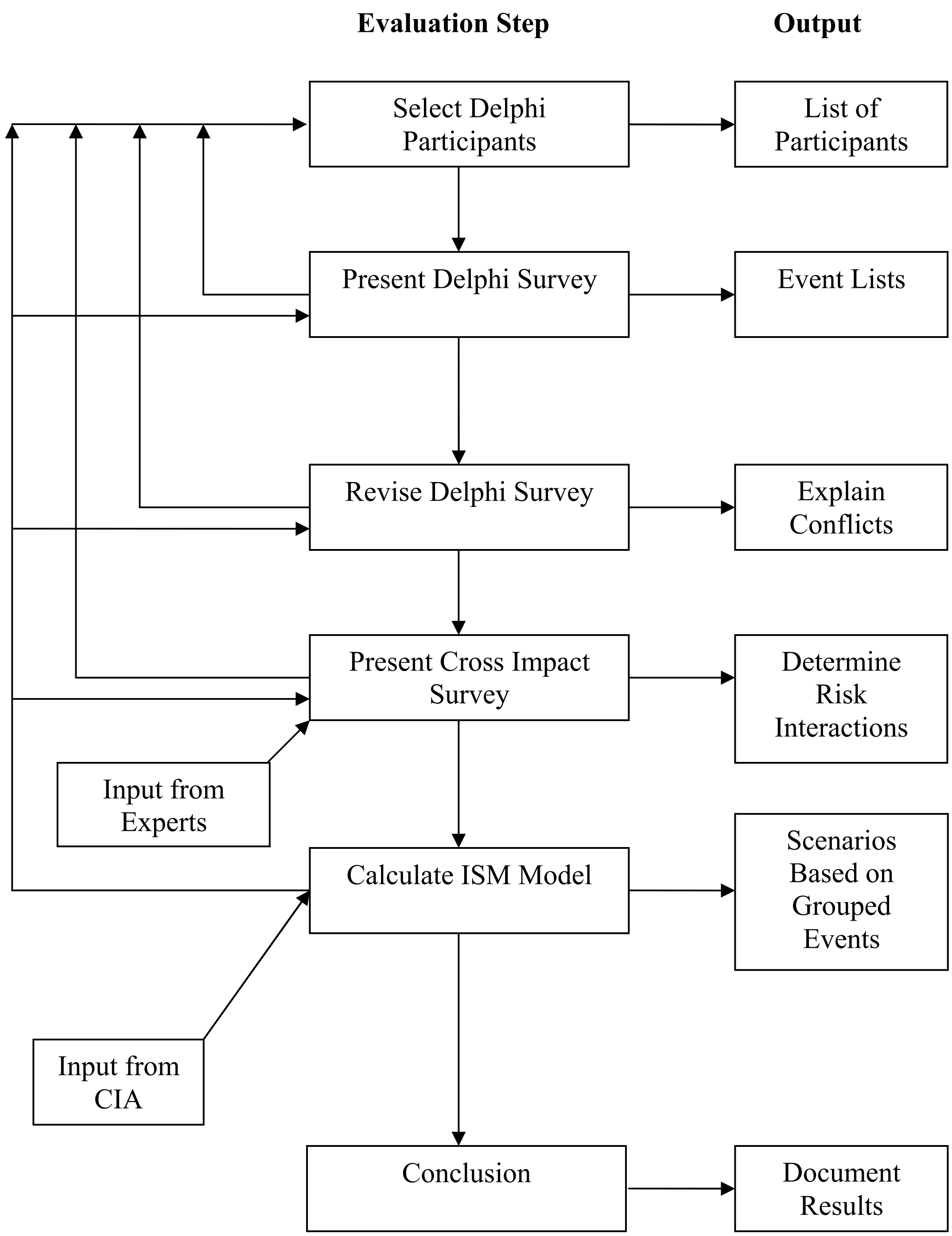

Figure 4.1 Research model flow.

4.2.1 Select Delphi Participants

The Delphi method (Dalkey, 1975) is well established and is a proven method for gathering information that is either difficult or impossible to gather with other techniques. In addition to posing questions anonymously to the selected group and then summarizing the results for the next round, we extend the traditional Delphi Method with a process known as snowballing (Herrmann, 2011). Snowballing is the use of current participants to help find new participants. The researcher reviewed the suggested participant on a case by case basis to determine if he/she met the qualifications and if qualified, allowed them to join the research (Linstone & Turoff, 1975).

The participants for the Delphi and subsequent phases were selected from personal and professional contacts. The participants were selected from small business owners or other managers that had business responsibility for business continuity and disaster recovery. We looked for business owners and workers that had been in business for at least three years. Potential participants were identified from the rolls of the Meadowlands Chamber of Commerce where the researcher served as the past Vice Chairman of the Technology Committee. Additional participants were invited from business contacts in other organizations such as the New Jersey State Chamber of Commerce and the ChemParma business group whose members were associated with the Chemical and Pharmaceutical industry. An email shown in Appendix B was sent to invite them to participate. A minimum of 100 emails were be sent in the hope of identifying 50-80 participants. Many more emails were sent when the minimum number was not initially satisfied. The research committee was also leveraged for names of more potential participants. More invites were sent to try to supplement participants who left the study between phases.

The first set of emails was selected from the membership list of the Meadowlands Regional Chamber of Commerce. Fifty companies were be solicited for the pilot, with that hope that 10 participated. The initial selection was made by selecting the first company email and then every tenth company, until a total of 50 invites was made. When the end of the list was reached, we went back to the top of the overall list and started over by selecting email record number 2 and then proceeding once again with every tenth company until we reach another 50 emails sent. This process continued until we reached our participation number. The grouping of emails into blocks of fifty reduced the chance that a spam alert was raise by the internet hosting provider that could have blocked the release of future emails.

When we did not reach the expected number of participants, additional lists were used to supplement the Meadowlands Regional Chamber of Commerce membership. Emails were selected in sets of fifty, taking every tenth email. The emails were taken from the membership lists of the New Jersey State Chamber of Commerce, the ChemPharma networking group, the NJ Better Business Bureau membership list, and personal business contacts mailing lists developed over the author’s twenty-eight years in business. Selections were limited to companies in New Jersey, New York, Connecticut, Pennsylvania, Delaware, and Maryland.

4.2.2 Present Delphi Survey

The problem identified in the current research is the difficulty of developing a business continuity/disaster recovery plan using expert knowledge of small business owners to create the model. BC/DR planning is commonly divided over a group of people that may or may not be co-located within a reasonable distance. Our approach is used to create models over a wide area. The research attempts to assist small business owners in their creation of BC/DR plans by developing a cross impact model and a series of scenarios generated by ISM software based on their judgments. The first round of the Delphi asks participants to review a list of risks and mitigation actions. Relative rankings are assigned to the list items. They were also asked to add to these lists based on their experiences and knowledge.

Before the development of the modeling process, a literature search was performed that revealed that no such models have been developed that utilize both a cross impact model and ISM for small business disaster planning purposes. Neither academic nor practitioner communities have tackled this problem. Methods existed that made recommendations to improve plans, but none used a general mathematical model to help determine the consequences of using such a model.

4.2.3 Summarize/Distribute Delphi Results

Following each round of the Delphi, the results of the round will be given to each participant using the email that they used to confirm their consent. The results in summary written and tabular forms were added ahead of the additional rounds of Delphi and also at the end of the ISM calculations. Details may be found in Section 4.5.5.

4.2.4 Revise Delphi Survey

Having completed one round of the Delphi survey, the expanded risk and action lists created in the previous phase were sent back to the participants to assign relative importance probabilities for those items with which they were familiar. Conflicts arising due to a difference in professional opinion and procedure were returned to the group for discussion and explanation.

4.2.5 Present Cross Impact Survey

Once the risk list was finalized via the Delphi surveys, the values assigned by the rankings were transformed to input suitable for Cross Impact Analysis by a panel of experts. The base event base probabilities for the event set, known as *P(i)*, was set to a value of 0.50. The influence probabilities of the events paired two at a time, known as *C(i,j)* were determined by the average values of the influence probabilities as described in Section 4.5.4. We only asked participants to give probabilities for areas in which they consider themselves competent (Turoff et al., 2014). The output from the calculation evaluates the Gamma variable, *G(i)*, which takes into account the impact of events that have not been explicitly specified. The finite set of risk events which we used to determine the Cross Impact influence probabilities was, by definition of finite, incomplete. Other factors that were not in the explicit list under study may have influenced a particular event and either mitigated or exacerbated it. The calculation of the Cross Impact probabilities were based on the probability that a particular event occured, *P(i)*, the probability of the *i*-th event given that an influencing event, *j*, was certain to occur (R_{ij}) and the probability of the *i*-th event given that an influencing event, *j*, was certain to not occur (S_{ij}).

The calculation of the influence probabilities does not balance unless non-explicitly specified events are taken into account. The *G(i)* variable is used to balance the equations. A high value of *G(i)* shows that the events under study have not taken into account many possible outside influences. A small value of *G(i)* shows that the events under study are more complete and take into account more of the possible influences on an event (Turoff, 1972). The output values from the CIA model are the input for the ISM scenario model.

4.2.6 Calculate ISM Model

ISM merges with CIA by taking the *C(i,j)* values from CIA and using them to create the directed graphs that shows the influence of one event on another. The top 10% of the absolute values of all *C(i,j)*'s are put into an ordered list from highest to lowest. ISM is then used to determine if any internal cycles between events exist. The grouping of the event chains represents mini-scenarios that can be treated as a single, dynamically linked package. A linked package is said to occur when and only when all events in the chain occur. We will choose the 10% value for the ISM chain analysis in order to concentrate on the highest impact scenarios. Using a cut-off value much higher than 10% includes too many events and does not allow for the proper emphasis on the highest priority scenarios (Turoff et al., 2014).

4.2.7 Validating the Model

The process model was validated by the respondents through a self-assessment survey included in the Post Survey questionnaire. Significance test calculations were not made due to the low response rate.

4.2.8 Conclusion

Following the evaluation with participants, the results will be written into the final report. The deviations from the hypotheses will be exposed and the final results documented. Other observations will be turned into a listing of future research ideas (Vaishnavi & Kuechler, 2004).

4.3 Research Questions

This section presents the high-level research questions that will guide the evaluation of this study.

> RQ1. Can Delphi, Cross Impact Analysis, and Interpretive Structural Modeling be used to develop the basis for an emergency preparedness plan for small businesses?
>
> RQ2. How can a model based on these three techniques best be designed to assist in developing the basis for an emergency preparedness plan for a small business?

In order to test these research questions, a model was developed combining Delphi surveys, Cross Impact Analysis, and Interpretive Structural Modeling to help business owners and planners to create a basis for the highest return on their planning dollar. Our study used an Administrator (the study director, Art Hendela) to assist the flow of the model development. Participants began by participating in the Delphi survey rounds to enumerate the hazard event set and to assign relative subjective probabilities. These probabilities were assigned to each item in the Likert scale and hidden from the participant to shield them from as much mathematics as possible. An expert group then assigned their cross impact probabilities based on their best judgments of effectiveness. The number of events was constrained by the list determined by the Delphi survey. The output from the Cross Impact Analysis was used as the input for the Interpretive

Structural Model which grouped high impact events into mini-scenarios. It is these scenarios on which planners should concentrate to create the most value with a limited budget.

The creation of the model was a business extension of the Critical Infrastructure Simulation work that Dr Murray Turoff presented at an ISCRAM conference in May, 2014 (Turoff et al., 2014). Whereas the previous trials of the CIA-SIM approach centered on Critical Infrastructure scenarios, the current study introduced the domain to include a small to medium business emphasis not previously researched. Traditional disaster planning was performed by entities such as government and Fortune 1000 companies which have the wherewithal to produce and rehearse a disaster recovery plan. Our study emphasized helping small to medium business entities, which, as defined by the US Small Business Administration, were those companies with less than 500 employees. Companies of this size do not typically have full time planning and recovery experts on staff. Business interruptions to these entities have a great impact on the employees and communities that they serve. The motivation of the research was to find cost effective improvement schemes creating business continuity/disaster recovery plans where the cost of creating the plan and concentration on high valued scenarios met in equilibrium.

4.4 Evaluation Method – Use of Professionals

A group of 50 to 80 people who were small and medium sized business owners or managers with a responsibility for business continuity/disaster planning were used for a field study. During the study individuals helped develop the basis for a business continuity/disaster recovery plan by estimating the probability of risk events, adding or deleting events with a stated reason, and assigning relative probabilities of how each event influences another. The study group took a pre-participation survey before starting and then a post participation survey following the development of the risk and action set and estimates. The individuals used in the study were selected from a pool of volunteers, companies, and other organizations.

The people who accepted to participate as experts were familiar with some aspects of business continuity/disaster recovery planning. The administrator was charged with actually running the modeling software. The experts and the administrator were charged with performing the following tasks:

Table 4.2 Tasks for Participants and Administrator

No.	Task	Motivation
1.	Take the pre-survey.	Determine baseline expectations.
2.	Read the instructions for the Delphi Study.	Develop a baseline understanding of how to participate in the Delphi study.
3.	Assign base probability of original risks and mitigating actions.	Determine how likely risks are to disrupt a business and how likely mitigating actions are to minimize the disruption
4.	Change base risks, with reason for adding new risks and mitigating actions or deleting old ones.	Create a new list that more likely reflects the current business interruption risk and mitigating actions. Estimate the probability and annotate reasons for the deletion or addition.
5.	Repeat steps 3 and 4 until satisfied with the results.	Distribute results for a second and possibly third round of input or discussion.
6.	Assign the cross impact probabilities for each event pair with input from expert panel.	Complete the necessary input data to run the model.
7.	Administrator runs the model.	Produce the cross impact outputs.
8.	Administrator runs the export of the results and prints the spreadsheet.	Capture the results for the entered input probabilities.
9.	Administrator analyzes the output and determines if there are probability adjustments necessary for proper protection.	Distribute the CIA output to the experts to see if it makes sense.
10.	Administrator develops ISM model.	Create mini scenarios based on CIA output.
11.	Take the post-survey.	Analyze the data.

4.5 Evaluation Design

The research methodology utilized the Delphi Method to collect information via Survey Monkey surveys. The decision on the final software was based on cost and implementation timing. Regardless of the final software choice, the functionality was to collect the data needed to create a final list of the risks and actions to be studied. Once the list was finalized, Cross Impact probabilities were collected for use in the CIA and ISM models. The validated CIA version 0.1 software was used for the final calculations.

4.5.1 Participants

The participants were recruited using personal and professional contacts in the business community cultivated over the past thirty years. Each was given access to the model development surveys to input risk and mitigation action list modifications, probabilities and comments. The participants were chosen based on belonging to at least one of the following classifications:

1. Small business owners with at least three years of business experience.
2. Those responsible for business continuity/disaster recovery planning inside the small businesses as designated by the business owner.
3. Experts in emergency management, business continuity, and disaster recovery.

4.5.2 Design of Survey Rounds

Potential participants were asked via email to take a pre-survey and to consent to participation. The pre-survey allowed the researchers to qualify those respondents who would like to participate in the study. The qualification to participate was based on the answers to the pre-survey. Specifically, the respondent must be a member of one of the three groups as outlined in section 4.5.1. Once qualified, the respondents were encouraged to snowball the group by suggesting others who might also qualify. In additional rounds only those that were new to the group were needed to pre-qualify to participate. Those that are participating in multiple rounds did not have to pre-qualify again. The group was set to between 50 and 80 participants for any round.

4.5.3 Pilot Delphi Study

A pilot was conducted which used the survey instruments outlined in Appendices D, Pre-Model Survey; E, Post Model Survey; and G, Delphi Round 1 Tasks and Survey Questions, using the invitation found in Appendix B, Sample Invitation. The following was added to the instructions for the pilot only:

1) The purpose of this preliminary study is to gather your feedback to determine if any of the areas are confusing and also to find out how long the process takes. We anticipate that the taking of the main survey should take no more than 30 to 60 minutes on average, but this process will confirm that time.
2) An additional question is added to the survey to ask if any of the questions were confusing and to explain a little about what you found confusing.

Selection of participants was made from the list of Meadowlands Regional Chamber membership that had email addresses attached to their profile. We selected every tenth member in the list by business name. Invitations were sent in blocks of fifty. This helped to gauge the response rate and willingness of the members to participate in this research.

4.5.4 Round 1 Delphi – Determine Base Risk and Action Set

Each qualified participant was given access to the Delphi surveys and instructions on how to participate. Each of the participants was given two lists. The first, shown in Table 4.3, was a list of risks based on the recent study by Turoff (Turoff et al., 2014) and the recently published New York City Sandy resiliency report (PlanNYC, 2013). The second list, shown in Table 4.4, was a set of mitigation actions that can lessen the effect of the threats. This list is based on Henry's categories published in (Henry, 2006). These initial lists were given to the participants via the online survey system where they were asked to rank each item's importance, add to the list, delete from the list, and comment on the list. Once the comment period passed, the researcher consolidated the comments and reissued the lists to the participants. This aggregated set was sent to the group for a second evaluation round. The group performed the following activities on the revised sets:

1. Provide an indication of relative importance via a Likert-scale rating survey.
2. Remove risk/mitigation action items that are not relevant for further study. Comment on why the item should be removed.
3. Add events/mitigation items not considered in the base sets. Comment on why the item should be added.

Participants signed up to receive the list with a set of instructions. The participants performed their tasks anonymously. Only the researcher knew who commented. Through the analysis of the input, we identified factors that were the most relevant to study. These results helped to improve the factors, instructions, and guided the next iteration (Benbunan-Fich, 2001). The task detail is listed in Appendix G.

Table 4.3 Example Risks (Turoff et al., 2014)

No.	Risk Event	Explanation
1.	Fires underway	There are major fires out of control.
2.	Water supply undrinkable	The normal water supply is contaminated.
3.	Electrical energy cutoff	Electricity is unavailable except for too few portable generators.
4.	Natural gas supply unusable	Natural Gas is unavailable; Leaks exist in the system. Tanks of compressed gas are in very short supply.
5.	Sewage untreated	The sewage system is not functional and has backed up in places.
6.	No gasoline	There is no significant store of gasoline for emergency vehicles or public vehicles.
7.	No airports	There are no functional local airports.
8.	Emergency responders lacking	Trained Emergency Responders are in short supply; Many have chosen to help their families; this includes local government and utility maintenance personnel.
9.	Hazardous materials leaking	Chemical Plants, locations of hazardous materials, and contaminants are unsecured and could develop further leakages.
10.	No medical services	Hospitals and clinics cannot fully function; Medical supplies and prescriptions are unobtainable; there is no air rescue functioning; Inadequate maintenance and supplies for ambulances.
11.	No information network	The Internet is not functioning. The local emergency center is cut off from most networked sources. There is no single list and map of all critical facilities in the area; the command center is understaffed and key people are missing.
12.	Community help limited	Community organizations have not been able to organize to aid response. There are few public shelters. Citizen volunteers are very few in number.
13.	Road network clogged	A majority of the roads are not serviceable; Solid waste and construction debris is excessive and is blocking roads and rescue attempts; Government public works and construction companies have not been able to respond to the situation nor coordinate their activities; Public transportation has shut down; some roads have become "parking lots."
14.	Communication systems not functioning	Communication systems are unreliable; Emergency communications are not fully functional; Cell towers are out of backup energy supplies; Incompatible communication equipment is in use among many different response organizations. No telephones.
15.	Local government not functioning	Local governments in the area of the disaster are not able to fully function and key people cannot be reached. Limited or no security (police, firemen, public services).
16.	Private stores not available	Food shortages are occurring; People are raiding stores for supplies; There is no agreement with supermarkets, hardware stores, etc. to provide needed materials and substances; Homes, on the average, have only a few days of food and water; Private organizations are not contributing to the response to this disaster.

Table 4.4 Example Actions (Henry, 2006)

No.	Action	Explanation
1.	Create business continuity/disaster recovery plan	First step to recovery is to know what to do when a disaster strikes.
2.	Create incident command team	Create a set of people to help with the response across many disciplines. Not just managers but also people who actually do the work.
3.	Build flood walls	Protect your property with sandbags or other types of retaining walls to prevent flooding. Make sure sump pumps work.
4.	Add backup power generators	Provide for building power if power from the utility is lost. Make sure you have adequate supplies of different types of batteries for flashlights, radios, cell phones, etc.
5.	Backup computer systems offsite	Duplicate your data in several places to make sure it is accessible and safe.
6.	Copy vital records to offsite location	Make sure that procedures and formulae are not in one place.
7.	Cross train for alternate jobs	If one person cannot make it to work, can someone else adequately fill in?
8.	Certify some staff in first aid	If a disaster happened during the work day, is there someone who can be a first responder?
9.	Arrange alternate transportation	If roads are closed, is alternate transportation such as trains or ferries available?
10.	Review insurance requirements	If disaster strikes, will you have adequate protection to be compensated for your losses?
11.	Clear obstructions ahead of time	Trim trees and debris from buildings and wires.
12.	Add building cameras and alarm systems	For as long as communication links exist, you can monitor building security while you are unable to drive to the location.
13.	Add computer HW/SW redundancy	Create hot spares for immediate use if others are destroyed. Make sure you have enough licenses for software.
14.	Create vendor contact list	Have alternate vendor sources if a key supplier is in the middle of a disaster zone.
15.	Create customer contact list	Know how to communicate with customers if you are unable to supply them with their orders.
16.	Create product material stockpile	Minimize downtime by adding to raw material inventories if a supplier is in a disaster zone.

4.5.5 Round 2 Delphi – Revise Risk/Action Lists

Those respondents who return to participate in Round 2 viewed a summary of Round 1 results ahead of the actual Round 2 survey. The specifics of the results were in the form of text describing the number of respondents, the business categories covered by the respondents, and the most active risk and action categories as ranked by the Round 1 participants. Following the text summary were numeric charts showing the counts, and average response rankings for each of the sixteen major risk and mitigation action categories.

The group of approximately 50 to 80 participants read the directions for round two and began to take the survey. The list of risk and action events were revised based on the additions to the base sets used for Round 1. The revised lists underwent a second evaluation in the same manner as the first. Relative probabilities were assigned by the participants and the list modified based on their input.

There was minimal disagreement after this second round so the list was considered to be final and was used to develop the input to the Cross Impact Model software and the Interpretive Structural Modeling software. The survey took place over a four week period. Consensus was reached at this point, so a third Delphi round was not performed which would have been needed to find reasons for the discrepancies and to bring about a final decision. The group performed the tasks as shown in Appendix I.

4.5.6 Round 3 Delphi – Resolve Discrepancies

Those respondents who returned to participate in Round 3 were to view a summary of Round 2 results ahead of the actual Round 3 survey. The specifics of the results would have been in the form of text describing the number of respondents, the business categories covered by the respondents, and the most active risk and action categories as ranked by the Round 2 participants. Following the text summary would have been numeric charts showing the counts, and average response rankings for each of the major sixteen risk and mitigation action categories. Since there was no need for a Round 3, then the text and summary statistics were sent to the participants via the email which was used to consent to taking the survey.

If there had been any large discrepancies existing in the estimates, a discussion would have been held online with all of the participants to determine why large disagreements exist. After analysis of the answers, an average value would be used to run the final model.

4.5.7 Round 4 – Administrator Creates Input for Cross Impact Model

The list of the most important 15 to 20 risks, including new ones added to the base set, became the basis for an expert panel to determine the Cross Impact Analysis interactions. Only risks were evaluated. Each risk was evaluated for influences based on the assumption that the event will not occur. The expert indicated on the Likert scale the likelihood of occurrence of each of the threat events given that the selected event will not occur. For example from Table 4.3, negative risk 1 reads “Fire underway.” In order to determine the influence on other risks, we turn the negative risk into a positive event which reads “No fires underway.” In this case the expert now knows that there are no fires endangering the business. No other assumptions were made except that there were no fires. The remainder of the risk list was then presented in turn. Again, based on Table 4.3, the expert read Event #2, “Water supply undrinkable.” If the participant felt they were qualified to answer, they marked one of the following choices where

NT = Not True
PNT = Probably True
MNT = Maybe Not True
NR = No Relationship
NJ = No Judgment (not qualified to make a judgment)

Table 4.5 Sample Round 4 Survey

No.	**Event**	**Response**							
1.	No fires underway								
2.	Water supply undrinkable	NT		PT	MNT		NR	NJ	Comments
		1	2	3	4	5	6	7	
3.	Electrical energy cutoff	NT		PT	MNT		NR	NJ	Comments
		1	2	3	4	5	6	7	
	Repeat with values though base event 16.								

For the purposes of the CIA input, each survey choice was assigned one of the following underlying probabilities:

1(NT)=0.01, 2=0.10, 3(PT)=0.20, 4(MNT)=0.30, 5=0.40, 6(NR)=0.50, 7=no value

By convention for CIA input, 1(NT) is given a value of 0.01 to take into account that there is always a small probability of an event occurring, however slight.

Choosing option 7, NJ or No Judgment, is clicked whenever the participant did not feel qualified to make a judgment. Choosing NJ did not dilute the average value for the probability input to CIA nor was counted toward the final number of respondents, N, for that question.

The results of the Delphi were analyzed and put into a form usable by the Cross Impact Analysis software. The resulting input model was run by the Administrator. Cross impact analysis results was put into a spreadsheet, analyzed into a final report, and shared with the participants.

The experts who participated received the results in an email attachment that included a text description of what was analyzed and what the results were. A technical summary listed the most import risk interactions as ranked by the values of C_{ij}.

4.5.8 Round 5 – Administrator Creates Input for Interpretive Structural Modeling

The results of the Cross Impact Analysis software were the input for the Interpretive Structural Modeling process to determine possible scenarios. The scenario results were shared with the participants.

The results of the Interpretive Structural Modeling were emailed to the small business owners who participated in all Delphi Rounds and to the experts who helped create the Cross Impact Analysis interaction probabilities. This final email contained the summary from the Delphi results and the Interpretive Structural Modeling diagrams with an explanation of how these possible scenarios may be a high impact business interruption that needs attention. Recommendations on how to use this information as a basis for protecting a business will be included. A random drawing of all Delphi Participants was made to determine the winner of the three $50 American Express gift cards.

4.6 Measurement and Data Analysis

4.6.1 Cross Impact Analysis Model

Average values for the values of P(i) and C(i,j) were input to the CIA 0.1 software to determine the values necessary for the production of ISM model scenarios. The details of the underlying calculations may be found in a paper by Turoff (Turoff, 1972).

4.6.2 ISM Model

The output of the CIA calculations became the basis for the discovery of potential high valued scenarios via Interpretive Structural Modeling. The C_{ij} values greater and equal to a value that represents the top ten percent of those values from the Cross Impact Model are added into an ordered chart. Application of the ISM methodology as detailed in (Bañuls et al., 2013) produces the reachability matrix and the final scenario outputs.

4.6.3 Measures

In order to study how the model impacts participants with varying amounts of business continuity planning, both qualitative and quantitative methods were used. The qualitative measures included semi-structured interviews and the quantitative measures will include surveys using Likert-type scales.

4.6.4 Questionnaires

A set of Pre and Post participation questions was made available to each participant that took part in the surveys. These questions were used to measure the level of business continuity/disaster recovery knowledge as well as the expectations for developing the model. The survey questions are shown in Appendix D and E.

4.6.5 Data Analysis

4.6.5.1 Statistical Analysis. Descriptive statistics such as arithmetic mean, median, and standard deviation were used to study the results of the survey answers. The central tendency of data is described by the mean and median. The mean is the average value of the population set. The median is a boundary value separating the high and low groups of answers, the middle value of the ordered set. In sets with even number of items, the median is the average of the two middle values. The standard deviation measures the dispersion of the answers around the central value.

These descriptive statistics provide an easy way to represent a large set of values with a single number. Unfortunately they also hide details that may prove important. The single values do not show the trends in the data, either over time, or outlying values that occur.

4.5.6.2 Reliability Checking. Unlike traditional experimental results, the main product from this process is the creation of the basis of a business continuity/disaster recovery plan and the documentation that accompanies it. Recommendations will be made for the enhancement of the model process. A listing of suggestions will be created from the survey and interview results and prioritized for inclusion into future research.

4.7 Methodology for Administering Survey Rounds

To judge the wording used in the survey, a pilot version of the pre-survey was sent to ten business associates via email. Seven of the ten completed the survey which asked for comments on the length of the survey and if the wording was confusing. The survey was hosted by Survey Monkey and was open from January 20, 2015 to February 5, 2015. Suggestions were incorporated into the Round 1 survey.

The methodology used for the Rounds 1 and 2 of the research was a snowballing Collaborative Design Delphi study that targeted small business people with at least three years of experience. This allowed participants to recommend additional participants that could be screened for being qualified. A qualified participant was one that worked in a small business as defined by the United States Small Business Administration, worked in the business for at least three years and having the business located in in New Jersey, New York, Connecticut, Pennsylvania, Maryland, or Delaware.

In Round 1, 646 potential participants from the researcher's professional contacts at the Meadowlands Regional Chamber of Commerce were selected to receive emailed invitations to participate in the research study. The New Jersey State Chamber of Commerce sent the invitation to 700 member companies on the researcher's behalf. The Round 1 survey was hosted by Surveymonkey.com and was open from February 26, 2015 to April 1, 2015. The complete survey is shown in Appendix G.

The response to the survey was tediously slow. Reminder emails were sent on three occasions to make the total number of contact emails to be approximately 4000 in order to receive the minimum required response of at least fifty completed surveys. The use of Survey Monkey's research participant service was investigated. Survey Monkey does not help find potential participants when the survey size is more than 50 individual question items. Each item in a matrix question counts as an individual item. The total length of the Round 1 survey instrument was over 250 items. Survey Monkey could also not guarantee that the same respondents would be used in Round 2.

The Round 1 Main Survey showed each risk and preparation category and the corresponding items in those categories. The participants were asked for their judgment regarding each item. The judgment was made by clicking one of the levels in a six level Likert type scale. The scale and weighting factors are shown in Table 4.6.

Table 4.6 Risk Judgment Scale

Risk Level	Weighting Value
Critically Important	5
Very Important	4
Somewhat Important	3
Minor Importance	2
No Importance	1
No Judgment	0

Note: “No Judgment” votes were allowed but were not used in the calculation of averages.

If a respondent felt that a particular risk might cause an immediate business interruption, the respondent might click “Critically Important.” If the risk might or might not cause a business interruption, the respondent might click “Somewhat Important.” If the risk item was not a concern the respondent might click “No Importance.” Intermediate choices were given for answers in between. If the item did not apply to their business or if they did not feel qualified to make a judgment of its importance, the respondent would click “No Judgment” or leave all choices blank. A blank was the default value and was considered to be equivalent to “No Judgment.” Survey Monkey does not provide the ability to display a default value explicitly.

At the end of each category, a free text box was available for the respondents to make suggestions of other risk items that should have been included in the list. The suggestions in these category text boxes were the basis for the risk items evaluated in Round 2.

In order to assess the relative importance of a particular judgment, a weighting factor is applied. Each selection of a risk level by a participant is multiplied by the weighting value and summed. Figure 4.2 shows the formula for the calculation.

$$W = (\sum_{1}^{n} (JudgmentCategoryVotes) * CategoryWeightingValue)$$

Figure 4.2 Calculation of the weighted value for a risk or preparation category.

For example:

Item 1 receives 4 votes for “Critically important,” 7 votes for “Very Important,” 21 votes for “Somewhat Important,” 13 votes for “Minor importance,” 6 votes for “No importance,” and 10 voted “No Judgment.” The total weighted value is:

$$W = 4*5 + 7*4 + 21*3 + 13*2 + 6*1 = 143. \tag{4.1}$$

N is already used in the calculation of the mean value and is not used again to calculate W. The mean is the highest order sorting parameter for the results tables. The weighted value and the number of highest value category votes are used only for breaking ties between category items.

In order to determine the most important risks, the mean of the items are sorted in descending order within each category and also across all categories. The highest valued mean item is considered to be the most important concern to the small business workers. We use the following scale to interpret the results.

Table 4.7 Risk Interpretation Scale for Mean Values

Risk Mean Value	Risk Interpretation
4.0 – 4.4+	High Concern
3.5 – 3.9	Moderately High Concern
2.9 – 3.4	Moderate Concern
2.3 – 2.8	Moderately Weak Concern
< 1.5 – 2.3	Weak Concern

Note: No values fell below a mean of 1.5.

In like manner, respondents were asked for their judgments regarding preparations or mitigating actions for each given category. In order to keep from identifying particular preparations for a particular business, the respondents only answered whether a preparation was applicable to their business or only to other businesses. No specific preparations that a specific business made were asked.

If a respondent felt that a particular preparation applied to their business, the respondent was instructed to click “Applies to my business.” If the preparation item did not apply to their business, but applied only to other businesses, the respondent was instructed to click “Applies Only to Other Businesses.” If the item did not apply to their business or any other, or if they did not feel qualified to make a judgment of its applicability, the respondent would click “No Judgment” or leave all choices blank. A blank was the default value and was considered to be equivalent to “No Judgment.”

The judgment was made by clicking one of the levels in a three level Likert Scale. The scale and weighting factors are shown in Table 4.8. The application of the formula in Figure 4.1 applies to the preparation weighted value also.

Table 4.8 Preparation Judgment Scale

Preparation Judgment	Weighting Value
Applies to my business	2
Applies only to other businesses	1
No Judgment	0

In order to determine the most important preparation, the weighted items are sorted in descending order within each category and also across all categories. The highest valued weighted item is considered to be a measure of applicability of a preparation item to the small business. We use the following scale to interpret the results.

Table 4.9 Preparation Action Interpretation Scale for Mean Values

Action Mean Value	Action Interpretation
1.7 – 1.8+	High Concern
1.4 – 1.6	Moderately High Concern
1.0 – 1.3	Moderate Concern
0.7 – 0.9	Moderately Weak Concern
< 0.5 – 0.7	Weak Concern

Note: No values fell below a mean of 0.5.

At the end of each category, a free text box was available for the respondents to make suggestions of other preparation items that should have been included in the list. The suggestions in these category text boxes were the basis for the evaluation of preparations in Round 2.

For Round 2, the suggestions for new risk and preparation items that respondents optionally entered at the end of each Round 1 category were formed into a new survey. The same scales for risks and preparations from Round 1 were used for Round 2. The results of the Round 1 surveys were used to create a website using Google Sites. The results site was divided into four areas: “Risk results by category,” “Risk results across all categories,” “Action results by category,” and “Action results across all categories.”

The group of sixty Round 1 participants was sent an email invitation with a link to the Round 1 results website and a link to the Round 2 Survey Monkey survey. A PDF copy of the respondent’s Round 1 answers was attached for their review. After answering the new Round 2 questions that were based on the text suggestions from each Round 1 category, the respondents were given a chance to continue through the Round 1 questions again and change any of their answers. The Round 2 survey was open from June 1, 2015 to July 2, 2015. The complete survey is shown in Appendix J.

Round 3 was an optional Delphi survey if additional suggestions for risk and preparation items were made in the open text section of each Round 2 category. No suggestions were made. A Round 3 Delphi was therefore not deemed to be necessary by the lead researcher.

Round 4 used three individuals with background in emergency management to create the R_{ij} probability estimates as input to the Cross Impact Model software. The estimates were based on the combined results of Rounds 1 and 2. The list of risk items was sorted by highest mean across all categories, then by weighted value, and then by the highest valued column. Round 2 weighted values were multiplied by the N for Round 1, then divided by the N for round 2 to put the values on a common basis. This was done due to the lower response of round 2.

For example, Appendix N shows the consolidated risk results for Round 1 and Round 2. The highest value concern based on the mean is from Round 1, “Business reputation tarnished” with a value of 4.42. The next two items are “Loss of documents and company materials/ records" from Round 2 and "Electricity cut off" from Round 1, both with a mean value of 4.29. How is the tie in mean value to be broken? With a smaller N in Round 2, the use of the denominator for the mean may be less only because of the number of respondents. The denominator in the calculation of the mean is found by multiplying the number of votes in a particular category by the weighting factor for that category. Each vote in category "5" is worth 5 points. A vote in the "4" category is worth 4 points, a "3" vote, 3 points, a "2" vote is 2 points, and a "1" vote is 1 point.

The fire category item received the following number of votes for each category:

20 votes in category 5 = 20*5 = 100 points

15 votes in category 4 = 15*4 = 60 points

4 votes in category 3 = 4*3 = 12 points

2 votes in category 2 = 2*2 = 4 points

0 votes in category 1 = 0 points

The total number of points for the fire item is 100+60+12+4+0 = 177 points.

In like manner, the point total for the Round 1 item that is tied with the Fire is 25*5 + 16*4 + 6*3 + 1*2 + 1 = 210 points.

The only reason that the Round 1 item received a higher score is because sixty people participated in Round 1 and only 42 participated in Round 2. Grossing up the Round 2 score as if it would be a Round 1 category removes this inequality. To do this, we multiply the ratio of Round 1 participants to Round 2 participants, which is 60/42. Doing that calculation, the number of equivalent Round 1 points received by the Round 2 item is:

$$177 * 60/42 = 251 \text{ points.} \tag{4.2}$$

Since 251 points is greater than 210 points, the Round 2 item is higher in the sort order.

A set of 25 risks were then chosen from the sorted list broken down as follows: 5 input risks, 15 dynamic event risks, and 5 output risks. Input risks are ones that are given to occur for the case of the scenario under investigation. For instance, “Fire underway” or “Computer server not fully backed up” is considered to have occurred. These input risks are the given conditions for the model. Dynamic Event risks are ones that change during the time of the event. Examples are “Roads clogged with traffic” or “Personnel not available during an emergency.” Output Event risks are ones that are caused or exasperated because of the Initial and Dynamic events. Examples are “Business reputation tarnished” or “Computer data lost.”

The Round 4 survey asked for the input to the cross impact model software. An eleven level scale was used to gather the subjective estimates from the three people with background in emergency management who were familiar with the estimation process. Table 4.10 shows the probability levels.

Table 4.10 Subjective Estimate Probabilities for Cross Impact Model Input

Level	Percent Value
1	1%
2	10%
3	20%
4	30%
5	40%
6	50%
7	60%
8	70%
9	80%
10	90%
11	99%

The base probability of occurrence of each event, P_i, was collected. In turn the influence probability of each Risk Item against the others was collected. For example, Input Risk, "I1–Computer server not fully backed up," is paired against the other remaining twenty-four risks to assess the influence that it has on the others. The process is done for each input and dynamic risk. Output risks are not evaluated as they are only influenced by input and dynamic risks.

The estimates were consolidated by the researcher and returned via email for discussion. Discrepancies between the estimates were reduced and final input probabilities consolidated into the input form necessary for the Cross Impact Model calculations. All three participants in the estimation process came to agreement on the direction of the influence and the actual values. The final probability estimates for P_i and R_{ij} were input into Cross Impact Modeling software that was part of a joint development effort between the faculty of NJIT and Pablo de Olavide University at Seville, Spain (Turoff et al., 2015). The software was CIM 0.1, Cross Impact Software. Results from the

CIM software were reformatted for input to the Round 5, Interpretive Structural Modeling algorithm.

A post survey was given to the group to gauge the satisfaction with the process. This survey can be found in Appendix E.

4.8 Methodology for Round 5, Interpretive Structural Modeling

The Interpretive Structural Modeling input was the output from the twenty-five events chosen for evaluation in Round 4, Cross Impact Analysis. The events used for the Cross Impact Analysis are assigned a sequential number from 1 to 25. The meaning of each number is shown in Table 4.11.

Table 4.11 Event Numbers Assigned to Interpretive Structural Model

Event Number	Code	Meaning
1	I1	Computer server not fully backed up
2	I2	Fires underway
3	I3	Hurricane in area
4	I4	Business continuity plan not tested
5	I5	Local government not functioning
6	DE1	Electricity cut off
7	DE2	No communication networks
8	DE3	Computer hardware fails
9	DE4	Personnel not available during an emergency
10	DE5	Violent crime committed by employee during work hours
11	DE6	Backup power supply not available
12	DE7	Access to facility forbidden
13	DE8	Telephones out of service
14	DE9	Internet connectivity lost
15	DE10	Increased lead time due to storm or other event
16	DE11	Roads flooded
17	DE12	Gasoline in short supply
18	DE13	Roads clogged with traffic
19	DE14	Crime rate increase near place of business
20	DE15	Product in transport destroyed
21	O1	Loss of documents and company materials/records
22	O2	Business reputation tarnished
23	O3	Computer data lost
24	O4	Raw material cost increase
25	O5	Raw materials contaminated

The C_{ij} values output by the Cross Impact Software were sorted to find a value that would include both positive and negative influences. An absolute value of 0.80

included both the positive influences and the negative influences while limiting positive influences. The next value that would include negative influences was 0.50 and would have included many more results. As is shown in the results section, the influence diagrams become quite crowded as you add more values. Table 4.12 shows the breakdown of C_{ij} values.

Table 4.12 Counts of $|C_{ij}|$ Data Values

$\lvert C_{ij}\rvert$ Value	Count
>1.50	20
>1.00	50
>0.80	107
>0.50	145
>0.20	194
=0.00	406

With 0.80 chosen as the minimum C_{ij} value, the positive and negative adjacency matrices can be produced. Each event is numbered from 1 to N, where N is the number of events. In our case N=25. Two NxN matrices are created. The first NxN matrix is filled with the positive C_{ij} values that are above the threshold. The second NxN matrix is filled with the negative C_{ij} values that are below the threshold. These two matrices are then copied. In the copies of the matrices, a “1” was placed in each cell that contained a C_{ij} value.

The adjacency matrix is created by dividing a table of size 2N x 2N into four quadrants. In our case of 25 events by 25 events, the adjacency table will be two times that or 50 by 50. This new table is divided into four quadrants. By mathematical convention, Quadrant 1 is the upper right portion of the table. Quadrant 2 is the upper left. Quadrant 3 is the lower left. Quadrant 4 is the lower right. The individual positive and negative C_{ij} matrices are placed into the quadrants as follows. The positive C_{ij} matrix is placed into both Quadrant 2 and Quadrant 4. The negative C_{ij} matrix is placed into both Quadrant 1 and Quadrant 3. Figure 4.3 shows this relationship.

Quadrant 2	**Quadrant 1**
Positive C_{ij} adjacency matrix, Table 5.78. Positive columns and rows. (+Col/+Row).	Negative C_{ij} adjacency matrix, Table 5.79. Negative columns and positive rows. (-Col/+Row).
Quadrant 3	**Quadrant 4**
Negative C_{ij} adjacency matrix, Table 5.79. Positive columns and negative rows. (+Col/-Row).	Positive C_{ij} adjacency matrix, Table 5.78. Negative columns and rows. (-Col/-Row).

Figure 4.3 Quadrant number with corresponding C_{ij} matrices.

Each of the columns and rows is given a number corresponding to its event identifier. In our case the numbers range from one to twenty-five. Numbers one through five correspond to events I1 through I5. Numbers six through twenty correspond to events DE1 through DE15. Numbers twenty-one through twenty-five correspond to events O1 through O5.

Once the adjacency matrix is created, the next step is to create the "reachability matrix." The reachability matrix is an identity matrix added to the adjacency matrix. The result is the adjacency matrix with a "1" along the diagonal from the upper left to the lower right corner. Each "1" in a column shows an influence of the column event on the row event. These are called antecedents. Each row that contains a "1" shows an event that has been influenced by the column event. These are called succedents. From this final reachability matrix, influence diagrams can be drawn.

The diagrams are drawn by making a circle for each of the events and labeling them with the event number. For each column event, a line is drawn from the circle with the corresponding event number to the event row number that contains a “1”. This is repeated for all columns.

Once drawn, scenarios can be created. A set of event circles connected in a cycle of lines constitutes a part of a scenario. The scenarios are depicted on the diagram by a rounded edged box. Direct cycles are a set of two circles that point to each other. Their event numbers are entered into the scenario box and placed in parentheses. Outbound lines are redrawn to the succedent event and the original event circles deleted. New cycles may appear that are indirect. An event may connect to a series of several events and then back. These events are added to the scenarios, outbound lines are redrawn and the original lines and circles deleted. This process is repeated until there are no more cycles. The events left in the box comprise the most significant scenario for which to prepare. The final influence diagrams appear in Section 5.11.

CHAPTER 5

RESEARCH RESULTS

This chapter is a detailed presentation of the results of this research. Section 5.1 presents the results of the Pre-Survey. Section 5.2 describes the Round 1 results gathered for risk items by each individual risk category. Section 5.3 describes the Round 1 results for risk items across all risk categories. Section 5.4 describes the Round 1 results gathered for action items by each individual action category. Section 5.5 describes the Round 1 results for action items across all action categories. Section 5.6 presents the risk item results for Round 2. Section 5.7 presents the Round 1 and Round 2 risk results consolidated across all risk categories. Section 5.8 presents the Round 1 and Round 2 action results consolidated across all action categories. Section 5.9 summarizes the Round 1 and Round 2 results and explains why no Round 3 was necessary. Section 5.10 shows the results of Round 4 which was the performance of the Cross Impact Analysis calculations. Section 5.11 presents the results of Round 5 which are the scenarios developed though Interpretive Structural Modeling. Section 5.12 presents the results of the Post-Survey. Section 5.13 shows the results of the research in comparison to the study's research questions.

5.1 Round 1 Pre-Survey

The Round 1 survey was broken into three parts, the consent statement, the pre-survey, and a main survey with the base set of risk and action factors. Part 1 was the consent statement. Seventy–seven respondents consented to participate in the study. Once consent was secured, the participant could then move to the pre-survey. Seventy people participated in the pre-survey. Sixty people moved onto the main survey where fifty-three fully completed all questions.

No one industry sector answered in a significant number in order to perform statistical analysis by sector. The main participating businesses were non-profit organizations (14%/7 responses), Computer, IT, and Technology businesses (8%/4 responses), and Business/Professional services, Financial services, Health Care, and Manufacturers each with (6%/3 responses each).

Question 1 of the pre-survey investigated the respondent's general interest in the risk and mitigation research topic. Question 1 was divided into five parts. A seven level Likert scale was used that ranged from Not Important to Very Important with the corresponding weights between 1 and 7, respectively.

Part a gauged the level of interest in the risk process from a professional or job level. The overall assessment for professional/job interest, part a, was 4.40, or a little more than "Somewhat Important." The full results are shown in Table 5.1a.

Table 5.1a Responses to "I have a professional or job-related interest in the topic" (Q1a)

Job Interest Level	Count	%	
Not Important (1)	9	13%	25%
(2)	8	12%	
(3)	3	5%	34%
Somewhat Important (4)	13	19%	
(5)	7	10%	
(6)	15	22%	41%
Very important (7)	12	18%	
Total	**67**	**100%**	**100%**
Weighted Average	**4.40**		

Part b gauged the respondent's general interest in the subject. For the general interest part of the question, part b, the result was 4.61. The full results are shown in Table 5.1b.

Table 5.1b Responses to "I have a general interest in the area" (Q1b)

General Interest Level	Count	%	
Not Important (1)	5	8%	17%
(2)	6	9%	
(3)	5	8%	39%
Somewhat Important (4)	13	20%	
(5)	7	11%	
(6)	20	31%	44%
Very important (7)	8	13%	
Total	**64**	**100%**	**100%**
Weighted Average	**4.61**		

Part c gauged the respondent's opinion of the research team's reputation. The reputation of the research team, part c, showed an average result of 5.12, which is quite positive. The full results are shown in Table 5.1c.

Table 5.1c Responses to "The reputation of the developer/research team" (Q1c)

Researcher Reputation	Count	%	
Not Important (1)	6	9%	14%
(2)	3	5%	
(3)	1	2%	36%
Somewhat Important (4)	11	17%	
(5)	11	17%	
(6)	12	18%	50%
Very important (7)	21	32%	
Total	**65**	**100%**	**100%**
Weighted Average	**5.12**		

Part d gauged the level of curiosity of how the model worked. The curiosity of the how the model worked, part d, was 4.06. The full results are shown in Table 5.1d.

Table 5.1d Responses to "I was curious about how the modeling method worked" (Q1d)

Curiosity of Model Working	Count	%	
Not Important (1)	8	12%	21%
(2)	6	9%	
(3)	8	12%	55%
Somewhat Important (4)	16	25%	
(5)	12	18%	
(6)	9	14%	24%
Very important (7)	6	9%	
Total	**65**	**100%**	**100%**
Weighted Average	**4.06**		

Lastly, part e measured the expectation of how convenient this modeling method was expected to be versus traditional planning methods. Lastly, the expected convenience of this modeling method versus traditional planning methods, part e, was 4.20. The full results are shown in Table 5.1e.

Table 5.1e Responses to "More convenient than traditional planning methods" (Q1e)

Planning Convenience	Count	%	
Not Important (1)	8	12%	15%
(2)	2	3%	
(3)	6	9%	65%
Somewhat Important (4)	22	34%	
(5)	14	22%	
(6)	6	9%	20%
Very important (7)	7	11%	
Total	**65**	**100%**	**100%**
Weighted Average	**4.20**		

Question 2 asked about the expected ease of the survey process. A seven level Likert scale was used that ranged from Difficult to Easy with the corresponding weights between 1 and 7, respectively. Only 14% of the respondents thought that the process would be difficult. This compares favorably to 55% that thought that the process would be moderately difficult. The weighted average was 4.49. Table 5.2 shows the complete distribution.

Table 5.2 Responses to "How easy or difficult do you expect this process to be?" (Q2)

Survey Ease	Count	%	
Difficult (1)	5	8%	14%
(2)	4	6%	
(3)	6	9%	55%
(4)	22	33%	
(5)	9	13%	
(6)	10	15%	31%
Easy (7)	11	16%	
Total	**67**	**100%**	**100%**
Weighted Average	**4.49**		

Question 3 asked the respondents to identify their gender. Sixty seven respondents answered the question. Of these sixty-seven, fifty-three (78%) identified as male and 14

(21%) identified as female. Table 5.3 shows how the sixty-seven respondents identified their gender.

Table 5.3 Responses to “What is your gender?” (Q3)

Gender	Count	%
Male	53	78%
Female	14	22%
Total	**67**	**100%**

Question 4 asked the respondents to identify their ethnicity and race. The respondent group was not diverse. Of the sixty-five respondents, sixty-five (95%) were white, two (3%) were black and one (2%) was Hispanic. Table 5.4 shows how the full distribution.

Table 5.4 Responses to “Ethnic/Racial Background” (Q4)

Ethnicity/Race	Count	%
Black/African-American	2	3%
Hispanic (Mexican, Puerto-Rican, etc.)	1	2%
Native American	0	0%
Asian or Asian-American	0	0%
White	62	95%
Other	0	0%
Total	**65**	**100%**

Question 5 was used to determine the age range of the respondents. The ages of the respondents ranged from 28 to 80 with the majority of respondents older than 55 years of age (64%) Table 5.5 shows the full age distribution.

Table 5.5 Responses to "What is your current age?" (Q5)

Age Group	Count	%
21-34 years old	3	5%
35-44 years old	7	12%
45-54 years old	11	19%
55-64 years old	26	46%
65+ years old	10	18%
Total	**57**	**100%**

Question 6 asked if English was the respondent's first language. The majority (88%) of the respondents spoke English as their First Language. The survey did not ask for the details of what other languages were spoken. The distribution of First Language is shown in Table 5.6.

Table 5.6 Responses to "Is English your native or first language?" (Q6)

First Language	Count	%
English	57	88%
Other	8	12%
Total	**65**	**100%**

Question 7 asked about the highest completed education level. The overwhelming majority, 71%, of the respondents held at least a bachelor's degree. When counting people that had at least some college, the number climbs to 86%. Table 5.7 shows the complete distribution of the respondents' education level.

Table 5.7 Responses to "Highest education completed" (Q7)

Highest Education	Count	%
High School	7	11%
Some College	6	9%
Associates	4	6%
Bachelors	24	36%
Masters	17	26%
Doctorate	6	9%
None of the above	2	3%
Total	**66**	**100%**

Question 8 dealt with the number of years of experience that the respondents had in their jobs. The distribution was quite even over the range 3-39 years with the group band of 10-19 years holding largest count and percentage, 19 respondents, 30%. The following, Table 5.8, shows the respondent's distribution of the number of years in their current business.

Table 5.8 Responses to "How many years have you worked at your current business?" (Q8)

Business Experience	Count	%
3-9 years	15	24%
10-19 years	19	30%
20-29 years	14	22%
30-39 years	10	16%
40 and more years	5	8%
Total	**63**	**100%**

Question 9 asked about the respondents' job responsibility. Given that the survey was distributed mostly to small businesses that were members of the Meadowlands Regional Chamber of Commerce and the New Jersey State Chamber of Commerce, it is not surprising that the bulk of the respondents that took the responsibility and interest to fill in the questionnaire, 46%, were the actual business owners. The second largest respondent group was workers in the small business, but not the actual owner. Table 5.9 shows the entire distribution.

Table 5.9 Responses to “What is your responsibility for Business Continuity/Disaster Recovery?” (Q9)

Job Responsibility	Count	%
Business owner	31	46%
Business worker	22	33%
Planner	3	4%
Emergency worker	1	2%
Government worker	0	0%
Other	10	15%
Total	**67**	**100%**

Question 10 asked the respondents for their assessment of how hard or how easy learning the concepts and ideas behind business interruption might be. A seven level Likert scale was used that was divided from “Hard to Learn” to “Easy to Learn” with the corresponding weights between 1 and 7, respectively. The overall assessment was 4.95, which tends towards “Easy to Learn.” The full results are shown in Table 5.10.

Table 5.10 Responses to “Will the ideas behind the business interruption risks be…? (Q10)

Ease of Learning	Count	%	
Hard to Learn (1)	0	0%	2%
(2)	1	2%	
(3)	5	8%	59%
(4)	28	42%	
(5)	6	9%	
(6)	14	21%	39%
Easy to Learn (7)	12	18%	
Total	**66**	**100%**	**100%**
Weighted Average	**4.95**		

Question 11 asked about expectations of answering the surveys. A seven level Likert scale was used to measure the expectation divided from Frustrating to Not Frustrating with the corresponding weights between 1 and 7, respectively. Most respondents were neutral regarding the frustration level, but none thought the surveys would be frustrating. The overall assessment was 4.72. The full results are shown in Table 5.11.

Table 5.11 Responses to "Do you expect that answering the surveys will be …?" (Q11)

Answering Survey	Count	%	
Frustrating (1)	0	0%	9%
(2)	6	9%	
(3)	9	13%	54%
(4)	21	32%	
(5)	6	9%	
(6)	12	18%	37%
Not Frustrating (7)	13	19%	
Total	**67**	**100%**	**100%**
Weighted Average	**4.72**		

Question 12 asked if respondents thought that answering the surveys would be a productive use of their time. A seven level Likert scale was divided from Unproductive to Productive with the corresponding weights between 1 and 7, respectively. Of the 68 respondents to this question, 24 or 35%, were neutral that answering the surveys would be productive. On the positive end, 26 or 38%, of the respondents viewed answering the surveys as productive or nearly so. The overall assessment tended towards productive with a weighted average of 4.74. The full results are shown in Table 5.12.

Table 5.12 Responses to "Do you expect that answering the surveys will prove to be…?" (Q12)

Answering Survey	Count	%	
Unproductive (1)	1	1%	7%
(2)	4	6%	
(3)	5	7%	55%
(4)	24	35%	
(5)	8	12%	
(6)	20	29%	38%
Productive (7)	6	9%	
Total	**68**	**100%**	**100%**
Weighted Average	**4.74**		

Question 13 was divided into three parts. Each part used a seven level Likert scale that ranged from Definitely Not to Definitely Yes with the corresponding weights between 1 and 7, respectively.

Part a gauged the expectation that the list of risks and actions would be comprehensive. On the scale of one to seven, the overall assessment of the risk and action list being comprehensive, part a, was 4.82. The full results are shown in Table 5.13a.

Table 5.13a Responses to "Do you expect that the risks and actions will be a comprehensive list?" (Q13a)

Comprehensive List	Count	%	
Definitely Not (1)	2	3%	4%
(2)	1	1%	
(3)	1	1%	62%
Unsure (4)	33	49%	
(5)	8	12%	
(6)	10	15%	33%
Definitely Yes(7)	12	18%	
Total	**67**	**100%**	**100%**
Weighted Average	**4.82**		

Part b gauged the respondent's expectation that the lists of risks and actions would increase the quality of their business interruption planning. For part b, the majority of respondents expected that the list of risks and actions would increase the quality of their planning. The weighted average result was 5.01. The full results are shown in Table 5.13b.

Table 5.13b Responses to "Do you expect that the lists of risks and actions will increase the quality of your planning?"(Q13b)

Increase Planning Quality	Count	%	
Definitely Not (1)	2	3%	4%
(2)	1	1%	
(3)	2	2%	56%
Unsure (4)	20	30%	
(5)	15	22%	
(6)	18	27%	40%
Definitely Yes(7)	9	13%	
Total	**67**	**100%**	**100%**
Weighted Average	**5.01**		

Part c asked about their feelings towards participating by asking the respondent's level of resentment in being required to evaluate risks and actions. The result for part c, showed little resentment in evaluating the risks and actions. The weighted average result was 2.24. The full results are shown in Table 5.13c.

Table 5.13c Responses to "I resent being required to evaluate risks and actions for use in the model" (Q13c)

Resent Taking Survey	Count	%	
Definitely Not (1)	31	47%	62%
(2)	10	15%	
(3)	6	9%	36%
Unsure (4)	17	26%	
(5)	1	2%	
(6)	1	2%	2%
Definitely Yes(7)	0	0%	
Total	**66**	**100%**	**100%**
Weighted Average	**2.24**		

Question 14 asked about the expectation regarding the completeness of the final model. A seven level Likert scale was used to measure the expectation divided from Not Useful at All to Very Useful with the corresponding weights between 1 and 7, respectively. Most respondents expected a useful outcome with only one expecting that the final model would not be useful at all. The overall average was 5.15. The full results are shown in Table 5.14.

Table 5.14 Responses to "Overall, how complete do you expect the final model to be?" (Q14)

Model Completeness	Count	%	
Not Useful at All (1)	1	1%	4%
(2)	2	3%	
(3)	0	0%	53%
(4)	24	36%	
(5)	11	16%	
(6)	14	21%	43%
Very Useful (7)	15	22%	
Total	**67**	**100%**	**100%**
Weighted Average	**5.15**		

Question 15 asked about how much time it might take to complete the surveys. The choices were broken down into six time bands ranging from less than 30 minutes to more than ten hours. The majority of the respondents, 70%, thought that the surveys would be completed in less than one hour. The full results are shown in Table 5.15.

Table 5.15 Responses to "How much time do you foresee yourself evaluating the risks and actions? (Q15)

Time to Complete	Count	%
< 30 minutes (1)	21	32%
30 minutes–1 hour	25	38%
1-3 hours	10	15%
4-6 hours	5	8%
7-9 hours	0	0%
10+ hours	4	7%
Total	**65**	**100%**

Question 16 asked the respondents about their understanding of risks and actions and was divided into three parts. A five level Likert scale was used for all three parts that ranged from Strongly Disagree to Strongly Agree with the corresponding weights between 1 and 5, respectively.

Part a asked if the respondents understood how risks and actions worked. The overall assessment for Part a, the understanding how the risks and actions worked, was 3.84. About a quarter were unsure of these concepts. This means that some of the estimates made about them might have been confused. The full results are shown in Table 5.16a.

Table 5.16a Responses to “I understand how the risks and actions work” (Q16a)

Understand Risks and Actions	**Count**	**%**
Strongly Disagree (1)	0	0%
Disagree (2)	2	3%
Neither Agree Nor Disagree (3)	16	24%
Agree(4)	40	60%
Strongly Agree(5)	9	13%
Total	**67**	**100%**
Weighted Average	**3.84**	

Part b asked about their understanding of the difference between risks and actions. For part b, the majority of respondents understood the difference between risks and actions yielding a weighted average result of 4.15. The full results are shown in Table 5.16b.

Table 5.16b Responses to “I understand the differences between the risks and actions” (Q16b)

Understand Differences	**Count**	**%**
Strongly Disagree (1)	0	0%
Disagree (2)	0	0%
Neither Agree Nor Disagree (3)	10	15%
Agree(4)	37	55%
Strongly Agree(5)	20	30%
Total	**67**	**100%**
Weighted Average	**4.15**	

Part c asked about their general attitude towards learning new things. Part c showed that a vast majority of those responding to the survey liked to learn new things. The weighted average result was 4.48. The full results are shown in Table 5.16c.

Table 5.16c Responses to "I like to learn new things" (Q16c)

Like to Learn	Count	%
Strongly Disagree (1)	0	0%
Disagree (2)	0	0%
Neither Agree Nor Disagree (3)	4	6%
Agree(4)	27	40%
Strongly Agree(5)	36	54%
Total	**67**	**100%**
Weighted Average	**4.48**	

Question 17 was an open text question asking for any problems encountered during the answering of the pre-survey. Two people responded that the questions were difficult to answer before actually seeing the main survey questions.

5.2 Round 1 Risk Results by Category

At the end of Round 1, there were fifty-three completed surveys and seven partially completed ones. There is a table in this section for each risk category. The shaded values at the top of each table are the average values for all of the numeric columns. This provides the reader with the ability to compare an individual row to the average for a particular category. Each of the tables uses the columns shown in Table 5.17.

Table 5.17 Table Legend for Risk Data by Category

Column Title	Meaning
Text	Survey text
N	Number of respondents
MEAN	Average value
S.D.	Standard Deviation
5	Critically Important
4	Very Important
3	Somewhat Important
2	Minor Importance
1	No Importance
0	No Judgment
W	Total Weighted Value (See calculation equation, Figure 4.2)

There are sixteen risk categories with different numbers of items being judged. The total number of risk items judged in Round 1 is one hundred forty-eight. These categories, the corresponding summary table, and the number of risk items judged are shown in Table 5.18.

Table 5.18 Table of Risk Categories and the Number of Risks

Round 1 Risk Result Category	**Table Number**	**Number of Risks**
Financial Risk	5.24	26
Fire Risk	5.25	3
Flood Risk	5.26	8
Government Risk	5.27	7
Health Risk	5.28	6
Legal Risk	5.29	16
Personnel Risk	5.30	11
Product Risk	5.31	9
Property Risk	5.32	10
Security Risk	5.33	4
Supply Chain Risk	5.34	7
Technology/Data Risk	5.35	20
Terrorism Risk	5.36	3
Transportation Risk	5.37	7
Utility Risk	5.38	7
Weather Risk	5.39	4
TOTAL:		148

The most important item in the Financial Risk category was "Business reputation tarnished." It is very difficult to rebound from an owner or partner being prosecuted for wrong doing or having bad or false reviews undermine the reputation of a company's product. The full Financial Risk results are shown in Table 5.19.

Table 5.19 Round 1 Financial Risk Results

Text	N	MEAN	S.D.	5	4	3	2	1	0	W
CATEGORY MEAN	52	2.92	1.6	9	14	10	5	8	6	152
Business reputation tarnished	53	4.42	1.1	36	11	2	1	2	1	234
Cash liquidity constrained	53	3.66	1.4	16	20	9	2	3	3	194
Money stolen due to inadequate financial controls	53	3.53	1.5	18	16	7	2	8	2	187
Becoming dependent on too few customers	53	3.53	1.4	15	19	8	3	6	2	187
Business continuity plan non-existent	53	3.42	1.5	15	16	10	3	6	3	181
Not paying required payroll taxes	53	3.30	1.8	19	14	4	2	8	6	175
Insufficient insurance	52	3.27	1.5	11	18	9	5	6	3	170
Demand for product weakens	53	3.17	1.6	11	18	10	2	7	5	168
Customers constrain cash flow with non-payment/stretched payments	53	3.09	1.6	9	20	9	1	10	4	164
Intellectual property stolen	50	3.00	1.8	14	10	9	3	7	7	150
Bank loan denied	53	2.94	1.6	7	21	7	4	8	6	156
Competitors flood market with similar products	52	2.92	1.4	6	18	7	9	11	1	152
Business continuity plan not tested	52	2.85	1.3	5	12	18	8	5	4	148
Building insurance lapsed	52	2.83	1.7	10	14	6	7	9	6	147
Lack of new product development	53	2.77	1.7	9	15	8	5	8	8	147
Lack of succession planning	53	2.75	1.5	5	17	9	8	10	4	146
Inaccurate market intelligence	52	2.77	1.5	4	17	12	6	8	5	144
Lowering of financial rating/credit score	53	2.62	1.6	7	11	14	6	6	9	139
State tax audit	52	2.62	1.4	4	10	18	7	8	5	136
Federal tax audit	53	2.55	1.4	4	11	14	11	7	6	135
Errors and Omissions Insurance inadequate	53	2.53	1.6	5	11	16	3	11	7	134
Stock market plunges	53	2.38	1.5	4	9	14	9	10	7	126
Product launch delays	52	2.29	1.6	4	11	11	5	12	9	119
Loss of learning accreditation	53	2.13	1.5	1	14	9	6	13	10	113
Currency fluctuations affect pricing	53	2.02	1.5	2	9	10	7	17	8	107
Directors insurance inadequate	50	1.68	1.5	1	5	13	4	12	15	84

Cash liquidity constrained was the second most important financial risk. Many types of businesses, such as farms, apartment management, and manufacturing have much of their assets in solid, hard objects. These assets need to be sold to convert them to cash to meet payroll, mortgage obligations, and the like. Hard assets require longer lead times to convert to cash than softer assets such as stocks or bonds.

The lowest rated items in the Financial Risk category were "Currency fluctuations affect pricing" and "Directors insurance inadequate." These results are not surprising as the small businesses participating in the study may have a local scope. Companies that do not engage in international sales are less affected by currency fluctuations that could negatively affect profitability. In like manner, the size of the company and the way a small business is organized into a C Corporation, S Corporation, partnership, or sole proprietorship affects the requirements and need for directors insurance.

Fires can cause great damage to a business by destroying property and inventory. It is not surprising that an interruption due to a fire or an explosion is a major concern to the business. The full Fire Risk results are shown in Table 5.20.

Table 5.20 Round 1 Fire Risk Results

Text	N	MEAN	S.D.	5	4	3	2	1	0	W
CATEGORY MEAN	51	3.55	1.5	18	14	8	5	3	3	181
Fires underway	51	3.80	1.5	24	12	5	4	3	3	194
Facility explosion	51	3.69	1.6	23	11	6	4	3	4	188
Building not passing fire inspection	51	3.16	1.4	7	18	12	7	4	3	161

Floods can also cause great damage by destroying property and products. Comparison of the weighted values showed that floods were not as big a concern as fires. It may be that the location of the businesses participating in this study were not prone to flooding. Businesses outside of flood zones still had moderate concern for a flood caused by burst pipes. The surprise result in this category was that "Extra high tide surges due to weather" was not a major concern. During Hurricane Sandy, storm surges caused major damage. The businesses participating in the study were most likely outside of these storm surge areas. The full Flood Risk results are shown in Table 5.21.

Table 5.21 Round 1 Flood Risk Results

Text	N	MEAN	S.D.	5	4	3	2	1	0	W
CATEGORY MEAN	52	2.79	1.7	11	11	10	5	9	7	145
Flood in area	52	3.35	1.4	11	16	14	5	3	3	174
Burst Pipes	52	3.31	1.5	12	16	11	5	5	3	172
First floor becomes flooded	52	3.19	1.7	16	12	7	5	7	5	166
Local water levels rise	52	2.96	1.4	8	12	15	7	7	3	154
Second floor becomes flooded	52	2.60	2.0	16	6	6	1	11	12	135
Basement becomes flooded	52	2.52	1.7	9	8	11	7	7	10	131
Mudslide blocks building access	51	2.39	1.8	10	7	7	4	15	8	122
Extra high tide surges due to weather	52	2.02	1.7	4	10	7	5	14	12	105

"Additional costs due to new regulations" was of moderately high concern in the small businesses in the Government Risk category. Many small businesses run on very thin profit margins. Additional costs due to government mandates may not only interrupt a business but cause it to discontinue operations entirely. For example, government mandates based on the number of employees can make business expansion much more expensive. Recent requirements to provide healthcare benefits for all employees in companies with fifty or more employees can cause a hyper increase in benefit costs when expanding a business from forty-nine to fifty employees. "Hyper increase in benefit costs" was the number two concern for the participants. The addition of the fiftieth employee adds the expense for healthcare premiums for the first forty-nine employees. This additional expense could be prohibitive. Table 5.22 shows the full results for the Government Risk category.

Table 5.22 Round 1 Government Risk Results

Text	N	MEAN	S.D.	5	4	3	2	1	0	W
CATEGORY MEAN	52	2.83	1.6	9	13	10	8	6	7	147
Additional costs due to new regulations	53	3.49	1.3	9	25	10	4	2	3	185
Hyper increase in benefit costs	52	3.35	1.6	13	21	5	3	4	6	174
Government overthrown	52	3.12	1.8	16	10	8	7	4	7	162
Local government not functioning	52	2.63	1.6	6	11	14	7	7	7	137
Government shutdown	52	2.60	1.5	6	11	9	14	6	6	135
Breach of HIPAA compliant data	52	2.54	1.8	9	11	7	8	6	11	132
Community help limited	52	2.06	1.4	3	4	14	10	14	7	107

The items in the Health Risk category have an average rating of "Very Important." This is not surprising. If the workforce is sick or is exposed to dangerous materials and chemicals, then they cannot work. Table 5.23 shows the full results for the Health Risk category.

Table 5.23 Round 1 Health Risk Results

Text	N	MEAN	S.D.	5	4	3	2	1	0	W
CATEGORY MEAN	52	3.67	1.5	20	17	6	2	5	3	191
Workforce unavailable due to epidemic	52	3.88	1.3	21	18	5	3	4	1	202
Hazardous materials leaking	52	3.75	1.7	26	13	1	2	6	4	195
Lack of response to safety issue	52	3.73	1.3	17	18	11	0	4	2	194
Dangerous materials on premises	52	3.60	1.7	20	18	2	1	7	4	187
Chemical release in area	51	3.59	1.5	17	16	7	4	5	2	183
No medical services	52	3.58	1.5	16	18	8	3	4	3	186

The concern with items in the Legal Risk category was mixed. The most important item which was judged to be of moderately high concern was "Violent crime committed by employee during work hours." Vicarious liability places the civil liability for injuries on the company. The second most important concern was "Computer based email lost during legal discovery." These lost emails might be required for legal reasons. Losing required emails could also lead to a loss of reputation which was the main concern in the financial category. Table 5.24 shows the full results for the Legal Risk category.

Table 5.24 Round 1 Legal Risk Results

Text	N	MEAN	S.D.	5	4	3	2	1	0	W
CATEGORY MEAN	51	2.94	1.8	11	16	6	4	7	7	150
Violent crime committed by employee during work hours	51	3.75	1.6	24	13	1	5	6	2	191
Computer based email lost during legal discovery	52	3.56	1.2	11	20	14	3	2	2	185
Lawsuit – vicarious liability from employee behavior	51	3.59	1.3	14	19	7	6	4	1	183
Lawsuit – sexual harassment	51	3.53	1.5	14	21	5	2	7	2	180
Falsifying qualification and certifications to perform work	51	3.35	1.6	14	16	8	4	5	4	171
Lawsuit – discrimination	51	3.33	1.5	11	21	6	3	7	3	170
Working without proper government permits	51	3.12	1.7	11	17	8	3	6	6	159
Lawsuit – intellectual property rights	52	2.83	1.8	12	12	5	8	8	7	147
Lawsuit – product liability	52	2.79	1.9	12	14	4	6	5	11	145
Use of pirated software for key purposes	51	2.75	1.7	6	19	5	5	9	7	140
Copyright infringement	52	2.62	1.7	6	15	9	7	5	10	136
Credit Card processing is not PCI compliant	51	2.59	1.8	9	11	9	4	8	10	132
Publishing false product claims	52	2.54	1.9	9	15	5	1	10	12	132
Trademark infringement	51	2.33	1.8	7	13	5	3	11	12	119
Patent infringement	52	2.17	1.8	5	15	3	5	9	15	113
Violation of export control restrictions	50	1.98	1.8	6	9	5	3	12	15	99

In the Personnel Risk category, the highest concern was "Personnel not available during an emergency." This concern stems from a business owner's need to keep a business operating following an emergency. Having the correct people available minimizes the damage or allows recovery to occur as quickly as possible. The second biggest concern was "Death of a key officer." It has been my experience that when a key officer or the owner of the business dies, the business falters or fails. A business continuity and succession plan could prevent the business from failing.

The weakest two concerns for the personnel category were both union related. They were “Workforce unavailable due to a strike” and “Union grievance process too long.” These results could be related to the participating small businesses not being unionized. Table 5.25 shows the full Personnel Risk category results.

Table 5.25 Round 1 Personnel Risk Results

Text	N	MEAN	S.D.	5	4	3	2	1	0	W
CATEGORY MEAN	51	3.16	1.6	10	17	9	4	5	5	161
Personnel not available during an emergency	51	3.92	1.1	19	17	10	2	3	0	200
Death of key officer	51	3.82	1.3	19	16	10	2	2	2	195
Key personnel not available during crisis	51	3.75	1.3	17	17	9	4	3	1	191
Key personnel in plane crash	50	3.66	1.4	16	17	9	2	4	2	183
Key personnel quits	51	3.51	1.2	7	26	11	1	5	1	179
Key personnel kidnapped	51	3.31	1.6	15	14	9	3	5	5	169
Top talent refuses to work for you	51	3.22	1.3	5	22	11	7	4	2	164
Key personnel contact list non-existent	51	3.16	1.2	3	23	12	6	6	1	161
Promotion of ineffective employees to key positions	51	3.16	1.4	7	20	9	7	5	3	161
Workforce unavailable due to strike	50	1.76	1.8	5	10	1	5	10	19	88
Union grievance process too long	50	1.52	1.6	1	8	7	3	12	19	76

“Vital records not secured” was of moderate concern in the Product Risk category and was judged first in this category by a wide margin. Vital records may contain the formulae or detailed production steps for a company’s product. If vital records are compromised, competitors might be able to produce a similar product and gain a competitive advantage. Most of the businesses that answered the survey were not in the food industry so it is not a surprise that refrigeration was a weak concern for this group. Table 5.26 shows the full Product Risk category results.

Table 5.26 Round 1 Product Risk Results

Text	N	MEAN	S.D.	5	4	3	2	1	0	W
CATEGORY MEAN	50	2.12	1.8	6	11	6	3	9	14	106
Vital records not secured	50	3.14	1.6	8	21	7	4	4	6	157
Process machinery breakdown	50	2.38	1.9	8	12	5	4	8	13	119
Product requires constant electricity	49	2.24	1.9	8	8	7	4	9	13	110
Outsourcing creates non-competitive pricing environment	49	2.12	1.8	5	10	9	2	8	15	104
Formulation details destroyed	50	2.02	1.8	6	8	6	4	13	13	101
Product in transport destroyed	50	2.00	1.8	4	13	5	2	9	17	100
Product requires other temperature control	50	1.96	1.8	5	8	7	6	8	16	98
Validated manufacturing environment spoiled	49	1.71	1.8	3	10	5	1	12	18	84
Product requires refrigeration	49	1.65	1.8	4	8	4	2	13	18	81

The first concern in the Property Risk category was “Access to facility forbidden,” which was judged to be of moderately high concern. This may arise do to evacuation orders or physical damage to entrances. The second biggest concern, “Emergency responders lacking” might be explained if the business owner were not able to access a building, then emergency workers might not be able gain access and help either. It was surprising that the respondents were not so concerned about the alarm system not working or that windows were unprotected from being broken. This might indicate that the responding businesses were not located in high crime areas. Table 5.27 shows the full Property Risk category results.

Table 5.27 Round 1 Property Risk Results

Text	N	MEAN	S.D.	5	4	3	2	1	0	W
CATEGORY MEAN	51	3.16	1.4	8	18	11	6	6	2	161
Access to facility forbidden	52	3.62	1.3	16	18	6	6	6	0	188
Emergency responders lacking	51	3.45	1.4	11	21	8	4	5	2	176
Alternate location not available	51	3.39	1.3	9	23	7	4	7	1	173
Employee theft	51	3.24	1.5	10	17	12	3	5	4	165
Valuable items on premises	50	3.20	1.3	8	15	15	6	3	3	160
Earthquake in area	51	3.14	1.6	11	16	8	4	9	3	160
Downed trees block building access	50	3.00	1.5	8	15	8	9	8	2	150
Crime rate increase near place of business	50	2.92	1.2	3	15	18	5	7	2	146
Alarm system not working	50	2.92	1.3	2	18	16	5	6	3	146
Windows unprotected from being broken	50	2.84	1.3	1	19	12	10	5	3	142

The first concern in the Security Risk category was “Lack of intrusion detection,” which was judged to be of moderate concern. This is unusual because in the Property Risk category, a related item, “Alarm system not working” was considered the second least concern. In both of these two categories the least concern had to do with windows. In the Property Risk category it was that the windows were unprotected from becoming broken, while in the Security Risk category the respondents were least concerned about windows being unprotected from intrusion. The full Security Risk category results are shown in Table 5.28.

Table 5.28 Round 1 Security Risk Results

Text	N	MEAN	S.D.	5	4	3	2	1	0	W
CATEGORY MEAN	51	3.06	1.6	12	12	10	6	6	5	156
Lack of intrusion detection	52	3.27	1.3	10	15	13	9	3	2	170
Violent crime committed on premises	51	3.24	1.6	14	15	5	7	6	4	165
Production equipment sabotaged	50	3.00	1.9	17	9	5	3	8	8	150
Windows unprotected from intrusion	50	2.76	1.5	7	10	15	5	8	5	138

The main Supply Chain Risk category item which was judged to be of moderately weak concern was that a key supplier went out of business. Regardless of business type, the need for suppliers is essential to provide raw materials for a manufacturing company or particular skills to a service business. The least concern in this category was raw material contamination and a private place to store raw materials. This is easily explained from the Pre-survey results that most respondents were not in manufacturing. The full Supply Chain Risk category results are shown in Table 5.29.

Table 5.29 Round 1 Supply Chain Risk Results

Text	N	MEAN	S.D.	5	4	3	2	1	0	W
CATEGORY MEAN	50	2.36	1.7	5	11	8	6	9	10	118
Key supplier goes out of business	52	2.79	1.6	8	11	13	8	6	6	145
Lack of spare parts	51	2.61	1.7	6	17	6	5	7	10	133
Priority service contracts not established to repair equipment	50	2.56	1.6	6	10	11	9	7	7	128
Strategic Partner goes out of business	49	2.57	1.6	6	11	11	5	9	7	126
Not having alternate supply sources for raw materials	51	2.35	1.8	7	13	5	4	10	12	120
Raw materials contaminated	50	1.78	1.7	4	9	5	2	14	16	89
Private stores not available	50	1.68	1.5	0	9	7	8	11	15	84

The Technology/Data Risk category showed that the main concerns for the business centered on losing data. It did not matter if the loss was due to a hacker, carelessness, or an inadequate backup. The mean for data loss was over 4.0, "Very Important," on the survey Likert scale and "High Concern" on the risk interpretation scale. The respondents judged ensuring compliance with software licensing when setting up a temporary location as a moderately weak concern. The emergency situation placed "Insufficient software licenses for temporary location" at the bottom of the Technology/Data Risk results. The full Technology/Data Risk category results are shown in Table 5.30.

Table 5.30 Round 1 Technology/Data Risk Results

Text	N	MEAN	S.D.	5	4	3	2	1	0	W
CATEGORY MEAN	50	3.70	1.3	15	20	8	3	4	2	185
Computer data lost	52	4.06	1.1	20	22	7	0	2	1	211
Computer virus attacks network	51	4.06	1.2	23	17	7	0	3	1	207
No communication networks	50	4.06	1.0	20	19	7	2	2	0	203
Computer server not fully backed up	51	4.04	1.1	18	24	6	0	2	1	206
Computer system hacked	51	4.02	1.2	22	19	5	0	4	1	205
Cyber-attack on computer infrastructure	50	4.02	1.3	23	16	6	0	4	1	201
Malware embedded in software	51	3.98	1.2	20	19	7	2	2	1	203
Computer hardware fails	51	3.94	1.1	17	21	10	0	2	1	201
Large scale data breach	50	3.82	1.4	20	15	8	2	3	2	191
Software no longer runs on new computers	50	3.82	1.2	16	20	8	2	3	1	191
Server Administrator passwords lost	49	3.69	1.3	13	22	6	4	2	2	181
Internet provider failure	50	3.62	1.1	7	29	6	4	4	0	181
Computer/laptop stolen	50	3.58	1.4	13	22	4	5	4	2	179
Virus protection out of date	51	3.55	1.2	9	23	11	4	3	1	181
Internet connectivity lost	50	3.54	1.1	8	24	9	5	4	0	177
Computer operating system no longer supported	50	3.52	1.3	12	18	11	4	3	2	176
Cell phone stolen	50	3.24	1.2	6	18	13	8	5	0	162
Computer stored credit card information stolen	50	3.18	1.9	17	14	3	1	7	8	159
Source code not available for recompiling	50	3.00	1.7	10	16	8	4	4	8	150
Insufficient software licenses for temporary location	50	2.78	1.4	2	18	12	7	7	4	139

The Terrorism Risk category was brief but showed moderately high concern for a terrorist attack and civil unrest. Table 5.31 shows the full Terrorism Risk category results.

Table 5.31 Round 1 Terrorism Risk Results

Text	N	MEAN	S.D.	5	4	3	2	1	0	W
CATEGORY MEAN	50	3.50	1.4	15	13	11	5	4	2	175
Terrorist attack in area	50	3.74	1.4	19	14	8	4	4	1	187
Bomb threat issued	50	3.40	1.4	14	12	12	6	4	2	170
Civil unrest near place of business	50	3.36	1.4	13	12	13	6	4	2	168

The Transportation Risk category gauged moderate concern on how workers might be able to get to work in the case of some kind of event. The main concerns were "Roads flooded," "Roads filled with debris," and "Roads clogged with traffic." In these situations employees would not be able to reach their workplace at all or be seriously delayed. The weakest concern was "Seaports not open." This is explained by the mix of businesses participating. The businesses had minimum need for shipment by sea for their products or supplies. The full Transportation Risk category results are shown in Table 5.32.

Table 5.32 Round 1 Transportation Risk Results

Text	N	MEAN	S.D.	5	4	3	2	1	0	W
CATEGORY MEAN	49	2.55	1.4	4	10	12	10	11	3	125
Roads flooded	50	3.36	1.2	7	20	12	7	3	1	168
Roads filled with debris	50	3.12	1.3	6	17	12	9	4	2	156
Roads clogged with traffic	50	3.06	1.1	1	20	18	5	4	2	153
Buses unavailable	49	2.14	1.2	3	4	9	16	15	2	105
Trains unavailable	49	2.14	1.2	2	5	12	11	17	2	105
Airports not open	49	1.92	1.1	1	3	11	14	16	4	94
Seaports not open	48	1.90	1.5	5	3	8	6	18	8	91

The main result for the Utility Risk category showed one of the highest concerns in the entire survey, "Electricity cut off." This item was judged as "High Concern." Without electricity modern business comes to a halt. Computers cannot run. Cell phones cannot be recharged. Manufacturing lines cannot not run and produce products. It is no wonder that lack of electricity and the availability of backup power were the major concerns. The respondents showed moderately weak concern about the loss of natural gas supply despite the fact that many backup systems use natural gas for generating electricity. The full Utility Risk category results are shown in Table 5.33.

Table 5.33 Round 1 Utility Risk Results

Text	N	MEAN	S.D.	5	4	3	2	1	0	W
CATEGORY MEAN	48	3.54	1.3	13	16	11	3	3	2	170
Electricity cut off	49	4.29	0.9	25	16	6	1	1	0	210
Backup power supply not available	47	4.02	1.0	17	19	7	3	1	0	189
Telephones out of service	48	3.90	0.9	12	24	8	3	1	0	187
Water supply undrinkable	48	3.54	1.3	15	10	15	3	4	1	170
Gasoline in short supply	49	3.22	1.3	7	16	17	2	4	3	158
Sewage treatment unavailable	46	3.07	1.4	7	12	13	7	5	2	141
Natural gas supply unusable	48	2.79	1.6	7	12	12	4	7	6	134

The Weather Risk category was short but showed a moderately high concern for disruptions due to hurricane. This can be explained by the recent memories of Hurricane Sandy and the devastation it produced inside of the research geographic area. Storms often occur in the target geographic region of the United States which explains why “Severe drought in area” is at the bottom of the participant’s concerns. The full Weather Risk category results are shown in Table 5.34.

Table 5.34 Round 1 Weather Risk Results

Text	N	MEAN	S.D.	5	4	3	2	1	0	W
CATEGORY MEAN	50	3.40	1.2	9	15	16	8	3	1	170
Hurricane in area	51	3.80	1.0	14	20	11	5	1	0	194
Tornado in area	50	3.66	1.1	11	20	12	5	2	0	183
Electrical storm in area	51	3.22	1.1	8	11	20	9	2	1	164
Severe drought in area	50	2.76	1.2	4	8	19	11	7	1	138

5.3 Round 1 Risk Results Across All Categories

There were fifty-three completed surveys and seven partially completed surveys at the end of Round 1. This section consolidates the results of all sixteen risk categories. The table is sorted by the mean, then by the weighted value, W, and then by the number of highest value selections, as shown in column 5. This sort order shows the risk items which cause the most concern to the respondents. The table uses the columns shown in Table 5.35.

Table 5.35 Table Legend for Risk Data by Category

Column Title	Meaning
Risk Category	The original category for the risk item
Text	Survey text
N	Number of respondents
MEAN	Average value
S.D.	Standard Deviation
5	Critically Important
4	Very Important
3	Somewhat Important
2	Minor Importance
1	No Importance
0	No Judgment
W	Total Weighted Value (See calculation equation, Figure 4.2)

The risk item of highest concern was from the financial category, “Business reputation tarnished.” Other major concerns were “Electricity cut off” and “Computer data lost." These last two categories may have an effect on the business reputation by showing a lack of preparation. They may not be a direct result of a decision made by the business owner. It is notable that seven of the top ten rated risks are in the Data/Technology area. Data can be lost by hardware failure as well as hackers stealing data. Losing electricity can be caused by laser weather events, but can also occur when a circuit becomes overloaded and the circuit breaker opens. Either event can suspend operations for a period of time.

Other actions taken by someone in the business may tarnish the reputation of the business to the point that few people wish to be customers. The loss of reputation, due to events that may involve serving a jail sentence, may negate a business person's ability to establish another business for the rest of their life.

Respondents showed weak concern for the three lowest rated risks, "Private stores not available," "Product requires refrigeration," and "Union grievance process too long," Each of these risks may be concerns of different businesses, but not the ones who participated in this survey. To give an idea of the main risk concerns of the small business owners and to easily contrast them in one table with risks that were not of great concern we show the top 10 and bottom 10 risk results across all categories in Table 5.36. The full list is shown in Appendix L.

Table 5.36 Top 10 and Bottom 10 Round 1 Risk Results Across All Categories

Risk Category	Text	N	MEAN	S.D.	5	4	3	2	1	0	W
TOP 10											
Financial	Business reputation tarnished	53	4.42	1.1	36	11	2	1	2	1	234
Utility	Electricity cut off	49	4.29	0.9	25	16	6	1	1	0	210
Technology/ Data	Computer data lost	52	4.06	1.1	20	22	7	0	2	1	211
Technology/ Data	Computer virus attacks network	51	4.06	1.2	23	17	7	0	3	1	207
Technology/ Data	No communication networks	50	4.06	1.0	20	19	7	2	2	0	203
Technology/ Data	Computer server not fully backed up	51	4.04	1.1	18	24	6	0	2	1	206
Technology/ Data	Computer system hacked	51	4.02	1.2	22	19	5	0	4	1	205
Technology/ Data	Cyber-attack on computer infrastructure	50	4.02	1.3	23	16	6	0	4	1	201
Utility	Backup power supply not available	47	4.02	1.0	17	19	7	3	1	0	189
Technology/ Data	Malware embedded in software	51	3.98	1.2	20	19	7	2	2	1	203
BOTTOM 10											
Product	Product requires other temperature control	50	1.96	1.8	5	8	7	6	8	16	98
Transportation	Airports not open	49	1.92	1.1	1	3	11	14	16	4	94
Transportation	Seaports not open	48	1.90	1.5	5	3	8	6	18	8	91
Supply Chain	Raw materials contaminated	50	1.78	1.7	4	9	5	2	14	16	89
Personnel	Workforce unavailable due to strike	50	1.76	1.8	5	10	1	5	10	19	88
Product	Validated manufacturing environment spoiled	49	1.71	1.8	3	10	5	1	12	18	84
Financial	Directors Insurance inadequate	50	1.68	1.5	1	5	13	4	12	15	84
Supply Chain	Private stores not available	50	1.68	1.5	0	9	7	8	11	15	84
Product	Product requires refrigeration	49	1.65	1.8	4	8	4	2	13	18	81
Personnel	Union grievance process too long	50	1.52	1.6	1	8	7	3	12	19	76

NOTE: The full list appears in Appendix L.

5.4 Round 1 Action Results By Category

The second part of the Round 1 survey asked how the respondents felt towards actions that could mitigate or prepare for the risks rated in part 1 of the survey. This part of the survey asked whether a particular preparation action applied to their business or only other businesses. The terror category was the only category not asked about in this section as it was considered to apply to all businesses.

There were fifty-three completed surveys and seven partially completed ones. There is a table in this section for each action category. The shaded values at the top of each table are the average values for all of the numeric columns. This shaded row provides the reader with an easy way to compare an individual row to the average finding for a particular category. Each of the tables uses the columns shown in Table 5.37.

Table 5.37 Table Legend for Action Data by Category

Column Title	Meaning
Text	Survey text
N	Number of respondents
MEAN	Average value
S.D.	Standard Deviation
2	Applies to my business
1	Applies only to other businesses
0	No Judgment
W	Total Weighted Value (See calculation equation, Figure 4.2)

There are fifteen action categories with different numbers of items being judged. The total number of action items judged in Round 1 is one hundred thirty-three. These categories, the corresponding summary table, and the number of action items judged are shown in Table 5.38.

Table 5.38 Table of Action Categories and the Number of Actions

Round 1 Action Result Category	Table Number	Number of Actions
Financial Action	5.44	16
Fire Action	5.45	6
Flood Action	5.46	6
Government Action	5.47	3
Health Action	5.48	4
Legal Action	5.49	8
Personnel Action	5.50	7
Product Action	5.51	18
Property Action	5.52	7
Security Action	5.53	6
Supply Chain Action	5.54	6
Technology/Data Action	5.55	24
Transportation Action	5.56	3
Utility Action	5.57	5
Weather Risk	5.58	14
TOTAL:		133

In the Financial Action category, the most important actions to take to help prevent business interruption were “Broaden customer base,” “File taxes on time,” and “Lower expenses.” A business that does not continually find new customers will become too dependent on them. A large customer going out of business will substantially damage a company’s revenue. Paying the taxes on time will ensure that penalties are not assessed which in turns helps lower expenses. Making sure that money is spent on the right items at the best prices helps the company lower expenses.

Items that did not apply to the business answering the survey included “Value product in strong currency” and “Place stop loss stock orders.” The demographic of the businesses responding to the survey most likely did not include financial firms or ones engaged in foreign commerce. The full results are shown in Table 5.39.

Table 5.39 Round 1 Financial Action Results

Text	N	MEAN	S.D.	2	1	0	W
CATEGORY MEAN	51	1.39	0.8	31	10	10	71
Broaden customer base	51	1.80	0.6	45	2	4	92
File taxes on time	51	1.78	0.6	45	1	5	91
Lower expenses	51	1.78	0.6	44	3	4	91
Pay required taxes	51	1.73	0.7	43	2	6	88
Create business continuity plan	52	1.69	0.6	39	10	3	88
Strengthen cash flow/lessen debt	51	1.65	0.7	38	8	5	84
Add alternate revenue sources	51	1.45	0.8	33	8	10	74
Negotiate better payment terms	50	1.42	0.8	32	7	11	71
Create succession plan	50	1.36	0.8	27	14	9	68
Create continuous audit system	51	1.33	0.8	26	16	9	68
Find alternate insurance	50	1.34	0.8	27	13	10	67
Improve insurance renewal procedures	50	1.28	0.8	24	16	10	64
Self-finance operation	51	1.20	0.9	25	11	15	61
Increase insurance coverage	49	1.18	0.8	20	18	11	58
Value product in strong currency	51	0.75	0.9	14	10	27	38
Place stop loss stock orders	50	0.68	0.8	10	14	26	34

In the Fire Action category the most important actions to take to help prevent business interruption were to "Buy fire extinguishers," "Buy smoke alarms," and "Create building evacuation plan." These are very good preparations to put out a fire and get your employees out of the building safely. Where the top three items show a concern for employee safety, the least applicable preparation "Schedule a fire protection audit" seems counterintuitive. The expert advice from a fire protection audit could help prepare a worksite and to correct problems before someone was injured. The time spent to perform an audit may actually help prevent a business interruption. The full results are shown in Table 5.40.

Table 5.40 Round 1 Fire Action Results

Text	N	MEAN	S.D.	2	1	0	W
CATEGORY MEAN	51	1.27	0.8	26	13	12	65
Buy fire extinguishers	51	1.59	0.7	38	5	8	81
Buy smoke alarms	51	1.37	0.8	30	10	11	70
Create building evacuation plan	51	1.33	0.8	26	16	9	68
Add sprinkler system	51	1.20	0.8	23	15	13	61
Improve fireproofing	51	1.18	0.8	22	16	13	60
Schedule a fire protection audit	50	1.00	0.8	18	14	18	50

In the Flood Action category the most important actions to take to help prevent business interruption were to raise electrical equipment and product inventory above flood stage. These preparations would keep essential items above the water level. Many houses have been elevated following Super Storm Sandy to minimize future flood damage. Raising the building was not considered so important for the businesses. It may be that raising an entire manufacturing facility would not be cost effective.

The least important preparation in the Flood Action category was considered to be "Fortify flood levies." Although it is necessary to have effective levies, this preparation might not be considered to be the responsibility of an individual company. Government entities would need to perform this action. The full results are shown in Table 5.41.

Table 5.41 Round 1 Flood Action Results

Text	N	MEAN	S.D.	2	1	0	W
CATEGORY MEAN	50	0.70	0.7	7	22	21	35
Raise electrical equipment above flood stage	50	0.84	0.8	11	20	19	42
Raise product inventory above flood stage	50	0.76	0.8	11	16	23	38
Build containment walls	49	0.73	0.7	7	22	20	36
Add building flood walls around property	50	0.66	0.6	4	25	21	33
Raise building above ground level	50	0.62	0.6	3	25	22	31
Fortify flood levies	50	0.60	0.6	3	24	23	30

The Government Action category was brief with only three items. Although the item that was most applicable to the business was "Lobby government for lesser regulations," the mean for this category was exactly a "1.0" or applicable only to other businesses. The split between being applicable to one's own business and being applicable only to other businesses was very even. Seventeen participants chose "Lobby government for lesser regulations" to be applicable to their business, while eighteen chose it to be applicable to only other businesses. Those other businesses may be large enough to have a government affairs department. Small businesses can leverage their small size by joining business associations that can lobby and act as an effective voice to the government. Sixteen respondents chose no judgment. The full results are shown in Table 5.42.

Table 5.42 Round 1 Government Action Results

Text	N	MEAN	S.D.	2	1	0	W
CATEGORY MEAN	50	0.74	0.8	10	17	23	37
Lobby government for lesser regulations	51	1.02	0.8	17	18	16	52
Increase safety of building codes	50	0.68	0.8	10	14	26	34
Buy out vulnerable properties	50	0.52	0.6	4	18	28	26

The Health Action category contained few items. The leading item was "Create emergency first aid pack" with over sixty per cent of the respondents choosing this as applicable to their business. This precaution was seen as very affordable and could lessen the effects of an injury in the workplace.

The least selected preparation was "Add filtration facility." Although inline filters can be applied inexpensively to most water systems, the idea of having a filtration facility seemed to be applicable to larger businesses that are not part of this study. The full results are shown in Table 5.43.

Table 5.43 Round 1 Health Action Results

Text	N	MEAN	S.D.	2	1	0	W
CATEGORY MEAN	50	0.98	0.8	16	17	17	49
Create emergency first aid pack	50	1.52	0.7	32	12	6	76
Move employees to safe area	50	0.98	0.8	16	17	17	49
Inoculate employees against infection	50	0.86	0.8	13	17	20	43
Add filtration facility	50	0.56	0.6	4	20	26	28

In the Legal Action category, the participants' main preparation was to ensure that they had enough legitimate licenses for their software. While they were concerned that their software was legitimate, they also showed that they were not afraid to take legal action if it was necessary. "Take legal action" was their second choice for a preparation action that applied to their business.

The least important preparation was considered to be "Maintain export compliance." Most of the respondents were not in a business where they exported goods. The full results are shown in Table 5.44.

Table 5.44 Round 1 Legal Action Results

Text	N	MEAN	S.D.	2	1	0	W
CATEGORY MEAN	51	0.94	0.8	16	16	19	48
Buy legitimate licenses	51	1.57	0.7	36	8	7	80
Take legal action	51	1.02	0.9	19	14	18	52
Report to government officials	50	0.96	0.8	15	18	17	48
Take PCI compliance audit	51	0.88	0.8	13	19	19	45
Create notification for customers to cancel credit cards	50	0.82	0.8	13	15	22	41
Draft cease/desist letter	51	0.80	0.8	11	19	21	41
Hire public relations firm	51	0.80	0.7	10	21	20	41
Maintain export compliance	51	0.71	0.8	10	16	25	36

In the Personnel Action category, the main item that applied to their business was "Create contact list." This simple procedure facilitates communications with key personnel when an emergency arises. It is easy to do and inexpensive.

"Create union/management team building" was the least important preparation as most of the businesses that responded to the survey were not union shops. This item would only apply to other businesses in this case. The full results are shown in Table 5.45.

Table 5.45 Round 1 Personnel Action Results

Text	N	MEAN	S.D.	2	1	0	W
CATEGORY MEAN	51	0.98	0.8	17	17	18	50
Create contact list	52	1.67	0.6	40	7	5	87
Change management team	52	1.06	0.8	19	17	16	55
Use replacement personnel	49	1.00	0.8	16	17	16	49
Recruit new manager	51	0.96	0.8	17	15	19	49
Increase offer to make company attractive	51	0.76	0.8	12	15	24	39
Improve union relations.	51	0.71	0.7	6	24	21	36
Create union/management team building	51	0.69	0.7	6	23	22	35

In the Product Action category, the items that most applied to the responding businesses were "Buy reputable equipment," "Store vital documents," and "Revise marketing materials." Reputable, quality equipment does not have to be replaced as often and may not need to be maintained as often. Storing vital documents, such as process procedures and key product formulae, will allow the business to continue in another location should a disaster strike the main facility. It was interesting that "Revise marketing material" was the third highest preparation. Outdated marketing materials can make a company look out of touch. Outdated materials may make a product look obsolete causing potential customers to look for a more modern business.

"Prepare food offsite" was the least important preparation as most of the businesses that responded to the survey were not in the food industry. The majority of the respondents selected "no judgment" for this item. The full results are shown in Table 5.46.

Table 5.46 Round 1 Product Action Results

Text	N	MEAN	S.D.	2	1	0	W
CATEGORY MEAN	51	0.98	0.8	16	17	18	50
Buy reputable equipment	51	1.57	0.7	34	12	5	80
Store vital documentation	51	1.41	0.8	31	10	10	72
Revise marketing materials.	51	1.33	0.8	29	10	12	68
Brainstorm new products	52	1.29	0.8	26	15	11	67
Innovate new products	52	1.27	0.8	26	14	12	66
Add preventive maintenance program	51	1.25	0.8	25	14	12	64
Test business continuity plan	51	1.14	0.8	21	16	14	58
Use manual procedures	51	1.04	0.9	20	13	18	53
Create new products with proprietary technology	52	0.94	0.8	15	19	18	49
Revalidate equipment	51	0.88	0.8	14	17	20	45
Move operations to secondary site	51	0.86	0.8	13	18	20	44
Provide strong certification process	51	0.76	0.7	8	23	20	39
Spread production over larger geographic area	51	0.75	0.7	9	20	22	38
Provide own inspectors	51	0.65	0.7	7	19	25	33
Buy non-electrical dehumidification equipment	50	0.64	0.6	4	24	22	32
Hire new market research firm	52	0.60	0.7	5	21	26	31
Limit customer order quantities	51	0.59	0.6	4	22	25	30
Prepare food offsite	51	0.55	0.7	5	18	28	28

The Property Action category's main preparation item was "Obtain proper permits." Obtaining proper permits shows a moderate concern that proper documents are in place before work begins This reinforces the main finding of the Legal Action category where having legitimate licenses was the most applicable action. In both cases, the respondents showed that proper procedures needed to be followed to avoid problems. The "Coordinate volunteer group" selection was the second highest value preparation. This showed concern for the surrounding community by being involved to make the area around the worksite better. Examples of volunteering would be fixing up recreation facilities prior to the beginning of a youth sports league or volunteering for a litter clean-up day.

"Hire heavy equipment for removal" was the least selected preparation. Most of the businesses that responded to the survey may not have needed to expand a building at the time of the survey. The full results are shown in Table 5.47.

Table 5.47 Round 1 Property Action Results

Text	N	MEAN	S.D.	2	1	0	W
CATEGORY MEAN	51	0.84	0.8	12	18	20	43
Obtain proper permits	51	1.00	0.8	17	17	17	51
Coordinate volunteer group	51	0.92	0.8	15	17	19	47
Renovate building to new code	51	0.90	0.8	14	18	19	46
Create community response	51	0.88	0.8	15	15	21	45
Plan alternate building access	51	0.88	0.8	13	19	19	45
Fortify building structure	51	0.71	0.7	8	20	23	36
Hire heavy equipment for removal	51	0.63	0.7	5	22	24	32

The three main items in the Security Actions category were "Add access security system," "Add security cameras," and "Improve security protection." All three items centered on protecting the business from break-ins and providing authorized access. Cameras can record activity for later review and provide evidence of a break-in.

"Add metal bars to windows" was not considered as applicable to their businesses as most were not located in high crime areas. The full results are shown in Table 5.48.

Table 5.48 Round 1 Security Action Results

Text	N	MEAN	S.D.	2	1	0	W
CATEGORY MEAN	50	1.08	0.8	18	17	15	54
Add access security system	50	1.32	0.8	27	12	11	66
Add security cameras	51	1.25	0.8	25	14	12	64
Improve security protection	50	1.20	0.8	22	16	12	60
Add check-in/check-out property procedures	50	1.08	0.8	18	18	14	54
Seal windows and doors	50	0.86	0.8	12	19	19	43
Add metal bars to windows	50	0.70	0.6	5	25	20	35

The Supply Chain category's main items centered on finding alternative resources to supplement current suppliers. The respondents thought that "Identify alternate suppliers" and "Add alternate contractors" were the best ways to minimize interruption due to a loss of a supplier or contractor.

"Reorder new raw materials" was considered to be more applicable to only other businesses but not by a wide margin. The full results are shown in Table 5.49.

Table 5.49 Round 1 Supply Chain Action Results

Text	N	MEAN	S.D.	2	1	0	W
CATEGORY MEAN	48	1.02	0.8	16	17	16	49
Identify alternate suppliers	48	1.31	0.8	25	13	10	63
Add alternate contractors	48	1.08	0.8	18	16	14	52
Create alternate supply chain	48	0.94	0.8	13	19	16	45
Increase spare part inventory	49	0.92	0.8	13	19	17	45
Find alternate partner	48	0.92	0.8	14	16	18	44
Reorder new raw materials	48	0.88	0.8	12	18	18	42

The Technology/Data Action category contained the most action items for consideration and had many of the highest ratings for applicability to one's own business. The main items that were found to be applicable to the business centered on protecting against unwanted access to the computer systems by adding and updating virus protection. Over 80% of the respondents chose these items as being applicable. This shows an awareness by businesses that viruses and other intrusions can apply to even very small businesses.

"Disassemble and rewrite source code" was considered to be more applicable only to other businesses. Only 6% of the businesses thought that reverse engineering software by dissembling and rewriting code was applicable to their business. Businesses that need to reverse engineer software may be running outdated versions that would not be supported by the vendor if a problem arose. The full results are shown in Table 5.50.

Table 5.50 Round 1 Technology/Data Action Results

Text	N	MEAN	S.D.	2	1	0	W
CATEGORY MEAN	51	1.24	0.8	25	13	13	63
Add virus protection	52	1.77	0.6	44	4	4	92
Update virus protection	51	1.73	0.6	40	8	3	88
Add adequate surge protection	51	1.67	0.7	40	5	6	85
Use wireless connections	51	1.65	0.7	38	8	5	84
Add software firewall	52	1.56	0.7	36	9	7	81
Improve backup procedures	51	1.57	0.7	36	8	7	80
Create backups for emergency procedure execution	52	1.50	0.8	35	8	9	78
Install hardware firewall	51	1.45	0.7	31	12	8	74
Add real time backup software	50	1.46	0.8	31	11	8	73
Add offsite backup	51	1.43	0.8	31	11	9	73
Add multi-tiered backup strategy	51	1.39	0.8	30	11	10	71
Use alternate communication services such as mail or courier	51	1.22	0.9	26	10	15	62
Update operating system during upgrade grace period	49	1.24	0.8	25	11	13	61
Encrypt/password protect hard drive	51	1.14	0.8	21	16	14	58
Create data deletion plan	51	1.08	0.8	18	19	14	55
Upgrade hardware and run old software under emulation.	48	1.13	0.8	20	14	14	54
Increase number of software licenses	51	1.06	0.8	19	16	16	54
Add remote destruction of data	50	1.04	0.8	17	18	15	52
Create hot site alternate location	51	1.02	0.8	17	18	16	52
Rebuild data from source documentation	49	1.00	0.8	17	15	17	49
Create hot spares	51	0.82	0.7	10	22	19	42
Buy password cracking software	52	0.71	0.7	7	23	22	37
Rebuild formulation	51	0.59	0.7	5	20	26	30
Disassemble and rewrite source code	50	0.50	0.6	3	19	28	25

The Terrorism category was not part of this survey as preparations were considered to be in the purview of government and applicable to all businesses. Study of this category can be included in future research.

The main finding in the Transportation Action category was that the best way to prepare for an transportation interruption was to set up a home office. Once setup, transportation to the central office was not as necessary. The alternative to the home office was to use an alternate means of transportation to avoid a business interruption. The full results are shown in Table 5.51.

Table 5.51 Round 1 Transportation Action Results

Text	N	MEAN	S.D.	2	1	0	W
CATEGORY MEAN	51	1.31	0.8	27	13	11	67
Plan home office	52	1.44	0.7	31	13	8	75
Use ground-based transportation	51	1.27	0.8	26	13	12	65
Use alternate transportation	51	1.20	0.8	24	13	14	61

The Utility Action category's "Add power generators" was the main preparation for preventing business interruption. It was considered applicable to 46% of the respondents compared to the next item, "Rent port-a-johns" which was applicable to only 16% of the respondent businesses. Storing additional gasoline was also considered less applicable. The storage may pose a hazard for both environmental and fire considerations. The full results are shown in Table 5.52.

Table 5.52 Round 1 Utility Action Results

Text	N	MEAN	S.D.	2	1	0	W
CATEGORY MEAN	51	0.84	0.8	11	20	19	43
Add power generators	50	1.24	0.8	23	16	11	62
Rent port-a-johns	51	0.76	0.7	8	23	20	39
Store additional gasoline	50	0.76	0.7	9	20	21	38
Install natural gas generator	51	0.75	0.7	9	20	22	38
Host own gas supply	51	0.75	0.7	8	22	21	38

The Weather Action Utility category's "Buy flash lights" (63%) and "Buy extra batteries" (56%) were the two main preparation items for preventing business interruption during bad weather. "Buying snow shovels" and "Fill vehicle gas tanks" were next with 54% and 45%, respectively. It was surprising that more businesses did not consider filling gas tanks a high preparation priority. This may be an indication of the increase in telecommuting with alternate home offices not making transportation as important.

Less than 4% of the respondents considered “Buying charcoal grill” and “Buy charcoal” as applicable preparations. The companies were not in the food services business and may not have prepared food. A majority of homes in the survey area used gas to cook, alleviating the need for charcoal grills as an alternate means to prepare food. The full results are shown in Table 5.53.

Table 5.53 Round 1 Weather Action Results

Text	N	MEAN	S.D.	2	1	0	W
CATEGORY MEAN	51	0.84	0.8	12	19	20	43
Buy flash lights	51	1.47	0.8	32	11	8	75
Buy extra batteries	50	1.34	0.8	28	11	11	67
Buy snow shovels	50	1.32	0.8	27	12	11	66
Fill vehicle gas tanks	51	1.18	0.8	23	14	14	60
Freeze food	50	0.94	0.8	13	21	16	47
Add lightning rods to building	51	0.88	0.8	12	21	18	45
Buy gas/propane grill	50	0.76	0.7	8	22	20	38
Buy extra coolers	51	0.75	0.7	9	20	22	38
Store additional propane	51	0.71	0.7	8	20	23	36
Install storm shutters	50	0.62	0.6	4	23	23	31
Build storm shelter	51	0.55	0.6	2	24	25	28
Buy dry ice	50	0.54	0.6	4	19	27	27
Buy charcoal grill	51	0.49	0.6	2	21	28	25
Buy charcoal	51	0.45	0.5	1	21	29	23

5.5 Round 1 Action Results Across All Categories

There were fifty-three completed surveys and seven partially completed surveys at the end of Round 1. This section consolidates the results of all action categories. The table is sorted by the mean, then by the weighted value, W, and then by the number of highest value selections, as shown in column 2. This sort order shows the action items which are most applicable to the respondents' businesses and breaks ties between the items. The table uses the columns shown in Table 5.54.

Table 5.54 Table Legend for Action Data by Category

Column Title	Meaning
Action Category	The original category for the action item
Text	Survey text
N	Number of respondents
MEAN	Average value
S.D.	Standard Deviation
2	Applies to my business
1	Applies only to other businesses
0	No Judgment
W	Total Weighted Value (See calculation equation, Figure 4.2)

The action item which was considered most applicable to their own business was from the financial category, "Broaden customer base." Other major concerns were "Add virus protection," "File taxes on time," and "Lower expenses." Three of the top four action items are from the financial category as were six of the top ten. Proper financial control and management are paramount to running a profitable business. Two other of the top ten most applicable action items were from the Technology/Data category. Adding and updating virus protection were considered applicable to their own business to ensure that data was not lost or breached. Data that becomes lost as a result of hardware failure helps explain that surge protection is very applicable to prevent business interruption. Power surges can permanently damage computer components.

Respondents did not consider various weather preparations as applicable to their business. Of the five lowest categories, three were weather preparations, “Buy dry ice,” “Buy charcoal grill,” “Buy charcoal.” The mix of responding companies did not include any food service businesses which may explain this lack of concern for alternate ways to prepare food. Many home kitchens in the target geographic area use natural gas for cooking. To give an idea of the most important preparation actions of the small business owners and to easily contrast them in one table with preparation actions that were considered to be less applicable to their business, we show the top ten and bottom ten results in Table 5.55. The full list appears in Appendix M.

Table 5.55 Table Top 10 and Bottom 10 Round 1 Action Results Across All Categories

Action Category	Text	N	MEAN	S.D.	2	1	0	W
TOP 10								
Financial	Broaden customer base	51	1.80	0.6	45	2	4	92
Technology/Data	Add virus protection	52	1.77	0.6	44	4	4	92
Financial	File taxes on time	51	1.78	0.6	45	1	5	91
Financial	Lower expenses	51	1.78	0.6	44	3	4	91
Financial	Pay required taxes	51	1.73	0.7	43	2	6	88
Technology/Data	Update virus protection	51	1.73	0.6	40	8	3	88
Financial	Create business continuity plan	52	1.69	0.6	39	10	3	88
Personnel	Create contact list	52	1.67	0.6	40	7	5	87
Technology/Data	Add adequate surge protection	51	1.67	0.7	40	5	6	85
Financial	Strengthen cash flow/lessen debt	51	1.65	0.7	38	8	5	84
BOTTOM 10								
Product	Limit customer order quantities	51	0.59	0.6	4	22	25	30
Flood	Fortify flood levies	50	0.60	0.6	3	24	23	30
Health	Add filtration facility	50	0.56	0.6	4	20	26	28
Product	Prepare food offsite	51	0.55	0.7	5	18	28	28
Weather	Build storm shelter	51	0.55	0.6	2	24	25	28
Weather	Buy dry ice	50	0.54	0.6	4	19	27	27
Government	Buy out vulnerable properties	50	0.52	0.6	4	18	28	26
Technology/Data	Disassemble and rewrite source code	50	0.50	0.6	3	19	28	25
Weather	Buy charcoal grill	51	0.49	0.6	2	21	28	25
Weather	Buy charcoal	51	0.45	0.5	1	21	29	23

Note: The full list appears in Appendix M.

5.6 Round 2 Risk Results

The Round 2 survey was sent to the sixty respondents who participated in Round 1. Of those sixty, forty-one completed the survey and one partially completed it. The Round 2 survey questions were from the suggestions for new risk and action items entered in Round 1. Each invitation email had a copy of the respondent's selections to Round 1 in a PDF format. After making selections for the new category items, the respondent could continue to change their Round 1 selections at their own discretion.

The total number of items that were evaluated in Round 2 was small compared to the total number of items in Round 1. As such, there is one summary table which shows all items across all Round 2 categories. The summary table uses the columns shown in Table 5.56.

Table 5.56 Table Legend for Round 2 Risk Data Across All Categories

Column Title	Meaning
Risk Category	Survey risk category
Text	New survey item text as suggested in Round 1
N	Number of respondents
MEAN	Average value
S.D.	Standard Deviation
5	Critically Important
4	Very Important
3	Somewhat Important
2	Minor Importance
1	No Importance
0	No Judgment
W	Total Weighted Value (See calculation equation, Figure 4.2)

The highest rated items for Round 2 were "Loss of documents and company materials/records," "Loss of liability insurance," and "On the job injuries." The loss of documents in Round 2 was related to operating documents such as invoices, original software, and other paper records needed to continue operations. This was different from the vital records item of Round 1 where the respondents were concerned about the documents which contained product formulae and production process details. The second highest ranked risk item was “Loss of liability insurance.” Losing this insurance could place the financial liability of an injury on the business owner personally instead of within the business entity. The third highest ranked item was “On the job injuries.” Losing workers due to injury not only places a business at risk for negligence lawsuits, but takes workers away from their assigned jobs.

It was surprising that “Customer loans not repaid” was one of the three least concerns to the respondents with a rating of “Moderately Weak Concern.” It is possible that the businesses that responded did not issue credit terms and required payment at the time of the purchase. “Natural gas shortage” was rated to be of weak concern. The infrastructure for distribution inside of the target geographic area and the latest techniques to uncover new sources of natural gas put this item next to the bottom for this round. Related to abundant natural gas was the last (lowest ranked) weak concern of our survey group which was “Utilities unavailable to prepare food.” Natural gas usually continues to flow even in the face of disaster. Only areas where explosions may occur and areas that are evacuated as a result of the disaster have gas supplies cut. The full Round 2 Risk results are shown in Table 5.57.

Table 5.57 Round 2 Risk Results Across All Categories

Risk Category	Text	N	MEAN	S.D.	5	4	3	2	1	0	W
Fire	Loss of documents and company materials/records	41	4.29	0.8	20	15	4	2	0	0	176
Financial	Loss of liability insurance	41	3.88	1.2	15	13	10	0	2	1	159
Health	On the job injuries	38	3.76	0.9	6	21	8	2	1	0	143
Government	Increased regulations	40	3.70	0.8	6	19	12	3	0	0	148
Health	Exposure to hazardous materials	39	3.51	1.4	9	18	4	3	2	3	137
Government	Unexpected audit	41	3.39	1.0	6	12	16	6	1	0	139
Fire	Fire caused by bad weather	41	3.32	1.4	8	16	6	6	2	3	136
Financial	Unforeseen insurance rateables increase	41	3.32	1.3	5	16	14	2	1	3	136
Fire	Combustion due to improperly stored or disposed of supplies or refuse	41	3.29	1.6	10	16	2	6	3	4	135
Flood	Downturn in business due to floods in other areas	41	3.24	1.2	7	9	16	5	4	0	133
Legal	Vicarious liability for employee actions	40	3.15	1.6	6	16	9	2	1	6	126
Financial	Customer filing for bankruptcy, chapter 7 or 11	41	3.10	1.6	9	10	9	7	1	5	127
Personnel	Employee theft requiring dismissal	41	3.05	1.5	5	16	9	3	3	5	125
Government	Unexpected inspection	41	3.00	1.1	3	10	16	9	2	1	123
Supply Chain	Increased lead time due to storm or other event	41	2.98	1.3	3	14	12	6	3	3	122
Legal	Liability of employee operating a company vehicle	41	2.95	1.8	8	14	7	0	4	8	121
Product	Raw material cost increase	38	3.03	1.6	7	13	4	6	4	4	115
Weather	Snow storm in area	41	2.93	1.1	3	9	16	9	3	1	120
Financial	Unplanned workmen's compensation increase	41	2.83	1.4	3	12	14	4	3	5	116
Supply Chain	Changes in vendor terms	41	2.76	1.4	5	8	9	12	5	2	113
Supply Chain	Changes in global raw material supply, price, or availability	41	2.68	1.6	6	10	7	7	5	6	110
Financial	Customer loans not repaid	40	2.38	1.7	4	10	5	7	6	8	95
Product	Natural gas shortage	41	2.24	1.5	1	8	11	10	2	9	92
Utility	Utilities unavailable to prepare food	41	2.12	1.7	5	7	4	7	8	10	87

5.7 Round 1 and 2 Consolidated Risk Results

The results of the forty-two Round 2 surveys were consolidated with the risk results for Round 1. Because of the difference in the number of respondents, the mean value was used as the highest order sort parameter for this table. A modified weighted value was the next highest sort parameter. The weighted category value was multiplied by ratio of the number of Round 1 respondents to Round 2 respondents to produce the final Round 2 value. A column to show which round the item first appeared was added to the table. The summary table uses the columns described in Table 5.58.

Table 5.58 Table Legend for Round 1 and Round 2 Risk Data Across All Categories

Column Title	Meaning
R	Round number, either 1 or 2
Risk Category	Survey risk category
Text	Survey item text
N	Number of respondents
MEAN	Average value
S.D.	Standard Deviation
5	Critically Important
4	Very Important
3	Somewhat Important
2	Minor Importance
1	No Importance
0	No Judgment
W'	Normalized Weighted Value (See calculation equation, Figure 4.2)

The three highest ranked risk items across Round 1 and 2 were from Round 1, "Business reputation tarnished," from Round 2, "Loss of documents and company materials/records," and from Round 1, "Electricity cut off." It is interesting that above all risks that might cause a business interruption, "business reputation tarnished" was the highest concern. Approximately 68% of the respondents gave that item the highest rating. This was followed by fires causing the loss of documents. The "Critically Important" rating was given by 49% of the Round 2 respondents who rated this item. The third highest concern was the loss of electricity with 51% of the respondents choosing this as critically important. Without electricity the business cannot operate although alternative sites might be established. If the critical documents are lost, the ability to collect money and produce the product could be impaired. When you cannot fulfill your obligations to your customers, whether it is because of fire or loss of electricity, your reputation as a reliable business may be irreparably tarnished.

Across Rounds 1 and 2, the three weakest concerns all came from Round 1. They were "Private stores not available," "Product requires refrigeration," and "Union grievance process too long." These items were not applicable for the types of businesses that responded to the survey. To give an idea of the highest important risk concerns of the small business owners and to easily contrast them in one table with ones that were of a weaker concern, we show the top ten and bottom ten results in Table 5.59. The full list is shown in Appendix N.

Table 5.59 Top 10 and Bottom 10 Round 1 Plus Round 2 Consolidated Risk Results Across All Categories

R	Risk Category	Text	N	MEAN	S.D.	5	4	3	2	1	0	W'
		TOP 10										
1	Financial	Business reputation tarnished	53	4.42	1.1	36	11	2	1	2	1	234
2	Fire	Loss of documents and company materials/ records	41	4.29	0.8	20	15	4	2	0	0	251
1	Utility	Electricity cut off	49	4.29	0.9	25	16	6	1	1	0	210
1	Technology/ Data	Computer data lost	52	4.06	1.1	20	22	7	0	2	1	211
1	Technology/ Data	Computer virus attacks network	51	4.06	1.2	23	17	7	0	3	1	207
1	Technology/ Data	No communication networks	50	4.06	1.0	20	19	7	2	2	0	203
1	Technology/ Data	Computer server not fully backed up	51	4.04	1.1	18	24	6	0	2	1	206
1	Technology/ Data	Computer system hacked	51	4.02	1.2	22	19	5	0	4	1	205
1	Technology/ Data	Cyber-attack on computer infrastructure	50	4.02	1.3	23	16	6	0	4	1	201
1	Utility	Backup power supply not available	47	4.02	1.0	17	19	7	3	1	0	189
		BOTTOM 10										
1	Product	Product requires other temperature control	50	1.96	1.8	5	8	7	6	8	16	98
1	Transportation	Airports not open	49	1.92	1.1	1	3	11	14	16	4	94
1	Transportation	Seaports not open	48	1.90	1.5	5	3	8	6	18	8	91
1	Supply Chain	Raw materials contaminated	50	1.78	1.7	4	9	5	2	14	16	89
1	Personnel	Workforce unavailable due to strike	50	1.76	1.8	5	10	1	5	10	19	88
1	Product	Validated manufacturing environment spoiled	49	1.71	1.8	3	10	5	1	12	18	84
1	Financial	Directors insurance inadequate	50	1.68	1.5	1	5	13	4	12	15	84
1	Supply Chain	Private stores not available	50	1.68	1.5	0	9	7	8	11	15	84
1	Product	Product requires refrigeration	49	1.65	1.8	4	8	4	2	13	18	81
1	Personnel	Union grievance process too long	50	1.52	1.6	1	8	7	3	12	19	76

NOTE: The full list appears in Appendix N.

5.8 Round 1 and 2 Consolidated Action Results

This section consolidates the results of all action categories from both Rounds 1 and 2. There was only one additional action item that was included from those already listed in Section 5.2. The table is sorted by the mean, then by the normalized weighted value, W', and then by the number of highest value selections, as shown in column 2. This sort order shows the action items which are most applicable to the respondents' businesses. The summary table uses the columns shown in Table 5.60.

Table 5.60 Table Legend for Action Data by Category

Column Title	Meaning
R	Round number, either 1 or 2
Action Category	The original category for the action item
Text	Survey text
N	Number of respondents
MEAN	Average value
S.D.	Standard Deviation
2	Applies to my business
1	Applies only to other businesses
0	No Judgment
W'	Normalized Weighted Value (See calculation, Figure 4.2)

The additional action item from Round 2 was "Hire lobbying firm." This item was rated as not applying to their own businesses. The top and bottom three items are the same as Round 1's highest ranked items. The top ten and bottom ten results are shown in Table 5.61. The full list is shown in Appendix O.

Table 5.61 Top10 and Bottom 10 Round 1 Plus Round 2 Consolidated Action Results Across All Categories

R	Action Category	Text	N	MEAN	S.D.	2	1	0	W'
		TOP 10							
1	Financial	Broaden customer base	51	1.80	0.6	45	2	4	92
1	Financial	File taxes on time	51	1.78	0.6	45	1	5	91
1	Financial	Lower expenses	51	1.78	0.6	44	3	4	91
1	Technology/ Data	Add virus protection	52	1.77	0.6	44	4	4	92
1	Financial	Pay required taxes	51	1.73	0.7	43	2	6	88
1	Technology/ Data	Update virus protection	51	1.73	0.6	40	8	3	88
1	Financial	Create business continuity plan	52	1.69	0.6	39	10	3	88
1	Personnel	Create contact list	52	1.67	0.6	40	7	5	87
1	Technology/ Data	Add adequate surge protection	51	1.67	0.7	40	5	6	85
1	Financial	Strengthen cash flow/lessen debt	51	1.65	0.7	38	8	5	84
		BOTTOM 10							
1	Technology/ Data	Rebuild formulation	51	0.59	0.7	5	20	26	30
1	Product	Limit customer order quantities	51	0.59	0.6	4	22	25	30
1	Health	Add filtration facility	50	0.56	0.6	4	20	26	28
1	Product	Prepare food offsite	51	0.55	0.7	5	18	28	28
1	Weather	Build storm shelter	51	0.55	0.6	2	24	25	28
1	Weather	Buy dry ice	50	0.54	0.6	4	19	27	27
1	Government	Buy out vulnerable properties	50	0.52	0.6	4	18	28	26
1	Technology/ Data	Disassemble and rewrite source code	50	0.50	0.6	3	19	28	25
1	Weather	Buy charcoal grill	51	0.49	0.6	2	21	28	25
1	Weather	Buy charcoal	51	0.45	0.5	1	21	29	23

NOTE: The full list appears in Appendix O.

5.9 Round 1 and 2 Summary With Round 3 Decision

A third round Delphi survey had been proposed if there were new suggestions that required the respondents to vote again. No further suggestions were made during Round 2. With no new risks or actions to make a survey and with the advice of the research advisor, a Round 3 Delphi survey was considered not to be necessary.

The amount of participation decreased with each round as potential participants tired and decided not to spend more time. The length of the survey was judged during the post survey to be the main issue against participation. Table 5.62 summarizes the participation over the entire research study.

Table 5.62 Participation Level Summary for all Surveys

Survey Part	Total Responses	Completed Survey
Consent to Participate	77	70
Pre-Survey	70	67
Round 1	60	53
Round 2	42	41
Post Survey	15	15

The participants represented a broad range of industries. Based on the qualification that the businesses needed to have been in business at least three years, it can be assumed that all had experienced Hurricane Sandy in some form or another. No industry category was represented in such a number as to perform statistical significance tests. The highest number of participates was from Non-Profit Organizations and those who worked in the computer field. The participants' industry category was asked only in Round 1. Eleven participants of that round chose not to answer the question. Table 5.63 summarizes the industry breakdown.

Table 5.63 Participation by Industry

Industry	Total Participants	%
Non-Profit Organizations	8	16
Computers, IT, and Technology Services	7	14
Business and Professional Services	3	6
Financial Services	3	6
Health Care	3	6
Manufacturers	3	6
Business Consulting	2	4
Entertainment	2	4
Insurance and Investments	2	4
Real Estate	2	4
Accountants and Accounting	1	2
Advertising and Media	1	2
Animal Healthcare	1	2
Automotive	1	2
Bakeries	1	2
Banks and Credit Unions	1	2
Construction Services	1	2
Food Distribution	1	2
Healthcare Services	1	2
Home Health Care Services	1	2
Marketing	1	2
Sales/Service	1	2
Transportation Service	1	2
TOTAL:	49	100

The main risk and action surveys were presented in Rounds 1 and 2. The items included in Round 1 represented those risk and action categories found during the literature review. The items used in Round 2 were the suggested new items proposed by participants in Round 1. The items in Round 2 were the new items suggested in Round 1. Any new suggestions made in Round 2 would have been the basis for a Round 3 survey. A Round 3 Delphi was not performed as there were no new risks or action items added during Round 2. With no additional suggestions for new risks or actions, the Delphi results were considered converged and the Cross Impact Analysis was performed. Table 5.64 summarizes the risk and action items used in each round.

Table 5.64 Risk and Action Items by Round

Risk and Action Category	Round 1 Risk Items	Round 1 Action Items	Round 2 Risk Items	Round 2 Action Items	New Items Suggested in Round 2
Financial	26	16	5	0	0
Fire	3	6	3	0	0
Flood	8	6	1	0	0
Government	7	3	3	0	0
Health	6	4	2	0	0
Legal	16	8	2	1	0
Personnel	11	7	1	0	0
Product	9	18	2	0	0
Property	10	7	0	0	0
Security	4	6	0	0	0
Supply Chain	7	6	3	0	0
Technology/Data	20	24	0	0	0
Terrorism	3	0	0	0	0
Transportation	7	3	0	0	0
Utility	7	5	1	0	0
Weather	4	14	1	0	0
TOTAL:	148	133	24	1	0

5.10 Round 4 Cross Impact Model Results

This section describes the results of the Cross Impact Model for the twenty-five items selected. The author and two members of the committee with experience in Emergency Management and experience with the probability estimation process selected twenty-five highly rated events to become the cross impact set of events. These twenty five events were divided into three groups. These three groups were:

1. Five Initial Condition Events, labeled I1 through I5, were numbered events 1 through 5. These events were given an initial probability of 0.5 and were considered to have a 50/50 chance of occurring at the beginning of the disaster.

2. Fifteen Dynamic Events, labeled DE1 through DE15, were numbered events 6 through 20. These events were given an initial probability of 0.5. The probability values of these events could change during the course of the disaster.
3. Five Outcome Events, labeled O1 to O5, were numbered events 21 to 25. These events were given an initial probability of 0.5. These events take on new probability values at the outcome of the disaster time period.

The initial input for the model was performed via Survey Monkey. The input survey asked for the initial probabilities of the events, P_i, and the probability of interaction between the events, R_{ij}. To make an assessment of the R_{ij} probabilities, each participant asked themselves the question, "How did the probability of an event occurring change if the initial event was certain to occur?" If there was no influence, then the R_{ij} probability remained at 0.5. When these judgments were made, it was assumed to be required that initial condition events could influence both dynamic and outcome events. Dynamic events could influence each other's probability of occurrence and outcome events. Outcome events could not influence any other event.

After the initial survey, the three results were averaged together, summarized, and redistributed. Items with probability disagreements were discussed and a final input value was developed by consensus. Each event's initial probability was set to 0.5 meaning that an event had an equal likelihood of occurring as not occurring. The chosen event items are shown in Table 4.11.

The interaction probabilities, R_{ij}, were input to the CIM software to calculate C_{ij} and G_i values. R_{ij} is the estimated probability of an event "i" on event "j" given that the "j" event is certain to occur. C_{ij} values measure the contribution of the "j-th" event on the occurrence of the "i-th" event. A positive C_{ij} value shows that the "j-th" event had a positive influence on the occurrence of the "i-th" event. A negative C_{ij} valued shows that the "j-th" event had a negative influence on the occurrence of the "i-th" event. G_i, known as Gamma, measures the influence of outside, unspecified events on the occurrence of the "i-th" event. A positive G_i value shows that outside influences had a positive influence on the occurrence of the "i-th" event. A negative G_i value shows that outside influences had a negative influence on the occurrence of the "i-th" event. The entire R_{ij} table used for the calculation of the C_{ij} and G_i values is shown in Table 5.65.

Table 5.65 Cross Impact R_{ij} Input Matrix

EVENTS	I1	I2	I3	I4	I5	DE1	DE2	DE3	DE4	DE5	DE6	DE7	DE8	DE9	DE10	DE11	DE12	DE13	DE14	DE15	O1	O2	O3	O4	O5
I1	OVP	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
I2	0.50	OVP	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
I3	0.50	0.50	OVP	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
I4	0.50	0.50	0.50	OVP	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
I5	0.50	0.50	0.50	0.50	OVP	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
DE1	0.50	0.60	0.70	0.50	0.50	OVP	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.60	0.50	0.53	0.50	0.50	0.50	0.50	0.50	0.50	0.50
DE2	0.53	0.60	0.70	0.50	0.53	0.73	OVP	0.50	0.50	0.50	0.63	0.50	0.60	0.83	0.50	0.60	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
DE3	0.53	0.57	0.53	0.50	0.50	0.50	0.50	OVP	0.63	0.50	0.60	0.50	0.50	0.53	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
DE4	0.50	0.60	0.77	0.53	0.60	0.70	0.57	0.53	OVP	0.57	0.50	0.80	0.67	0.57	0.53	0.63	0.67	0.57	0.60	0.50	0.50	0.50	0.50	0.50	0.50
DE5	0.50	0.53	0.57	0.50	0.57	0.60	0.53	0.53	0.50	OVP	0.50	0.50	0.53	0.53	0.53	0.50	0.50	0.50	0.60	0.53	0.50	0.50	0.50	0.50	0.50
DE6	0.53	0.60	0.60	0.60	0.50	0.60	0.57	0.53	0.53	0.53	OVP	0.60	0.57	0.50	0.50	0.60	0.50	0.53	0.50	0.53	0.50	0.50	0.50	0.50	0.50
DE7	0.50	0.60	0.63	0.50	0.40	0.60	0.53	0.50	0.50	0.53	0.50	OVP	0.50	0.50	0.50	0.60	0.50	0.57	0.57	0.50	0.50	0.50	0.50	0.50	0.50
DE8	0.50	0.60	0.70	0.50	0.53	0.77	0.73	0.50	0.50	0.60	0.60	0.50	OVP	0.50	0.50	0.50	0.50	0.53	0.53	0.50	0.50	0.50	0.50	0.50	0.50
DE9	0.57	0.60	0.70	0.50	0.50	0.77	0.99	0.93	0.50	0.63	0.70	0.50	0.53	OVP	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
DE10	0.50	0.57	0.73	0.60	0.50	0.67	0.57	0.63	0.57	0.57	0.53	0.67	0.63	0.57	OVP	0.60	0.67	0.57	0.50	0.63	0.50	0.50	0.50	0.50	0.50
DE11	0.50	0.53	0.70	0.50	0.50	0.50	0.50	0.50	0.53	0.50	0.50	0.57	0.50	0.53	0.50	OVP	0.50	0.53	0.50	0.50	0.50	0.50	0.50	0.50	0.50
DE12	0.50	0.53	0.70	0.50	0.57	0.73	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.60	OVP	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
DE13	0.50	0.60	0.67	0.50	0.60	0.67	0.57	0.50	0.50	0.50	0.50	0.50	0.57	0.57	0.50	0.60	0.53	OVP	0.50	0.50	0.50	0.50	0.50	0.50	0.50
DE14	0.50	0.53	0.43	0.50	0.63	0.67	0.53	0.50	0.50	0.50	0.50	0.50	0.60	0.53	0.50	0.43	0.53	0.50	OVP	0.50	0.50	0.50	0.50	0.50	0.50
DE15	0.50	0.57	0.60	0.50	0.50	0.50	0.60	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.57	0.50	0.50	0.57	OVP	0.50	0.50	0.50	0.50	0.50
O1	0.67	0.60	0.60	0.60	0.50	0.60	0.60	0.63	0.60	0.50	0.60	0.50	0.50	0.63	0.50	0.53	0.50	0.50	0.53	0.50	OVP	0.50	0.50	0.50	0.50
O2	0.67	0.57	0.60	0.67	0.50	0.63	0.57	0.63	0.60	0.70	0.60	0.67	0.50	0.60	0.60	0.50	0.47	0.47	0.60	0.60	0.50	OVP	0.50	0.50	0.50
O3	0.67	0.57	0.63	0.60	0.50	0.63	0.57	0.63	0.60	0.50	0.60	0.57	0.50	0.60	0.50	0.50	0.50	0.47	0.50	0.50	0.50	0.50	OVP	0.50	0.50
O4	0.50	0.60	0.60	0.50	0.57	0.57	0.53	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.60	0.57	0.57	0.50	0.53	0.53	0.50	0.50	0.50	OVP	0.50
O5	0.50	0.60	0.63	0.50	0.57	0.60	0.53	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.53	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	OVP

The output of the Cross Impact Model software showed some very interesting results. The highest value positive C_{ij} value was for "j=DE2-No communications networks" having a large effect on "i=DE9-Internet connectivity lost." This was an obvious result. If communications were knocked out because of a disaster, one lost internet connectivity. As obvious as this might be, it showed that the Cross Impact Method could produce reasonable results. Other top results included "j=DE7-Access to facility forbidden" influencing "i=DE4-Personnel not available during an emergency." This result was also very reasonable as the government might close roads or evacuate an area. Once these actions are taken by the government, personnel cannot report to their workplace. The top influence on the most important concern for business interruption was "j=DE5-Violent crime committed by employee during work hours" influencing "i=O2-Business reputation tarnished." A person who committed a major crime will have a serious negative effect on the reputation of a company.

Gi results were also reasonable. Gi measures the effect of events not explicitly entered into the model. The largest influence on an event item by outside influences was "DE9 – Internet connectivity lost." Many factors outside of a hurricane or a fire can interrupt internet connectivity. Two examples are: 1) an accident in the area of the building where a telephone pole housing the internet connection is knocked out and 2) a local router is defective and needs to be replaced. The second largest influence on an event item by outside influences not specified in the model was on "DE4-Personnel not available during an emergency." This also makes sense since we only specified a very limited set of reasons for someone not making it to work in the midst of a crisis. Some of those other outside influences could include employee injury, roads closed, or a family situation taking priority over a corporate crisis. The complete values for C_{ij} and G_i values is shown in Table 5.66.

Table 5.66 Cross Impact Matrix, C_{ij} and G_i Values

EVENTS	I1	I2	I3	I4	I5	DE1	DE2	DE3	DE4	DE5	DE6	DE7	DE8	DE9	DE10	DE11	DE12	DE13	DE14	DE15	O1	O2	O3	O4	O5
I1	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
I2	0.00	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
I3	0.00	0.00	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
I4	0.00	0.00	0.00	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
I5	0.00	0.00	0.00	0.00	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DE1	0.00	0.81	1.69	0.00	0.00	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.81	0.00	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DE2	0.24	0.81	1.69	0.00	0.24	1.99	OVP	0.00	0.00	0.00	1.06	0.00	0.81	3.17	0.00	0.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DE3	0.24	0.56	0.24	0.00	0.00	0.00	0.00	OVP	1.06	0.00	0.81	0.00	0.00	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DE4	0.00	0.81	2.42	0.24	0.81	1.69	0.56	0.24	OVP	0.56	0.00	2.77	1.42	0.56	0.24	1.06	1.42	0.56	0.81	0.00	0.00	0.00	0.00	0.00	0.00
DE5	0.00	0.24	0.56	0.00	0.56	0.81	0.24	0.24	0.00	OVP	0.00	0.00	0.24	0.24	0.24	0.00	0.00	0.00	0.81	0.24	0.00	0.00	0.00	0.00	0.00
DE6	0.24	0.81	0.81	0.81	0.00	0.81	0.56	0.24	0.24	0.24	OVP	0.81	0.56	0.00	0.00	0.81	0.00	0.24	0.00	0.24	0.00	0.00	0.00	0.00	0.00
DE7	0.00	0.81	1.06	0.00	-0.81	0.81	0.24	0.00	0.00	0.24	0.00	OVP	0.00	0.00	0.00	0.81	0.00	0.56	0.56	0.00	0.00	0.00	0.00	0.00	0.00
DE8	0.00	0.81	1.69	0.00	0.24	2.42	1.99	0.00	0.00	0.81	0.81	0.00	OVP	0.00	0.00	0.00	0.00	0.24	0.24	0.00	0.00	0.00	0.00	0.00	0.00
DE9	0.56	0.81	1.69	0.00	0.00	2.42	9.19	5.17	0.00	1.06	1.69	0.00	0.24	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DE10	0.00	0.56	1.99	0.81	0.00	1.42	0.56	1.06	0.56	0.56	0.24	1.42	1.06	0.56	OVP	0.81	1.42	0.56	0.00	1.06	0.00	0.00	0.00	0.00	0.00
DE11	0.00	0.24	1.69	0.00	0.00	0.00	0.00	0.00	0.24	0.00	0.00	0.56	0.00	0.24	0.00	OVP	0.00	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DE12	0.00	0.24	1.69	0.00	0.56	1.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.81	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DE13	0.00	0.81	1.42	0.00	0.81	1.42	0.56	0.00	0.00	0.00	0.00	0.00	0.56	0.56	0.00	0.81	0.24	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DE14	0.00	0.24	-0.56	0.00	1.06	1.42	0.24	0.00	0.00	0.00	0.00	0.00	0.81	0.24	0.00	-0.56	0.24	0.00	OVP	0.00	0.00	0.00	0.00	0.00	0.00
DE15	0.00	0.56	0.81	0.00	0.00	0.00	0.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.56	0.00	0.00	0.56	OVP	0.00	0.00	0.00	0.00	0.00
O1	1.42	0.81	0.81	0.81	0.00	0.81	0.81	1.06	0.81	0.00	0.81	0.00	0.00	1.06	0.00	0.24	0.00	0.00	0.24	0.00	OVP	0.00	0.00	0.00	0.00
O2	1.42	0.56	0.81	1.42	0.00	1.06	0.56	1.06	0.81	1.69	0.81	1.42	0.00	0.81	0.81	0.00	-0.24	-0.24	0.81	0.81	0.00	OVP	0.00	0.00	0.00
O3	1.42	0.56	1.06	0.81	0.00	1.06	0.56	1.06	0.81	0.00	0.81	0.56	0.00	0.81	0.00	0.00	0.00	-0.24	0.00	0.00	0.00	0.00	OVP	0.00	0.00
O4	0.00	0.81	0.81	0.00	0.56	0.56	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.81	0.56	0.56	0.00	0.24	0.24	0.00	0.00	0.00	OVP	0.00
O5	0.00	0.81	1.06	0.00	0.56	0.81	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	OVP
G	0.0	0.0	0.0	0.0	0.0	-1.78	-5.42	-1.58	-8.09	-2.22	-3.72	-2.15	-4.63	-11.42	-7.34	-1.61	-2.65	-3.60	-1.56	-1.65	-4.85	-7.20	-4.65	-2.70	-1.87

The C_{ij} chart not only allows us to pick out the largest influence between any two events, but allows us to examine how each outcome event is influenced. The following tables show how each event is influenced.

Table 5.67 shows the output event "21-O1-Loss of documents and company materials/records." The events that influence O1 are very reasonable. The most influential is the chance that a business might take by not backing up the server. If a natural disaster occurs such as a hurricane or a fire, the hardware may be damaged and the data lost permanently. It also makes sense that there is little influence from roads being flooded until the flood breaches the actual building.

Table 5.67 Event 21-O1 Loss of Documents and Company Materials/Records (G_i = -4.85)

C_{ij} Value	Event
1.42	I1 - Computer server not fully backed up
1.06	DE3 - Computer hardware fails
1.06	DE9 - Internet connectivity lost
0.81	I2 - Fires underway
0.81	I3 - Hurricane in area
0.81	I4 - Business continuity plan not tested
0.81	DE1 - Electricity cut off
0.81	DE2 - No communication networks
0.81	DE4 - Personnel not available during an emergency
0.81	DE6 - Backup power supply not available
0.24	DE11 - Roads flooded
0.24	DE14 - Crime rate increase near place of business

Table 5.68 shows the output event "22-O2-Business reputation tarnished." The influence events are varied. The main event that would tarnish the business reputation is having an employee commit a violent crime during working hours. In this case, a business owner may be culpable under vicarious liability laws. Time consuming legal proceedings coupled with media reports of the crime could irreparably damage the business' reputation. The O2 event also had the highest negative G value. A high negative G value indicates that there are many outside events that adversely affect the outcome that were not explicitly entered into the model. This high value makes sense as there are many more things that can tarnish a business' reputation than the fifteen items that are listed in the table.

This outcome event, O2/event 22, was the most important to the respondents. It had the largest number of interactions with other events compared to any other outcome event. Only two events in the table had a negative impact on this outcome occurring. These events were "DE12-Gasoline in short supply" and "DE13-Roads clogged with traffic," both with a value of -0.24. Gasoline being in short supply and roads being clogged with traffic tend to remove any blame against the business' reputation as they are out of the business' control. This and the other four outcome events show the major causal relationships influencing the outcomes in the consensus view of the participants.

Table 5.68 Event 22-O2 Business Reputation Tarnished (G_i = -7.20)

C_{ij} Value	Event
1.69	DE5 - Violent crime committed by employee during work hours
1.42	I1 - Computer server not fully backed up
1.42	I4 - Business continuity plan not tested
1.42	DE7 - Access to facility forbidden
1.06	DE1 - Electricity cut off
1.06	DE3 - Computer hardware fails
0.81	I3 - Hurricane in area
0.81	DE4 - Personnel not available during an emergency
0.81	DE6 - Backup power supply not available
0.81	DE9 - Internet connectivity lost
0.81	DE10 - Increased lead time due to storm or other event
0.81	DE14 - Crime rate increase near place of business
0.81	DE15 - Product in transport destroyed
0.56	I2 - Fires underway
0.56	DE2 - No communication networks
-0.24	NOT DE12 - Gasoline in short supply
-0.24	NOT DE13 - Roads clogged with traffic

Table 5.69 shows the output event "23-O3-Computer data lost." The largest influence on this outcome was computer data not being fully backed up. If some of the lower influence events occurred such as Internet connectivity cut off, then real time backup could not occur, putting corporate data at risk. Physical damage from a fire or flood would make the data loss permanent.

Table 5.69 Event 23-O3 Computer Data Lost (G_i = -4.65)

C_{ij} Value	Event
1.42	I1 - Computer server not fully backed up
1.06	I3 - Hurricane in area
1.06	DE1 - Electricity cut off
1.06	DE3 - Computer hardware fails
0.81	I4 - Business continuity plan not tested
0.81	DE4 - Personnel not available during an emergency
0.81	DE6 - Backup power supply not available
0.81	DE9 - Internet connectivity lost
0.56	I2 - Fires underway
0.56	DE2 - No communication networks
0.56	DE7 - Access to facility forbidden
-0.24	NOT DE13 - Roads clogged with traffic

Table 5.70 shows the output event, O4-Raw material cost increase. The largest influence event was that there was a fire underway. This could affect raw material pricing in several different manners. The fire could contaminate the raw material. The fire could make shipping costs increase when suppliers need to avoid the fire. The fire could actually destroy the supply of the raw materials which would cause a price increase. One of the minor influences is “No communications networks.” In this event it is plausible to think that not having a communications network lessens the ability to shop for the best prices.

Table 5.70 Event 24-O4 Raw Material Cost Increase (G_i = -2.70)

C_{ij} Value	Event
0.81	I2 - Fires underway
0.81	I3 - Hurricane in area
0.81	DE10 - Increased lead time due to storm or other event
0.56	I5 - Local government not functioning
0.56	DE1 - Electricity cut off
0.56	DE11 - Roads flooded
0.56	DE12 - Gasoline in short supply
0.24	DE2 - No communication networks
0.24	DE14 - Crime rate increase near place of business
0.24	DE15 - Product in transport destroyed

Table 5.71 shows the output event, O5-Raw materials contaminated. On the surface, this and output event O4 would seem to be connected. This event shares all of the same influence events as O4, but at different influence levels. It makes sense that events that would cause the price to increase could also be the same events that might cause contamination.

Table 5.71 Event 25-O5 Raw Materials Contaminated (G_i = -1.87)

C_{ij} Value	Event
1.06	I3 - Hurricane in area
0.81	I2 - Fires underway
0.81	DE1 - Electricity cut off
0.56	I5 - Local government not functioning
0.24	DE2 - No communication networks
0.24	DE11 - Roads flooded

We next examine the event influence via Interpretive Structural Modeling.

5.11 Round 5 Interpretive Structural Modeling Results

We used two values for C_{ij} for the calculation of the Interpretive Structural Model. The two values were 1.00 and 0.80. Using two values provided us a way to better see how strongly events influenced one another. Base work with the influence was performed on 0.80 since all values at the 0.80 level also include the events at the 1.00 level. Once 0.80 was chosen as the minimum C_{ij} value, the process to produce the adjacency matrix began. The first step is to eliminate all C_{ij} absolute values that are below the 0.80 threshold. Values below 0.80 include many events that do not strongly influence one another. The resulting C_{ij} chart is shown in Table 5.72.

Table 5.72 C_{ij} Values with $|C_{ij}| > 0.80$

EVENTS	I1	I2	I3	I4	I5	DE1	DE2	DE3	DE4	DE5	DE6	DE7	DE8	DE9	DE10	DE11	DE12	DE13	DE14	DE15	O1	O2	O3	O4	O5
I1	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
I2	0.00	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
I3	0.00	0.00	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
I4	0.00	0.00	0.00	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
I5	0.00	0.00	0.00	0.00	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DE1	0.00	0.81	1.69	0.00	0.00	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DE2	0.00	0.81	1.69	0.00	0.00	1.99	OVP	0.00	0.00	0.00	1.06	0.00	0.81	3.17	0.00	0.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DE3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	OVP	1.06	0.00	0.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DE4	0.00	0.81	2.42	0.00	0.81	1.69	0.00	0.00	OVP	0.00	0.00	2.77	1.42	0.00	0.00	1.06	1.42	0.00	0.81	0.00	0.00	0.00	0.00	0.00	0.00
DE5	0.00	0.00	0.00	0.00	0.00	0.81	0.00	0.00	0.00	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.81	0.00	0.00	0.00	0.00	0.00	0.00
DE6	0.00	0.81	0.81	0.81	0.00	0.81	0.00	0.00	0.00	0.00	OVP	0.81	0.00	0.00	0.00	0.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DE7	0.00	0.81	1.06	0.00	-0.81	0.81	0.00	0.00	0.00	0.00	0.00	OVP	0.00	0.00	0.00	0.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DE8	0.00	0.81	1.69	0.00	0.00	2.42	1.99	0.00	0.00	0.81	0.81	0.00	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DE9	0.00	0.81	1.69	0.00	0.00	2.42	9.19	5.17	0.00	1.06	1.69	0.00	0.00	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DE10	0.00	0.00	1.99	0.81	0.00	1.42	0.00	1.06	0.00	0.00	0.00	1.42	1.06	0.00	OVP	0.81	1.42	0.00	0.00	1.06	0.00	0.00	0.00	0.00	0.00
DE11	0.00	0.00	1.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DE12	0.00	0.00	1.69	0.00	0.00	1.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.81	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DE13	0.00	0.81	1.42	0.00	0.81	1.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.81	0.00	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DE14	0.00	0.00	0.00	0.00	1.06	1.42	0.00	0.00	0.00	0.00	0.00	0.00	0.81	0.00	0.00	0.00	0.00	0.00	OVP	0.00	0.00	0.00	0.00	0.00	0.00
DE15	0.00	0.00	0.81	0.00	0.00	0.00	0.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	OVP	0.00	0.00	0.00	0.00	0.00
O1	1.42	0.81	0.81	0.81	0.00	0.81	0.81	1.06	0.81	0.00	0.81	0.00	0.00	1.06	0.00	0.00	0.00	0.00	0.00	0.00	OVP	0.00	0.00	0.00	0.00
O2	1.42	0.00	0.81	1.42	0.00	1.06	0.00	1.06	0.81	1.69	0.81	1.42	0.00	0.81	0.81	0.00	0.00	0.00	0.81	0.81	0.00	OVP	0.00	0.00	0.00
O3	1.42	0.00	1.06	0.81	0.00	1.06	0.00	1.06	0.81	0.00	0.81	0.00	0.00	0.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	OVP	0.00	0.00
O4	0.00	0.81	0.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	OVP	0.00
O5	0.00	0.81	1.06	0.00	0.00	0.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	OVP

Once the $|C_{ij}| > 0.80$ values are tabulated, the next step is to create two matrices. The first matrix contains the positive values of C_{ij} above the threshold of 0.80. Zero is substituted for all other values. This substitution result is shown in Table 5.73.

Table 5.73 C_{ij} Values with $C_{ij} > 0.80$

EVENTS	I1	I2	I3	I4	I5	DE1	DE2	DE3	DE4	DE5	DE6	DE7	DE8	DE9	DE10	DE11	DE12	DE13	DE14	DE15	O1	O2	O3	O4	O5
I1	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
I2	0.00	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
I3	0.00	0.00	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
I4	0.00	0.00	0.00	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
I5	0.00	0.00	0.00	0.00	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DE1	0.00	0.81	1.69	0.00	0.00	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DE2	0.00	0.81	1.69	0.00	0.00	1.99	OVP	0.00	0.00	0.00	1.06	0.00	0.81	3.17	0.00	0.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DE3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	OVP	1.06	0.00	0.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DE4	0.00	0.81	2.42	0.00	0.81	1.69	0.00	0.00	OVP	0.00	0.00	2.77	1.42	0.00	0.00	1.06	1.42	0.00	0.81	0.00	0.00	0.00	0.00	0.00	0.00
DE5	0.00	0.00	0.00	0.00	0.00	0.81	0.00	0.00	0.00	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.81	0.00	0.00	0.00	0.00	0.00	0.00
DE6	0.00	0.81	0.81	0.81	0.00	0.81	0.00	0.00	0.00	0.00	OVP	0.81	0.00	0.00	0.00	0.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DE7	0.00	0.81	1.06	0.00	0.00	0.81	0.00	0.00	0.00	0.00	0.00	OVP	0.00	0.00	0.00	0.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DE8	0.00	0.81	1.69	0.00	0.00	2.42	1.99	0.00	0.00	0.81	0.81	0.00	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DE9	0.00	0.81	1.69	0.00	0.00	2.42	9.19	5.17	0.00	1.06	1.69	0.00	0.00	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DE10	0.00	0.00	1.99	0.81	0.00	1.42	0.00	1.06	0.00	0.00	0.00	1.42	1.06	0.00	OVP	0.81	1.42	0.00	0.00	1.06	0.00	0.00	0.00	0.00	0.00
DE11	0.00	0.00	1.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DE12	0.00	0.00	1.69	0.00	0.00	1.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.81	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DE13	0.00	0.81	1.42	0.00	0.81	1.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.81	0.00	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DE14	0.00	0.00	0.00	0.00	1.06	1.42	0.00	0.00	0.00	0.00	0.00	0.00	0.81	0.00	0.00	0.00	0.00	0.00	OVP	0.00	0.00	0.00	0.00	0.00	0.00
DE15	0.00	0.00	0.81	0.00	0.00	0.00	0.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	OVP	0.00	0.00	0.00	0.00	0.00
O1	1.42	0.81	0.81	0.81	0.00	0.81	0.81	1.06	0.81	0.00	0.81	0.00	0.00	1.06	0.00	0.00	0.00	0.00	0.00	0.00	OVP	0.00	0.00	0.00	0.00
O2	1.42	0.00	0.81	1.42	0.00	1.06	0.00	1.06	0.81	1.69	0.81	1.42	0.00	0.81	0.81	0.00	0.00	0.00	0.81	0.81	0.00	OVP	0.00	0.00	0.00
O3	1.42	0.00	1.06	0.81	0.00	1.06	0.00	1.06	0.81	0.00	0.81	0.00	0.00	0.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	OVP	0.00	0.00
O4	0.00	0.81	0.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	OVP	0.00
O5	0.00	0.81	1.06	0.00	0.00	0.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	OVP

The second matrix contains the negative values of C_{ij} below the threshold of -0.80. Zero is substituted for all positive numbers that are in Table 5.72. This result is shown in Table 5.74.

Table 5.74 C_{ij} Values with C_{ij} < -0.80

EVENTS	I1	I2	I3	I4	I5	DE1	DE2	DE3	DE4	DE5	DE6	DE7	DE8	DE9	DE10	DE11	DE12	DE13	DE14	DE15	O1	O2	O3	O4	O5
I1	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
I2	0.00	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
I3	0.00	0.00	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
I4	0.00	0.00	0.00	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
I5	0.00	0.00	0.00	0.00	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DE1	0.00	0.00	0.00	0.00	0.00	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DE2	0.00	0.00	0.00	0.00	0.00	0.00	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DE3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DE4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DE5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DE6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DE7	0.00	0.00	0.00	0.00	-0.81	0.00	0.00	0.00	0.00	0.00	0.00	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DE8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DE9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DE10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DE11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DE12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DE13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	OVP	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DE14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	OVP	0.00	0.00	0.00	0.00	0.00	0.00
DE15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	OVP	0.00	0.00	0.00	0.00	0.00
O1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	OVP	0.00	0.00	0.00	0.00
O2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	OVP	0.00	0.00	0.00
O3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	OVP	0.00	0.00
O4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	OVP	0.00
O5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	OVP

After the elimination of the values that do not fall in the threshold of $|C_{ij}| > 0.80$, the next step is to create a binary matrix. The binary matrix uses a value of "1" if the value is above the threshold and "0" otherwise. Zero is substituted for "OVP" along the diagonal of the matrix. These substitutions are shown in Tables 5.75 and 5.76.

Table 5.75 Binary C_{ij} Values for $C_{ij} > 0.80$, the Positive C_{ij} Matrix

EVENTS	I1	I2	I3	I4	I5	DE1	DE2	DE3	DE4	DE5	DE6	DE7	DE8	DE9	DE10	DE11	DE12	DE13	DE14	DE15	O1	O2	O3	O4	O5
I1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
DE2	0	1	1	0	0	1	0	0	0	0	1	0	1	1	0	1	0	0	0	0	0	0	0	0	0
DE3	0	0	0	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE4	0	1	1	0	1	1	0	0	0	0	0	1	1	0	0	1	1	0	1	0	0	0	0	0	0
DE5	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
DE6	0	1	1	1	0	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0
DE7	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
DE8	0	1	1	0	0	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE9	0	1	1	0	0	1	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE10	0	0	1	1	0	1	0	1	0	0	0	1	1	0	0	1	1	0	0	1	0	0	0	0	0
DE11	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE12	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
DE13	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
DE14	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
DE15	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
O1	1	1	1	1	0	1	1	1	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
O2	1	0	1	1	0	1	0	1	1	1	1	1	0	1	1	0	0	0	1	1	0	0	0	0	0
O3	1	0	1	1	0	1	0	1	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
O4	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
O5	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 5.76 Binary C_{ij} Values for $C_{ij} < -0.80$, the Negative C_{ij} Matrix

EVENTS	I1	I2	I3	I4	I5	DE1	DE2	DE3	DE4	DE5	DE6	DE7	DE8	DE9	DE10	DE11	DE12	DE13	DE14	DE15	O1	O2	O3	O4	O5
I1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE7	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
O1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
O2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
O3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
O4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
O5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Tables 5.75 and 5.76 are next placed into the adjacency matrix. The adjacency matrix is described in detail in Section 4.8. The individual positive and negative C_{ij} matrices were placed into the quadrants as follows. The positive C_{ij} matrix was placed into both Quadrant 2 and Quadrant 4. The negative C_{ij} matrix was placed into both Quadrant 1 and Quadrant 3. Figure 4.3 shows this relationship.

Each of the columns and rows is given a number corresponding to its event identifier. In our case the numbers range from one to twenty-five. Numbers one through five correspond to events I1 through I5. Numbers six through twenty correspond to events DE1 through DE15. Numbers twenty-one through twenty-five correspond to events O1 through O5.

The binary matrices are placed into the full adjacency matrix as shown in Appendix P.

In order to determine the ability of one event to influence another, we must create a reachability matrix. This is done by adding an identity matrix to the adjacency matrix. An identity matrix is a matrix with ones along the entire diagonal. The addition of an identity matrix to a matrix does not change the base matrix mathematical properties. Appendix Q shows the resultant reachability matrix.

Each column in the adjacency matrix that has a “1” in it is considered to have influence over the events in the row containing the “1”. Each column is called an antecedent because it occurs before the event being influenced. Each row event is called a succedent. For example, column 1, which is event “I1 – Computer server not fully backed up” has a “1” in the rows associated with events, “O1 – Loss of documents and company materials/records,” “O2 – Business reputation tarnished,” and “O3 – Computer data lost.” The three row events are indeed influenced by the column event. If the computer server is not fully backed up and the server hard drive is broken, company information is lost, O3, the information lost may be in the form of documents and records, O1, and an order may not be filled showing customers that you are an unreliable vendor, thus tarnishing your reputation, O2.

An influence diagram can be constructed from the adjacency matrix to visually see how one event affects another. To create an influence diagram, a circle is drawn for each event. In Figure 5.2, the Input events are labeled, 1-5, Dynamic events, 6-20, and Output events, 21-25. For each column in the adjacency matrix, an outward arrow is drawn from that column event, to each row event that contains a “1”. In the previous example, an arrow would be drawn from the circle representing Event 3 to the circles representing events 7, 13, and 9. There are no direct connections to any other events.

At the $|C_{ij}| > 0.80$ level some of the events show that there is a direct influence on the output events by the Input events. One example is with input event 1, shown in Figure 5.1.

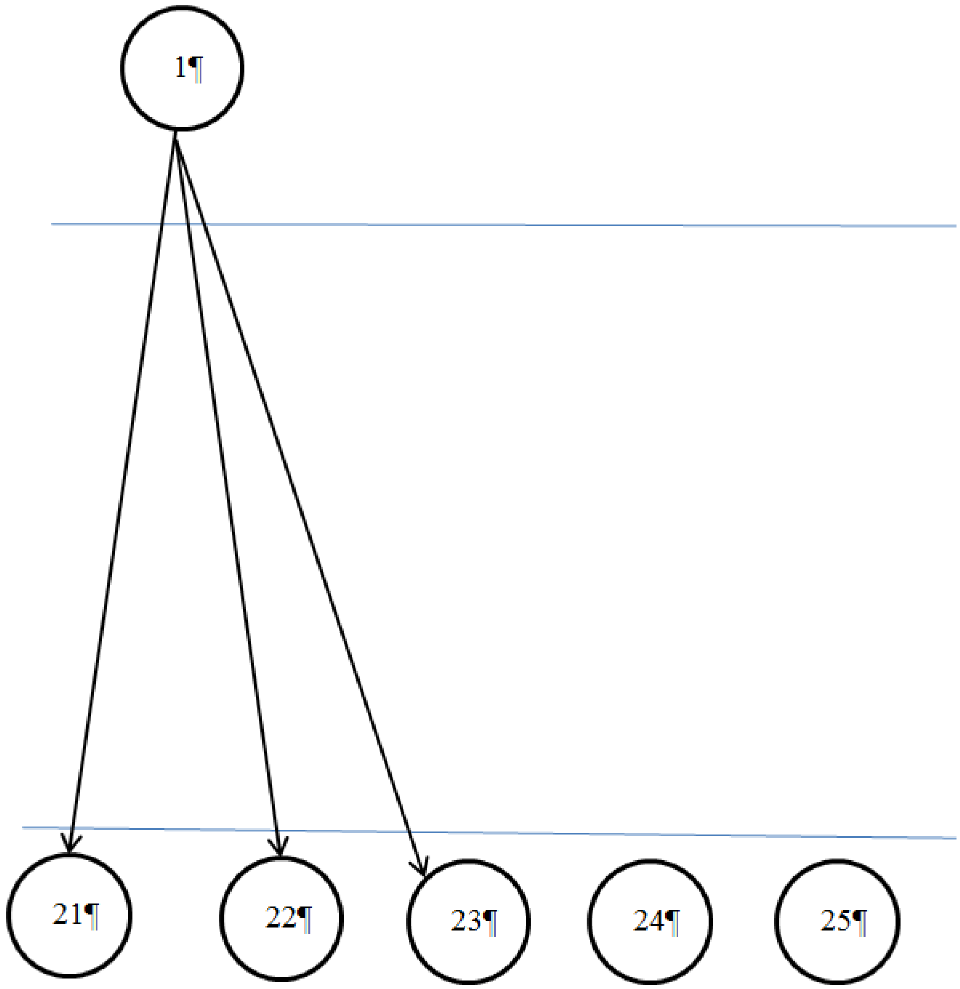

Figure 5.1 Influence of event 1, "I1-Computer server not backed-up," at the |Cij| > 0.80 level. It is the same diagram for $|C_{ij}| > 1.00$.

Events may influence one another directly, as in the case of events "7-DE2-No communications Networks" and "14-DE9-Internet connectivity lost." This tight coupling of events is called a scenario. When this occurs a box with rounded corners is used instead of a circle. The tightly coupled events are entered into the box inside of parentheses. Any lines from the individual events to other events are redrawn from the box to the circles. There may be a case where each of the individual events that have been grouped influence the same event. In that case only one line is drawn. The individual event circles and their influence lines are deleted from the base diagram. The result of combining a set of events and removing the individual events and connections from the diagram is known as a collapse.

Once the diagram is updated, other cycles may be discovered. A cycle may not only be two events that directly influence one another, but may be a set of events that influence another event and then another event and then back. When this grouping returns to a collapse, the new set of events are added to the collapse. Parentheses are added around the outside of the new items for each new grouping.

It is sometimes easiest to start with a higher $|C_{ij}|$ value to lessen the complexity when finding cycles. At $|C_{ij}| > 1.00$, shown in Figure 5.4, the first cycle was event "7-DE2-No communications Networks" and "14-DE9-Internet connectivity lost." Once the base diagram was updated, events "13-DE8-Telephones out of service," "9-DE4-Personnel not available during an emergency," and "8-DE3-Computer hardware fails" were added to the group in the second collapse.

This set of five events,

- 7-DE2-No communication networks
- 14-DE9-Internet connectivity lost
- 8-DE3-Computer hardware fails
- 9-DE4-Personnel not available during an emergency
- 12-DE7-Access to facility forbidden

constitutes a macro scenario within the set of all events. We will call this scenario event set "MACRO X." All of the events inside of MACRO X either occur or do not occur together as a group. The thick lines in Figure 5.2 show the cycles that form the collapse into the scenario. The lines between events 7 and 14 go directly from one event back into the other. These two events directly reinforce each other. The other events that are connected by thick lines are 13, 9, and 8. These events influence each other, one by one, and back into events 7 and 14. Figure 5.2 shows the influence of MACRO X on other events and also the events that are influenced by MACRO X.

Events influencing MACRO X are:

- 3-I3-Hurricane in area
- 6-DE1-Electricity cut off
- 10-DE5-Violent crime committed by employee during work hours
- 11-DE6-Backup power supply not available
- 12-DE7-Access to facility forbidden
- 16-DE11-Roads flooded
- 17-DE12-Gasoline in short supply

Events that are influenced by MACRO X are:

- 15-DE10-Increased lead time due to storm or other event
- 20-DE15-Product in transport destroyed
- 21-O1-Loss of documents and company materials/records
- 22-O2-Business reputation tarnished
- 23-O3-Computer data lost

To show the influence from and to MACRO X, lines that do not show direct influence are eliminated from Figure 5.2. Figure 5.3 shows all influence lines between the hurricane input event 3 and all dynamic and output events with MACRO X shown as one event.

At the $|C_{ij}| > 0.80$, two additional events are added to MACRO X to form MACRO X2. These two events are:

- 19-DE14-Crime rate increase near place of business
- 10-DE5-Violent crime committed by employee during work hours

The development of the diagrams for MACRO X2 shows the results of collapses at two levels, $|C_{ij}| > 1.00$ with the additions of values at $|C_{ij}| > 0.80$. At the higher influence level of $|C_{ij}| > 1.00$ we have a direct influence coupling between events 7 and 14 followed by a chain of influence from {7,14} to 13, 9, and 8. When these values collapse and the influence lines for $|C_{ij}| > 0.80$ are added, events 19, 10 are added to the chain to become the diagram shown in Figure 5.5.

At the $|C_{ij}| > 1.00$, let X = {7,14}, the directly connected events.

THEN add to X the next connected events, 13, 9, and 8 at the $|C_{ij}| > 1.00$.

LET Y = {X,13,9,8}

The result of the creation of Y, which is MACRO X, is shown in Figure 5.3. If we take Figure 5.3 and add some less influential events at the $|C_{ij}| > 0.80$ level we create a new cycle to include events 19 and 10.

Let Z = {Y,19,10}

Expanding Z we obtain,

Z = {{X,13,9,8},19,10}.

Finally to obtain MACRO X2, we expand Z one last time.

MACRO X2 = Z = {{{7,14},13,9,8},19,10}

This final set is shown in Figures 5.5 and 5.6.

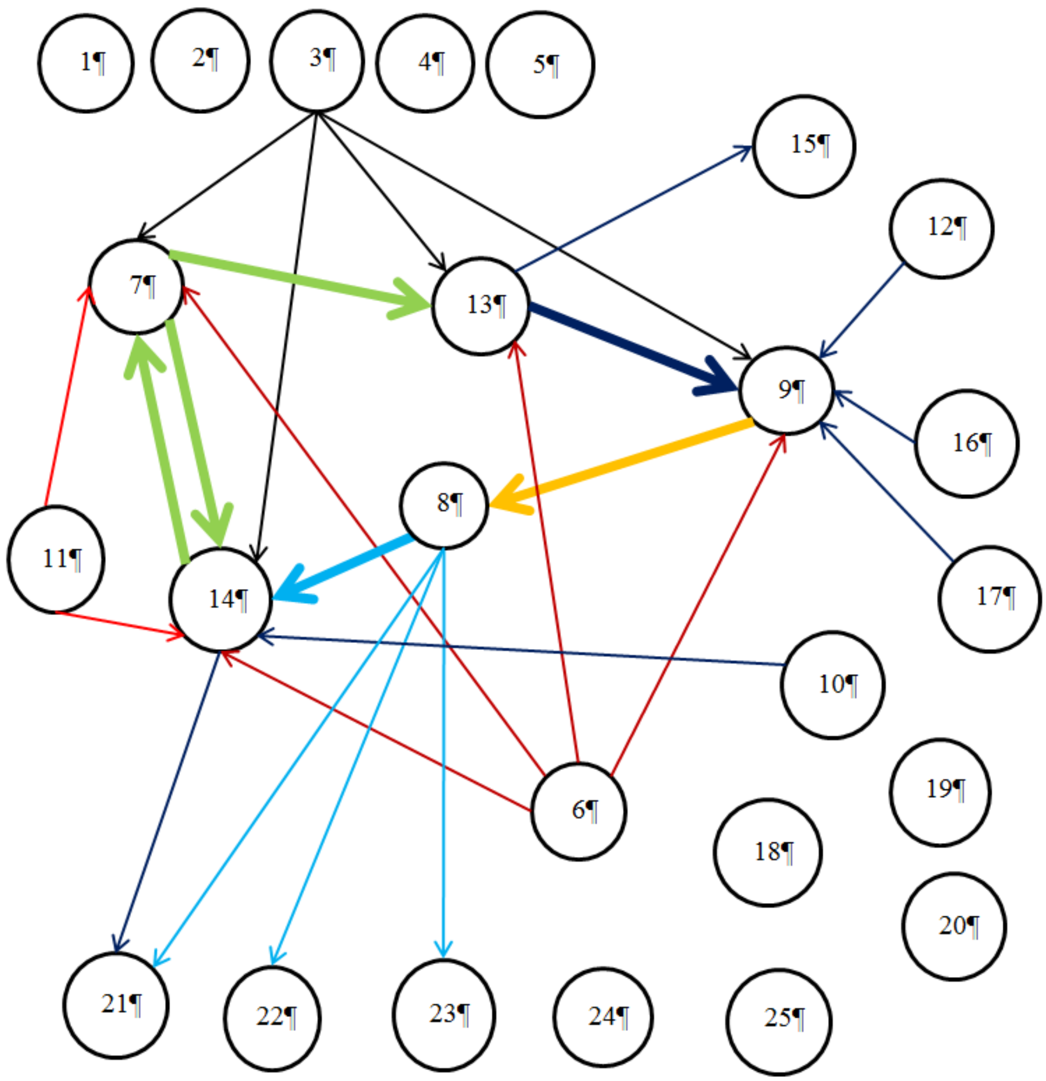

Figure 5.2 Development of the MACRO X event cycle for the input hurricane event at the $|C_{ij}| > 1.00$ level. The thick lines between events 7, 14, 13, 9, and 8 show items that comprise MACRO X. Thin lines show the influence of the events on MACRO X or events that influence MACRO X. All other influence lines are eliminated from this diagram.

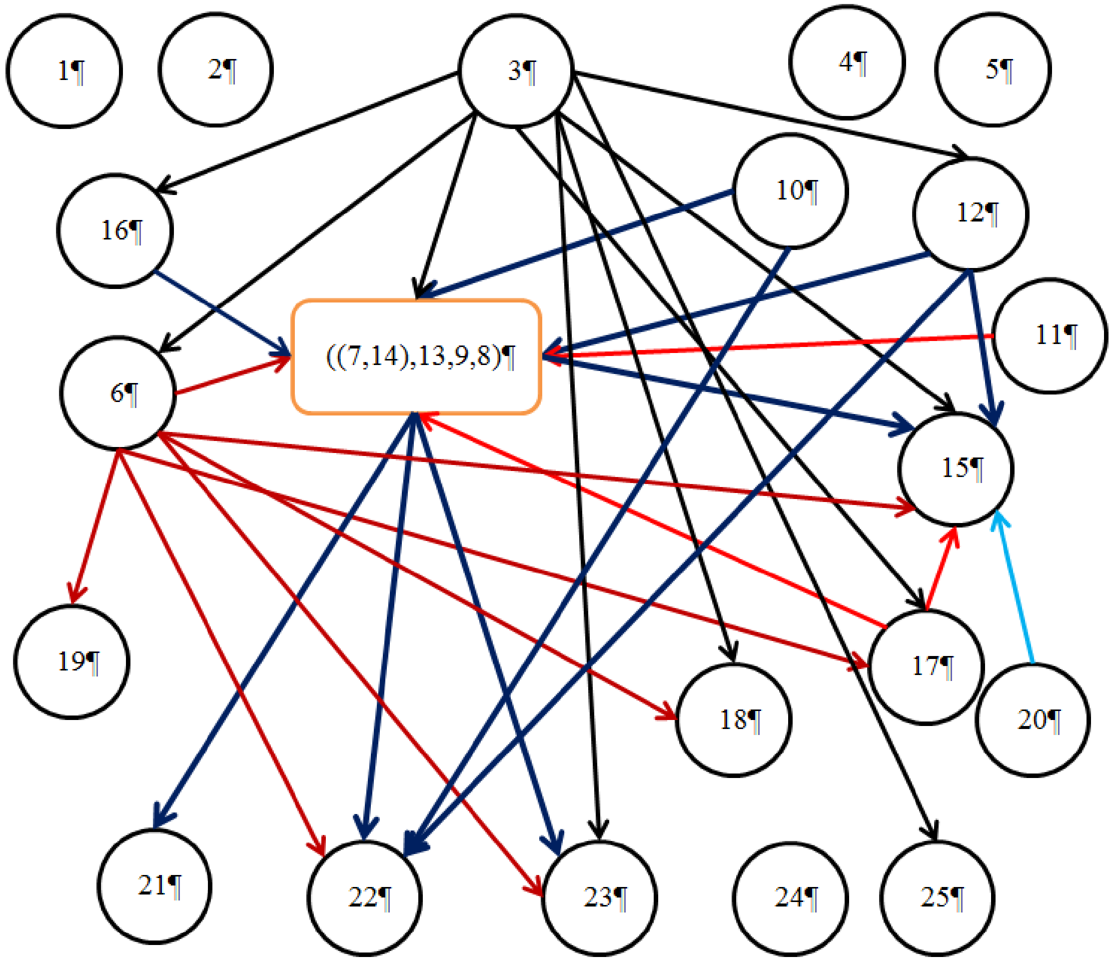

Figure 5.3 Influence of the hurricane event on all events at the $|C_{ij}| > 1.00$ level. This shows the combination of events of the second collapse.

Returning to the influence events with $|C_{ij}| > 0.80$, a new grouping occurs. At this level, a new cycle is created which adds event "19-DE14-Crime rate increase near place of business" to create the third collapse. The final collapse added event "10-DE5-Violent Crime committed by employee during work hours." Each collapse adds a set of new events which a small business owner must consider for continuing their business. This final collapse is shown in Figure 5.5.

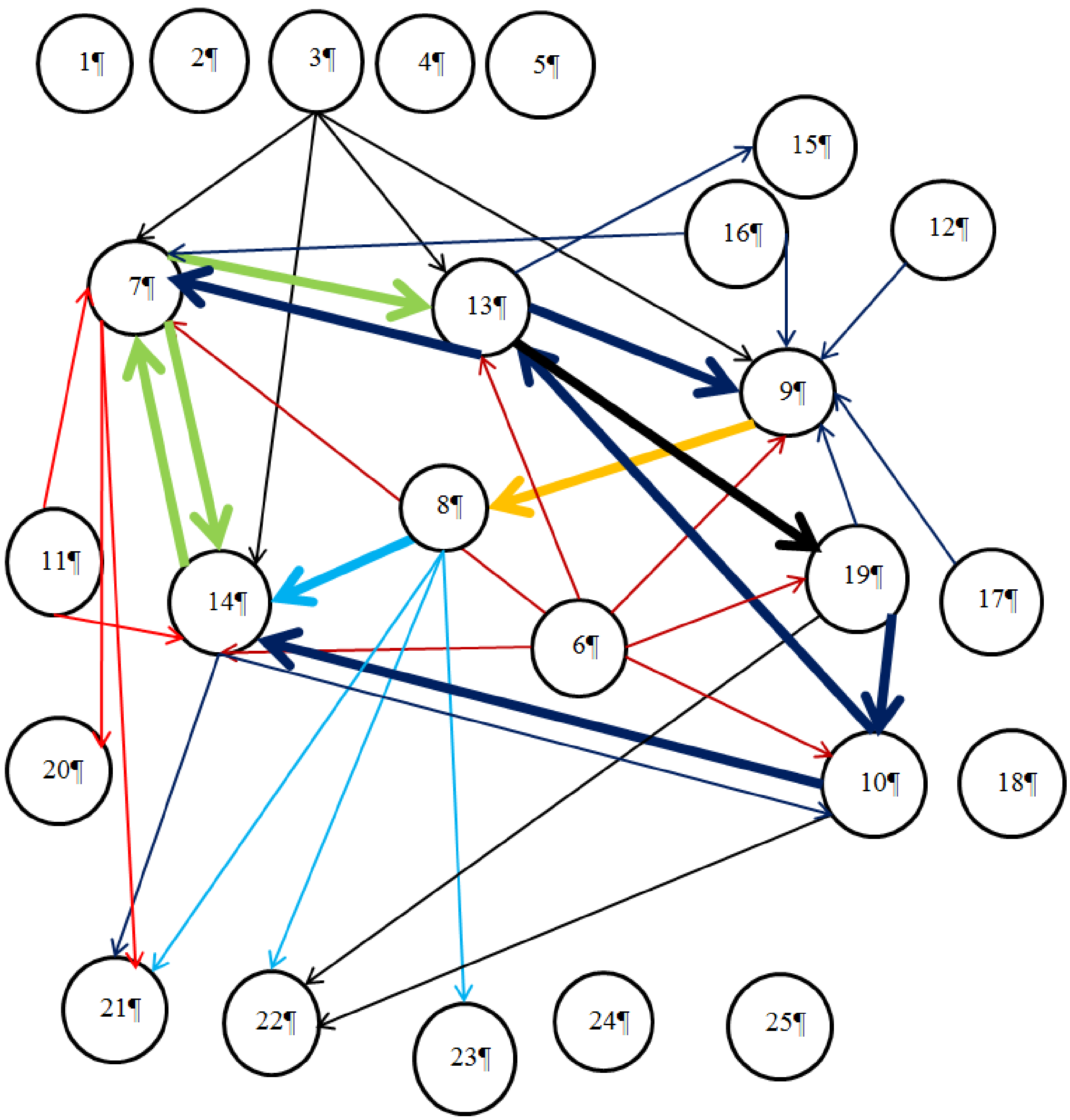

Figure 5.4 Development of the MACRO X2 event cycle for the input hurricane event at the $|C_{ij}| > 0.80$ level. The thick lines between events 7, 14, 13, 9, 8, 19, and 10 show items that comprise MACRO X2. Thin lines show the influence of the events on MACRO X2 or events that influence MACRO X2. All other influence lines are eliminated from this diagram.

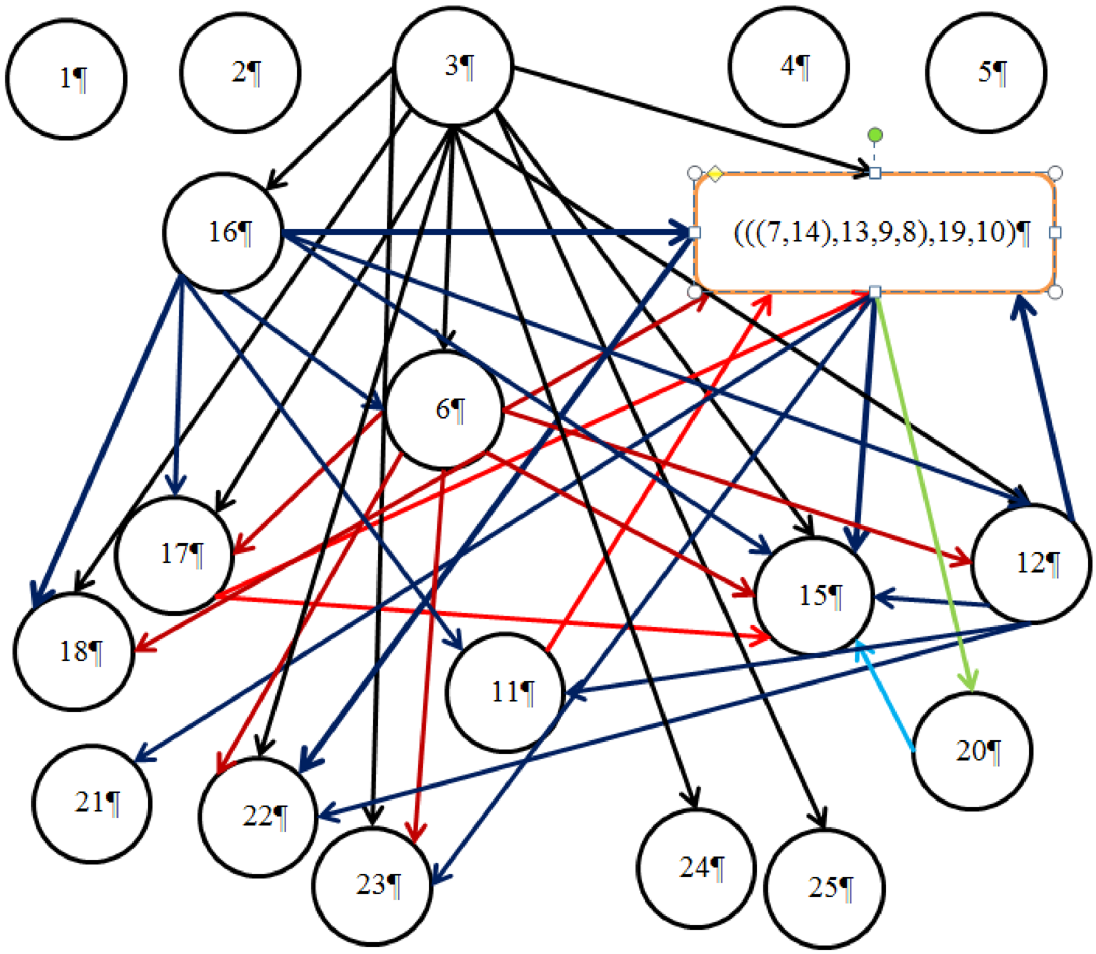

Figure 5.5 Influence of event 3, "I3-Hurricane in area," on all events at the $|C_{ij}| > 0.80$ level.

This grouping is plausible. If there are no communication networks, event 7, there is no internet connectivity, event 14. If there are no communications networks then there is no telephone service which is event 13. Unable to contact needed personnel, the employees are not available to help because they might not even know that they are needed at work, event 9. Without the key personnel, computer hardware may fail because those who know how to safely shut down equipment are not there, event 8. During a crisis people may resort to stealing and looting for items needed for basic survival or those to enhance life after the crisis subsides. In either case it is an increase in crime rate, event 19. Lastly, in an effort to protect their property, the people who depend on the store for their living may resort to violence to keep looters at bay. This is an example of event 10.

Arrows that point into the scenario represent an influence on the pointed to event. In Figure 5.5 we see that the input event “3-I3-Hurricane in area,” events “16-DE11-Roads flooded,” “6-DE1-Electricity shutoff,” “11-DE6-Backup power supply not available” influence the occurrence of the scenario. This result is also plausible. If the hurricane, event 3, had not occurred, the communications system might not have failed and the neighborhood may have remained relatively crime free. The loss of electricity may have shut down communications, event 6. Flooded roads, event 16, may have kept personnel from reaching the workplace. Event 11, backup power supply not available may have caused the hardware to fail. All of these influencing events reinforce the events in the scenario.

The relationships become clearer when the minimum value for C_{ij} is increased from 0.80 to 1.00, thereby eliminating some of the interactions. The higher the C_{ij} value that is used as a threshold, the higher the influence on the events. At the 1.00 level, the cycles that added events 19 and 10 to the scenario disappear leaving events 7, 14, 13, 9, and 8. The revised influence diagram for the hurricane event, Event 3, at the $|C_{ij}| > 1.00$ level is shown in Figure 5.3.

The decision to use a particular threshold value is arbitrary. Weaker influences of one event on another may be the only influences for a particular event. Without the weaker events, the influence diagram shows orphans with no connections. An example of an orphan event is event 3 to event 24. At the $|C_{ij}| > 1.00$ level there is no influence on event "24-O4-Raw material cost increase." The influence connection appears at the 0.80 value. It becomes a decision for the business to make on what events to prepare against. Weaker influences are considered to be less likely to occur. Tables 5.67 through Table 5.71 show all influences that directly affect the Output events. A list of all events and their estimated influence on each other is located in Appendix K.

If the threshold value for $|C_{ij}|$ is too low, too many events will appear on the diagram. When all of the events are combined, the resulting diagram can be especially messy for a large number of events. Figure 5.6 shows the result for all events at $|C_{ij}| > 0.80$.

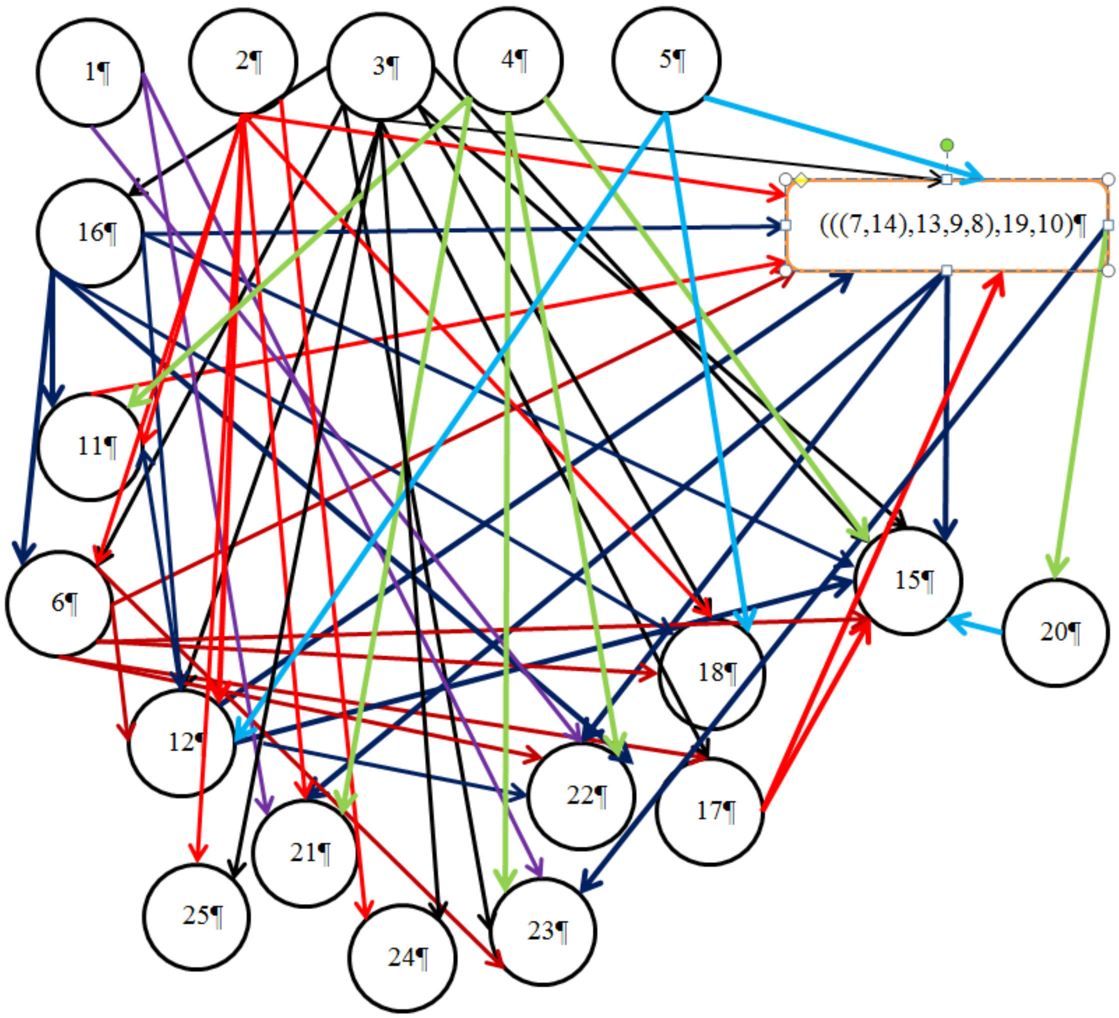

Figure 5.6 Influence of all events at the $|C_{ij}| > 0.80$ level after collapsing cycles.

If the threshold is too high, then not enough events show on the diagram to give any meaningful insight. Event 2, "I2-Fires underway" shows no influence on any of the Outcome events at the $|C_{ij}| > 1.00$ level. This is shown in Figure 5.7. Certainly, fires are a type of disaster for which all businesses must prepare. Each event must be examined in the light of all $|C_{ij}|$ values. Event low values may influence the business decision necessary for proper preparation.

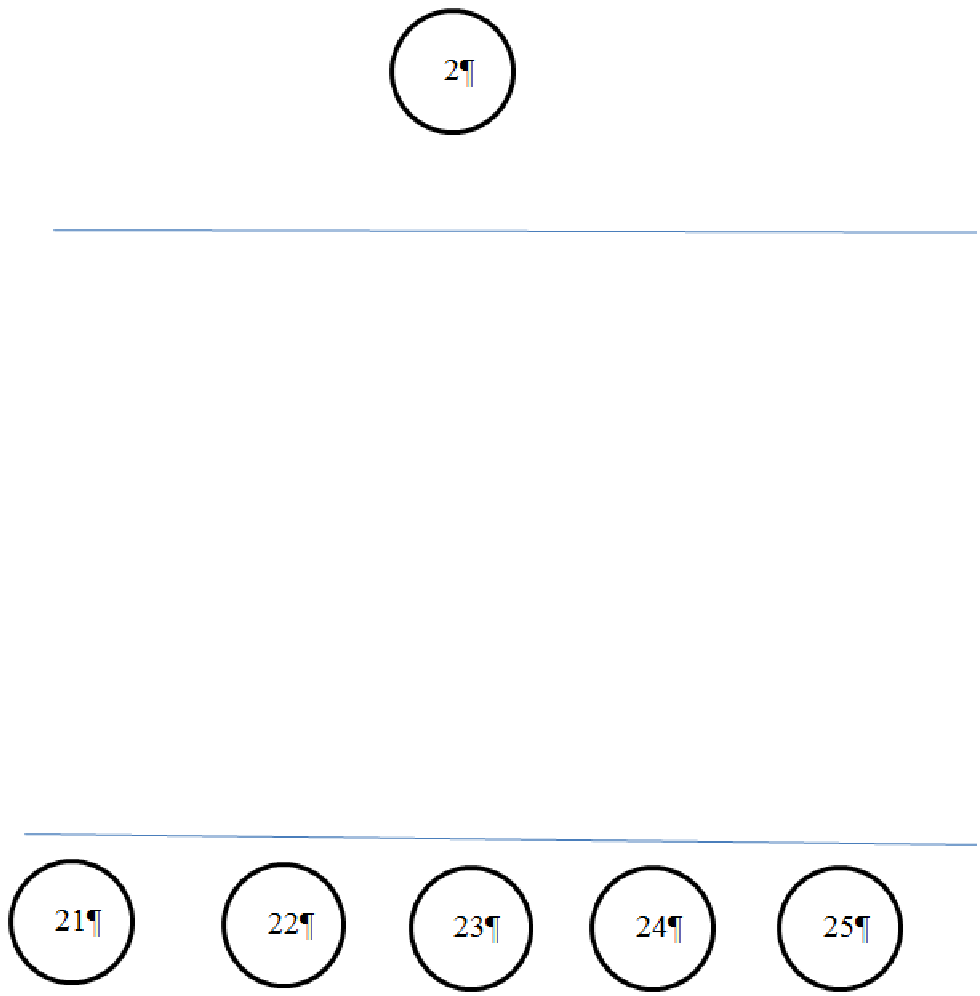

Figure 5.7 Lack of influence of event 2, “I2-Fires underway,” at the $|C_{ij}| > 1.00$ level.

The higher value $|C_{ij}|$ can also provide a set of events that do not show an influence on the Outcomes, but only the intermediate Dynamic Events. Event 5, “I5-Local government not functioning” influences Event 19, “DE14-Crime rate increase near place of business,” but does not influence any of the Outcome events at the 1.00 level. This is shown in Figure 5.8.

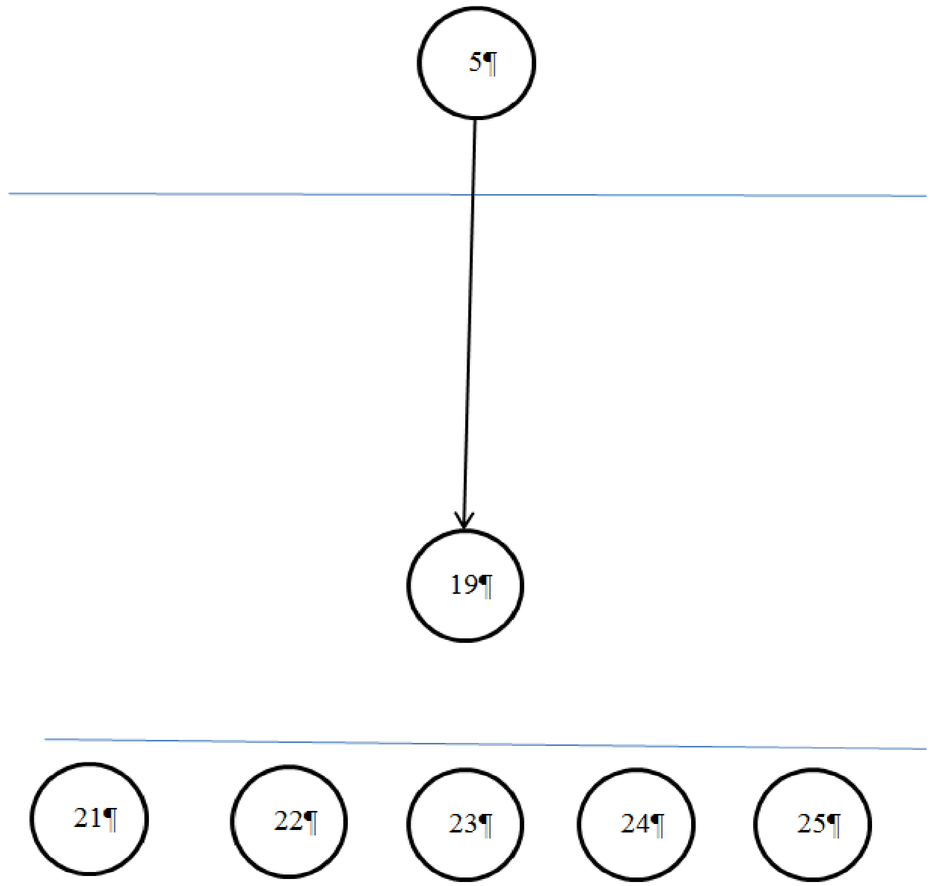

Figure 5.8 Influence of event 5, "I5-Local government not functioning," on dynamic event 19, "DE14-Crime rate increase near place of business," while having no influence on outcome events at the $|C_{ij}| > 1.00$ level.

Figure 5.8 shows a case where the use of $|C_{ij}| > 1.00$ influences a dynamic event, "Crime rate increase near the place of business," but does not go on to influence any of the output events. Interpreting this case means understanding what might influence the five Outcomes. Crime can influence Event 21, "O1-Loss of documents and company materials/records," if civil unrest leads to the destruction of the business property. This connection is made at the 0.24 level. However, the influence is not great. Event 22, "O2-Business reputation tarnished," is indirectly influenced through Event 19 at the 0.81 level. Event 5 directly influences the Outcome events 24 and 25 at the 0.56 level. No influence is considered to occur either directly or indirectly for Outcome event 23, "O3-Computer data lost." This shows that adjustments may have to be made to a plan as computer data becoming lost can be potentially as influenced by government not functioning as by losing the documents and records.

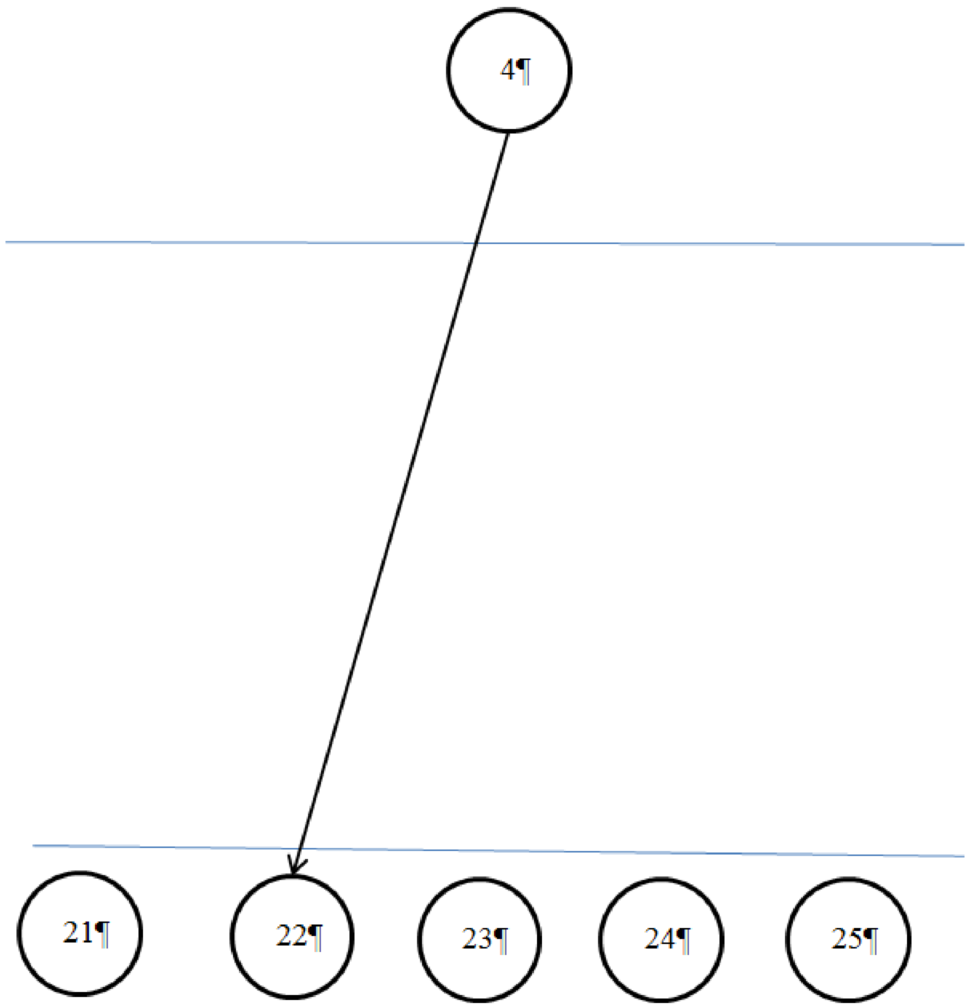

Figure 5.9 Lack of influence of event 4, "I4-Business continuity plan not tested," at the $|C_{ij}| > 1.00$ level.

At the $|C_{ij}| > 1.00$ level, there is only one influence line which directly connects Input event, "I4-Business continuity plan not tested," with the Outcome event 22, "O2-Business reputation tarnished." Here is a case where one single connection can be significant. Event 22, “O2-Business reputation tarnished” was the highest ranked risk for all businesses participating in this study. It is significant that the major event that can tarnish the reputation could be the business continuity plan not being tested. When combined with the other direct Input connection to this event, “I1-Computer server not fully backed up,” we have the start of preparations for creating a business continuity plan. This is shown in Figure 5.9.

5.12 Post Survey Results

The forty-two Round 2 participants were contacted to participate in a post survey to gauge the participants' reactions to the research process and to ask for improvements for the future. Invitations were sent via email with follow-ups via phone call and when possible, by personal visit. The survey used a Likert-type scale for ten questions and twenty-three open ended questions. The survey is shown in Appendix E. Fifteen people accepted the invitation to participate. Only one open ended question was answered. The summary of all data follows.

Question 2 asked about how much time it took to complete the surveys. The choices were broken down into five time bands ranging from less than 1 hour to more than ten hours. The majority of the respondents, 73% said that the surveys were completed in less than one hour which compares favorably with the 70% result of the respondents from the pre-survey that thought it would take less than one hour. The full results are shown in Table 5.77.

Table 5.77 Responses to "About how much total time did you spent on this project?" (Q2)

Time to Complete	Count	%
< 1 hour	11	73%
1-2 hours	3	20%
3-4 hours	1	8%
5-9 hours	0	0%
10+ hours	0	0%
Total	**15**	**100%**

Question 3 asked about the ease of the survey process. A seven level Likert scale was used that ranged from Easy to Difficult with the corresponding weights between 1 and 7, respectively. While 14% of the respondents in the pre-survey thought that the process would be difficult, the post survey showed that none of the 14 who responded thought that the process was difficult. Seventy-nine percent of the respondents thought that the process was easy. This compares very favorably to only 31% in the pre-survey that thought that the process would be easy. The weighted average was 1.93. Despite the response that the survey process was "easy," those whom the researcher invited personally or by phone who decided to not participate, cited a lack of time to continue. Others who did not respond at all may have refused due to other time commitments or perceived difficulty. Table 5.78 shows the complete distribution.

Table 5.78 Responses to "How easy or difficult was this process for you?" (Q3)

Survey Ease	Count	%	
Easy (1)	5	36%	79%
(2)	6	43%	
(3)	2	14%	21%
(4)	1	7%	
(5)	0	0%	
(6)	0	0%	0%
Difficult (7)	0	0%	
Total	**14**	**100%**	**100%**
Weighted Average	**1.93**		

Question 4 asked about the respondents' job responsibility. During the presurvey, thirty-one of the sixty-seven who responded to the job responsibility question or 46%, were the actual business owners. Of the fifteen who answered the post survey, 53% of the respondents were the business owners. Table 5.79 shows the entire distribution.

Table 5.79 Responses to “I evaluate these risks and actions as a…” (Q4)

Job Responsibility	Count	%
Business owner	8	53%
Business worker	7	47%
Planner	0	0%
Emergency worker	0	0%
Government worker	0	0%
Other	0	0%
Total	**15**	**100%**

Question 5 asked about whether the list of risk categories was complete. A five level Likert scale was used to measure the response divided from Strongly Disagree to Strongly Agree with the corresponding weights between 1 and 5, respectively. All but two respondents thought that the lists of categories were complete. Those respondents were neutral. The overall average was 4.27. The full results are shown in Table 5.80.

Table 5.80 Responses to “The list of risk categories is complete” (Q5)

Risk Category Completeness	Count	%	
Strongly Disagree (1)	0	0%	0%
(2)	0	0%	
(3)	2	13%	13%
(4)	7	47%	87%
Strongly Agree (5)	6	40%	
Total	**15**	**100%**	**100%**
Weighted Average	**4.27**		

No one responded to open ended Question 6, “I would add the following risk categories to the list.”

Question 7 asked about whether the wording of the risk categories was clear. A five level Likert scale was used to measure the response divided from Strongly Disagree to Strongly Agree with the corresponding weights between 1 and 5, respectively. All but one respondent thought that the wording of the risk categories was complete. That one respondent was neutral. The overall average was 4.13. The full results are shown in Table 5.81.

Table 5.81 Responses to "The wording of risk categories is clear" (Q7)

Risk Category Wording Clear	Count	%	
Strongly Disagree (1)	0	0%	0%
Disagree (2)	0	0%	
Neither Disagree or Agree (3)	1	7%	7%
Agree (4)	11	73%	93%
Strongly Agree (5)	3	20%	
Total	**15**	**100%**	**100%**
Weighted Average	**4.13**		

No one responded to open ended Question 8, "I would revise the wording of the following risks in the table."

Question 9 asked about whether the wording of the risk categories was clear. A five level Likert scale was used to measure the response divided from Strongly Disagree to Strongly Agree with the corresponding weights between 1 and 5, respectively. Eighty percent of the respondents answered that the lists of all of the risks were complete. The overall average was 4.07. The full results are shown in Table 5.82.

Table 5.82 Responses to "The lists of risks are complete" (Q9)

Risk List Complete	Count	%	
Strongly Disagree (1)	0	0%	0%
Disagree (2)	0	0%	
Neither Disagree or Agree (3)	3	20%	20%
Agree (4)	8	53%	80%
Strongly Agree (5)	4	27%	
Total	**15**	**100%**	**100%**
Weighted Average	**4.07**		

No one responded to open ended Question 10, "I would add these risks to the list," Question 11, "Why would you add these?", Question 12, "I would delete the following risks from the list," or Question 13, "Why would you delete these?"

Question 14 asked about whether the list of actions was complete. A five level Likert scale was used to measure the response divided from Strongly Disagree to Strongly Agree with the corresponding weights between 1 and 5, respectively. All but three respondents thought that the list of actions was complete. Those three respondents were neutral. The overall average was 4.00. The full results are shown in Table 5.83.

Table 5.83 Responses to "The list of actions is complete" (Q14)

Action List Completeness	Count	%	
Strongly Disagree (1)	0	0%	0%
Disagree (2)	0	0%	
Neither Disagree or Agree (3)	3	20%	20%
Agree (4)	9	60%	80%
Strongly Agree (5)	3	20%	
Total	**15**	**100%**	**100%**
Weighted Average	**4.00**		

No one responded to open ended Question 15, “I would add these actions to the list,” Question 16, “Why do you add these?”, Question 17, “I would delete the following actions from the list,” Question 18, “Why would you delete these?”, Question 19, “What did you like about the process?”, Question 20, “What did you like about the process?”, or Question 21, “What else would help you learn the underlying model concepts?”

Question 22 asked about whether the instructions for the Delphi were clear. A five level Likert scale was used to measure the response divided from Strongly Disagree to Strongly Agree with the corresponding weights between 1 and 5, respectively. Five respondents were neutral and two-thirds thought that the list of instructions was clear. The overall average was 3.73. The full results are shown in Table 5.84.

Table 5.84 Responses to “The instructions for the Delphi were clear” (Q22)

Delphi Instructions Were Clear	**Count**	**%**	
Strongly Disagree (1)	0	0%	0%
Disagree (2)	0	0%	
Neither Disagree or Agree (3)	5	33%	33%
Agree (4)	9	60%	67%
Strongly Agree (5)	1	7%	
Total	**15**	**100%**	**100%**
Weighted Average	**3.73**		

No one responded to open ended Question 23, “I would clarify the following parts of the instructions.”

Question 24 asked about whether the list of risks was complete. A five level Likert scale was used to measure the response divided from Strongly Disagree to Strongly Agree with the corresponding weights between 1 and 5, respectively. Three of the fifteen respondents were neutral and 80% agreed or strongly agreed that the list of risks was complete. The overall average was 4.33. The full results are shown in Table 5.85.

Table 5.85 Responses to "The list of risks is complete" (Q24)

Risk List is Complete	**Count**	**%**	
Strongly Disagree (1)	0	0%	0%
Disagree (2)	0	0%	
Neither Disagree or Agree (3)	3	20%	20%
Agree (4)	4	27%	80%
Strongly Agree (5)	8	53%	
Total	**15**	**100%**	**100%**
Weighted Average	**4.33**		

Question 25 asked about whether the respondents understood how risks might influence each other. A five level Likert scale was used to measure the response divided from Strongly Disagree to Strongly Agree with the corresponding weights between 1 and 5, respectively. Five of the fifteen respondents were neutral and a majority agreed that they understood how the risks can influence one another. The overall average was 3.87. The full results are shown in Table 5.86.

Table 5.86 Responses to "I understand how risks can influence each other" (Q25)

Understand How Risks Influence Each Other	Count	%	
Strongly Disagree (1)	0	0%	0%
Disagree (2)	0	0%	
Neither Disagree or Agree (3)	5	33%	33%
Agree (4)	7	47%	67%
Strongly Agree (5)	3	20%	
Total	**15**	**100%**	**100%**
Weighted Average	**3.87**		

Question 26 asked about whether the respondents understood differences between the risks. A five level Likert scale was used to measure the response divided from Strongly Disagree to Strongly Agree with the corresponding weights between 1 and 5, respectively. Three of the fifteen respondents were neutral and the majority agreed that they understood the difference between the risks. The overall average was 4.07. The full results are shown in Table 5.87.

Table 5.87 Responses to "I understand how risks can influence each other" (Q26)

Understand Difference Between Risks	Count	%	
Strongly Disagree (1)	0	0%	0%
Disagree (2)	0	0%	
Neither Disagree or Agree (3)	3	20%	20%
Agree (4)	8	53%	80%
Strongly Agree (5)	4	27%	
Total	**15**	**100%**	**100%**
Weighted Average	**4.07**		

No one responded to open ended Question 27, "I would delete the following risks" or Question 28, "Why would you delete these?"

Question 29 asked about whether the list of actions was complete. A five level Likert scale was used to measure the response divided from Strongly Disagree to Strongly Agree with the corresponding weights between 1 and 5, respectively. Three of the fourteen respondents were neutral and majority answered that the list of actions was complete. The overall average was 4.00. The full results are shown in Table 5.88.

Table 5.88 Responses to "The list of actions is complete" (Q29)

Action List is Complete	**Count**	**%**	
Strongly Disagree (1)	0	0%	0%
Disagree (2)	0	0%	
Neither Disagree or Agree (3)	3	21%	21%
Agree (4)	8	57%	79%
Strongly Agree (5)	3	22%	
Total	**14**	**100%**	**100%**
Weighted Average	**4.00**		

No one responded to open ended Question 30, "I would delete the following actions from the list," Question 31, "Why would you delete these?", or Question 32, "What else would help you learn to create a plan?"

Question 33 asked about whether the response time from the administrator met their expectations. A five level Likert scale was used to measure the response divided from Strongly Disagree to Strongly Agree with the corresponding weights between 1 and 5, respectively. Five of the fifteen respondents were neutral and a majority answered that they agreed that the administrator was responsive. The overall average was 3.73. The full results are shown in Table 5.89.

Table 5.89 Responses to “Response time from the Administrator met my expectations” (Q33)

Administrator Response Time	Count	%	
Strongly Disagree (1)	0	0%	0%
Disagree (2)	0	0%	
Neither Disagree or Agree (3)	5	33%	33%
Agree (4)	9	60%	67%
Strongly Agree (5)	1	7%	
Total	**15**	**100%**	**100%**
Weighted Average	**3.73**		

Eight people responded to open Question 34, “How would you improve the process?” Five of the eight wished that the process used shorter surveys (63%). Two thought that the process was fine as it was (25%). One was not sure how this might help them (12%). The individual responses are listed in Table 5.90.

Table 5.90 Responses to “How would you improve the process?” (Q34)

How to Improve the Process
Took a lot of time
Take less time
Shorter surveys
Nothing. It was fine.
Tell me more how this might help me?
Nothing. Very well done.
Shorter
Make it shorter

The response rate for the post-survey was low compared to the pre-survey or Rounds 1 or 2. Of the forty-two contacts only fifteen surveys were completed. Those who refused participation cited a lack of time. This rushed feeling was probably responsible for those participating to only answer the Likert scale questions and not the open ended ones. The one open ended question regarding how to improve the process only contained a few words. The responses mostly stated that the surveys should be shorter. Given that over four thousand contacts were made to secure sixty Round 1 responses, future research using small business owners and workers needs to be designed to be completed in a shorter time period. The researcher concludes that participation rates would likely increase.

The administration of the post survey at the beginning of the new year is also significant to the participation and time constraints felt by the respondents. Year-end, quarterly, and monthly federal and state tax filing requirements begin with the new year. Performing the survey in a different month of the year than January may improve the response rate.

5.13 Research Question Results

This research was conducted based on the following two research questions.

> RQ1. Can Delphi, Cross Impact Analysis, and Interpretive Structural Modeling be used to develop the basis for an emergency preparedness plan for small businesses?
>
> RQ2. How can a model based on these three techniques best be designed to assist in developing the basis for an emergency preparedness plan for a small business?

RQ1 asks if the three methods can be used to develop the basis for an emergency preparedness plan. Yes, we have demonstrated that the three methods can be used as a basis for a plan. Although the methodology is complex, the output from this research is certainly a viable basis for an emergency preparedness plan. The scenario for Event 3, "I3-Hurricane in the area" shows a very plausible result. The scenario created at the $|C_{ij}| > 1.00$ shows the need to prepare for communications and internet outages and to have key personnel available to help with minimizing the effects of the hurricane. Once these significant events are known, planning and preparations can be made to minimize the event's devastation.

RQ2 asks how the three techniques can be designed to assist in the development of an emergency preparedness plan. The results and feedback from participants shows that the best way to design the use of this methodology to develop the basis of a plan is to shorten the amount of time it takes to use the methodology. The main concern of participants was that the survey part of the method took more time than they anticipated. The mathematics of the preparation of CIA and ISM input are beyond the mathematical skills of most business people. The best design is therefore one that shortens the amount of time needed to perform the survey and then integrates and hides the mathematics involved in the production of the CIA and ISM results. This integration of the surveys to create the input for the CIA survey flowing into ISM software to create the influence diagrams would be the best design. It would hide the complex mathematics and save time from input to interpretation.

CHAPTER 6

IMPLICATIONS FOR EMERGENCY MANAGEMENT PLANNING

The development of a plan to minimize business downtime in the face of disaster is a daunting task for any organization. Taking the time to determine what is critical to keep a business running when disaster strikes competes with the small business owners' normal day to day activities. Planning is a time consuming activity that is normally secondary to handling payroll, manufacturing, tax filings, regulatory compliance, sales, marketing, and shipping customer orders. This research gives the small business owner a head start on creating an effective plan.

An essential step in creating an emergency preparedness plan is to determine the risks that the business may face. This research provides a list of sixteen categories to help focus the planning process on areas of concern. The next step after determining what high level disaster, such as fire or flood may occur, is to identify what might specifically cause damage. Inside of these sixteen risk categories we provide the owner a base set of one hundred seventy-two risk items and one hundred thirty-four preparation/action items to consider. Some items may not be applicable to a particular business. The list may spur ideas for items not on the base lists. Others items are what is exactly needed, but might not have been considered prior to this research.

Once the risks are assessed, priorities need to be set on how to prepare. Instead of using "gut feel" techniques for what is needed, the opinions of fellow business owners are available to help set the priorities. These sorted, ranked results help clarify the highest impact risks, both by category and across all categories.

There are many different risk items to select and prioritize. This research helps the small business to set those priorities by quantifying how one risk may influence another. Thinking about how one risk influences another is tedious and complex. This research quantifies the influence of one risk on another using subjective probability estimates. These estimates are used in the Cross Impact Analysis software to mathematically quantify what combinations of risks should be considered for preparation. Output from the program can be sorted by the highest risk values.

Once risk interactions are quantified, this research helps find groups of interactions that represent the highest value items for which to prepare. The method combines individual events into scenarios. These scenarios represent the most concentrated use of limited budgets for mitigating small business interruption.

For example, this research study found that event "22-O2-Business reputation tarnished" was the single largest concern of all respondents. Looking at the influences that affected event "22-O3-Business reputation tarnished" by the hurricane event, I3, the research found a scenario comprised of five items at $|C_{ij}| > 1.00$. This scenario is detailed in Section 5.11 and is made up of the following events:

- 7-DE2-No communication networks
- 14-DE9-Internet connectivity lost
- 13-DE8-Telephones out of service
- 9-DE4-Personnel not available during an emergency
- 8-DE3-Computer hardware fails

This scenario implies certain preparations and actions that can be used to protect the reputation of a small business during a crisis. The set of items in the scenario implies the need to protect the communications systems so that key personnel can be contacted and possibly brought in to help recovery. A lack of communications may result in not being able to help customers when competitors are better prepared to serve them in a time of need.

The items that help to create the basis for the plan can be found in the list of preparation action items shown in Section 5.8. The list shows that the number one preparation action item was to broaden your customer base. If your business is interrupted, a broader customer base will help sustain at least some of the business and provide a chance to find more customers. Protecting the communications systems and contacting key employees implies securing power backup. For example, a power generator can operate the communications/data systems and add redundancy to each process. This avoids a single point of failure.

There are several items in the top fifteen preparation/action items list that can help to protect against communications interruption. The first implies action for event "9-DE4-Personnel not available during an emergency," is that you should "Create a contact list." This contact list needs to be in multiple locations in electronic and non-electronic form. The electronic form could be on an Outlook Exchange server, a Word or text document on your laptop, and in your contact list on your phone. If the electricity is out for an extended period or if the electronic version is destroyed, then a paper copy of the contacts could prove essential.

The next events in the scenario, events "7-DE2-No communication networks" and "14-DE9-Internet connectivity lost" are directly linked, meaning that one event influences the other and vice versa. A set of intertwined events implies that redundancy is essential. Combining the loss of the communications network, internet and event "13-DE8-Telephones out of service" implies the need for another preparation action, "Use wireless connections." Because of an event such as a hurricane, communication wires may be down in the area around a particular place of business. Wireless cellular communications may still operate depending on the location of the cell towers. Cellular communications in the form of smart phones provides a multiple level backup if the office phones are damaged. The smartphone provides other communications features that are invaluable in a crisis. A tethered cell phone connection comprised of a cell phone and a wire put to a port in the laptop can provide needed internet access. Email can be received and sent over this tethered equipment or directly to and from the cell phone itself. Short messages up to 160 characters can be sent via text message using a communications protocol know as SMS or "Short Message Service." A smartphone provides several backup communications options. Another example is that employees can be trained to check Twitter for messages about the business during emergencies, since Twitter, as an SMS, can work even when cell phone networks are overloaded.

Event "8-DE3-Computer hardware fails" implies more redundancy and backup is necessary to minimize a failure. Additionally there is an implication that the hardware must be protected from damage in some manner. Another of the top fifteen preparations is "Add adequate surge protection." Storms may generate lightning strikes causing spikes in power which can damage electronic equipment permanently. Surge protectors intercept these spikes in electrical voltage and can prevent that damage.

As with any other electrical equipment, it is implied that surge protectors can fail and also need a backup. If the surge protector fails and the equipment is damaged, then the data needs to be duplicated. One backup strategy to improve redundancy is to have a local backup using external drives at the facility. Critical data is sent to these devices on a timely basis, either in real time or on a periodic basis. If the connection to the internet is active, then backup of data can be sent to a facility in the cloud where damage from the same storm is unlikely. Another level of redundancy is to rotate backup devices to offsite storage using a records management facility.

Usually affordable to only large organizations, a redundant operating site, known as a "hot site" receives data on a scheduled basis and is prepared to become the main operating location if an emergency occurs. Unfortunately, the cost of a hot site may be prohibitive to small businesses that have trouble even affording backup generators. The cost may have been the reason that installing a backup generator was only rated by participants as an average preparation.

From breaking down the individual items of the scenario and using the preparation/action list provided, the small business owner can look for a less time consuming way to protect their business and their business reputation. The lists may provide ideas for preparations that they did not consider.

CHAPTER 7

CONTRIBUTIONS

There are two anticipated main contributions of this work. The first is the development of the Cross Impact and Interpretive Structural model that can potentially change how Business Continuity/Disaster Recovery (BC/DR) plans are created to improve recovery following a business disruption. No such planning method currently utilizes a mathematically based model to describe how a BC/DR plan might be improved. The development of such plans inside corporations is a time consuming task. Business continuity/disaster recovery planning is necessary from a business recovery point of view, but does not generate revenue for a positive return on investment in the traditional sense. Teaching planning skills by using a modeling tool can open the way to faster, better, and cheaper improvement to business recovery planning, especially for smaller organizations that do not have full-time planning support staff. The use of the CIA/ISM model will hopefully enable people teaching business recovery/disaster recovery to more efficiently convey concepts and increase the desire of planners to determine how BR/DC plans may be improved.

At the same time, personnel more familiar with planning will be able to further optimize the allocation of budget resources as the CIA/ISM model provides the ability to rank potential improvements based on C_{ij} values and ISM scenarios. Discussions by expert groups may uncover plan improvements not seen before. At a minimum, the results of the model will spur new discussions on how best to improve BC/DR plans from the ever changing risks. Cross Impact Analysis has been widely used as a planning tool since its creation in the early 1970's. The development of the planning model will extend Cross Impact Analysis to create a basis for business continuity/disaster recovery. The results report is an example of support documentation necessary to justify changes to BC/DR plans that other systems do not often supply. Streamlining the justification can decrease the planning cycle, resulting in better recovery chances. The CIA/ISM model extends the idea of expert/learner participation in absentia by providing expertly devised risk and action sets helpful as a starting point for future planning personnel.

Secondly, another potential contribution of the CIA/ISM model is the demonstration that human knowledge can be integrated into a model of a complex system. The system can be developed and used by professionals in many fields without knowing how to program computers. The knowledge base for the model integrates concepts from cross impact analysis, structural modeling, and the Delphi Method (Turoff, 1970).

No prior study has been undertaken that uses the combination of the Delphi Method, Cross Impact Analysis, and Interpretive Structural Modeling to create a basis for a BC/DR plan. Understanding the interaction between risk factors and not just their summarized importance will further clarify how BC/DR plans can be optimized for better recovery.

Further contributions can be divided into two categories, those that help small businesses directly and those that help the research community at large.

7.1 Contributions for Small Businesses

The output from the development of this small business emergency preparedness model can contribute to helping small businesses in various ways. Some of these contributions are:

1. Understanding the preparations necessary to minimize business interruptions.
2. Minimizing the expenditure on interruption preparations by concentrating on the highest impact scenarios.
3. Minimizing confusion by the business owner and staff by knowing how to react in an emergency.
4. Lowering insurance rates by having a written plan, depending on the insurance company.
5. Focusing training protocols on the most important scenarios.
6. Minimizing any business interruptions thereby increasing the chance that the business will remain viable.
7. Understanding various risks before making business decisions that could be potentially interruptive.
8. Learning about different risks in different kinds of businesses that can help decision making when expanding into a different type of business.
9. Better protecting vital records and assets.
10. Complying with federal, state, and local laws including, but not limited to, fire codes, Occupational Safety and Health Administration regulations (OSHA), and environmental guidelines (EPA/DEP).

7.2 Contributions for the Research Community

The current research makes contributions to the research community aside from the ones that help small business owners. Specifically:

1. Establishes a base library of small business risks and mitigation actions that can be used as a starting point for future research into business interruption, disaster recovery, and emergency management.
2. Expands the use of Delphi into the small business realm where it has not been utilized.
3. Extends Cross Impact Analysis into an area for modeling business risk.
4. Promotes cross disciplinary development of a business continuity/disaster recovery plan.
5. Establishes a methodology for combining Delphi surveys, Cross Impact Analysis, and Interpretive Structural Modeling into an area where mathematical modeling has not taken hold.
6. Creates a basis for a model that can be used for different areas of research outside of the small business continuity/disaster recovery area.
7. Adds to the body of Emergency Preparedness research and knowledge.
8. Creates a basis for low cost development of business continuity/disaster recovery plans that can be expanded into other areas
9. Fosters communication between the small business community and the academic research world.
10. Creates a base survey that can be extended into different research areas.

CHAPTER 8

FUTURE RESEARCH

This research was a good first step towards helping small businesses better prepare for disasters such as Hurricane Sandy. Of the one hundred seventy-two consolidated round 1 and round 2 risk events, only twenty-five events were used for the Cross Impact and Interpretive Structural Models. The remaining one hundred forty-seven events could be used as the basis for other models.

This research did not use the one hundred thirty-four preparation items in a model. Much research is performed looking at how risks exacerbate a situation. A fertile research area could be the modeling of how preparation events interrelate to improve a situation.

This research looked at a narrow geographic area, the Middle Atlantic States of the United States. This area was chosen as the greatest damage area due to Hurricane Sandy. The methods and instruments in this research could be applied to other geographic regions inside and outside the United States to see the risks that are of the most concern to small businesses. Comparative research could be conducted using medium and large businesses to gain insight into how preparations are conducted at those businesses.

The research used a cross section of different businesses based on those who responded to the survey. No one industry segment answered in numbers to be statistically significant. A study could be conducted with sufficient respondents in a particular industry, such as food distribution, to make statistically significant insights.

This model is based on the most important consensus risks by the small businesses responding. A future study of small business risk using only emergency managers should be conducted for comparison of results given their professional perspective.

The actual creation of the ISM diagrams is a tedious, manual process. Software is developed that aids in the process, but future research would be helped by the development of software that connects from the Cross Impact phase, through the Interpretive Structural Model calculations, and outputs the diagrams. Analysis of all possible scenarios at all C_{ij} levels could be studied using scenario software such as CIASS (Huega et al., 2015).

Now that the top risks and actions are known, a smaller, more targeted study should be performed on a particular industry. The risks and actions study should be separated to shorten the survey time and attract a higher participation rate.

CHAPTER 9

CONCLUSION

Small business owners have many responsibilities from sales to product shipment, employee relations to paying bills. With so many responsibilities, time to plan for disasters can be secondary until the need arises and the small business is interrupted or permanently closed due to an outside event. Getting the attention of small business owners and workers to participate in this study was very difficult. It was not anticipated that over four thousand email and personal contacts would be needed to receive only sixty responses. This low response rate is why the study of small business disaster recovery planning has been limited and why this research is so valuable.

Those sixty responses provide the basis for quantifying risks in a form not usually available to small businesses. Workers familiar with emergency response to subjectively judge the risk interactions produced a plausible scenario to protect against long term shut down following a significant interruption event such as a hurricane. The backing up of data and ensuring proper communications during a crisis are easily affordable to even very small businesses. Most small business workers have cell phones which provide several different ways to communicate. If voice service is not available, then most phones can send emails. If email service is not available, then a browser chat session may be available in a phone's browser. If the internet connection is down, then a text may be able to be sent as text uses a different communications network than the other methods. One device, a cell phone, can be a lifeline during a crisis.

The Delphi method was easy to use to gather the data that was necessary to enter into the mathematical models. Using Survey Monkey as the means to gather the data was not without limitations. Although the user interface made it easy to program the survey questions, the lack of being able to select a default value such as “No Judgment” added more time for the participants to explicitly make a selection when they did not feel qualified to make another choice.

The length of the survey was an impediment to participation. Many potential participants and even those that did participate cited that the use of one half hour or more to estimate the risk and action events was too long. Those who did participate saw the potential benefit and gained insight into areas of interruption that they had never considered. Based on this feedback, I conclude that the risk areas should be studied in a separate survey from rating the action areas. Only the top risk areas should be used in the study to further shorten the time necessary to participate.

The CIA-ISM methodology is complicated and is not for small business owners that do not have a deep understanding of mathematics. The amount of work needed to determine the top risks, create a survey to measure interaction of these risks, calculate the values needed for input to Cross Impact Analysis and then create diagrams of how the risk interactions influence one another is well beyond the time that small business owners have to do their planning. The amount of time to prepare the inputs for the models is significantly longer than one-half hour. The use of a consultant to aid the implementation of the method is essential.

APPENDIX A

MODEL INSTRUCTIONS

This appendix outlines the steps for the study.

1. The subject reads the study introduction.
2. The subject reads and signs the Consent Form to indicate his/her consent by indicating their agreement on the consent page.
3. The subject fills out a pre-survey questionnaire.
4. The subject reviews the evaluation instructions.
5. The participants evaluate the base set of business continuity/disaster recovery risks and actions and suggest modifications and/or additions.
6. Evaluation includes rating the relative importance of each event
7. In part 2 of the study, a group of qualified experts adds probability inputs for the revised set of risks and actions and evaluate the new items that have been added to the list.
8. If necessary, a third Delphi survey study is added to discuss major disagreements in importance and probability factors.
9. A panel of experts determines the influence factors between the most important risk items for input to the Cross Impact Analysis (CIA) software.
10. CIA and Interpretive Structural Modeling results are calculated and reported.
11. Following the end of the evaluation periods, approximately four weeks per round depending on the nature of the task, the participants fill out their post-input survey questionnaires.
12. The investigator holds a debriefing session online for the benefit of the participants. The online discussion would also help indicate what subset of the participants might wish to make probability estimates for the final set of events.

APPENDIX B

SAMPLE INVITATION

This appendix contains a sample email used to find potential participants.

Dear Fellow member of the Meadowlands Regional Chamber of Commerce and small business person:

You are receiving this email because you may be able to help your business and others lessen the interruption due to an event such as Hurricane Sandy.

As part of my Ph.D. research through the New Jersey Institute of Technology, please click the link below to begin the survey.

As a token of thanks for completing the surveys, you will be entered into a drawing for 1 of 3 $50 American Express gift cards. Full details of the study are in the STUDY DETAILS section.

Here is a link to the survey:

[SurveyLink]

Please complete the survey no later than Monday, March 16, 2015. Thank you for your help.

Sincerely,

Art Hendela

Ph.D. Candidate in Information Systems

New Jersey Institute of Technology

Fellow small business owner since 1988.

If you need to take a break and return to complete the Risk and Analysis section at a later time, please click https://www.surveymonkey.com/r/RisksAndActions

You must use the same computer to continue the survey where you left off or your prior answers will not have been saved. Your computer must also allow cookies.

This research was approval by NJIT's Institutional Review Board under protocol F2014-14.

STUDY DETAILS:

For further detail, please visit [WEBSITE LINK – See Study Detail section below].

Please note: If you do not wish to receive further emails from us, please click the link below, and you will be automatically removed from our mailing list.

[RemoveLink]

STUDY DETAILS:

According to the Federal Emergency Management Agency website, https://www.fema.gov/protecting-your-businesses, 40% of businesses that experience a disaster never reopen their doors. The cost to reopen after just few inches of water can be in the tens of thousands of dollars. Other types of business interruptions can be just as damaging. This study will help to make you aware of the types of risks that you may face and how to minimize them.

You are receiving this email because we are fellow members of the Chamber and I believe that you are qualified to participate in my research study. The end result of the study is the creation of a model and a set of recommendations that can potentially help your small businesses to better prepare against business interruptions for events such as Hurricane Sandy. By participating in this process, you will receive a list of recommendations that have been evaluated by other small business people and experts in the field. Results and recommendation will be identified by the type of business for which they are most appropriate. I am performing this research in collaboration with Murray Turoff and Roxanne Hiltz, who are both Distinguished Professors in the Information Systems department at NJIT.

To participate in this study there are two requirements:

1) you must be 18 years of age or older
2) you must have at least 3 years of professional experience running a business or being responsible for the business continuity/disaster recovery aspect of the business.

I encourage you to forward this email to other people that you think might be qualified and willing to participate. I need a minimum of 50 participants to complete my dissertation study and sincerely hope to receive at least one hundred responses especially from those businesses that experienced Hurricane Sandy or other major business interruptions. Participation requires filling out three surveys with the first one taking approximately 5 minutes, the second one between 20 and 40 minutes, and the last one approximately 10 minutes.

The first survey is a pre survey for background information and your expectations concerning the study. The second survey is in two parts. The first part is a list of events that might occur that could interrupt your business operations such as a building fire, a hurricane, or a flood. The second part is a set of possible factors that will mitigate the adverse events. You will be given a base list of events and then asked to add or subtract from the list with a brief explanation of each change. These initial lists have been compiled through extensive research. Also you will give a relative idea about how you feel the event has of incapacitating your business. Do not try to respond to questions that you do not feel comfortable in answering. A “No Judgment” vote is available for all questions. The third survey is a follow-up post survey that will measure the effectiveness of the survey process. No one will be identified with respect to who wrote comments, options or estimate choices. In addition, there will be a discussion board where you may, if you wish, enter into an on-going discussion with the other group members to share ideas, enter suggestions on each new survey and discuss any related viewpoints. You will have approximately one month to complete each survey and the discussion board may be used anytime at your convenience. This research required approval by NJIT's Institutional Review Board under protocol F2014-14 to ensure no adverse effects for participants. No adverse effects are foreseen for participating in this study. Moreover, in developing this research, we have found that many participants found new and better ways to protect their businesses from being interrupted.

Outline of the process:
Following your acceptance and consent to participate, you will be shown the pre-survey. The pre-survey just asks a few background questions and asks about what you are expecting from your participation. In like manner, the post-survey at the end will ask you what you liked and perhaps did not like.

The main body of the study will be centered on risks that may interrupt your business operations and what kinds of preparations and mitigating actions you take to minimize any down time. The survey is broken into sections by category of risk and their corresponding actions. The following categories are used for the initial surveys.

- Financial Risks and Actions
- Fire Risk and Actions
- Flood Risk and Actions
- Government Risk and Actions
- Health Risk and Actions
- Legal Risk and Actions
- Personnel Risk and Actions
- Product Risk and Actions
- Property Risk and Actions
- Security Risk and Actions
- Supply Chain Risk and Actions
- Technology/Data Risk and Actions
- Terrorism Risk and Actions
- Transportation Risk and Actions
- Utility Risk and Actions
- Weather Risk and Actions

New categories will be added based on the responses we receive to this survey. Once the additions of your categories, risks, and actions are added, we will ask you one more time to rate how well they fit your business.

At that time, we will take those second round responses and apply the mathematics to it in order to create a model of what are the most significant risks and preparations for those risks. When you finish each round of the surveys you will receive a written summary, both textual and in tables, of what types of businesses participated and what the most important risk and mitigation actions are to minimize business interruption. At the end of the study, you will receive a report via the email that you used to consent to the study with the full findings. These findings are important as they can guide you on how to prepare for business interruptions and minimize your losses.

APPENDIX C

SUBJECT CONSENT FORM

This appendix contains the consent form used for permission to participate.

NEW JERSEY INSTITUTE OF TECHNOLOGY
323 MARTIN LUTHER KING BLVD.
NEWARK, NJ 07102

CONSENT TO PARTICIPATE IN A RESEARCH STUDY

TITLE OF STUDY: Collaborative Development of a Small Business Emergency Planning Model.

RESEARCH STUDY:

I,____, have been asked to participate in a research study under the direction of **Drs. Murray Turoff and Starr Roxanne Hiltz**, dissertation supervisors, and Art Hendela, Ph.D. candidate.

Other professional persons who work with them as study staff may assist to act on for them.

PURPOSE:

The purpose of this study is to evaluate the factors used in small business emergency preparedness to create the basis for business continuity/disaster recovery plans as input to a cross impact and interpretive structural model, aid the learning process, and to gain insight to improving the resultant model.

DURATION:

My participation in this study will take place over a nine week period. Every three weeks there will be one survey taking **approximately 1-2 hours for the survey and any discussion. In total, it will take 1-2 hours, including reading directions and answering each of the three questionnaires**.

PROCEDURES:

I have been told that, during the course of this study, the following will occur:

- The subject reads the study introduction before clicking on "Next" button.
- The subject reads the Consent Form.
- The subject needs to indicate his/her consent by signing this consent form.
- The subject fills out a pre questionnaire.
- The subject reads the directions.

- The subject is given the initial set of aggregated emergency preparedness threats for evaluation.
- The subject can suggest new or modified event factors and can also suggest mitigation factors for any of the events. Some obvious mitigation factors will be included..
- At the end of the nine week period, the participants will complete evaluations and fill out the post-surveys.
- The investigator will hold a debriefing session online.

PARTICIPANTS:

I will be one of about **50-80** participants to participate in this study.

EXCLUSIONS:

I will inform the researcher if any of the following apply to me:

All participants must be 18 years old and above**.**

RISKS/DISCOMFORTS:

I have been told that the study described above may involve the following risks and/or discomforts:

As an online participant in this research, there is always the risk of intrusion by outside agents and, therefore the possibility of being identified exists. The experiment is not being run through a secure http connection, so your messages might be visible to experienced attackers.

There also may be risks and discomforts that are not yet known.

I fully recognize that there are risks that I may be exposed to by volunteering in this study which are inherent in participating in any study; I understand that I am not covered by NJIT's insurance policy for any injury or loss I might sustain in the course of participating in the study.

CONFIDENTIALITY:

I understand that "confidential" is not the same as "anonymous." Confidential means that my name will not be disclosed if there exists a documented linkage between my identity and my responses as recorded in the research records. Every effort will be made to maintain the confidentiality of my study records. If the findings from the study are published, I will not be identified by name. My identity will remain confidential unless disclosure is required by law.

PAYMENT FOR PARTICIPATION:

I have been told that I will receive the opportunity to win one of three $50 American Express gift cards as compensation for my participation in this study. The gift cards will be awarded by random drawing of those participants who complete all requirements of the study.

RIGHT TO REFUSE OR WITHDRAW:

I understand that my participation is voluntary and I may refuse to participate, or may discontinue my participation at any time with no adverse consequence. I also understand that the investigator has the right to withdraw me from the study at any time.

INDIVIDUAL TO CONTACT:

If I have any questions about my treatment or research procedures, I understand that I may contact the principal investigator Art Hendela, or his advisor:

Dr. Murray Turoff
Information Systems Department
New Jersey Institute of Technology
Newark, New Jersey 07102
Email: murray.turoff@gmail.com
Telephone: 973-596-3399

If I have any addition questions about my rights as a research subject, I may also contact the chair of the Institutional Review Board:

Norma Rubio, IRB Chair
New Jersey Institute of Technology
323 Martin Luther King Boulevard
Newark, NJ 07102
(973) 596-5825
rubio@njit.edu / irb@njit.edu

SIGNATURE OF PARTICIPANT

I have read this entire form, or it has been read to me, and I understand it completely. All of my questions regarding this form or this study have been answered to my complete satisfaction. I agree to participate in this research study.

Participant Name ______________________________

Signature ______________________________

Date ______________________________

APPENDIX D

PREMODEL SURVEY

This appendix contains the survey used to test the survey instruments.

PROJECT NAME: Collaborative Development of a Small Business Emergency Planning Model.

IDENTIFYING INFORMATION

(Dalkey, 1975) This page will be removed from the questionnaire as soon as we have put identifying codes on the other pages, in order to protect the confidentiality of your responses.

I understand confidential is not the same as anonymous. Confidential means that my name will not be disclosed even if there is a documented linkage between my identity and my responses as recorded in the research records. Every effort will be made to maintain the confidentiality of my study records. If the findings from the study are published, I will not be identified by name. My identity will remain confidential unless disclosure is required by law. After the draft of the final results of the study are completed, participants will have a chance to agree to have their name appear in a list of contributors to the study or to remain anonymous.

This study includes a series of background questions and up to three rounds of a "Delphi" process so that we might uncover risks and actions as they relate to your business.

I fully recognize that there are risks that I may be exposed to by volunteering in this study which are inherent in participating in any study. I understand that I am not covered for any injury or loss I might sustain in the course of participating in this study.

Adding your email to the field below and pressing the Consent and Continue button gives your consent to participate and that you have read and understood the preceding disclaimers and consent to participating in the Risks and Actions Pre-Survey, Risks and Actions Main Survey, and the Risks and Actions Post-Survey.

1. Personal Information

NAME____

ADDRESS____

CITY, STATE, ZIPCODE____

HOME TELEPHONE____

EMAIL ADDRESS ____

As a small to medium business, you face many threats that can interrupt your business operations and cause you to lose money or in the worst case lose your business. The set of surveys that you are completing deal with your opinions as to the threats you face and the actions you take or have taken to lessen the threat and restore your business operations. The threats that may cause interruption are called RISKS. The preparations and the things that you do to lessen your chance of an interruption and restore your business operations are called ACTIONS. The list of risks and actions that you will see in the surveys fall into the following categories:

- Financial Risks and Actions
- Fire Risk and Actions
- Flood Risk and Actions
- Government Risk and Actions
- Health Risk and Actions
- Legal Risk and Actions
- Personnel Risk and Actions
- Product Risk and Actions
- Property Risk and Actions
- Security Risk and Actions
- Supply Chain Risk and Actions
- Technology/Data Risk and Actions
- Terrorism Risk and Actions

- Transportation Risk and Actions
- Utility Risk and Actions
- Weather Risk and Actions

One example of a risk and an action is a fire on your premises. This risk will interrupt your business as records and other equipment are replaced. Actions that you might take in advance of a fire range from 1) buying fire insurance to 2) buying a fire extinguisher.

Different businesses have different levels of risks and different levels of actions that are needed to restore operations. As you complete these surveys we want you to think about the risks and actions that apply to your business.

Once we have your input, a process that includes experts in business continuity and disaster recovery will be able to take these inputs and develop a model that can be used as a basis for a business continuity plan, a disaster recovery plan, and a set of actions to take to prepare and prevent business interruptions.

SOME BACKGROUND INFORMATION

If you feel that any of these items invade your privacy, you are of course free to decline to answer them.

How important is each of the following reasons for your participating in this study? Choose either Not Important, Somewhat Important, or Very Important.

2. Interest Level

		Not Important		Somewhat Important			Very Important	
	I have a professional or job-related interest in the topic.	1	2	3	4	5	6	7
	I have a general interest in the area.	1	2	3	4	5	6	7
	The reputation of the developer/research team.	1	2	3	4	5	6	7
	I was curious about how the modeling method worked.	1	2	3	4	5	6	7
	More convenient than traditional planning methods.	1	2	3	4	5	6	7

3. Survey Difficulty

		Difficult					Easy	
	How easy or difficult do you expect this process to be?	1	2	3	4	5	6	7

4.	What is your gender?	• Male • Female	
5.	Ethnic/Racial Background	• Black/African-American • Hispanic (Mexican, Puerto-Rican, etc.) • Native American • Asian or Asian-American • White • Other	
6.	Background Information		
	Your age	___	
	Major/Profession	______	
	Nationality	______	
7.	Is English your native or first language?	• Yes • No	
8.	Highest Education completed	• Graduated High School • Some College • Associate's Degree • Bachelor's Degree • Master's Degree • Doctoral Degree • Post-doctoral studies	
9.	Business Background Information		
	How many years have you worked at your current business?	(Enter number)	
	What is your job title?		
	What business are you in?		
10.	What is your responsibility for Business Continuity/Disaster Recovery	• Business owner • Business worker • Planner • Emergency worker • Government worker • Other ________________	

Expectations about RISKS and ACTIONS

11.	Hard to Learn	1 2 3 4 5 6 7	Easy to Learn
12.	Frustrating	1 2 3 4 5 6 7	Not Frustrating
13.	Unproductive	1 2 3 4 5 6 7	Productive

14.	Do you expect that the threat or mitigation factors will be a comprehensive list?	Definitely not Unsure Definitely yes						
		1	2	3	4	5	6	7
	Do you expect that use of the factors will increase the quality of your planning?	Definitely not Unsure Definitely yes						
		1	2	3	4	5	6	7
	I resent being required to evaluate factors for use in the model.	Definitely not Unsure Definitely yes						
		1	2	3	4	5	6	7
15.	Overall, how complete do you expect the model to be?	Not Useful at All Very Useful						
		1	2	3	4	5	6	7

16.	How much time do you foresee yourself evaluating the risks and actions?	• Less than 30 minutes • 30 minutes to 1 hour • 1-3 hours • 4-6 hours • 7-9 hours • Ten hours or more	

For each of the following, please select a response that corresponds to the following scale:
SD = Strongly Disagree
D = Disagree
N = Neither Agree nor Disagree (Neutral)
A = Agree
SA = Strongly Agree

17.	Understanding the risks and actions							
	I understand how the risks and actions work	SD			Neutral			SA
		1	2	3	4	5	6	7
	I understand the differences between risks and actions	SD			Neutral			SA
		1	2	3	4	5	6	7

FOR THE PILOT STUDY ONLY:

18.	Did you find any of the questions on this survey confusing? If so which ones?	
19.	Please describe any problems that you had with completing the survey.	

Thank you very much for completing my survey!!!

APPENDIX E

POSTMODEL SURVEY

This appendix shows the survey given to participants following the calculation of all results.

PROJECT NAME: Collaborative Development of a Small Business Emergency Planning Model.

Thank you for your participation in this research study. Your input is appreciated not only by the research team but also by those businesses that benefit from its results.

This final survey gathers your thoughts about the process so that future research can be improved. Filling out the survey should take no more than 30 minutes.

1.	Please enter your email	
2.	About how much TOTAL time have you spent each week on this project including reading and writing, on and offline?	• Less than one hour • 1-2 hours • 3-4 hours • 5-9 hours • Ten hours or more

3. How easy or difficult was this process for you?			
	Easy	1 2 3 4 5 6 7	Difficult

No.	Item	Response
4.	I evaluated these risks and actions as a	• Business owner • Business worker • Planner • Emergency worker • Government worker • Other ________________

PART B 1. EXPERT JUDGMENT

Please answer the following questions if you participated as an emergency worker. If you participated as a planner, please proceed to Section B 2.

For each of the following, please select a response that corresponds to the following scale:
SD = Strongly Disagree
D = Disagree
N = Neither Agree nor Disagree (Neutral)
A = Agree
SA = Strongly Agree

No.	Item	Response
5.	The list of risk categories is complete.	SD Neutral SA
		1 | 2 | 3 | 4 | 5 | 6 | 7
6.	I would add the following risk categories to the list.	
7.	The wording of risk categories is clear.	SD Neutral SA
		1 | 2 | 3 | 4 | 5 | 6 | 7
8.	I would revise the wording of the following risk categories.	
9.	The list of risks is complete.	SD Neutral SA
		1 | 2 | 3 | 4 | 5 | 6 | 7
10.	I would add these risks to the list.	
11.	Why do you add these?	
12.	I would delete the following risks from the list.	
13.	Why would you delete these?	
14.	Questions about Actions and Preparations	
	The list of actions is complete.	SD Neutral SA
		1 2 3 4 5 6 7

No.	Item	Response
15.	I would add these actions to the list.	
16.	Why do you add these?	
17.	I would delete the following actions from the list.	
18.	Why would you delete these?	
19.	What did you like about the process?	
20.	What did you not like about the process?	
21.	What else would help you learn the underlying model concepts?	

PART B 2. PLANNER

Please answer the following questions if you are participating as a planner. If you are an emergency worker, please ignore this section.

For each of the following, please select a response that corresponds to the following scale:
SD = Strongly Disagree
D = Disagree
N = Neither Agree nor Disagree (Neutral)
A = Agree
SA = Strongly Agree

No.	Item	Response
22.	The instructions for the Delphi were clear	SD Neutral SA
		1 | 2 | 3 | 4 | 5 | 6 | 7
23.	I would clarify the following parts of the instructions.	
24.	The list of risks is complete	SD Neutral SA
		1 | 2 | 3 | 4 | 5 | 6 | 7
25.	I understand how risks can influence each other	SD Neutral SA
		1 | 2 | 3 | 4 | 5 | 6 | 7
26.	I understand the differences between risks	SD Neutral SA
		1 | 2 | 3 | 4 | 5 | 6 | 7
27.	I would delete the following risks.	
28.	Why would you delete these?	
29.	The list of actions was complete	SD Neutral SA
		1 2 3 4 5 6 7
30.	I would delete the following actions from the list.	
31.	Why would you delete these?	
32.	What else would help you	

No.	Item	Response
	learn to create a plan?	
33.	Response time from the Administrator met my expectations	SD Neutral SA
		1 | 2 | 3 | 4 | 5 | 6 | 7
34.	How would you improve the process?	

FOR THE PILOT STUDY ONLY:

35.	Did you find any of the questions on this survey confusing? If so which ones?	
36.	Please describe any problems that you had with completing the survey.	

Thank you very much.

APPENDIX F

DELPHI ROUND 1 CONSENT FORM

This appendix shows the consent form used for the round 1 Delphi survey.

NEW JERSEY INSTITUTE OF TECHNOLOGY
323 MARTIN LUTHER KING BLVD.
NEWARK, NJ 07102

CONSENT TO PARTICIPATE IN A RESEARCH STUDY

TITLE OF STUDY: Collaborative Development of a Small Business Emergency Planning Model.

RESEARCH STUDY:

I,____, have been asked to participate in a research study under the direction of **Drs. Murray Turoff and Starr Roxanne Hiltz**.

Other professional persons who work with them as study staff may assist to act on for them.

PURPOSE:

The purpose of this study is to supplement a list of event factors and mitigating actions that can cause business interruptions and lessen their effect. Each participant will give subjective probabilities of how important an event and mitigating factor is to their business. The participants will add or delete events and actions that are not pertinent to their business.

DURATION:

My participation in this study will last for 2-4 weeks **approximately 1-2 hours for the completion of the surveys, including being informed by the investigator about how the survey works, taking the surveys, and answering the followup questions.**

PROCEDURES:

I have been told that, during the course of this study, the following will occur:

- The subject reads the study introduction.
- The subject reads the Consent Form.
- The subject signs the Consent Form.
- The subject is given the list of tasks on which to work.

- The subject finishes all the tasks.
- The subject completes the post evaluation survey.

PARTICIPANTS:

I will be one of about __**50-80**__ participants to participate in this study.

EXCLUSIONS:

- I will inform the researcher if any of the following apply to me:
- All participants must be 18 years old and above**.**

RISKS/DISCOMFORTS:

- I have been told that the study described above may involve the following risks and/or discomforts:
- **As an online participant in this research, there is always the risk of intrusion by outside agents and, therefore the possibility of being identified exists. The experiment is not being run through a secure http connection, so your messages might be visible to experienced attackers.**
- There also may be risks and discomforts that are not yet known.
- I fully recognize that there are risks that I may be exposed to by volunteering in this study which are inherent in participating in any study; I understand that I am not covered by or NJIT's insurance policy for any injury or loss I might sustain in the course of participating in the study.

CONFIDENTIALITY:

I understand that "confidential" is not the same as "anonymous." Confidential means that my name will not be disclosed if there exists a documented linkage between my identity and my responses as recorded in the research records. Every effort will be made to maintain the confidentiality of my study records. If the findings from the study are published, I will not be identified by name. My identity will remain confidential unless disclosure is required by law.

PAYMENT FOR PARTICIPATION:

I have been told that I will receive the opportunity to win of three $50 American Express gift cards as compensation for my participation in this study. The gift cards will be awarded by random drawing of those participants who complete all requirements of the study.

RIGHT TO REFUSE OR WITHDRAW:

- I understand that my participation is voluntary and I may refuse to participate, or may discontinue my participation at any time with no adverse consequence. I also understand that the investigator has the right to withdraw me from the study at any time.

INDIVIDUAL TO CONTACT:

If I have any questions about my treatment or research procedures, I understand that I should contact the principal investigator at:

Dr. Murray Turoff
Information Systems Department
New Jersey Institute of Technology
Newark, New Jersey 07102
Email: murray.turoff@gmail.com
Telephone: 973-596-3399

If I have any addition questions about my rights as a research subject, I may contact:

Norma Rubio, IRB Chair
New Jersey Institute of Technology
323 Martin Luther King Boulevard
Newark, NJ 07102
(973) 596-5825
rubio@njit.edu / irb@njit.edu

SIGNATURE OF PARTICIPANT

I have read this entire form, or it has been read to me, and I understand it completely. All of my questions regarding this form or this study have been answered to my complete satisfaction. I agree to participate in this research study.

Participant Name ________________________________

Signature ________________________________

Date ________________________________

APPENDIX G

DELPHI ROUND 1 TASKS AND SURVEY QUESTIONS

This appendix shows the tasks and questions used for the round 1 Delphi survey.

Tasks

Welcome and thank you for taking the time to participate in a Delphi study to create the basis for better business continuity and disaster recovery plans. This study asks for your opinions regarding the importance of various events in disrupting your business. We will also ask your opinion and how important various mitigating actions can be to guard against such disruptions. The final output of these surveys is a model of the most important risks to prepare against.

Participation in this round should take between 30 and 60 minutes and is strictly confidential. You will be asked to answer a series of questions in two or three survey rounds. In no case will responses from individual responses be identified unless consent is explicitly granted to do so. Additionally findings from this study will be published in aggregate form.

You will be then be given a base list of risks that could interrupt your business and a list of actions that might mitigate or lessen the interruption. Read over each list and rate how important they are to your business. Think in terms of an event that might interrupt your business or an action that you might likely take to prevent or lessen an event from happening. For example, a threat event such as “Fires underway” might be very serious if you are in a wood structure and not as serious if you are in a cinderblock building. On the list of mitigating actions, you might consider “Add fire suppression system” very important if you are in a wooden structure or a high rise, but not as important if you are in a one story cinderblock building. There is no right or wrong answer.

Once you have assigned values to the lists of items provided, the next part is the opportunity to add items to the lists. Add any risk and mitigating action that you feel should be on the list with a brief reason as to why it should be there. You are then asked which risks and mitigation actions should be removed and your reasons for the removal.

The creation of the event list, the probability of those events, and their mitigating factors will be used in a second round study where an expert panel will determine how each of the top risks interrelates with the others.

As a small to medium business, you face many threats that can interrupt your business operations and cause you to lose money, or, in the worst case, lose your business. The set of surveys that you are completing deal with your opinions as to the threats you face and the actions you take or have taken to lessen the threat and restore your business operations. The threats that may cause interruption are called RISKS. The preparations and the things that you do to lessen your chance of an interruption and restore your business operations are called mitigating ACTIONS.

Different businesses have different levels of risks and different levels of actions that are needed to restore operations. As you complete these surveys we want you to think about the risks and actions that apply to your business.

Once we have your input, a process that includes experts in business continuity and disaster recovery will be able to take these inputs and develop a model that can be used as a basis for a business continuity plan, a disaster recovery plan, and a set of actions to take to prepare and prevent business interruptions.

Please ensure that you mark all factors

Table G.1 Risk and Action Survey Task List – Round 1

No.	Task
1.	Open up your web browser. It does not matter which one you use.
2.	Type the web address for the survey in the address bar. https://www.surveymonkey.com/s/RisksAndActions
3.	Choose the category of your business from the list provided. Example business categories are: • Advertising & Media • Arts, Culture & Entertainment • Automotive, Aviation & Marine • Business & Professional Services • Communications • Computers, IT & Technology You may only pick one or enter one in the space provided if none of the items matches your business.
4.	After clicking Next you will read the following: For each of the following pages you will see a risk category as you saw in the preliminary instructions. For each category you will see a list of potential risks that fit that category. For each of the risks in the list, think about how it might affect or not affect the running of your business and then make a choice on the scale. If the risk is something that you think about all of the time and you might lose sleep over it, you might choose "Critically Important." If the risk is nothing that you ever think about interrupting your business like a flood on the top of a mountain, then perhaps you would choose "Not Important." If the risk doesn't apply to you, then choose "No judgment." You are evaluating the risks in terms of which ones are important to **you and/or your business.** Thank you for your help. Click Next.
5.	When the main entries of the survey appears, please look at the list of risks and the list of mitigating actions. For each risk and mitigation action, mark a value for its importance for your business. Your answers will go into creating a

<table>
<tr><th>No.</th><th>Task</th></tr>
<tr><td></td><td>ranking value to determine the most important events and actions for the next step. The follow-up study will look consolidate the answers from this round and ask for your input again.</td></tr>
<tr><td>6.</td><td>Next to each item, please choose one of the following ranks.

CI=Critically Important
VI=Very Important
SI=Somewhat Important
MI=Minor Importance
NI=No importance
NJ=No judgment

<table>
<tr><th>No</th><th>Event</th><th>Response</th></tr>
<tr><td>3.</td><td>Financial Risk</td><td></td></tr>
<tr><td></td><td>Bank loan denied</td><td>CI | VI | SI | MI | NI | NJ</td></tr>
<tr><td></td><td>Becoming dependent on too few customers</td><td>CI | VI | SI | MI | NI | NJ</td></tr>
<tr><td></td><td>Building insurance lapsed</td><td>CI | VI | SI | MI | NI | NJ</td></tr>
<tr><td></td><td>Business continuity plan non-existent</td><td>CI | VI | SI | MI | NI | NJ</td></tr>
</table>

A full listing of all of the risks and preparations follows this table.</td></tr>
<tr><td>7.</td><td>Repeat Step 6 for all risks and actions.</td></tr>
<tr><td>8.</td><td>After assigning importance values to each item, please add any risk or mitigating action that you believe is missing. Add your reason for doing so. If you have no additions, please go on to step 9.</td></tr>
<tr><td>9.</td><td>Please complete the post evaluation survey when asked.</td></tr>
</table>

Next to each factor, please choose one of the following ranks.

CI=Critically Important
VI=Very Important
SI=Somewhat Important
MI=Minor Importance
NI=No importance
NJ=No judgment

	Business Category	
	Advertising & Media	
	Advertising	
	Home Health Care Services	
	Media	
	Signs & Displays	
	Arts, Culture & Entertainment	
	Entertainment	
	Automotive, Aviation & Marine	
	Airlines/Aviation/Airports/ Aircraft	
	Auto & Truck	
	Sales/Service/Leasing/ Parts	
	Towing/Repair Services	
	Business & Professional Services	
	Accountants & Accounting Services	
	Risk Management	
	Attorneys	
	Business Services	
	Consultants	
	Communications	
	Marketing Services/ Communications/Internet	
	Marketing	
	Telecommunications	
	Computers, IT & Technology	
	Computer Hardware/Software/ Equipment	

	Computer Networking & Consulting	
	Computer Services/Equipment	
	Website Design & Hosting	
	Employment & Staffing	
	Coaching - Business/Career/ Executive	
	Employment Services/Agency/Staffing	
	Family, Community & Non-Profit	
	Child Care	
	Non-Profit Organizations/ Associations	
	Finance & Insurance	
	Banks/Credit Unions	
	Financial Services	
	Insurance & Investment Services	
	Risk Management Consulting	
	Government & Education	
	Education/Schools/Colleges /Universities	
	Government Advocacy & Communications	
	Government Agencies	
	Libraries	
	Health Care	
	Hospitality Management	
	Hospitals/Healthcare Services	
	Medical Information	
	Physicians/Medical Services/Wellness/ Therapy	
	Home & Garden	
	Landscapers	
	Pest Control Services	
	Plumbing Services	
	Industrial & Manufacturing	
	Fire Equipment/Safety	
	Manufacturers	

	Rental Equipment & Services	
	Vending Machines	
	<u>Lodging, Travel & Tourism</u>	
	Hotels/Motels/Extended Stay	
	Transportation & Services	
	Travel Services	
	<u>Personal Services & Care</u>	
	Fitness Facility	
	Funeral Home	
	Spa Services	
	<u>Pets & Veterinary</u>	
	Animal Services	
	Pet Services	
	<u>Public Utilities & Environment</u>	
	Electrical Services/Products	
	Energy Services	
	Environmental Consulting	
	Utilities	
	<u>Real Estate & Construction</u>	
	Construction Services/Contracting/Home	
	Improvement/Equipment	
	Real Estate Developers/Realtors/ Brokers	
	Real Estate Services	
	Realtors/Brokers - Commercial	
	<u>Restaurants, Food & Beverages</u>	
	Bakeries	
	Caterers & Banquet Services	
	Food Products/Distributors/ Services/Equipment	
	Restaurants/Delis/Cafes	
	<u>Shopping & Specialty Retail</u>	

	Office Supplies/Stationers/ Furniture/Equipment	
	Promotional Items & Corporate Gifts	
	Retail - Other	
	Shopping	
	Sports & Recreation	
	Other	
	Event Planning & Management	
	Import/Export	
	Public Relations/Public Affairs	
	Renewable Energy	
2.	I am in this line of business that was not listed above	
No.	**Event**	**Response**
3.	**Financial Risk**	
	Bank loan denied	CI VI SI MI NI NJ
	Becoming dependent on too few customers	CI VI SI MI NI NJ
	Building insurance lapsed	CI VI SI MI NI NJ
	Business continuity plan non-existent	CI VI SI MI NI NJ
	Business continuity plan not tested	CI VI SI MI NI NJ
	Business reputation tarnished	CI VI SI MI NI NJ
	Cash liquidity constrained	CI VI SI MI NI NJ
	Competitors flood market with similar products	CI VI SI MI NI NJ
	Currency fluctuations affect pricing	CI VI SI MI NI NJ
	Customers constrain cash flow with non-payment/stretched payments	CI VI SI MI NI NJ

	Demand for product weakens	CI VI SI MI NI NJ
	Directors Insurance inadequate	CI VI SI MI NI NJ
	Errors and Omissions Insurance inadequate	CI VI SI MI NI NJ
	Federal tax audit	CI VI SI MI NI NJ
	Inaccurate market intelligence	CI VI SI MI NI NJ
	Insufficient insurance	CI VI SI MI NI NJ
	Intellectual property stolen	CI VI SI MI NI NJ
	Lack of new product development	CI VI SI MI NI NJ
	Lack of succession planning	CI VI SI MI NI NJ
	Loss of learning accreditation	CI VI SI MI NI NJ
	Lowering of financial rating/credit score	CI VI SI MI NI NJ
	Money stolen due to inadequate financial controls	CI VI SI MI NI NJ
	Not paying required payroll taxes	CI VI SI MI NI NJ
	Product launch delays	CI VI SI MI NI NJ
	State tax audit	CI VI SI MI NI NJ
	Stock market plunges	CI VI SI MI NI NJ

4.	Please add any additional financial risks that should be included in this list	
5.	**Fire Risk**	
	Building not passing fire inspection	CI | VI | SI | MI | NI | NJ
	Facility explosion	CI | VI | SI | MI | NI | NJ
	Fires underway	CI | VI | SI | MI | NI | NJ
6.	Please add any additional fire risks that should be included in this list	
7.	**Flood Risk**	
	Burst Pipes	CI | VI | SI | MI | NI | NJ
	Flood in area	CI | VI | SI | MI | NI | NJ
	Mudslide blocks building access	CI | VI | SI | MI | NI | NJ
	Local water levels rise	CI | VI | SI | MI | NI | NJ
	Extra high tide surges due to weather	CI | VI | SI | MI | NI | NJ
	Basement becomes flooded	CI | VI | SI | MI | NI | NJ
	First floor becomes flooded	CI | VI | SI | MI | NI | NJ
	Second floor becomes flooded	CI | VI | SI | MI | NI | NJ

8.	Please add any additional flood risks that should be included in this list	
9.	**Government Risk**	
	Additional costs due to new regulations	CI | VI | SI | MI | NI | NJ
	Breach of HIPAA compliant data	CI | VI | SI | MI | NI | NJ
	Community help limited	CI | VI | SI | MI | NI | NJ
	Government overthrown	CI | VI | SI | MI | NI | NJ
	Government shutdown	CI | VI | SI | MI | NI | NJ
	Hyper increase in benefit costs	CI | VI | SI | MI | NI | NJ
	Local government not functioning	CI | VI | SI | MI | NI | NJ
10.	Please add any additional government risks that should be included in this list	
11.	**Health Risk**	
	Chemical release in area	CI | VI | SI | MI | NI | NJ
	Dangerous materials on premises	CI | VI | SI | MI | NI | NJ
	Hazardous materials leaking	CI | VI | SI | MI | NI | NJ
	Lack of response to safety issue	CI | VI | SI | MI | NI | NJ

	No medical services	CI | VI | SI | MI | NI | NJ
	Workforce unavailable due to epidemic	CI | VI | SI | MI | NI | NJ
12.	Please add any additional health risks that should be included in this list	
13.	**Legal Risk**	
	Computer based email lost during legal discovery	CI | VI | SI | MI | NI | NJ
	Copyright infringement	CI | VI | SI | MI | NI | NJ
	Credit Card processing is not PCI compliant	CI | VI | SI | MI | NI | NJ
	Falsifying qualification and certifications to perform work	CI | VI | SI | MI | NI | NJ
	Lawsuit – discrimination	CI | VI | SI | MI | NI | NJ
	Lawsuit – intellectual property rights	CI | VI | SI | MI | NI | NJ
	Lawsuit – product liability	CI | VI | SI | MI | NI | NJ
	Lawsuit – sexual harassment	CI | VI | SI | MI | NI | NJ
	Lawsuit – vicarious liability from employee behavior	CI | VI | SI | MI | NI | NJ
	Patent infringement	CI | VI | SI | MI | NI | NJ
	Publishing false product claims	CI | VI | SI | MI | NI | NJ
	Trademark infringement	CI | VI | SI | MI | NI | NJ
	Use of pirated software for key purposes	CI | VI | SI | MI | NI | NJ

	Violation of export control restrictions	CI | VI | SI | MI | NI | NJ
	Violent crime committed by employee during work hours	CI | VI | SI | MI | NI | NJ
	Working without proper government permits	CI | VI | SI | MI | NI | NJ
14.	Please add any additional legal risks that should be included in this list	
15.	**Personnel Risk**	
	Personnel not available during an emergency	CI | VI | SI | MI | NI | NJ
	Death of key officer	CI | VI | SI | MI | NI | NJ
	Key personnel contact list non-existent	CI | VI | SI | MI | NI | NJ
	Key personnel in plane crash	CI | VI | SI | MI | NI | NJ
	Key personnel kidnapped	CI | VI | SI | MI | NI | NJ
	Key personnel not available during crisis	CI | VI | SI | MI | NI | NJ
	Key personnel quits	CI | VI | SI | MI | NI | NJ
	Promotion of ineffective employees to key positions	CI | VI | SI | MI | NI | NJ
	Top talent refuses to work for you	CI | VI | SI | MI | NI | NJ
	Union Grievance process too long	CI | VI | SI | MI | NI | NJ
	Workforce unavailable due to strike	CI | VI | SI | MI | NI | NJ

16.	Please add any additional personnel risks that should be included in this list	
17.	**Product Risk**	
	Formulation details destroyed	CI VI SI MI NI NJ
	Outsourcing creates non-competitive pricing environment	CI VI SI MI NI NJ
	Process machinery breakdown	CI VI SI MI NI NJ
	Product in transport destroyed	CI VI SI MI NI NJ
	Validated manufacturing environment spoiled	CI VI SI MI NI NJ
	Vital records not secured	CI VI SI MI NI NJ
	Product requires refrigeration	CI VI SI MI NI NJ
	Product requires constant electricity	CI VI SI MI NI NJ
	Product requires other temperature control	CI VI SI MI NI NJ
18.	Please add any additional product risks that should be included in this list	
19.	**Property Risk**	
	Access to facility forbidden	CI VI SI MI NI NJ
	Alternate location not available	CI VI SI MI NI NJ

	Crime rate increase near place of business	CI | VI | SI | MI | NI | NJ
	Downed trees block building access	CI | VI | SI | MI | NI | NJ
	Earthquake in area	CI | VI | SI | MI | NI | NJ
	Emergency responders lacking	CI | VI | SI | MI | NI | NJ
	Employee theft	CI | VI | SI | MI | NI | NJ
	Alarm system not working	CI | VI | SI | MI | NI | NJ
	Windows unprotected from being broken	CI | VI | SI | MI | NI | NJ
	Valuable items on premises	CI | VI | SI | MI | NI | NJ
20.	Please add any additional property risks that should be included in this list	
21.	**Security Risk**	
	Lack of intrusion detection	CI | VI | SI | MI | NI | NJ
	Production equipment sabotaged	CI | VI | SI | MI | NI | NJ
	Violent crime committed on premises	CI | VI | SI | MI | NI | NJ
	Windows unprotected from intrusion	CI | VI | SI | MI | NI | NJ
22.	Please add any additional security risks that should be included in this list	

23.	**Supply Chain Risk**	
	Key supplier goes out of business	CI | VI | SI | MI | NI | NJ
	Lack of spare parts	CI | VI | SI | MI | NI | NJ
	Not having alternate supply sources for raw materials	CI | VI | SI | MI | NI | NJ
	Priority service contracts not established to repair equipment	CI | VI | SI | MI | NI | NJ
	Private stores not available	CI | VI | SI | MI | NI | NJ
	Raw materials contaminated	CI | VI | SI | MI | NI | NJ
	Strategic Partner goes out of business	CI | VI | SI | MI | NI | NJ
24.	Please add any additional supply chain risks that should be included in this list	
25.	**Technology/Data Risk**	
	Cell phone stolen	CI | VI | SI | MI | NI | NJ
	Computer data lost	CI | VI | SI | MI | NI | NJ
	Computer hardware fails	CI | VI | SI | MI | NI | NJ
	Computer operating system no longer supported	CI | VI | SI | MI | NI | NJ

	Computer server not fully backed up	CI | VI | SI | MI | NI | NJ
	Computer stored credit card information stolen	CI | VI | SI | MI | NI | NJ
	Computer virus attacks network	CI | VI | SI | MI | NI | NJ
	Computer/laptop stolen	CI | VI | SI | MI | NI | NJ
	Cyber-attack on computer infrastructure	CI | VI | SI | MI | NI | NJ
	Insufficient software licenses for temporary location	CI | VI | SI | MI | NI | NJ
	Internet connectivity lost	CI | VI | SI | MI | NI | NJ
	Internet provider failure	CI | VI | SI | MI | NI | NJ
	Large scale data breach	CI | VI | SI | MI | NI | NJ
	Malware embedded in software	CI | VI | SI | MI | NI | NJ
	No communication networks	CI | VI | SI | MI | NI | NJ
	Server Administrator passwords lost	CI | VI | SI | MI | NI | NJ
	Software no longer runs on new computers	CI | VI | SI | MI | NI | NJ
	Source code not available for recompiling	CI | VI | SI | MI | NI | NJ
	Virus protection out of date	CI | VI | SI | MI | NI | NJ
26.	Please add any additional technology/data risks that should be included in this list	CI | VI | SI | MI | NI | NJ
27.	**Terrorism Risk**	

	Bomb threat issued	CI | VI | SI | MI | NI | NJ
	Civil unrest near place of business	CI | VI | SI | MI | NI | NJ
	Terrorist attack in area	CI | VI | SI | MI | NI | NJ
28.	Please add any additional terrorism risks that should be included in this list	
29.	**Transportation Risk**	
	Buses unavailable	CI | VI | SI | MI | NI | NJ
	Trains unavailable	CI | VI | SI | MI | NI | NJ
	Airports not open	CI | VI | SI | MI | NI | NJ
	Seaports not open	CI | VI | SI | MI | NI | NJ
	Roads filled with debris	CI | VI | SI | MI | NI | NJ
	Roads clogged with traffic	CI | VI | SI | MI | NI | NJ
	Roads flooded	CI | VI | SI | MI | NI | NJ
30.	Please add any additional transportation risks that should be included in this list	
31.	**Utility Risk**	

	Backup power supply not available	CI | VI | SI | MI | NI | NJ
	Electricity cut off	CI | VI | SI | MI | NI | NJ
	Gasoline in short supply	CI | VI | SI | MI | NI | NJ
	Natural gas supply unusable	CI | VI | SI | MI | NI | NJ
	Sewage treatment unavailable	CI | VI | SI | MI | NI | NJ
	Telephones out of service	CI | VI | SI | MI | NI | NJ
	Water supply undrinkable	CI | VI | SI | MI | NI | NJ
32.	Please add any additional utility risks that should be included in this list	
33.	**Weather Risk**	
	Electrical storm in area	CI | VI | SI | MI | NI | NJ
	Hurricane in area	CI | VI | SI | MI | NI | NJ
	Severe drought in area	CI | VI | SI | MI | NI | NJ
	Tornado in area	CI | VI | SI | MI | NI | NJ
34.	Please add any additional weather risks that should be included in this list	

Next to each item, please choose one of the following ranks.

MB=Applies to my business
OB=Applies only to other businesses
NJ=No judgment

35.	**Financial Preparations**	
	Add alternate revenue sources	MB OB NJ
	Broaden customer base	MB OB NJ
	Create business continuity plan	MB OB NJ
	Create continuous audit system	MB OB NJ
	Create succession plan	MB OB NJ
	File taxes on time	MB OB NJ
	Find alternate insurance	MB OB NJ
	Improve insurance renewal procedures	MB OB NJ
	Increase insurance coverage	MB OB NJ
	Lower expenses	MB OB NJ
	Negotiate better payment terms	MB OB NJ
	Pay required taxes	MB OB NJ
	Place stop loss stock orders	MB OB NJ
	Self-finance operation	MB OB NJ
	Strengthen cash flow/lessen debt	MB OB NJ
	Value product in strong currency	MB OB NJ

36.	Please add any additional financial preparations that should be included in this list	
37.	**Fire Preparations**	
	Add sprinkler system	MB OB NJ
	Buy fire extinguishers	MB OB NJ
	Buy smoke alarms	MB OB NJ
	Create building evacuation plan	MB OB NJ
	Improve fireproofing	MB OB NJ
	Schedule a fire protection audit	MB OB NJ
38.	Please add any additional fire preparations that should be included in this list	
39.	**Flood Preparations**	
	Build containment walls	MB OB NJ
	Raise building above ground level	MB OB NJ
	Add building flood walls around property	MB OB NJ
	Fortify flood levies	MB OB NJ
	Raise electrical equipment above flood stage	MB OB NJ

	Raise product inventory above flood stage	MB | OB | NJ
40.	Please add any additional flood preparations that should be included in this list	
41.	**Government Preparations**	
	Lobby government for lesser regulations	MB | OB | NJ
	Buy out vulnerable properties	MB | OB | NJ
	Increase safety of building codes	MB | OB | NJ
42.	Please add any additional government preparations that should be included in this list	
43.	**Health Preparations**	
	Add filtration facility	MB | OB | NJ
	Create emergency first aid pack	MB | OB | NJ
	Inoculate employees against infection	MB | OB | NJ
	Move employees to safe area	MB | OB | NJ
44.	Please add any additional health preparations that should be included in this list	

45.	**Legal Preparations**	
	Buy legitimate licenses	MB OB NJ
	Create notification for customers to cancel credit cards	MB OB NJ
	Draft cease/desist letter	MB OB NJ
	Hire public relations firm	MB OB NJ
	Maintain export compliance	MB OB NJ
	Report to government officials	MB OB NJ
	Take legal action	MB OB NJ
	Take PCI compliance audit	MB OB NJ
46.	Please add any additional legal preparations that should be included in this list	
47.	**Personnel Preparations**	
	Change management team	MB OB NJ
	Create contact list	MB OB NJ
	Create union/management team building	MB OB NJ
	Improve union relations.	MB OB NJ
	Increase offer to make company attractive	MB OB NJ
	Recruit new manager	MB OB NJ

	Use replacement personnel	MB / OB / NJ
48.	Please add any additional personnel preparations that should be included in this list	
49.	Add preventive maintenance program	MB / OB / NJ
	Brainstorm new products	MB / OB / NJ
	Buy non-electrical dehumidification equipment	MB / OB / NJ
	Buy reputable equipment	MB / OB / NJ
	Create new products with proprietary technology	MB / OB / NJ
	Hire new market research firm	MB / OB / NJ
	Innovate new products	MB / OB / NJ
	Limit customer order quantities	MB / OB / NJ
	Move operations to secondary site	MB / OB / NJ
	Prepare food offsite	MB / OB / NJ
	Provide own inspectors	MB / OB / NJ
	Provide strong certification process	MB / OB / NJ
	Revalidate equipment	MB / OB / NJ
	Revise marketing materials.	MB / OB / NJ
	Spread production over larger geographic area	MB / OB / NJ

	Store vital documentation	MB | OB | NJ
	Test business continuity plan	MB | OB | NJ
	Use manual procedures	MB | OB | NJ
50.	Please add any additional product preparations that should be included in this list	
51.	**Property Preparations**	MB | OB | NJ
	Coordinate volunteer group	MB | OB | NJ
	Create community response	MB | OB | NJ
	Fortify building structure	MB | OB | NJ
	Hire heavy equipment for removal	MB | OB | NJ
	Obtain proper permits	MB | OB | NJ
	Plan alternate building access	MB | OB | NJ
	Renovate building to new code	MB | OB | NJ
52.	Please add any additional property preparations that should be included in this list	
53.	**Security Preparations**	
	Add access security system	MB | OB | NJ

	Add check-in Check out property procedures.	MB | OB | NJ
	Add metal bars to windows	MB | OB | NJ
	Add security cameras	MB | OB | NJ
	Improve security protection	MB | OB | NJ
	Seal windows and doors	MB | OB | NJ
54.	Please add any additional security preparations that should be included in this list	
55.	**Supply Chain Preparations**	
	Add alternate contractors	MB | OB | NJ
	Create alternate supply chain	MB | OB | NJ
	Find alternate partner	MB | OB | NJ
	Identify alternate suppliers	MB | OB | NJ
	Increase spare part inventory	MB | OB | NJ
	Reorder new raw materials	MB | OB | NJ
56.	Please add any additional supply chain preparations that should be included in this list	
57.	**Technology/Data Preparations**	

	Add adequate surge protection	MB | OB | NJ
	Add software firewall	MB | OB | NJ
	Add multi-tiered backup strategy	MB | OB | NJ
	Add offsite backup	MB | OB | NJ
	Add real time backup software	MB | OB | NJ
	Add remote destruction of data	MB | OB | NJ
	Add virus protection	MB | OB | NJ
	Buy password cracking software	MB | OB | NJ
	Create backups for emergency procedure execution	MB | OB | NJ
	Create data deletion plan	MB | OB | NJ
	Create hot site alternate location	MB | OB | NJ
	Create hot spares	MB | OB | NJ
	Disassemble and rewrite source code	MB | OB | NJ
	Encrypt/password protect hard drive	MB | OB | NJ
	Improve backup procedures	MB | OB | NJ
	Increase number of software licenses	MB | OB | NJ
	Install hardware firewall	MB | OB | NJ
	Rebuild data from source documentation	MB | OB | NJ
	Rebuild formulation	MB | OB | NJ

	Update operating system during upgrade grace period	MB | OB | NJ
	Update virus protection	MB | OB | NJ
	Upgrade hardware and run old software under emulation.	MB | OB | NJ
	Use alternate communication services such as mail or courier	MB | OB | NJ
	Use wireless connections	MB | OB | NJ
58.	Please add any additional technology/data preparations that should be included in this list	
59.	**Transportation Preparations**	
	Plan home office	MB | OB | NJ
	Use alternate transportation	MB | OB | NJ
	Use ground-based transportation	MB | OB | NJ
60.	Please add any additional transportation preparations that should be included in this list	
61.	**Utility Preparations**	
	Add power generators	MB | OB | NJ
	Host own gas supply	MB | OB | NJ
	Install natural gas generator	MB | OB | NJ

	Rent port-a-johns	MB | OB | NJ
	Store additional gasoline	MB | OB | NJ
62.	Please add any additional utility preparations that should be included in this list	
63.	**Weather Preparations**	
	Add lightning rods to building	MB | OB | NJ
	Build storm shelter	MB | OB | NJ
	Buy charcoal	MB | OB | NJ
	Buy charcoal grill	MB | OB | NJ
	Buy dry ice	MB | OB | NJ
	Buy extra batteries	MB | OB | NJ
	Buy extra coolers	MB | OB | NJ
	Buy flash lights	MB | OB | NJ
	Buy gas/propane grill	MB | OB | NJ
	Buy snow shovels	MB | OB | NJ
	Fill vehicle gas tanks	MB | OB | NJ
	Freeze food	MB | OB | NJ
	Install storm shutters	MB | OB | NJ

	Store additional propane	MB | OB | NJ
64.	Please add any additional weather preparations that should be included in this list	

FOR THE PILOT STUDY ONLY:

65.	Did you find any of the questions on this survey confusing? If so which ones?	
66.	Please describe any problems that you had with completing the survey.	

APPENDIX H

DELPHI ROUND 2 CONSENT FORM

This appendix contains the consent form used for new participants starting at Round 2.

NEW JERSEY INSTITUTE OF TECHNOLOGY
323 MARTIN LUTHER KING BLVD.
NEWARK, NJ 07102

CONSENT TO PARTICIPATE IN A RESEARCH STUDY

TITLE OF STUDY: Collaborative Development of a Small Business Emergency Planning Model.

RESEARCH STUDY:

I,____, have been asked to participate in a research study under the direction of **Dr. Murray Turoff and Starr Roxanne Hiltz**.

Other professional persons who work with them as study staff may assist to act on for them.

PURPOSE:

The purpose of this study is to collect and analyze possible interactions between business continuity/disaster recovery event factors. These aggregated factors and associated probabilities will be input into Cross Impact Analysis and Interpretive Structural Modeling software to gain insight into those possible interactions.

DURATION:

My participation in this study will last for **2-4 weeks with approximately 1-2 hours for the survey and any discussion. In total, it will take 1-2 hours, including reading directions and answering all three questionnaires over time**.

PROCEDURES:

I have been told that, during the course of this study, the following will occur:

- The subject reads the study introduction before clicking on "Next" button.
- The subject reads the Consent Form.
- The subject needs to indicate his/her consent by signing this consent form.
- The subject fills out a pre questionnaire, if they have not participated in Round 1.

- The subject reads the directions.
- The subject finishes a small exercise about event factor interactions.
- At the end of the four-week period, the participants will fill out the post-surveys.

PARTICIPANTS:

I will be one of about **__50-80_** participants to participate in this study.

EXCLUSIONS:

I will inform the researcher if any of the following apply to me:

All participants must be 18 years old and above**.**

RISKS/DISCOMFORTS:

I have been told that the study described above may involve the following risks and/or discomforts:

As an online participant in this research, there is always the risk of intrusion by outside agents and, therefore the possibility of being identified exists. The experiment is not being run through a secure http connection, so your messages might be visible to experienced attackers.

There also may be risks and discomforts that are not yet known.

I fully recognize that there are risks that I may be exposed to by volunteering in this study which are inherent in participating in any study; I understand that I am not covered by NJIT's insurance policy for any injury or loss I might sustain in the course of participating in the study.

CONFIDENTIALITY:

I understand that "confidential" is not the same as "anonymous." Confidential means that my name will not be disclosed if there exists a documented linkage between my identity and my responses as recorded in the research records. Every effort will be made to maintain the confidentiality of my study records. If the findings from the study are published, I will not be identified by name. My identity will remain confidential unless disclosure is required by law.

PAYMENT FOR PARTICIPATION:

I have been told that I will receive the opportunity for one of three $50 American Express gift cards as compensation for my participation in this study. The gift cards will be awarded by random drawing of those participants who complete all requirements of the study.

RIGHT TO REFUSE OR WITHDRAW:

I understand that my participation is voluntary and I may refuse to participate, or may discontinue my participation at any time with no adverse consequence. I also understand that the investigator has the right to withdraw me from the study at any time.

INDIVIDUAL TO CONTACT:

If I have any questions about my treatment or research procedures, I understand that I should contact the principal investigator at:

Dr. Murray Turoff
Information Systems Department
New Jersey Institute of Technology
Newark, New Jersey 07102
Email: murray.turoff@gmail.com
Telephone: 973-596-3399

If I have any addition questions about my rights as a research subject, I may contact:

Norma Rubio, IRB Chair
New Jersey Institute of Technology
323 Martin Luther King Boulevard
Newark, NJ 07102
(973) 596-5825
rubio@njit.edu / irb@njit.edu

SIGNATURE OF PARTICIPANT

I have read this entire form, or it has been read to me, and I understand it completely. All of my questions regarding this form or this study have been answered to my complete satisfaction. I agree to participate in this research study.

Participant Name ______________________________

Signature ______________________________

Date ______________________________

APPENDIX I

DELPHI ROUND 2 TASKS

This appendix contains the round 2 Delphi study tasks.

Welcome and thank you for taking the time to participate in the Round 2 Delphi Study about risks and actions. We have consolidated the results from the first round. The surveys that you answer now are similar to the ones from the first round with the additional items added for both the Risks and Actions. Once this round is completed, your answers will be given to a group of experts to prepare the input for the creation of the mathematical model. Interaction probabilities will be created and used by Cross Impact Model Analysis and Interpretive Structural Modeling software. This software will be used to measure the interactions of risk factors as a basis for the creation of a business continuity/disaster recovery (BC/DR) plan. A BC/DR plan is created to determine the best use of limited budget resources to improve preparedness against business interruptions from events like Hurricane Sandy.

You will work individually to answer the survey questions. At the end of the four-week study period, the aggregate of all participants will be consolidated and analyzed. If there is much disagreement regarding the applicability of individual risks and actions we may ask you to participate in a very brief third round survey. Once all of the surveys are complete, we will run the final cross impact analysis and interpretive structural models. At your option the final results of the study will be emailed to you. Your identity will remain confidential.

Please ensure that you mark all factors

Table I.1 Risk and Action Survey Task List – Round 2

<table>
<tr><th>No.</th><th>Task</th></tr>
<tr><td>1.</td><td>Open up your web browser. It does not matter which one you use.</td></tr>
<tr><td>2.</td><td>Type the web address for the survey in the address bar.</td></tr>
<tr><td>3.</td><td>Choose the category of your business from the list provided.
Example business categories are:
• Advertising & Media
• Arts, Culture & Entertainment
• Automotive, Aviation & Marine
• Business & Professional Services
• Communications
• Computers, IT & Technology
You may only pick one or enter one in the space provided if none of the items matches your business.</td></tr>
<tr><td>4.</td><td>After clicking Next you will read the instructions given at the beginning of this section.
Click Next.</td></tr>
<tr><td>5.</td><td>When the main entries of the survey appears, please look at the list of risks and the list of mitigating actions. For each risk and mitigation action, mark a value for its importance for your business. Your answers will go into creating a ranking value to determine the most important events and actions for the next step. The follow-up study will look to consolidate the answers from this round and ask for your input again.</td></tr>
<tr><td>6.</td><td>Next to each factor, please choose one of the following ranks.

For the risk survey questions:
CI=Critically Important
VI=Very Important
SI=Somewhat Important
MI=Minor Importance
NI=No importance
NJ=No judgment

For the preparation survey question:
MB=Applies to my business
OB=Applies only to other businesses
NJ= No judgment
<table>
<tr><th>No.</th><th>Event</th><th colspan="6">Response</th></tr>
<tr><td>3.</td><td>Financial Risk</td><td colspan="6"></td></tr>
<tr><td></td><td>Bank loan denied</td><td>CI</td><td>VI</td><td>SI</td><td>MI</td><td>NI</td><td>NJ</td></tr>
<tr><td></td><td>Becoming dependent on too few customers</td><td>CI</td><td>VI</td><td>SI</td><td>MI</td><td>NI</td><td>NJ</td></tr>
</table>
</td></tr>
</table>

No.	Task							
		Building insurance lapsed	CI	VI	SI	MI	NI	NJ
		Business continuity plan non-existent	CI	VI	SI	MI	NI	NJ
7.	Repeat Step 6 for all risks and actions.							
8.	After assigning importance values to each item, please add any risk or mitigating action that you believe is missing. Add your reason for doing so. If you have no additions, please go on to step 9.							
9.	Please complete the post evaluation survey when asked.							

APPENDIX J

ROUND 2 SURVEY QUESTIONS

This appendix contains the round 2 Delphi study questions.

Next to each factor, please choose one of the following ranks.

CI=Critically Important
VI=Very Important
SI=Somewhat Important
MI=Minor Importance
NI=No importance
NJ=No judgment

Welcome and thank you for taking the time to participate in the second round of a Delphi study to create the basis for better business continuity and disaster recovery plans. Based on the results of the first round, there are several additional risks and actions that need your evaluation. This study asks for your opinions regarding the importance of these new events in disrupting your business. If after evaluating these new items, you feel that your opinion has changed on the previous survey, you may go and change your prior answers. A copy of your prior results is attached in PDF format in the invitation email. Click only on those items you wish to change.

Participation in this round should take between 7 and 15 minutes and is strictly confidential. You will be asked to answer a series of questions in two or three survey rounds. In no case will individual responses be identified unless consent is explicitly granted to do so. Findings from this study will be published in aggregate form.

Read over the new list items and rate how important they are to your business. There is no right or wrong answer.

Once you have assigned values to the new list items provided, please add any new items that should be included in the lists.

PLEASE ANSWER ONLY THOSE QUESTIONS THAT CONCERN YOUR BUSINESS. SKIP CATEGORIES AND QUESTIONS THAT DO NOT APPLY TO YOUR BUSINESS. YOU MAY STOP AND CONTINUE ON THE SAME COMPUTER BY PRESSING THE EXIT BUTTON IN THE UPPER RIGHT. RETURN TO THE SURVEY BY CLICKING THE SURVEY LINK AGAIN.

As a small to medium business, you face many threats that can interrupt your business operations and cause you to lose money or in the worst case lose your business. The set of surveys that you are completing deal with your opinions as to the threats you face and the actions you take or have taken to lessen the threat and restore your business operations. The threats that may cause interruption are called RISKS. The preparations and the things that you do to lessen your chance of an interruption and restore your business operations are called mitigating ACTIONS.

Different businesses have different levels of risks and different levels of actions that are needed to restore operations. As you complete these surveys we want you to think about the risks and actions that apply to your business.

Once we have your input, a process that includes experts in business continuity and disaster recovery will be able to take these inputs and develop a model that can be used as a basis for a business continuity plan, a disaster recovery plan, and a set of actions to take to prepare for and prevent business interruptions.

For each of the following pages you will see a risk category as you saw in the preliminary instructions. For each category you will see a list of potential new risks that fit that category.

For each of the risks in the list, think about how it might affect or not affect the running of your business and then make a choice on the scale.

If the risk is something that you think about all of the time and you might lose sleep over it, you might choose "Critically Important."

If the risk is nothing that you ever think about interrupting your business like a flood on the top of a mountain, then perhaps you would choose "Not Important." If the risk doesn't apply to you, then choose "No judgment."

You are evaluating the risks in terms of which ones are important to **you and/or your business.**

Thank you for your help.

1.	Enter Email	
No.	**Event**	**Response**
2.	**New Financial Risk**	
	Loss of liability insurance	CI | VI | SI | MI | NI | NJ
	Unplanned workmen's compensation increase	CI | VI | SI | MI | NI | NJ
	Unforeseen insurance rateables increase	CI | VI | SI | MI | NI | NJ
	Customer filing for bankruptcy, chapter 7 or 11	CI | VI | SI | MI | NI | NJ
	Customer Loans not repaid	CI | VI | SI | MI | NI | NJ
	Please add any additional financial risks that should be included in this list	
3.	**New Fire Risk**	
	Combustion due to improperly stored or disposed of supplies or refuse	CI | VI | SI | MI | NI | NJ
	Fire caused by bad weather	CI | VI | SI | MI | NI | NJ
	Loss of documents and company materials/records	CI | VI | SI | MI | NI | NJ

	Please add any additional fire risks that should be included in this list	
4.	**New Flood Risk**	
	Downturn in business due to floods in other areas	CI | VI | SI | MI | NI | NJ
	Please add any additional flood risks that should be included in this list	
5.	**New Government Risk**	
	Unexpected audit	CI | VI | SI | MI | NI | NJ
	Unexpected inspection	CI | VI | SI | MI | NI | NJ
	Increased regulations	CI | VI | SI | MI | NI | NJ
	Please add any additional government risks that should be included in this list	
6.	**New Health Risk**	
	On the job injuries	CI | VI | SI | MI | NI | NJ
	Exposure to hazardous materials	CI | VI | SI | MI | NI | NJ
	Please add any additional health risks that should be included in this list	
7.	**New Legal Risk**	

	Liability of employee operating a company vehicle	CI | VI | SI | MI | NI | NJ
	Vicarious liability for employee actions	CI | VI | SI | MI | NI | NJ
	Please add any additional legal risks that should be included in this list	
8.	**New Personnel Risk**	
	Employee theft requiring dismissal	CI | VI | SI | MI | NI | NJ
	Please add any additional personnel risks that should be included in this list	
9.	**New Product Risk**	
	Raw material cost increase	CI | VI | SI | MI | NI | NJ
	Natural gas shortage	CI | VI | SI | MI | NI | NJ
	Please add any additional product risks that should be included in this list	
10.	**New Supply Chain Risk**	
	Changes in global raw material supply, price, or availability	CI | VI | SI | MI | NI | NJ
	Increased lead time due to storm or other event	CI | VI | SI | MI | NI | NJ
	Changes in vendor terms	CI | VI | SI | MI | NI | NJ

	Please add any additional supply chain risks that should be included in this list	
11.	**New Utility Risk**	
	Utilities unavailable to prepare food	CI | VI | SI | MI | NI | NJ
	Please add any additional utility risks that should be included in this list	
12.	**New Weather Risk**	
	Snow storm in area	CI | VI | SI | MI | NI | NJ
	Please add any additional weather risks that should be included in this list	
13.	**New Legal Preparations**	
	Hire lobbying firm	MB | OB | NJ
	Please add any additional legal preparations that should be included in this list	
14.	**Based on these new questions, do you wish to revise any of your answers from round 1?**	Yes | No

APPENDIX K

FULL C_{IJ} AND G_I INFLUENCE VALUES

This appendix contains the full results for the C_{ij} and G_i influence values for all events.

Row	Event	Col	Event	C_{ij}
14	DE9 - Internet connectivity lost	14	DE9 - Internet connectivity lost	**G.** -11.42
9	DE4 - Personnel not available during an emergency	9	DE4 - Personnel not available during an emergency	**G.** -8.09
15	DE10 - Increased lead time due to storm or other event	15	DE10 - Increased lead time due to storm or other event	**G.** -7.34
22	O2 - Business reputation tarnished	22	O2 - Business reputation tarnished	**G.** -7.20
7	DE2 - No communication networks	7	DE2 - No communication networks	**G.** -5.42
21	O1 - Loss of documents and company materials/records.	21	O1 - Loss of documents and company materials/records.	**G.** -4.85
23	O3 - Computer data lost	23	O3 - Computer data lost	**G.** -4.65
13	DE8 - Telephones out of service	13	DE8 - Telephones out of service	**G.** -4.63
11	DE6 - Backup power supply not available	11	DE6 - Backup power supply not available	**G.** -3.72
18	DE13 - Roads clogged with traffic	18	DE13 - Roads clogged with traffic	**G.** -3.60
24	O4 - Raw material cost increase	24	O4 - Raw material cost increase	**G.** -2.70
17	DE12 - Gasoline in short supply	17	DE12 - Gasoline in short supply	**G.** -2.65
10	DE5 - Violent crime committed by employee during work hours	10	DE5 - Violent crime committed by employee during work hours	**G.** -2.22
12	DE7 - Access to facility forbidden	12	DE7 - Access to facility forbidden	**G.** -2.15
25	O5 - Raw materials contaminated	25	O5 - Raw materials contaminated	**G.** -1.87
6	DE1 - Electricity cut off	6	DE1 - Electricity cut off	**G.** -1.78
20	DE15 - Product in transport destroyed	20	DE15 - Product in transport destroyed	**G.** -1.66

Row	Event	Col	Event	C_{ij}
16	DE11 - Roads flooded	16	DE11 - Roads flooded	**G.** -1.61
8	DE3 - Computer hardware fails	8	DE3 - Computer hardware fails	**G.** -1.58
19	DE14 - Crime rate increase near place of business	19	DE14 - Crime rate increase near place of business	**G.** -1.56
1	I1 - Computer server not fully backed up	1	I1 - Computer server not fully backed up	**G.** 0.00
2	I2 - Fires underway	2	I2 - Fires underway	**G.** 0.00
3	I3 - Hurricane in area	3	I3 - Hurricane in area	**G.** 0.00
4	I4 - Business continuity plan not tested	4	I4 - Business continuity plan not tested	**G.** 0.00
5	I5 - Local government not functioning	5	I5 - Local government not functioning	**G.** 0.00
14	DE9 - Internet connectivity lost	7	DE2 - No communication networks	9.19
14	DE9 - Internet connectivity lost	8	DE3 - Computer hardware fails	5.17
7	DE2 - No communication networks	14	DE9 - Internet connectivity lost	3.17
9	DE4 - Personnel not available during an emergency	12	DE7 - Access to facility forbidden	2.77
9	DE4 - Personnel not available during an emergency	3	I3 - Hurricane in area	2.42
13	DE8 - Telephones out of service	6	DE1 - Electricity cut off	2.42
14	DE9 - Internet connectivity lost	6	DE1 - Electricity cut off	2.42
15	DE10 - Increased lead time due to storm or other event	3	I3 - Hurricane in area	1.99
7	DE2 - No communication networks	6	DE1 - Electricity cut off	1.99
17	DE12 - Gasoline in short supply	6	DE1 - Electricity cut off	1.99
13	DE8 - Telephones out of service	7	DE2 - No communication networks	1.99
6	DE1 - Electricity cut off	3	I3 - Hurricane in area	1.69
7	DE2 - No communication networks	3	I3 - Hurricane in area	1.69
13	DE8 - Telephones out of service	3	I3 - Hurricane in area	1.69
14	DE9 - Internet connectivity lost	3	I3 - Hurricane in area	1.69
16	DE11 - Roads flooded	3	I3 - Hurricane in area	1.69

Row	Event	Col	Event	C_{ij}
17	DE12 - Gasoline in short supply	3	I3 - Hurricane in area	1.69
9	DE4 - Personnel not available during an emergency	6	DE1 - Electricity cut off	1.69
22	O2 - Business reputation tarnished	10	DE5 - Violent crime committed by employee during work hours	1.69
14	DE9 - Internet connectivity lost	11	DE6 - Backup power supply not available	1.69
21	O1 - Loss of documents and company materials/records.	1	I1 - Computer server not fully backed up	1.42
22	O2 - Business reputation tarnished	1	I1 - Computer server not fully backed up	1.42
23	O3 - Computer data lost	1	I1 - Computer server not fully backed up	1.42
18	DE13 - Roads clogged with traffic	3	I3 - Hurricane in area	1.42
22	O2 - Business reputation tarnished	4	I4 - Business continuity plan not tested	1.42
15	DE10 - Increased lead time due to storm or other event	6	DE1 - Electricity cut off	1.42
18	DE13 - Roads clogged with traffic	6	DE1 - Electricity cut off	1.42
19	DE14 - Crime rate increase near place of business	6	DE1 - Electricity cut off	1.42
15	DE10 - Increased lead time due to storm or other event	12	DE7 - Access to facility forbidden	1.42
22	O2 - Business reputation tarnished	12	DE7 - Access to facility forbidden	1.42
9	DE4 - Personnel not available during an emergency	13	DE8 - Telephones out of service	1.42
9	DE4 - Personnel not available during an emergency	17	DE12 - Gasoline in short supply	1.42
15	DE10 - Increased lead time due to storm or other event	17	DE12 - Gasoline in short supply	1.42
12	DE7 - Access to facility forbidden	3	I3 - Hurricane in area	1.06
23	O3 - Computer data lost	3	I3 - Hurricane in area	1.06
25	O5 - Raw materials contaminated	3	I3 - Hurricane in area	1.06
19	DE14 - Crime rate increase near place of business	5	I5 - Local government not functioning	1.06
22	O2 - Business reputation tarnished	6	DE1 - Electricity cut off	1.06

Row	Event	Col	Event	C_{ij}
23	O3 - Computer data lost	6	DE1 - Electricity cut off	1.06
15	DE10 - Increased lead time due to storm or other event	8	DE3 - Computer hardware fails	1.06
21	O1 - Loss of documents and company materials/records.	8	DE3 - Computer hardware fails	1.06
22	O2 - Business reputation tarnished	8	DE3 - Computer hardware fails	1.06
23	O3 - Computer data lost	8	DE3 - Computer hardware fails	1.06
8	DE3 - Computer hardware fails	9	DE4 - Personnel not available during an emergency	1.06
14	DE9 - Internet connectivity lost	10	DE5 - Violent crime committed by employee during work hours	1.06
7	DE2 - No communication networks	11	DE6 - Backup power supply not available	1.06
15	DE10 - Increased lead time due to storm or other event	13	DE8 - Telephones out of service	1.06
21	O1 - Loss of documents and company materials/records.	14	DE9 - Internet connectivity lost	1.06
9	DE4 - Personnel not available during an emergency	16	DE11 - Roads flooded	1.06
15	DE10 - Increased lead time due to storm or other event	20	DE15 - Product in transport destroyed	1.06
6	DE1 - Electricity cut off	2	I2 - Fires underway	0.81
7	DE2 - No communication networks	2	I2 - Fires underway	0.81
9	DE4 - Personnel not available during an emergency	2	I2 - Fires underway	0.81
11	DE6 - Backup power supply not available	2	I2 - Fires underway	0.81
12	DE7 - Access to facility forbidden	2	I2 - Fires underway	0.81
13	DE8 - Telephones out of service	2	I2 - Fires underway	0.81
14	DE9 - Internet connectivity lost	2	I2 - Fires underway	0.81
18	DE13 - Roads clogged with traffic	2	I2 - Fires underway	0.81
21	O1 - Loss of documents and company materials/records.	2	I2 - Fires underway	0.81
24	O4 - Raw material cost increase	2	I2 - Fires underway	0.81
25	O5 - Raw materials contaminated	2	I2 - Fires underway	0.81

Row	Event	Col	Event	C_{ij}
11	DE6 - Backup power supply not available	3	I3 - Hurricane in area	0.81
20	DE15 - Product in transport destroyed	3	I3 - Hurricane in area	0.81
21	O1 - Loss of documents and company materials/records.	3	I3 - Hurricane in area	0.81
22	O2 - Business reputation tarnished	3	I3 - Hurricane in area	0.81
24	O4 - Raw material cost increase	3	I3 - Hurricane in area	0.81
11	DE6 - Backup power supply not available	4	I4 - Business continuity plan not tested	0.81
15	DE10 - Increased lead time due to storm or other event	4	I4 - Business continuity plan not tested	0.81
21	O1 - Loss of documents and company materials/records.	4	I4 - Business continuity plan not tested	0.81
23	O3 - Computer data lost	4	I4 - Business continuity plan not tested	0.81
9	DE4 - Personnel not available during an emergency	5	I5 - Local government not functioning	0.81
18	DE13 - Roads clogged with traffic	5	I5 - Local government not functioning	0.81
10	DE5 - Violent crime committed by employee during work hours	6	DE1 - Electricity cut off	0.81
11	DE6 - Backup power supply not available	6	DE1 - Electricity cut off	0.81
12	DE7 - Access to facility forbidden	6	DE1 - Electricity cut off	0.81
21	O1 - Loss of documents and company materials/records.	6	DE1 - Electricity cut off	0.81
25	O5 - Raw materials contaminated	6	DE1 - Electricity cut off	0.81
20	DE15 - Product in transport destroyed	7	DE2 - No communication networks	0.81
21	O1 - Loss of documents and company materials/records.	7	DE2 - No communication networks	0.81
21	O1 - Loss of documents and company materials/records.	9	DE4 - Personnel not available during an emergency	0.81
22	O2 - Business reputation tarnished	9	DE4 - Personnel not available during an emergency	0.81
23	O3 - Computer data lost	9	DE4 - Personnel not available during an emergency	0.81

Row	Event	Col	Event	C_{ij}
13	DE8 - Telephones out of service	10	DE5 - Violent crime committed by employee during work hours	0.81
8	DE3 - Computer hardware fails	11	DE6 - Backup power supply not available	0.81
13	DE8 - Telephones out of service	11	DE6 - Backup power supply not available	0.81
21	O1 - Loss of documents and company materials/records.	11	DE6 - Backup power supply not available	0.81
22	O2 - Business reputation tarnished	11	DE6 - Backup power supply not available	0.81
23	O3 - Computer data lost	11	DE6 - Backup power supply not available	0.81
11	DE6 - Backup power supply not available	12	DE7 - Access to facility forbidden	0.81
7	DE2 - No communication networks	13	DE8 - Telephones out of service	0.81
19	DE14 - Crime rate increase near place of business	13	DE8 - Telephones out of service	0.81
22	O2 - Business reputation tarnished	14	DE9 - Internet connectivity lost	0.81
23	O3 - Computer data lost	14	DE9 - Internet connectivity lost	0.81
22	O2 - Business reputation tarnished	15	DE10 - Increased lead time due to storm or other event	0.81
24	O4 - Raw material cost increase	15	DE10 - Increased lead time due to storm or other event	0.81
6	DE1 - Electricity cut off	16	DE11 - Roads flooded	0.81
7	DE2 - No communication networks	16	DE11 - Roads flooded	0.81
11	DE6 - Backup power supply not available	16	DE11 - Roads flooded	0.81
12	DE7 - Access to facility forbidden	16	DE11 - Roads flooded	0.81
15	DE10 - Increased lead time due to storm or other event	16	DE11 - Roads flooded	0.81
17	DE12 - Gasoline in short supply	16	DE11 - Roads flooded	0.81
18	DE13 - Roads clogged with traffic	16	DE11 - Roads flooded	0.81

Row	Event	Col	Event	C_{ij}
9	DE4 - Personnel not available during an emergency	19	DE14 - Crime rate increase near place of business	0.81
10	DE5 - Violent crime committed by employee during work hours	19	DE14 - Crime rate increase near place of business	0.81
22	O2 - Business reputation tarnished	19	DE14 - Crime rate increase near place of business	0.81
22	O2 - Business reputation tarnished	20	DE15 - Product in transport destroyed	0.81
14	DE9 - Internet connectivity lost	1	I1 - Computer server not fully backed up	0.56
8	DE3 - Computer hardware fails	2	I2 - Fires underway	0.56
15	DE10 - Increased lead time due to storm or other event	2	I2 - Fires underway	0.56
20	DE15 - Product in transport destroyed	2	I2 - Fires underway	0.56
22	O2 - Business reputation tarnished	2	I2 - Fires underway	0.56
23	O3 - Computer data lost	2	I2 - Fires underway	0.56
10	DE5 - Violent crime committed by employee during work hours	3	I3 - Hurricane in area	0.56
10	DE5 - Violent crime committed by employee during work hours	5	I5 - Local government not functioning	0.56
17	DE12 - Gasoline in short supply	5	I5 - Local government not functioning	0.56
24	O4 - Raw material cost increase	5	I5 - Local government not functioning	0.56
25	O5 - Raw materials contaminated	5	I5 - Local government not functioning	0.56
24	O4 - Raw material cost increase	6	DE1 - Electricity cut off	0.56
9	DE4 - Personnel not available during an emergency	7	DE2 - No communication networks	0.56
11	DE6 - Backup power supply not available	7	DE2 - No communication networks	0.56
15	DE10 - Increased lead time due to storm or other event	7	DE2 - No communication networks	0.56
18	DE13 - Roads clogged with traffic	7	DE2 - No communication networks	0.56
22	O2 - Business reputation tarnished	7	DE2 - No communication networks	0.56
23	O3 - Computer data lost	7	DE2 - No communication networks	0.56

Row	Event	Col	Event	C_{ij}
15	DE10 - Increased lead time due to storm or other event	9	DE4 - Personnel not available during an emergency	0.56
9	DE4 - Personnel not available during an emergency	10	DE5 - Violent crime committed by employee during work hours	0.56
15	DE10 - Increased lead time due to storm or other event	10	DE5 - Violent crime committed by employee during work hours	0.56
16	DE11 - Roads flooded	12	DE7 - Access to facility forbidden	0.56
23	O3 - Computer data lost	12	DE7 - Access to facility forbidden	0.56
11	DE6 - Backup power supply not available	13	DE8 - Telephones out of service	0.56
18	DE13 - Roads clogged with traffic	13	DE8 - Telephones out of service	0.56
9	DE4 - Personnel not available during an emergency	14	DE9 - Internet connectivity lost	0.56
15	DE10 - Increased lead time due to storm or other event	14	DE9 - Internet connectivity lost	0.56
18	DE13 - Roads clogged with traffic	14	DE9 - Internet connectivity lost	0.56
20	DE15 - Product in transport destroyed	16	DE11 - Roads flooded	0.56
24	O4 - Raw material cost increase	16	DE11 - Roads flooded	0.56
24	O4 - Raw material cost increase	17	DE12 - Gasoline in short supply	0.56
9	DE4 - Personnel not available during an emergency	18	DE13 - Roads clogged with traffic	0.56
12	DE7 - Access to facility forbidden	18	DE13 - Roads clogged with traffic	0.56
15	DE10 - Increased lead time due to storm or other event	18	DE13 - Roads clogged with traffic	0.56
12	DE7 - Access to facility forbidden	19	DE14 - Crime rate increase near place of business	0.56
20	DE15 - Product in transport destroyed	19	DE14 - Crime rate increase near place of business	0.56
7	DE2 - No communication networks	1	I1 - Computer server not fully backed up	0.24
8	DE3 - Computer hardware fails	1	I1 - Computer server not fully backed up	0.24

Row	Event	Col	Event	C_{ij}
11	DE6 - Backup power supply not available	1	I1 - Computer server not fully backed up	0.24
10	DE5 - Violent crime committed by employee during work hours	2	I2 - Fires underway	0.24
16	DE11 - Roads flooded	2	I2 - Fires underway	0.24
17	DE12 - Gasoline in short supply	2	I2 - Fires underway	0.24
19	DE14 - Crime rate increase near place of business	2	I2 - Fires underway	0.24
8	DE3 - Computer hardware fails	3	I3 - Hurricane in area	0.24
9	DE4 - Personnel not available during an emergency	4	I4 - Business continuity plan not tested	0.24
7	DE2 - No communication networks	5	I5 - Local government not functioning	0.24
13	DE8 - Telephones out of service	5	I5 - Local government not functioning	0.24
10	DE5 - Violent crime committed by employee during work hours	7	DE2 - No communication networks	0.24
12	DE7 - Access to facility forbidden	7	DE2 - No communication networks	0.24
19	DE14 - Crime rate increase near place of business	7	DE2 - No communication networks	0.24
24	O4 - Raw material cost increase	7	DE2 - No communication networks	0.24
25	O5 - Raw materials contaminated	7	DE2 - No communication networks	0.24
9	DE4 - Personnel not available during an emergency	8	DE3 - Computer hardware fails	0.24
10	DE5 - Violent crime committed by employee during work hours	8	DE3 - Computer hardware fails	0.24
11	DE6 - Backup power supply not available	8	DE3 - Computer hardware fails	0.24
11	DE6 - Backup power supply not available	9	DE4 - Personnel not available during an emergency	0.24
16	DE11 - Roads flooded	9	DE4 - Personnel not available during an emergency	0.24
11	DE6 - Backup power supply not available	10	DE5 - Violent crime committed by employee during work hours	0.24
12	DE7 - Access to facility forbidden	10	DE5 - Violent crime committed by employee during work hours	0.24

Row	Event	Col	Event	C_{ij}
15	DE10 - Increased lead time due to storm or other event	11	DE6 - Backup power supply not available	0.24
10	DE5 - Violent crime committed by employee during work hours	13	DE8 - Telephones out of service	0.24
14	DE9 - Internet connectivity lost	13	DE8 - Telephones out of service	0.24
8	DE3 - Computer hardware fails	14	DE9 - Internet connectivity lost	0.24
10	DE5 - Violent crime committed by employee during work hours	14	DE9 - Internet connectivity lost	0.24
16	DE11 - Roads flooded	14	DE9 - Internet connectivity lost	0.24
19	DE14 - Crime rate increase near place of business	14	DE9 - Internet connectivity lost	0.24
9	DE4 - Personnel not available during an emergency	15	DE10 - Increased lead time due to storm or other event	0.24
10	DE5 - Violent crime committed by employee during work hours	15	DE10 - Increased lead time due to storm or other event	0.24
21	O1 - Loss of documents and company materials/records.	16	DE11 - Roads flooded	0.24
25	O5 - Raw materials contaminated	16	DE11 - Roads flooded	0.24
18	DE13 - Roads clogged with traffic	17	DE12 - Gasoline in short supply	0.24
19	DE14 - Crime rate increase near place of business	17	DE12 - Gasoline in short supply	0.24
6	DE1 - Electricity cut off	18	DE13 - Roads clogged with traffic	0.24
11	DE6 - Backup power supply not available	18	DE13 - Roads clogged with traffic	0.24
13	DE8 - Telephones out of service	18	DE13 - Roads clogged with traffic	0.24
16	DE11 - Roads flooded	18	DE13 - Roads clogged with traffic	0.24
13	DE8 - Telephones out of service	19	DE14 - Crime rate increase near place of business	0.24
21	O1 - Loss of documents and company materials/records.	19	DE14 - Crime rate increase near place of business	0.24
24	O4 - Raw material cost increase	19	DE14 - Crime rate increase near place of business	0.24

Row	Event	Col	Event	C_{ij}
10	DE5 - Violent crime committed by employee during work hours	20	DE15 - Product in transport destroyed	0.24
11	DE6 - Backup power supply not available	20	DE15 - Product in transport destroyed	0.24
24	O4 - Raw material cost increase	20	DE15 - Product in transport destroyed	0.24
2	I2 - Fires underway	1	I1 - Computer server not fully backed up	0.00
3	I3 - Hurricane in area	1	I1 - Computer server not fully backed up	0.00
4	I4 - Business continuity plan not tested	1	I1 - Computer server not fully backed up	0.00
5	I5 - Local government not functioning	1	I1 - Computer server not fully backed up	0.00
6	DE1 - Electricity cut off	1	I1 - Computer server not fully backed up	0.00
9	DE4 - Personnel not available during an emergency	1	I1 - Computer server not fully backed up	0.00
10	DE5 - Violent crime committed by employee during work hours	1	I1 - Computer server not fully backed up	0.00
12	DE7 - Access to facility forbidden	1	I1 - Computer server not fully backed up	0.00
13	DE8 - Telephones out of service	1	I1 - Computer server not fully backed up	0.00
15	DE10 - Increased lead time due to storm or other event	1	I1 - Computer server not fully backed up	0.00
16	DE11 - Roads flooded	1	I1 - Computer server not fully backed up	0.00
17	DE12 - Gasoline in short supply	1	I1 - Computer server not fully backed up	0.00
18	DE13 - Roads clogged with traffic	1	I1 - Computer server not fully backed up	0.00
19	DE14 - Crime rate increase near place of business	1	I1 - Computer server not fully backed up	0.00
20	DE15 - Product in transport destroyed	1	I1 - Computer server not fully backed up	0.00
24	O4 - Raw material cost increase	1	I1 - Computer server not fully backed up	0.00
25	O5 - Raw materials contaminated	1	I1 - Computer server not fully backed up	0.00
1	I1 - Computer server not fully backed up	2	I2 - Fires underway	0.00
3	I3 - Hurricane in area	2	I2 - Fires underway	0.00

Row	Event	Col	Event	C_{ij}
4	I4 - Business continuity plan not tested	2	I2 - Fires underway	0.00
5	I5 - Local government not functioning	2	I2 - Fires underway	0.00
1	I1 - Computer server not fully backed up	3	I3 - Hurricane in area	0.00
2	I2 - Fires underway	3	I3 - Hurricane in area	0.00
4	I4 - Business continuity plan not tested	3	I3 - Hurricane in area	0.00
5	I5 - Local government not functioning	3	I3 - Hurricane in area	0.00
1	I1 - Computer server not fully backed up	4	I4 - Business continuity plan not tested	0.00
2	I2 - Fires underway	4	I4 - Business continuity plan not tested	0.00
3	I3 - Hurricane in area	4	I4 - Business continuity plan not tested	0.00
5	I5 - Local government not functioning	4	I4 - Business continuity plan not tested	0.00
6	DE1 - Electricity cut off	4	I4 - Business continuity plan not tested	0.00
7	DE2 - No communication networks	4	I4 - Business continuity plan not tested	0.00
8	DE3 - Computer hardware fails	4	I4 - Business continuity plan not tested	0.00
10	DE5 - Violent crime committed by employee during work hours	4	I4 - Business continuity plan not tested	0.00
12	DE7 - Access to facility forbidden	4	I4 - Business continuity plan not tested	0.00
13	DE8 - Telephones out of service	4	I4 - Business continuity plan not tested	0.00
14	DE9 - Internet connectivity lost	4	I4 - Business continuity plan not tested	0.00
16	DE11 - Roads flooded	4	I4 - Business continuity plan not tested	0.00
17	DE12 - Gasoline in short supply	4	I4 - Business continuity plan not tested	0.00
18	DE13 - Roads clogged with traffic	4	I4 - Business continuity plan not tested	0.00
19	DE14 - Crime rate increase near place of business	4	I4 - Business continuity plan not tested	0.00
20	DE15 - Product in transport destroyed	4	I4 - Business continuity plan not tested	0.00

Row	Event	Col	Event	C_{ij}
24	O4 - Raw material cost increase	4	I4 - Business continuity plan not tested	0.00
25	O5 - Raw materials contaminated	4	I4 - Business continuity plan not tested	0.00
1	I1 - Computer server not fully backed up	5	I5 - Local government not functioning	0.00
2	I2 - Fires underway	5	I5 - Local government not functioning	0.00
3	I3 - Hurricane in area	5	I5 - Local government not functioning	0.00
4	I4 - Business continuity plan not tested	5	I5 - Local government not functioning	0.00
6	DE1 - Electricity cut off	5	I5 - Local government not functioning	0.00
8	DE3 - Computer hardware fails	5	I5 - Local government not functioning	0.00
11	DE6 - Backup power supply not available	5	I5 - Local government not functioning	0.00
14	DE9 - Internet connectivity lost	5	I5 - Local government not functioning	0.00
15	DE10 - Increased lead time due to storm or other event	5	I5 - Local government not functioning	0.00
16	DE11 - Roads flooded	5	I5 - Local government not functioning	0.00
20	DE15 - Product in transport destroyed	5	I5 - Local government not functioning	0.00
21	O1 - Loss of documents and company materials/records.	5	I5 - Local government not functioning	0.00
22	O2 - Business reputation tarnished	5	I5 - Local government not functioning	0.00
23	O3 - Computer data lost	5	I5 - Local government not functioning	0.00
1	I1 - Computer server not fully backed up	6	DE1 - Electricity cut off	0.00
2	I2 - Fires underway	6	DE1 - Electricity cut off	0.00
3	I3 - Hurricane in area	6	DE1 - Electricity cut off	0.00
4	I4 - Business continuity plan not tested	6	DE1 - Electricity cut off	0.00
5	I5 - Local government not functioning	6	DE1 - Electricity cut off	0.00
8	DE3 - Computer hardware fails	6	DE1 - Electricity cut off	0.00
16	DE11 - Roads flooded	6	DE1 - Electricity cut off	0.00
20	DE15 - Product in transport destroyed	6	DE1 - Electricity cut off	0.00

Row	Event	Col	Event	C_{ij}
1	I1 - Computer server not fully backed up	7	DE2 - No communication networks	0.00
2	I2 - Fires underway	7	DE2 - No communication networks	0.00
3	I3 - Hurricane in area	7	DE2 - No communication networks	0.00
4	I4 - Business continuity plan not tested	7	DE2 - No communication networks	0.00
5	I5 - Local government not functioning	7	DE2 - No communication networks	0.00
6	DE1 - Electricity cut off	7	DE2 - No communication networks	0.00
8	DE3 - Computer hardware fails	7	DE2 - No communication networks	0.00
16	DE11 - Roads flooded	7	DE2 - No communication networks	0.00
17	DE12 - Gasoline in short supply	7	DE2 - No communication networks	0.00
1	I1 - Computer server not fully backed up	8	DE3 - Computer hardware fails	0.00
2	I2 - Fires underway	8	DE3 - Computer hardware fails	0.00
3	I3 - Hurricane in area	8	DE3 - Computer hardware fails	0.00
4	I4 - Business continuity plan not tested	8	DE3 - Computer hardware fails	0.00
5	I5 - Local government not functioning	8	DE3 - Computer hardware fails	0.00
6	DE1 - Electricity cut off	8	DE3 - Computer hardware fails	0.00
7	DE2 - No communication networks	8	DE3 - Computer hardware fails	0.00
12	DE7 - Access to facility forbidden	8	DE3 - Computer hardware fails	0.00
13	DE8 - Telephones out of service	8	DE3 - Computer hardware fails	0.00
16	DE11 - Roads flooded	8	DE3 - Computer hardware fails	0.00
17	DE12 - Gasoline in short supply	8	DE3 - Computer hardware fails	0.00
18	DE13 - Roads clogged with traffic	8	DE3 - Computer hardware fails	0.00
19	DE14 - Crime rate increase near place of business	8	DE3 - Computer hardware fails	0.00

Row	Event	Col	Event	C_{ij}
20	DE15 - Product in transport destroyed	8	DE3 - Computer hardware fails	0.00
24	O4 - Raw material cost increase	8	DE3 - Computer hardware fails	0.00
25	O5 - Raw materials contaminated	8	DE3 - Computer hardware fails	0.00
1	I1 - Computer server not fully backed up	9	DE4 - Personnel not available during an emergency	0.00
2	I2 - Fires underway	9	DE4 - Personnel not available during an emergency	0.00
3	I3 - Hurricane in area	9	DE4 - Personnel not available during an emergency	0.00
4	I4 - Business continuity plan not tested	9	DE4 - Personnel not available during an emergency	0.00
5	I5 - Local government not functioning	9	DE4 - Personnel not available during an emergency	0.00
6	DE1 - Electricity cut off	9	DE4 - Personnel not available during an emergency	0.00
7	DE2 - No communication networks	9	DE4 - Personnel not available during an emergency	0.00
10	DE5 - Violent crime committed by employee during work hours	9	DE4 - Personnel not available during an emergency	0.00
12	DE7 - Access to facility forbidden	9	DE4 - Personnel not available during an emergency	0.00
13	DE8 - Telephones out of service	9	DE4 - Personnel not available during an emergency	0.00
14	DE9 - Internet connectivity lost	9	DE4 - Personnel not available during an emergency	0.00
17	DE12 - Gasoline in short supply	9	DE4 - Personnel not available during an emergency	0.00
18	DE13 - Roads clogged with traffic	9	DE4 - Personnel not available during an emergency	0.00

Row	Event	Col	Event	C_{ij}
19	DE14 - Crime rate increase near place of business	9	DE4 - Personnel not available during an emergency	0.00
20	DE15 - Product in transport destroyed	9	DE4 - Personnel not available during an emergency	0.00
24	O4 - Raw material cost increase	9	DE4 - Personnel not available during an emergency	0.00
25	O5 - Raw materials contaminated	9	DE4 - Personnel not available during an emergency	0.00
1	I1 - Computer server not fully backed up	10	DE5 - Violent crime committed by employee during work hours	0.00
2	I2 - Fires underway	10	DE5 - Violent crime committed by employee during work hours	0.00
3	I3 - Hurricane in area	10	DE5 - Violent crime committed by employee during work hours	0.00
4	I4 - Business continuity plan not tested	10	DE5 - Violent crime committed by employee during work hours	0.00
5	I5 - Local government not functioning	10	DE5 - Violent crime committed by employee during work hours	0.00
6	DE1 - Electricity cut off	10	DE5 - Violent crime committed by employee during work hours	0.00
7	DE2 - No communication networks	10	DE5 - Violent crime committed by employee during work hours	0.00
8	DE3 - Computer hardware fails	10	DE5 - Violent crime committed by employee during work hours	0.00
16	DE11 - Roads flooded	10	DE5 - Violent crime committed by employee during work hours	0.00
17	DE12 - Gasoline in short supply	10	DE5 - Violent crime committed by employee during work hours	0.00
18	DE13 - Roads clogged with traffic	10	DE5 - Violent crime committed by employee during work hours	0.00

Row	Event	Col	Event	C_{ij}
19	DE14 - Crime rate increase near place of business	10	DE5 - Violent crime committed by employee during work hours	0.00
20	DE15 - Product in transport destroyed	10	DE5 - Violent crime committed by employee during work hours	0.00
21	O1 - Loss of documents and company materials/records.	10	DE5 - Violent crime committed by employee during work hours	0.00
23	O3 - Computer data lost	10	DE5 - Violent crime committed by employee during work hours	0.00
24	O4 - Raw material cost increase	10	DE5 - Violent crime committed by employee during work hours	0.00
25	O5 - Raw materials contaminated	10	DE5 - Violent crime committed by employee during work hours	0.00
1	I1 - Computer server not fully backed up	11	DE6 - Backup power supply not available	0.00
2	I2 - Fires underway	11	DE6 - Backup power supply not available	0.00
3	I3 - Hurricane in area	11	DE6 - Backup power supply not available	0.00
4	I4 - Business continuity plan not tested	11	DE6 - Backup power supply not available	0.00
5	I5 - Local government not functioning	11	DE6 - Backup power supply not available	0.00
6	DE1 - Electricity cut off	11	DE6 - Backup power supply not available	0.00
9	DE4 - Personnel not available during an emergency	11	DE6 - Backup power supply not available	0.00
10	DE5 - Violent crime committed by employee during work hours	11	DE6 - Backup power supply not available	0.00
12	DE7 - Access to facility forbidden	11	DE6 - Backup power supply not available	0.00
16	DE11 - Roads flooded	11	DE6 - Backup power supply not available	0.00
17	DE12 - Gasoline in short supply	11	DE6 - Backup power supply not available	0.00
18	DE13 - Roads clogged with traffic	11	DE6 - Backup power supply not available	0.00
19	DE14 - Crime rate increase near place of business	11	DE6 - Backup power supply not available	0.00

Row	Event	Col	Event	C_{ij}
20	DE15 - Product in transport destroyed	11	DE6 - Backup power supply not available	0.00
24	O4 - Raw material cost increase	11	DE6 - Backup power supply not available	0.00
25	O5 - Raw materials contaminated	11	DE6 - Backup power supply not available	0.00
1	I1 - Computer server not fully backed up	12	DE7 - Access to facility forbidden	0.00
2	I2 - Fires underway	12	DE7 - Access to facility forbidden	0.00
3	I3 - Hurricane in area	12	DE7 - Access to facility forbidden	0.00
4	I4 - Business continuity plan not tested	12	DE7 - Access to facility forbidden	0.00
5	I5 - Local government not functioning	12	DE7 - Access to facility forbidden	0.00
6	DE1 - Electricity cut off	12	DE7 - Access to facility forbidden	0.00
7	DE2 - No communication networks	12	DE7 - Access to facility forbidden	0.00
8	DE3 - Computer hardware fails	12	DE7 - Access to facility forbidden	0.00
10	DE5 - Violent crime committed by employee during work hours	12	DE7 - Access to facility forbidden	0.00
13	DE8 - Telephones out of service	12	DE7 - Access to facility forbidden	0.00
14	DE9 - Internet connectivity lost	12	DE7 - Access to facility forbidden	0.00
17	DE12 - Gasoline in short supply	12	DE7 - Access to facility forbidden	0.00
18	DE13 - Roads clogged with traffic	12	DE7 - Access to facility forbidden	0.00
19	DE14 - Crime rate increase near place of business	12	DE7 - Access to facility forbidden	0.00
20	DE15 - Product in transport destroyed	12	DE7 - Access to facility forbidden	0.00
21	O1 - Loss of documents and company materials/records.	12	DE7 - Access to facility forbidden	0.00
24	O4 - Raw material cost increase	12	DE7 - Access to facility forbidden	0.00
25	O5 - Raw materials contaminated	12	DE7 - Access to facility forbidden	0.00
1	I1 - Computer server not fully backed up	13	DE8 - Telephones out of service	0.00

Row	Event	Col	Event	C_{ij}
2	I2 - Fires underway	13	DE8 - Telephones out of service	0.00
3	I3 - Hurricane in area	13	DE8 - Telephones out of service	0.00
4	I4 - Business continuity plan not tested	13	DE8 - Telephones out of service	0.00
5	I5 - Local government not functioning	13	DE8 - Telephones out of service	0.00
6	DE1 - Electricity cut off	13	DE8 - Telephones out of service	0.00
8	DE3 - Computer hardware fails	13	DE8 - Telephones out of service	0.00
12	DE7 - Access to facility forbidden	13	DE8 - Telephones out of service	0.00
16	DE11 - Roads flooded	13	DE8 - Telephones out of service	0.00
17	DE12 - Gasoline in short supply	13	DE8 - Telephones out of service	0.00
20	DE15 - Product in transport destroyed	13	DE8 - Telephones out of service	0.00
21	O1 - Loss of documents and company materials/records.	13	DE8 - Telephones out of service	0.00
22	O2 - Business reputation tarnished	13	DE8 - Telephones out of service	0.00
23	O3 - Computer data lost	13	DE8 - Telephones out of service	0.00
24	O4 - Raw material cost increase	13	DE8 - Telephones out of service	0.00
25	O5 - Raw materials contaminated	13	DE8 - Telephones out of service	0.00
1	I1 - Computer server not fully backed up	14	DE9 - Internet connectivity lost	0.00
2	I2 - Fires underway	14	DE9 - Internet connectivity lost	0.00
3	I3 - Hurricane in area	14	DE9 - Internet connectivity lost	0.00
4	I4 - Business continuity plan not tested	14	DE9 - Internet connectivity lost	0.00
5	I5 - Local government not functioning	14	DE9 - Internet connectivity lost	0.00
6	DE1 - Electricity cut off	14	DE9 - Internet connectivity lost	0.00
11	DE6 - Backup power supply not available	14	DE9 - Internet connectivity lost	0.00

Row	Event	Col	Event	C_{ij}
12	DE7 - Access to facility forbidden	14	DE9 - Internet connectivity lost	0.00
13	DE8 - Telephones out of service	14	DE9 - Internet connectivity lost	0.00
17	DE12 - Gasoline in short supply	14	DE9 - Internet connectivity lost	0.00
20	DE15 - Product in transport destroyed	14	DE9 - Internet connectivity lost	0.00
24	O4 - Raw material cost increase	14	DE9 - Internet connectivity lost	0.00
25	O5 - Raw materials contaminated	14	DE9 - Internet connectivity lost	0.00
1	I1 - Computer server not fully backed up	15	DE10 - Increased lead time due to storm or other event	0.00
2	I2 - Fires underway	15	DE10 - Increased lead time due to storm or other event	0.00
3	I3 - Hurricane in area	15	DE10 - Increased lead time due to storm or other event	0.00
4	I4 - Business continuity plan not tested	15	DE10 - Increased lead time due to storm or other event	0.00
5	I5 - Local government not functioning	15	DE10 - Increased lead time due to storm or other event	0.00
6	DE1 - Electricity cut off	15	DE10 - Increased lead time due to storm or other event	0.00
7	DE2 - No communication networks	15	DE10 - Increased lead time due to storm or other event	0.00
8	DE3 - Computer hardware fails	15	DE10 - Increased lead time due to storm or other event	0.00
11	DE6 - Backup power supply not available	15	DE10 - Increased lead time due to storm or other event	0.00
12	DE7 - Access to facility forbidden	15	DE10 - Increased lead time due to storm or other event	0.00
13	DE8 - Telephones out of service	15	DE10 - Increased lead time due to storm or other event	0.00

Row	Event	Col	Event	C_{ij}
14	DE9 - Internet connectivity lost	15	DE10 - Increased lead time due to storm or other event	0.00
16	DE11 - Roads flooded	15	DE10 - Increased lead time due to storm or other event	0.00
17	DE12 - Gasoline in short supply	15	DE10 - Increased lead time due to storm or other event	0.00
18	DE13 - Roads clogged with traffic	15	DE10 - Increased lead time due to storm or other event	0.00
19	DE14 - Crime rate increase near place of business	15	DE10 - Increased lead time due to storm or other event	0.00
20	DE15 - Product in transport destroyed	15	DE10 - Increased lead time due to storm or other event	0.00
21	O1 - Loss of documents and company materials/records.	15	DE10 - Increased lead time due to storm or other event	0.00
23	O3 - Computer data lost	15	DE10 - Increased lead time due to storm or other event	0.00
25	O5 - Raw materials contaminated	15	DE10 - Increased lead time due to storm or other event	0.00
1	I1 - Computer server not fully backed up	16	DE11 - Roads flooded	0.00
2	I2 - Fires underway	16	DE11 - Roads flooded	0.00
3	I3 - Hurricane in area	16	DE11 - Roads flooded	0.00
4	I4 - Business continuity plan not tested	16	DE11 - Roads flooded	0.00
5	I5 - Local government not functioning	16	DE11 - Roads flooded	0.00
8	DE3 - Computer hardware fails	16	DE11 - Roads flooded	0.00
10	DE5 - Violent crime committed by employee during work hours	16	DE11 - Roads flooded	0.00
13	DE8 - Telephones out of service	16	DE11 - Roads flooded	0.00
14	DE9 - Internet connectivity lost	16	DE11 - Roads flooded	0.00
22	O2 - Business reputation tarnished	16	DE11 - Roads flooded	0.00
23	O3 - Computer data lost	16	DE11 - Roads flooded	0.00

Row	Event	Col	Event	C_{ij}
1	I1 - Computer server not fully backed up	17	DE12 - Gasoline in short supply	0.00
2	I2 - Fires underway	17	DE12 - Gasoline in short supply	0.00
3	I3 - Hurricane in area	17	DE12 - Gasoline in short supply	0.00
4	I4 - Business continuity plan not tested	17	DE12 - Gasoline in short supply	0.00
5	I5 - Local government not functioning	17	DE12 - Gasoline in short supply	0.00
6	DE1 - Electricity cut off	17	DE12 - Gasoline in short supply	0.00
7	DE2 - No communication networks	17	DE12 - Gasoline in short supply	0.00
8	DE3 - Computer hardware fails	17	DE12 - Gasoline in short supply	0.00
10	DE5 - Violent crime committed by employee during work hours	17	DE12 - Gasoline in short supply	0.00
11	DE6 - Backup power supply not available	17	DE12 - Gasoline in short supply	0.00
12	DE7 - Access to facility forbidden	17	DE12 - Gasoline in short supply	0.00
13	DE8 - Telephones out of service	17	DE12 - Gasoline in short supply	0.00
14	DE9 - Internet connectivity lost	17	DE12 - Gasoline in short supply	0.00
16	DE11 - Roads flooded	17	DE12 - Gasoline in short supply	0.00
20	DE15 - Product in transport destroyed	17	DE12 - Gasoline in short supply	0.00
21	O1 - Loss of documents and company materials/records.	17	DE12 - Gasoline in short supply	0.00
23	O3 - Computer data lost	17	DE12 - Gasoline in short supply	0.00
25	O5 - Raw materials contaminated	17	DE12 - Gasoline in short supply	0.00
1	I1 - Computer server not fully backed up	18	DE13 - Roads clogged with traffic	0.00
2	I2 - Fires underway	18	DE13 - Roads clogged with traffic	0.00
3	I3 - Hurricane in area	18	DE13 - Roads clogged with traffic	0.00
4	I4 - Business continuity plan not tested	18	DE13 - Roads clogged with traffic	0.00

Row	Event	Col	Event	C_{ij}
5	I5 - Local government not functioning	18	DE13 - Roads clogged with traffic	0.00
7	DE2 - No communication networks	18	DE13 - Roads clogged with traffic	0.00
8	DE3 - Computer hardware fails	18	DE13 - Roads clogged with traffic	0.00
10	DE5 - Violent crime committed by employee during work hours	18	DE13 - Roads clogged with traffic	0.00
14	DE9 - Internet connectivity lost	18	DE13 - Roads clogged with traffic	0.00
17	DE12 - Gasoline in short supply	18	DE13 - Roads clogged with traffic	0.00
19	DE14 - Crime rate increase near place of business	18	DE13 - Roads clogged with traffic	0.00
20	DE15 - Product in transport destroyed	18	DE13 - Roads clogged with traffic	0.00
21	O1 - Loss of documents and company materials/records.	18	DE13 - Roads clogged with traffic	0.00
24	O4 - Raw material cost increase	18	DE13 - Roads clogged with traffic	0.00
25	O5 - Raw materials contaminated	18	DE13 - Roads clogged with traffic	0.00
1	I1 - Computer server not fully backed up	19	DE14 - Crime rate increase near place of business	0.00
2	I2 - Fires underway	19	DE14 - Crime rate increase near place of business	0.00
3	I3 - Hurricane in area	19	DE14 - Crime rate increase near place of business	0.00
4	I4 - Business continuity plan not tested	19	DE14 - Crime rate increase near place of business	0.00
5	I5 - Local government not functioning	19	DE14 - Crime rate increase near place of business	0.00
6	DE1 - Electricity cut off	19	DE14 - Crime rate increase near place of business	0.00
7	DE2 - No communication networks	19	DE14 - Crime rate increase near place of business	0.00

Row	Event	Col	Event	C_{ij}
8	DE3 - Computer hardware fails	19	DE14 - Crime rate increase near place of business	0.00
11	DE6 - Backup power supply not available	19	DE14 - Crime rate increase near place of business	0.00
14	DE9 - Internet connectivity lost	19	DE14 - Crime rate increase near place of business	0.00
15	DE10 - Increased lead time due to storm or other event	19	DE14 - Crime rate increase near place of business	0.00
16	DE11 - Roads flooded	19	DE14 - Crime rate increase near place of business	0.00
17	DE12 - Gasoline in short supply	19	DE14 - Crime rate increase near place of business	0.00
18	DE13 - Roads clogged with traffic	19	DE14 - Crime rate increase near place of business	0.00
23	O3 - Computer data lost	19	DE14 - Crime rate increase near place of business	0.00
25	O5 - Raw materials contaminated	19	DE14 - Crime rate increase near place of business	0.00
1	I1 - Computer server not fully backed up	20	DE15 - Product in transport destroyed	0.00
2	I2 - Fires underway	20	DE15 - Product in transport destroyed	0.00
3	I3 - Hurricane in area	20	DE15 - Product in transport destroyed	0.00
4	I4 - Business continuity plan not tested	20	DE15 - Product in transport destroyed	0.00
5	I5 - Local government not functioning	20	DE15 - Product in transport destroyed	0.00
6	DE1 - Electricity cut off	20	DE15 - Product in transport destroyed	0.00
7	DE2 - No communication networks	20	DE15 - Product in transport destroyed	0.00
8	DE3 - Computer hardware fails	20	DE15 - Product in transport destroyed	0.00
9	DE4 - Personnel not available during an emergency	20	DE15 - Product in transport destroyed	0.00

Row	Event	Col	Event	C_{ij}
12	DE7 - Access to facility forbidden	20	DE15 - Product in transport destroyed	0.00
13	DE8 - Telephones out of service	20	DE15 - Product in transport destroyed	0.00
14	DE9 - Internet connectivity lost	20	DE15 - Product in transport destroyed	0.00
16	DE11 - Roads flooded	20	DE15 - Product in transport destroyed	0.00
17	DE12 - Gasoline in short supply	20	DE15 - Product in transport destroyed	0.00
18	DE13 - Roads clogged with traffic	20	DE15 - Product in transport destroyed	0.00
19	DE14 - Crime rate increase near place of business	20	DE15 - Product in transport destroyed	0.00
21	O1 - Loss of documents and company materials/records.	20	DE15 - Product in transport destroyed	0.00
23	O3 - Computer data lost	20	DE15 - Product in transport destroyed	0.00
25	O5 - Raw materials contaminated	20	DE15 - Product in transport destroyed	0.00
1	I1 - Computer server not fully backed up	21	O1 - Loss of documents and company materials/records.	0.00
2	I2 - Fires underway	21	O1 - Loss of documents and company materials/records.	0.00
3	I3 - Hurricane in area	21	O1 - Loss of documents and company materials/records.	0.00
4	I4 - Business continuity plan not tested	21	O1 - Loss of documents and company materials/records.	0.00
5	I5 - Local government not functioning	21	O1 - Loss of documents and company materials/records.	0.00
6	DE1 - Electricity cut off	21	O1 - Loss of documents and company materials/records.	0.00
7	DE2 - No communication networks	21	O1 - Loss of documents and company materials/records.	0.00
8	DE3 - Computer hardware fails	21	O1 - Loss of documents and company materials/records.	0.00

Row	Event	Col	Event	C_{ij}
9	DE4 - Personnel not available during an emergency	21	O1 - Loss of documents and company materials/records.	0.00
10	DE5 - Violent crime committed by employee during work hours	21	O1 - Loss of documents and company materials/records.	0.00
11	DE6 - Backup power supply not available	21	O1 - Loss of documents and company materials/records.	0.00
12	DE7 - Access to facility forbidden	21	O1 - Loss of documents and company materials/records.	0.00
13	DE8 - Telephones out of service	21	O1 - Loss of documents and company materials/records.	0.00
14	DE9 - Internet connectivity lost	21	O1 - Loss of documents and company materials/records.	0.00
15	DE10 - Increased lead time due to storm or other event	21	O1 - Loss of documents and company materials/records.	0.00
16	DE11 - Roads flooded	21	O1 - Loss of documents and company materials/records.	0.00
17	DE12 - Gasoline in short supply	21	O1 - Loss of documents and company materials/records.	0.00
18	DE13 - Roads clogged with traffic	21	O1 - Loss of documents and company materials/records.	0.00
19	DE14 - Crime rate increase near place of business	21	O1 - Loss of documents and company materials/records.	0.00
20	DE15 - Product in transport destroyed	21	O1 - Loss of documents and company materials/records.	0.00
22	O2 - Business reputation tarnished	21	O1 - Loss of documents and company materials/records.	0.00
23	O3 - Computer data lost	21	O1 - Loss of documents and company materials/records.	0.00
24	O4 - Raw material cost increase	21	O1 - Loss of documents and company materials/records.	0.00

Row	Event	Col	Event	C_{ij}
25	O5 - Raw materials contaminated	21	O1 - Loss of documents and company materials/records.	0.00
1	I1 - Computer server not fully backed up	22	O2 - Business reputation tarnished	0.00
2	I2 - Fires underway	22	O2 - Business reputation tarnished	0.00
3	I3 - Hurricane in area	22	O2 - Business reputation tarnished	0.00
4	I4 - Business continuity plan not tested	22	O2 - Business reputation tarnished	0.00
5	I5 - Local government not functioning	22	O2 - Business reputation tarnished	0.00
6	DE1 - Electricity cut off	22	O2 - Business reputation tarnished	0.00
7	DE2 - No communication networks	22	O2 - Business reputation tarnished	0.00
8	DE3 - Computer hardware fails	22	O2 - Business reputation tarnished	0.00
9	DE4 - Personnel not available during an emergency	22	O2 - Business reputation tarnished	0.00
10	DE5 - Violent crime committed by employee during work hours	22	O2 - Business reputation tarnished	0.00
11	DE6 - Backup power supply not available	22	O2 - Business reputation tarnished	0.00
12	DE7 - Access to facility forbidden	22	O2 - Business reputation tarnished	0.00
13	DE8 - Telephones out of service	22	O2 - Business reputation tarnished	0.00
14	DE9 - Internet connectivity lost	22	O2 - Business reputation tarnished	0.00
15	DE10 - Increased lead time due to storm or other event	22	O2 - Business reputation tarnished	0.00
16	DE11 - Roads flooded	22	O2 - Business reputation tarnished	0.00
17	DE12 - Gasoline in short supply	22	O2 - Business reputation tarnished	0.00
18	DE13 - Roads clogged with traffic	22	O2 - Business reputation tarnished	0.00
19	DE14 - Crime rate increase near place of business	22	O2 - Business reputation tarnished	0.00
20	DE15 - Product in transport destroyed	22	O2 - Business reputation tarnished	0.00
21	O1 - Loss of documents and company materials/records.	22	O2 - Business reputation tarnished	0.00

Row	Event	Col	Event	C_{ij}
23	O3 - Computer data lost	22	O2 - Business reputation tarnished	0.00
24	O4 - Raw material cost increase	22	O2 - Business reputation tarnished	0.00
25	O5 - Raw materials contaminated	22	O2 - Business reputation tarnished	0.00
1	I1 - Computer server not fully backed up	23	O3 - Computer data lost	0.00
2	I2 - Fires underway	23	O3 - Computer data lost	0.00
3	I3 - Hurricane in area	23	O3 - Computer data lost	0.00
4	I4 - Business continuity plan not tested	23	O3 - Computer data lost	0.00
5	I5 - Local government not functioning	23	O3 - Computer data lost	0.00
6	DE1 - Electricity cut off	23	O3 - Computer data lost	0.00
7	DE2 - No communication networks	23	O3 - Computer data lost	0.00
8	DE3 - Computer hardware fails	23	O3 - Computer data lost	0.00
9	DE4 - Personnel not available during an emergency	23	O3 - Computer data lost	0.00
10	DE5 - Violent crime committed by employee during work hours	23	O3 - Computer data lost	0.00
11	DE6 - Backup power supply not available	23	O3 - Computer data lost	0.00
12	DE7 - Access to facility forbidden	23	O3 - Computer data lost	0.00
13	DE8 - Telephones out of service	23	O3 - Computer data lost	0.00
14	DE9 - Internet connectivity lost	23	O3 - Computer data lost	0.00
15	DE10 - Increased lead time due to storm or other event	23	O3 - Computer data lost	0.00
16	DE11 - Roads flooded	23	O3 - Computer data lost	0.00
17	DE12 - Gasoline in short supply	23	O3 - Computer data lost	0.00
18	DE13 - Roads clogged with traffic	23	O3 - Computer data lost	0.00
19	DE14 - Crime rate increase near place of business	23	O3 - Computer data lost	0.00
20	DE15 - Product in transport destroyed	23	O3 - Computer data lost	0.00
21	O1 - Loss of documents and company materials/records.	23	O3 - Computer data lost	0.00

Row	Event	Col	Event	C_{ij}
22	O2 - Business reputation tarnished	23	O3 - Computer data lost	0.00
24	O4 - Raw material cost increase	23	O3 - Computer data lost	0.00
25	O5 - Raw materials contaminated	23	O3 - Computer data lost	0.00
1	I1 - Computer server not fully backed up	24	O4 - Raw material cost increase	0.00
2	I2 - Fires underway	24	O4 - Raw material cost increase	0.00
3	I3 - Hurricane in area	24	O4 - Raw material cost increase	0.00
4	I4 - Business continuity plan not tested	24	O4 - Raw material cost increase	0.00
5	I5 - Local government not functioning	24	O4 - Raw material cost increase	0.00
6	DE1 - Electricity cut off	24	O4 - Raw material cost increase	0.00
7	DE2 - No communication networks	24	O4 - Raw material cost increase	0.00
8	DE3 - Computer hardware fails	24	O4 - Raw material cost increase	0.00
9	DE4 - Personnel not available during an emergency	24	O4 - Raw material cost increase	0.00
10	DE5 - Violent crime committed by employee during work hours	24	O4 - Raw material cost increase	0.00
11	DE6 - Backup power supply not available	24	O4 - Raw material cost increase	0.00
12	DE7 - Access to facility forbidden	24	O4 - Raw material cost increase	0.00
13	DE8 - Telephones out of service	24	O4 - Raw material cost increase	0.00
14	DE9 - Internet connectivity lost	24	O4 - Raw material cost increase	0.00
15	DE10 - Increased lead time due to storm or other event	24	O4 - Raw material cost increase	0.00
16	DE11 - Roads flooded	24	O4 - Raw material cost increase	0.00
17	DE12 - Gasoline in short supply	24	O4 - Raw material cost increase	0.00
18	DE13 - Roads clogged with traffic	24	O4 - Raw material cost increase	0.00
19	DE14 - Crime rate increase near place of business	24	O4 - Raw material cost increase	0.00

Row	Event	Col	Event	C_{ij}
20	DE15 - Product in transport destroyed	24	O4 - Raw material cost increase	0.00
21	O1 - Loss of documents and company materials/records.	24	O4 - Raw material cost increase	0.00
22	O2 - Business reputation tarnished	24	O4 - Raw material cost increase	0.00
23	O3 - Computer data lost	24	O4 - Raw material cost increase	0.00
25	O5 - Raw materials contaminated	24	O4 - Raw material cost increase	0.00
1	I1 - Computer server not fully backed up	25	O5 - Raw materials contaminated	0.00
2	I2 - Fires underway	25	O5 - Raw materials contaminated	0.00
3	I3 - Hurricane in area	25	O5 - Raw materials contaminated	0.00
4	I4 - Business continuity plan not tested	25	O5 - Raw materials contaminated	0.00
5	I5 - Local government not functioning	25	O5 - Raw materials contaminated	0.00
6	DE1 - Electricity cut off	25	O5 - Raw materials contaminated	0.00
7	DE2 - No communication networks	25	O5 - Raw materials contaminated	0.00
8	DE3 - Computer hardware fails	25	O5 - Raw materials contaminated	0.00
9	DE4 - Personnel not available during an emergency	25	O5 - Raw materials contaminated	0.00
10	DE5 - Violent crime committed by employee during work hours	25	O5 - Raw materials contaminated	0.00
11	DE6 - Backup power supply not available	25	O5 - Raw materials contaminated	0.00
12	DE7 - Access to facility forbidden	25	O5 - Raw materials contaminated	0.00
13	DE8 - Telephones out of service	25	O5 - Raw materials contaminated	0.00
14	DE9 - Internet connectivity lost	25	O5 - Raw materials contaminated	0.00
15	DE10 - Increased lead time due to storm or other event	25	O5 - Raw materials contaminated	0.00
16	DE11 - Roads flooded	25	O5 - Raw materials contaminated	0.00
17	DE12 - Gasoline in short supply	25	O5 - Raw materials contaminated	0.00

Row	Event	Col	Event	C_{ij}
18	DE13 - Roads clogged with traffic	25	O5 - Raw materials contaminated	0.00
19	DE14 - Crime rate increase near place of business	25	O5 - Raw materials contaminated	0.00
20	DE15 - Product in transport destroyed	25	O5 - Raw materials contaminated	0.00
21	O1 - Loss of documents and company materials/records.	25	O5 - Raw materials contaminated	0.00
22	O2 - Business reputation tarnished	25	O5 - Raw materials contaminated	0.00
23	O3 - Computer data lost	25	O5 - Raw materials contaminated	0.00
24	O4 - Raw material cost increase	25	O5 - Raw materials contaminated	0.00
22	O2 - Business reputation tarnished	17	DE12 - Gasoline in short supply	-0.24
22	O2 - Business reputation tarnished	18	DE13 - Roads clogged with traffic	-0.24
23	O3 - Computer data lost	18	DE13 - Roads clogged with traffic	-0.24
19	DE14 - Crime rate increase near place of business	3	I3 - Hurricane in area	-0.56
19	DE14 - Crime rate increase near place of business	16	DE11 - Roads flooded	-0.56
12	DE7 - Access to facility forbidden	5	I5 - Local government not functioning	-0.81

APPENDIX L

FULL ROUND 1 RISK RESULTS ACROSS ALL CATEGORIES

This appendix shows the results of all risks as voted by the participants in Round 1. The rows are sorted by columns MEAN, W, and 5.

Risk Category	Text	N	MEAN	S.D.	5	4	3	2	1	0	W
Financial	Business reputation tarnished	53	4.42	1.1	36	11	2	1	2	1	234
Utility	Electricity cut off	49	4.29	0.9	25	16	6	1	1	0	210
Technology/ Data	Computer data lost	52	4.06	1.1	20	22	7	0	2	1	211
Technology/ Data	Computer virus attacks network	51	4.06	1.2	23	17	7	0	3	1	207
Technology/ Data	No communication networks	50	4.06	1.0	20	19	7	2	2	0	203
Technology/ Data	Computer server not fully backed up	51	4.04	1.1	18	24	6	0	2	1	206
Technology/ Data	Computer system hacked	51	4.02	1.2	22	19	5	0	4	1	205
Technology/ Data	Cyber-attack on computer infrastructure	50	4.02	1.3	23	16	6	0	4	1	201
Utility	Backup power supply not available	47	4.02	1.0	17	19	7	3	1	0	189
Technology/ Data	Malware embedded in software	51	3.98	1.2	20	19	7	2	2	1	203
Technology/ Data	Computer hardware fails	51	3.94	1.1	17	21	10	0	2	1	201
Personnel	Personnel not available during an emergency	51	3.92	1.1	19	17	10	2	3	0	200
Utility	Telephones out of service	48	3.90	0.9	12	24	8	3	1	0	187
Health	Workforce unavailable due to epidemic	52	3.88	1.3	21	18	5	3	4	1	202

Risk Category	Text	N	MEAN	S.D.	5	4	3	2	1	0	W
Personnel	Death of key officer	51	3.82	1.3	19	16	10	2	2	2	195
Technology/ Data	Large scale data breach	50	3.82	1.4	20	15	8	2	3	2	191
Technology/ Data	Software no longer runs on new computers	50	3.82	1.2	16	20	8	2	3	1	191
Fire	Fires underway	51	3.80	1.5	24	12	5	4	3	3	194
Weather	Hurricane in area	51	3.80	1.0	14	20	11	5	1	0	194
Health	Hazardous materials leaking	52	3.75	1.7	26	13	1	2	6	4	195
Legal	Violent crime committed by employee during work hours	51	3.75	1.6	24	13	1	5	6	2	191
Personnel	Key personnel not available during crisis	51	3.75	1.3	17	17	9	4	3	1	191
Terrorism	Terrorist attack in area	50	3.74	1.4	19	14	8	4	4	1	187
Health	Lack of response to safety issue	52	3.73	1.3	17	18	11	0	4	2	194
Fire	Facility explosion	51	3.69	1.6	23	11	6	4	3	4	188
Technology/ Data	Server Administrator passwords lost	49	3.69	1.3	13	22	6	4	2	2	181
Financial	Cash liquidity constrained	53	3.66	1.4	16	20	9	2	3	3	194
Personnel	Key personnel in plane crash	50	3.66	1.4	16	17	9	2	4	2	183
Weather	Tornado in area	50	3.66	1.1	11	20	12	5	2	0	183
Property	Access to facility forbidden	52	3.62	1.3	16	18	6	6	6	0	188
Technology/ Data	Internet provider failure	50	3.62	1.1	7	29	6	4	4	0	181
Health	Dangerous materials on premises	52	3.60	1.7	20	18	2	1	7	4	187
Health	Chemical release in area	51	3.59	1.5	17	16	7	4	5	2	183

Risk Category	Text	N	MEAN	S.D.	5	4	3	2	1	0	W
Legal	Lawsuit – vicarious liability from employee behavior	51	3.59	1.3	14	19	7	6	4	1	183
Health	No medical services	52	3.58	1.5	16	18	8	3	4	3	186
Technology/ Data	Computer/Laptop stolen	50	3.58	1.4	13	22	4	5	4	2	179
Legal	Computer based email lost during legal discovery	52	3.56	1.2	11	20	14	3	2	2	185
Technology/ Data	Virus protection out of date	51	3.55	1.2	9	23	11	4	3	1	181
Technology/ Data	Internet connectivity lost	50	3.54	1.1	8	24	9	5	4	0	177
Utility	Water supply undrinkable	48	3.54	1.3	15	10	15	3	4	1	170
Financial	Money stolen due to inadequate financial controls	53	3.53	1.5	18	16	7	2	8	2	187
Financial	Becoming dependent on too few customers	53	3.53	1.4	15	19	8	3	6	2	187
Legal	Lawsuit – sexual harassment	51	3.53	1.5	14	21	5	2	7	2	180
Technology/ Data	Computer operating system no longer supported	50	3.52	1.3	12	18	11	4	3	2	176
Personnel	Key personnel quits	51	3.51	1.2	7	26	11	1	5	1	179
Government	Additional costs due to new regulations	53	3.49	1.3	9	25	10	4	2	3	185
Property	Emergency responders lacking	51	3.45	1.4	11	21	8	4	5	2	176
Financial	Business continuity plan non-existent	53	3.42	1.5	15	16	10	3	6	3	181
Terrorism	Bomb threat issued	50	3.40	1.4	14	12	12	6	4	2	170

Risk Category	Text	N	MEAN	S.D.	5	4	3	2	1	0	W
Property	Alternate location not available	51	3.39	1.3	9	23	7	4	7	1	173
Terrorism	Civil unrest near place of business	50	3.36	1.4	13	12	13	6	4	2	168
Transportation	Roads flooded	50	3.36	1.2	7	20	12	7	3	1	168
Government	Hyper increase in benefit costs	52	3.35	1.6	13	21	5	3	4	6	174
Flood	Flood in area	52	3.35	1.4	11	16	14	5	3	3	174
Legal	Falsifying qualification and certifications to perform work	51	3.35	1.6	14	16	8	4	5	4	171
Legal	Lawsuit – discrimination	51	3.33	1.5	11	21	6	3	7	3	170
Flood	Burst Pipes	52	3.31	1.5	12	16	11	5	5	3	172
Personnel	Key personnel kidnapped	51	3.31	1.6	15	14	9	3	5	5	169
Financial	Not paying required payroll taxes	53	3.30	1.8	19	14	4	2	8	6	175
Financial	Insufficient insurance	52	3.27	1.5	11	18	9	5	6	3	170
Security	Lack of intrusion detection	52	3.27	1.3	10	15	13	9	3	2	170
Security	Violent crime committed on premises	51	3.24	1.6	14	15	5	7	6	4	165
Property	Employee theft	51	3.24	1.5	10	17	12	3	5	4	165
Technology/ Data	Cell phone stolen	50	3.24	1.2	6	18	13	8	5	0	162
Weather	Electrical storm in area	51	3.22	1.1	8	11	20	9	2	1	164
Personnel	Top talent refuses to work for you	51	3.22	1.3	5	22	11	7	4	2	164
Utility	Gasoline in short supply	49	3.22	1.3	7	16	17	2	4	3	158
Property	Valuable items on premises	50	3.20	1.3	8	15	15	6	3	3	160
Flood	First floor becomes flooded	52	3.19	1.7	16	12	7	5	7	5	166

Risk Category	Text	N	MEAN	S.D.	5	4	3	2	1	0	W
Technology/ Data	Computer stored credit card information stolen	50	3.18	1.9	17	14	3	1	7	8	159
Financial	Demand for product weakens	53	3.17	1.6	11	18	10	2	7	5	168
Fire	Building not passing fire inspection	51	3.16	1.4	7	18	12	7	4	3	161
Personnel	Promotion of ineffective employees to key positions	51	3.16	1.4	7	20	9	7	5	3	161
Personnel	Key personnel contact list non-existent	51	3.16	1.2	3	23	12	6	6	1	161
Property	Earthquake in area	51	3.14	1.6	11	16	8	4	9	3	160
Product	Vital records not secured	50	3.14	1.6	8	21	7	4	4	6	157
Government	Government overthrown	52	3.12	1.8	16	10	8	7	4	7	162
Legal	Working without proper government permits	51	3.12	1.7	11	17	8	3	6	6	159
Transportation	Roads filled with debris	50	3.12	1.3	6	17	12	9	4	2	156
Financial	Customers constrain cash flow with non-payment/ stretched payments	53	3.09	1.6	9	20	9	1	10	4	164
Utility	Sewage treatment unavailable	46	3.07	1.4	7	12	13	7	5	2	141
Transportation	Roads clogged with traffic	50	3.06	1.1	1	20	18	5	4	2	153
Security	Production equipment sabotaged	50	3.00	1.9	17	9	5	3	8	8	150

Risk Category	Text	N	MEAN	S.D.	5	4	3	2	1	0	W
Financial	Intellectual property stolen	50	3.00	1.8	14	10	9	3	7	7	150
Technology/ Data	Source code not available for recompiling	50	3.00	1.7	10	16	8	4	4	8	150
Property	Downed trees block building access	50	3.00	1.5	8	15	8	9	8	2	150
Flood	Local water levels rise	52	2.96	1.4	8	12	15	7	7	3	154
Financial	Bank loan denied	53	2.94	1.6	7	21	7	4	8	6	156
Financial	Competitors flood market with similar products	52	2.92	1.4	6	18	7	9	11	1	152
Property	Crime rate increase near place of business	50	2.92	1.2	3	15	18	5	7	2	146
Property	Alarm system not working	50	2.92	1.3	2	18	16	5	6	3	146
Financial	Business continuity plan not tested	52	2.85	1.3	5	12	18	8	5	4	148
Property	Windows unprotected from being broken	50	2.84	1.3	1	19	12	10	5	3	142
Legal	Lawsuit – intellectual property rights	52	2.83	1.8	12	12	5	8	8	7	147
Financial	Building insurance lapsed	52	2.83	1.7	10	14	6	7	9	6	147
Legal	Lawsuit – product liability	52	2.79	1.9	12	14	4	6	5	11	145
Supply Chain	Key supplier goes out of business	52	2.79	1.6	8	11	13	8	6	6	145
Utility	Natural gas supply unusable	48	2.79	1.6	7	12	12	4	7	6	134
Technology/ Data	Insufficient software licenses for temporary location	50	2.78	1.4	2	18	12	7	7	4	139

Risk Category	Text	N	MEAN	S.D.	5	4	3	2	1	0	W
Financial	Lack of new product development	53	2.77	1.7	9	15	8	5	8	8	147
Financial	Inaccurate market intelligence	52	2.77	1.5	4	17	12	6	8	5	144
Security	Windows unprotected from intrusion	50	2.76	1.5	7	10	15	5	8	5	138
Weather	Severe drought in area	50	2.76	1.2	4	8	19	11	7	1	138
Financial	Lack of succession planning	53	2.75	1.5	5	17	9	8	10	4	146
Legal	Use of pirated software for key purposes	51	2.75	1.7	6	19	5	5	9	7	140
Government	Local government not functioning	52	2.63	1.6	6	11	14	7	7	7	137
Financial	Lowering of financial rating/credit score	53	2.62	1.6	7	11	14	6	6	9	139
Legal	Copyright infringement	52	2.62	1.7	6	15	9	7	5	10	136
Financial	State tax audit	52	2.62	1.4	4	10	18	7	8	5	136
Supply Chain	Lack of spare parts	51	2.61	1.7	6	17	6	5	7	10	133
Flood	Second floor becomes flooded	52	2.60	2.0	16	6	6	1	11	12	135
Government	Government shutdown	52	2.60	1.5	6	11	9	14	6	6	135
Legal	Credit card processing is not PCI compliant	51	2.59	1.8	9	11	9	4	8	10	132
Supply Chain	Strategic partner goes out of business	49	2.57	1.6	6	11	11	5	9	7	126
Supply Chain	Priority service contracts not established to repair equipment	50	2.56	1.6	6	10	11	9	7	7	128
Financial	Federal tax audit	53	2.55	1.4	4	11	14	11	7	6	135

Risk Category	Text	N	MEAN	S.D.	5	4	3	2	1	0	W
Legal	Publishing false product claims	52	2.54	1.9	9	15	5	1	10	12	132
Government	Breach of HIPAA compliant data	52	2.54	1.8	9	11	7	8	6	11	132
Financial	Errors and Omissions insurance inadequate	53	2.53	1.6	5	11	16	3	11	7	134
Flood	Basement becomes flooded	52	2.52	1.7	9	8	11	7	7	10	131
Flood	Mudslide blocks building access	51	2.39	1.8	10	7	7	4	15	8	122
Financial	Stock market plunges	53	2.38	1.5	4	9	14	9	10	7	126
Product	Process machinery breakdown	50	2.38	1.9	8	12	5	4	8	13	119
Supply Chain	Not having alternate supply sources for raw materials	51	2.35	1.8	7	13	5	4	10	12	120
Legal	Trademark infringement	51	2.33	1.8	7	13	5	3	11	12	119
Financial	Product launch delays	52	2.29	1.6	4	11	11	5	12	9	119
Product	Product requires constant electricity	49	2.24	1.9	8	8	7	4	9	13	110
Legal	Patent infringement	52	2.17	1.8	5	15	3	5	9	15	113
Transportation	Buses unavailable	49	2.14	1.2	3	4	9	16	15	2	105
Transportation	Trains unavailable	49	2.14	1.2	2	5	12	11	17	2	105
Financial	Loss of learning accreditation	53	2.13	1.5	1	14	9	6	13	10	113
Product	Outsourcing creates non-competitive pricing environment	49	2.12	1.8	5	10	9	2	8	15	104

Risk Category	Text	N	MEAN	S.D.	5	4	3	2	1	0	W
Government	Community help limited	52	2.06	1.4	3	4	14	10	14	7	107
Financial	Currency fluctuations affect pricing	53	2.02	1.5	2	9	10	7	17	8	107
Flood	Extra high tide surges due to weather	52	2.02	1.7	4	10	7	5	14	12	105
Product	Formulation details destroyed	50	2.02	1.8	6	8	6	4	13	13	101
Product	Product in transport destroyed	50	2.00	1.8	4	13	5	2	9	17	100
Legal	Violation of export control restrictions	50	1.98	1.8	6	9	5	3	12	15	99
Product	Product requires other temperature control	50	1.96	1.8	5	8	7	6	8	16	98
Transportation	Airports not open	49	1.92	1.1	1	3	11	14	16	4	94
Transportation	Seaports not open	48	1.90	1.5	5	3	8	6	18	8	91
Supply Chain	Raw materials contaminated	50	1.78	1.7	4	9	5	2	14	16	89
Personnel	Workforce unavailable due to strike	50	1.76	1.8	5	10	1	5	10	19	88
Product	Validated manufacturing environment spoiled	49	1.71	1.8	3	10	5	1	12	18	84
Financial	Directors Insurance inadequate	50	1.68	1.5	1	5	13	4	12	15	84
Supply Chain	Private stores not available	50	1.68	1.5	0	9	7	8	11	15	84
Product	Product requires refrigeration	49	1.65	1.8	4	8	4	2	13	18	81
Personnel	Union grievance process too long	50	1.52	1.6	1	8	7	3	12	19	76

APPENDIX M

FULL ROUND 1 ACTION RESULTS ACROSS ALL CATEGORIES

This appendix shows the results of all actions as voted by the participants in Round 1. The rows are sorted by columns MEAN, W, and 2.

Action Category	Text	N	MEAN	S.D.	2	1	0	W
Financial	Broaden customer base	51	1.80	0.6	45	2	4	92
Financial	File taxes on time	51	1.78	0.6	45	1	5	91
Financial	Lower expenses	51	1.78	0.6	44	3	4	91
Technology/Data	Add virus protection	52	1.77	0.6	44	4	4	92
Financial	Pay required taxes	51	1.73	0.7	43	2	6	88
Technology/Data	Update virus protection	51	1.73	0.6	40	8	3	88
Financial	Create business continuity plan	52	1.69	0.6	39	10	3	88
Personnel	Create contact list	52	1.67	0.6	40	7	5	87
Technology/Data	Add adequate surge protection	51	1.67	0.7	40	5	6	85
Financial	Strengthen cash flow/lessen debt	51	1.65	0.7	38	8	5	84
Technology/Data	Use wireless connections	51	1.65	0.7	38	8	5	84
Fire	Buy fire extinguishers	51	1.59	0.7	38	5	8	81
Legal	Buy legitimate licenses	51	1.57	0.7	36	8	7	80
Technology/Data	Improve backup procedures	51	1.57	0.7	36	8	7	80
Product	Buy reputable equipment	51	1.57	0.7	34	12	5	80
Technology/Data	Add software firewall	52	1.56	0.7	36	9	7	81
Health	Create emergency first aid pack	50	1.52	0.7	32	12	6	76

Action Category	Text	N	MEAN	S.D.	2	1	0	W
Technology/Data	Create backups for emergency procedure execution	52	1.50	0.8	35	8	9	78
Weather	Buy flash lights	51	1.47	0.8	32	11	8	75
Technology/Data	Add real time backup software	50	1.46	0.8	31	11	8	73
Financial	Add alternate revenue sources	51	1.45	0.8	33	8	10	74
Technology/Data	Install hardware firewall	51	1.45	0.7	31	12	8	74
Transportation	Plan home office	52	1.44	0.7	31	13	8	75
Technology/Data	Add offsite backup	51	1.43	0.8	31	11	9	73
Financial	Negotiate better payment terms	50	1.42	0.8	32	7	11	71
Product	Store vital documentation	51	1.41	0.8	31	10	10	72
Technology/Data	Add multi-tiered backup strategy	51	1.39	0.8	30	11	10	71
Fire	Buy smoke alarms	51	1.37	0.8	30	10	11	70
Financial	Create succession plan	50	1.36	0.8	27	14	9	68
Weather	Buy extra batteries	50	1.34	0.8	28	11	11	67
Financial	Find alternate insurance	50	1.34	0.8	27	13	10	67
Product	Revise marketing materials.	51	1.33	0.8	29	10	12	68
Financial	Create continuous audit system	51	1.33	0.8	26	16	9	68
Fire	Create building evacuation plan	51	1.33	0.8	26	16	9	68
Security	Add access security system	50	1.32	0.8	27	12	11	66
Weather	Buy snow shovels	50	1.32	0.8	27	12	11	66
Supply Chain	Identify alternate suppliers	48	1.31	0.8	25	13	10	63
Product	Brainstorm new products	52	1.29	0.8	26	15	11	67
Financial	Improve insurance renewal procedures	50	1.28	0.8	24	16	10	64

Action Category	Text	N	MEAN	S.D.	2	1	0	W
Product	Innovate new products	52	1.27	0.8	26	14	12	66
Transportation	Use ground-based transportation	51	1.27	0.8	26	13	12	65
Product	Add preventive maintenance program	51	1.25	0.8	25	14	12	64
Security	Add security cameras	51	1.25	0.8	25	14	12	64
Utility	Add power generators	50	1.24	0.8	23	16	11	62
Technology/Data	Update operating system during upgrade grace period	49	1.24	0.8	25	11	13	61
Technology/Data	Use alternate communication services such as mail or courier	51	1.22	0.9	26	10	15	62
Financial	Self-finance operation	51	1.20	0.9	25	11	15	61
Transportation	Use alternate transportation	51	1.20	0.8	24	13	14	61
Fire	Add sprinkler system	51	1.20	0.8	23	15	13	61
Security	Improve security protection	50	1.20	0.8	22	16	12	60
Weather	Fill vehicle gas tanks	51	1.18	0.8	23	14	14	60
Fire	Improve fireproofing	51	1.18	0.8	22	16	13	60
Financial	Increase insurance coverage	49	1.18	0.8	20	18	11	58
Product	Test business continuity plan	51	1.14	0.8	21	16	14	58
Technology/Data	Encrypt/password protect hard drive	51	1.14	0.8	21	16	14	58
Technology/Data	Upgrade hardware and run old software under emulation.	48	1.13	0.8	20	14	14	54
Technology/Data	Create data deletion plan	51	1.08	0.8	18	19	14	55

Action Category	Text	N	MEAN	S.D.	2	1	0	W
Security	Add check-in / check-out property procedures	50	1.08	0.8	18	18	14	54
Supply Chain	Add alternate contractors	48	1.08	0.8	18	16	14	52
Personnel	Change management team	52	1.06	0.8	19	17	16	55
Technology/Data	Increase number of software licenses	51	1.06	0.8	19	16	16	54
Product	Use manual procedures	51	1.04	0.9	20	13	18	53
Technology/Data	Add remote destruction of data	50	1.04	0.8	17	18	15	52
Legal	Take legal action	51	1.02	0.9	19	14	18	52
Government	Lobby government for lesser regulations	51	1.02	0.8	17	18	16	52
Technology/Data	Create hot site alternate location	51	1.02	0.8	17	18	16	52
Property	Obtain proper permits	51	1.00	0.8	17	17	17	51
Fire	Schedule a fire protection audit	50	1.00	0.8	18	14	18	50
Technology/Data	Rebuild data from source documentation	49	1.00	0.8	17	15	17	49
Personnel	Use replacement personnel	49	1.00	0.8	16	17	16	49
Health	Move employees to safe area	50	0.98	0.8	16	17	17	49
Personnel	Recruit new manager	51	0.96	0.8	17	15	19	49
Legal	Report to government officials	50	0.96	0.8	15	18	17	48
Product	Create new products with proprietary technology	52	0.94	0.8	15	19	18	49
Weather	Freeze food	50	0.94	0.8	13	21	16	47
Supply Chain	Create alternate supply chain	48	0.94	0.8	13	19	16	45

Action Category	**Text**	**N**	**MEAN**	**S.D.**	**2**	**1**	**0**	**W**
Property	Coordinate volunteer group	51	0.92	0.8	15	17	19	47
Supply Chain	Increase spare part inventory	49	0.92	0.8	13	19	17	45
Supply Chain	Find alternate partner	48	0.92	0.8	14	16	18	44
Property	Renovate building to new code	51	0.90	0.8	14	18	19	46
Property	Create community response	51	0.88	0.8	15	15	21	45
Product	Revalidate equipment	51	0.88	0.8	14	17	20	45
Legal	Take PCI compliance audit	51	0.88	0.8	13	19	19	45
Property	Plan alternate building access	51	0.88	0.8	13	19	19	45
Weather	Add lightning rods to building	51	0.88	0.8	12	21	18	45
Supply Chain	Reorder new raw materials	48	0.88	0.8	12	18	18	42
Product	Move operations to secondary site	51	0.86	0.8	13	18	20	44
Health	Inoculate employees against infection	50	0.86	0.8	13	17	20	43
Security	Seal windows and doors	50	0.86	0.8	12	19	19	43
Flood	Raise electrical equipment above flood stage	50	0.84	0.8	11	20	19	42
Technology/Data	Create hot spares	51	0.82	0.7	10	22	19	42
Legal	Create notification for customers to cancel credit cards	50	0.82	0.8	13	15	22	41
Legal	Draft cease/desist letter	51	0.80	0.8	11	19	21	41
Legal	Hire public relations firm	51	0.80	0.7	10	21	20	41
Personnel	Increase offer to make company attractive	51	0.76	0.8	12	15	24	39

Action Category	Text	N	MEAN	S.D.	2	1	0	W
Product	Provide strong certification process	51	0.76	0.7	8	23	20	39
Utility	Rent port-a-johns	51	0.76	0.7	8	23	20	39
Flood	Raise product inventory above flood stage	50	0.76	0.8	11	16	23	38
Utility	Store additional gasoline	50	0.76	0.7	9	20	21	38
Weather	Buy gas/propane grill	50	0.76	0.7	8	22	20	38
Financial	Value product in strong currency	51	0.75	0.9	14	10	27	38
Product	Spread production over larger geographic area	51	0.75	0.7	9	20	22	38
Utility	Install natural gas generator	51	0.75	0.7	9	20	22	38
Weather	Buy extra coolers	51	0.75	0.7	9	20	22	38
Utility	Host own gas supply	51	0.75	0.7	8	22	21	38
Flood	Build containment walls	49	0.73	0.7	7	22	20	36
Technology/Data	Buy password cracking software	52	0.71	0.7	7	23	22	37
Legal	Maintain export compliance	51	0.71	0.8	10	16	25	36
Property	Fortify building structure	51	0.71	0.7	8	20	23	36
Weather	Store additional propane	51	0.71	0.7	8	20	23	36
Personnel	Improve union relations.	51	0.71	0.7	6	24	21	36
Security	Add metal bars to windows	50	0.70	0.6	5	25	20	35
Personnel	Create union/management team building	51	0.69	0.7	6	23	22	35
Financial	Place stop loss stock orders	50	0.68	0.8	10	14	26	34

Action Category	Text	N	MEAN	S.D.	2	1	0	W
Government	Increase safety of building codes	50	0.68	0.8	10	14	26	34
Flood	Add building flood walls around property	50	0.66	0.6	4	25	21	33
Product	Provide own inspectors	51	0.65	0.7	7	19	25	33
Product	Buy non-electrical dehumidification equipment	50	0.64	0.6	4	24	22	32
Property	Hire heavy equipment for removal	51	0.63	0.7	5	22	24	32
Weather	Install storm shutters	50	0.62	0.6	4	23	23	31
Flood	Raise building above ground level	50	0.62	0.6	3	25	22	31
Product	Hire new market research firm	52	0.60	0.7	5	21	26	31
Flood	Fortify flood levies	50	0.60	0.6	3	24	23	30
Technology/Data	Rebuild formulation	51	0.59	0.7	5	20	26	30
Product	Limit customer order quantities	51	0.59	0.6	4	22	25	30
Health	Add filtration facility	50	0.56	0.6	4	20	26	28
Product	Prepare food offsite	51	0.55	0.7	5	18	28	28
Weather	Build storm shelter	51	0.55	0.6	2	24	25	28
Weather	Buy dry ice	50	0.54	0.6	4	19	27	27
Government	Buy out vulnerable properties	50	0.52	0.6	4	18	28	26
Technology/Data	Disassemble and rewrite source code	50	0.50	0.6	3	19	28	25
Weather	Buy charcoal grill	51	0.49	0.6	2	21	28	25
Weather	Buy charcoal	51	0.45	0.5	1	21	29	23

APPENDIX N

FULL ROUND 1 PLUS ROUND 2 CONSOLIDATED RISK RESULTS ACROSS ALL CATEGORIES

This appendix shows the results of all risks as voted by the participants in Round 1 and 2. The rows are sorted by columns MEAN, W', and 5.

R	Risk Category	Text	N	MEAN	S.D.	5	4	3	2	1	0	W'
1	Financial	Business reputation tarnished	53	4.42	1.1	36	11	2	1	2	1	234
2	Fire	Loss of documents and company materials/ records	41	4.29	0.8	20	15	4	2	0	0	251
1	Utility	Electricity cut off	49	4.29	0.9	25	16	6	1	1	0	210
1	Technology/ Data	Computer data lost	52	4.06	1.1	20	22	7	0	2	1	211
1	Technology/ Data	Computer virus attacks network	51	4.06	1.2	23	17	7	0	3	1	207
1	Technology/ Data	No communication networks	50	4.06	1.0	20	19	7	2	2	0	203
1	Technology/ Data	Computer server not fully backed up	51	4.04	1.1	18	24	6	0	2	1	206
1	Technology/ Data	Computer system hacked	51	4.02	1.2	22	19	5	0	4	1	205
1	Technology/ Data	Cyber-attack on computer infrastructure	50	4.02	1.3	23	16	6	0	4	1	201
1	Utility	Backup power supply not available	47	4.02	1.0	17	19	7	3	1	0	189
1	Technology/ Data	Malware embedded in software	51	3.98	1.2	20	19	7	2	2	1	203
1	Technology/ Data	Computer hardware fails	51	3.94	1.1	17	21	10	0	2	1	201

R	Risk Category	Text	N	MEAN	S.D.	5	4	3	2	1	0	W'
1	Personnel	Personnel not available during an emergency	51	3.92	1.1	19	17	10	2	3	0	200
1	Utility	Telephones out of service	48	3.90	0.9	12	24	8	3	1	0	187
2	Financial	Loss of liability insurance	41	3.88	1.2	15	13	10	0	2	1	227
1	Health	Workforce unavailable due to epidemic	52	3.88	1.3	21	18	5	3	4	1	202
1	Personnel	Death of key officer	51	3.82	1.3	19	16	10	2	2	2	195
1	Technology/ Data	Large scale data breach	50	3.82	1.4	20	15	8	2	3	2	191
1	Technology/ Data	Software no longer runs on new computers	50	3.82	1.2	16	20	8	2	3	1	191
1	Fire	Fires underway	51	3.80	1.5	24	12	5	4	3	3	194
1	Weather	Hurricane in area	51	3.80	1.0	14	20	11	5	1	0	194
2	Health	On the job injuries	38	3.76	0.9	6	21	8	2	1	0	204
1	Health	Hazardous materials leaking	52	3.75	1.7	26	13	1	2	6	4	195
1	Legal	Violent crime committed by employee during work hours	51	3.75	1.6	24	13	1	5	6	2	191
1	Personnel	Key personnel not available during crisis	51	3.75	1.3	17	17	9	4	3	1	191
1	Terrorism	Terrorist attack in area	50	3.74	1.4	19	14	8	4	4	1	187
1	Health	Lack of response to safety issue	52	3.73	1.3	17	18	11	0	4	2	194
2	Government	Increased regulations	40	3.70	0.8	6	19	12	3	0	0	211
1	Fire	Facility explosion	51	3.69	1.6	23	11	6	4	3	4	188

R	Risk Category	Text	N	MEAN	S.D.	5	4	3	2	1	0	W'
1	Technology/ Data	Server Administrator passwords lost	49	3.69	1.3	13	22	6	4	2	2	181
1	Financial	Cash liquidity constrained	53	3.66	1.4	16	20	9	2	3	3	194
1	Personnel	Key personnel in plane crash	50	3.66	1.4	16	17	9	2	4	2	183
1	Weather	Tornado in area	50	3.66	1.1	11	20	12	5	2	0	183
1	Property	Access to facility forbidden	52	3.62	1.3	16	18	6	6	6	0	188
1	Technology/ Data	Internet provider failure	50	3.62	1.1	7	29	6	4	4	0	181
1	Health	Dangerous materials on premises	52	3.60	1.7	20	18	2	1	7	4	187
1	Health	Chemical release in area	51	3.59	1.5	17	16	7	4	5	2	183
1	Legal	Lawsuit – vicarious liability from employee behavior	51	3.59	1.3	14	19	7	6	4	1	183
1	Health	No medical services	52	3.58	1.5	16	18	8	3	4	3	186
1	Technology/ Data	Computer/ laptop stolen	50	3.58	1.4	13	22	4	5	4	2	179
1	Legal	Computer based email lost during legal discovery	52	3.56	1.2	11	20	14	3	2	2	185
1	Technology/ Data	Virus protection out of date	51	3.55	1.2	9	23	11	4	3	1	181
1	Technology/ Data	Internet connectivity lost	50	3.54	1.1	8	24	9	5	4	0	177
1	Utility	Water supply undrinkable	48	3.54	1.3	15	10	15	3	4	1	170
1	Financial	Money stolen due to inadequate financial controls	53	3.53	1.5	18	16	7	2	8	2	187

R	Risk Category	Text	N	MEAN	S.D.	5	4	3	2	1	0	W'
1	Financial	Becoming dependent on too few customers	53	3.53	1.4	15	19	8	3	6	2	187
1	Legal	Lawsuit – sexual harassment	51	3.53	1.5	14	21	5	2	7	2	180
1	Technology/ Data	Computer operating system no longer supported	50	3.52	1.3	12	18	11	4	3	2	176
2	Health	Exposure to hazardous materials	39	3.51	1.4	9	18	4	3	2	3	196
1	Personnel	Key personnel quits	51	3.51	1.2	7	26	11	1	5	1	179
1	Government	Additional costs due to new regulations	53	3.49	1.3	9	25	10	4	2	3	185
1	Property	Emergency responders lacking	51	3.45	1.4	11	21	8	4	5	2	176
1	Financial	Business continuity plan non-existent	53	3.42	1.5	15	16	10	3	6	3	181
1	Terrorism	Bomb threat issued	50	3.40	1.4	14	12	12	6	4	2	170
2	Government	Unexpected audit	41	3.39	1	6	12	16	6	1	0	199
1	Property	Alternate location not available	51	3.39	1.3	9	23	7	4	7	1	173
1	Terrorism	Civil unrest near place of business	50	3.36	1.4	13	12	13	6	4	2	168
1	Transportation	Roads flooded	50	3.36	1.2	7	20	12	7	3	1	168
1	Government	Hyper increase in benefit costs	52	3.35	1.6	13	21	5	3	4	6	174
1	Flood	Flood in area	52	3.35	1.4	11	16	14	5	3	3	174

R	Risk Category	Text	N	MEAN	S.D.	5	4	3	2	1	0	W'
1	Legal	Falsifying qualification and certifications to perform work	51	3.35	1.6	14	16	8	4	5	4	171
1	Legal	Lawsuit – discrimination	51	3.33	1.5	11	21	6	3	7	3	170
2	Fire	Fire caused by bad weather	41	3.32	1.4	8	16	6	6	2	3	194
2	Financial	Unforeseen insurance rateables increase	41	3.32	1.3	5	16	14	2	1	3	194
1	Flood	Burst pipes	52	3.31	1.5	12	16	11	5	5	3	172
1	Personnel	Key personnel kidnapped	51	3.31	1.6	15	14	9	3	5	5	169
1	Financial	Not paying required payroll taxes	53	3.30	1.8	19	14	4	2	8	6	175
2	Fire	Combustion due to improperly stored or disposed of supplies or refuse	41	3.29	1.6	10	16	2	6	3	4	193
1	Financial	Insufficient insurance	52	3.27	1.5	11	18	9	5	6	3	170
1	Security	Lack of intrusion detection	52	3.27	1.3	10	15	13	9	3	2	170
2	Flood	Downturn in business due to floods in other areas	41	3.24	1.2	7	9	16	5	4	0	190
1	Security	Violent crime committed on premises	51	3.24	1.6	14	15	5	7	6	4	165
1	Property	Employee theft	51	3.24	1.5	10	17	12	3	5	4	165
1	Technology/ Data	Cell phone stolen	50	3.24	1.2	6	18	13	8	5	0	162
1	Weather	Electrical storm in area	51	3.22	1.1	8	11	20	9	2	1	164

R	Risk Category	Text	N	MEAN	S.D.	5	4	3	2	1	0	W'
1	Personnel	Top talent refuses to work for you	51	3.22	1.3	5	22	11	7	4	2	164
1	Utility	Gasoline in short supply	49	3.22	1.3	7	16	17	2	4	3	158
1	Property	Valuable items on premises	50	3.20	1.3	8	15	15	6	3	3	160
1	Flood	First floor becomes flooded	52	3.19	1.7	16	12	7	5	7	5	166
1	Technology/ Data	Computer stored credit card information stolen	50	3.18	1.9	17	14	3	1	7	8	159
1	Financial	Demand for product weakens	53	3.17	1.6	11	18	10	2	7	5	168
1	Fire	Building not passing fire inspection	51	3.16	1.4	7	18	12	7	4	3	161
1	Personnel	Promotion of ineffective employees to key positions	51	3.16	1.4	7	20	9	7	5	3	161
1	Personnel	Key personnel contact list non-existent	51	3.16	1.2	3	23	12	6	6	1	161
2	Legal	Vicarious liability for employee actions	40	3.15	1.6	6	16	9	2	1	6	180
1	Property	Earthquake in area	51	3.14	1.6	11	16	8	4	9	3	160
1	Product	Vital records not secured	50	3.14	1.6	8	21	7	4	4	6	157
1	Government	Government overthrown	52	3.12	1.8	16	10	8	7	4	7	162
1	Legal	Working without proper government permits	51	3.12	1.7	11	17	8	3	6	6	159

R	Risk Category	Text	N	MEAN	S.D.	5	4	3	2	1	0	W'
1	Transportation	Roads filled with debris	50	3.12	1.3	6	17	12	9	4	2	156
2	Financial	Customer filing for bankruptcy, Chapter 7 or 11	41	3.10	1.6	9	10	9	7	1	5	181
1	Financial	Customers constrain cash flow with non-payment/ stretched payments	53	3.09	1.6	9	20	9	1	10	4	164
1	Utility	Sewage treatment unavailable	46	3.07	1.4	7	12	13	7	5	2	141
1	Transportation	Roads clogged with traffic	50	3.06	1.1	1	20	18	5	4	2	153
2	Personnel	Employee theft requiring dismissal	41	3.05	1.5	5	16	9	3	3	5	179
2	Product	Raw material cost increase	38	3.03	1.6	7	13	4	6	4	4	164
2	Government	Unexpected inspection	41	3.00	1.1	3	10	16	9	2	1	176
1	Security	Production equipment sabotaged	50	3.00	1.9	17	9	5	3	8	8	150
1	Financial	Intellectual property stolen	50	3.00	1.8	14	10	9	3	7	7	150
1	Technology/ Data	Source code not available for recompiling	50	3.00	1.7	10	16	8	4	4	8	150
1	Property	Downed trees block building access	50	3.00	1.5	8	15	8	9	8	2	150
2	Supply Chain	Increased lead time due to storm or other event	41	2.98	1.3	3	14	12	6	3	3	174
1	Flood	Local water levels rise	52	2.96	1.4	8	12	15	7	7	3	154

R	Risk Category	Text	N	MEAN	S.D.	5	4	3	2	1	0	W'
2	Legal	Liability of employee operating a company vehicle	41	2.95	1.8	8	14	7	0	4	8	173
1	Financial	Bank loan denied	53	2.94	1.6	7	21	7	4	8	6	156
2	Weather	Snow storm in area	41	2.93	1.1	3	9	16	9	3	1	171
1	Financial	Competitors flood market with similar products	52	2.92	1.4	6	18	7	9	11	1	152
1	Property	Crime rate increase near place of business	50	2.92	1.2	3	15	18	5	7	2	146
1	Property	Alarm system not working	50	2.92	1.3	2	18	16	5	6	3	146
1	Financial	Business continuity plan not tested	52	2.85	1.3	5	12	18	8	5	4	148
1	Property	Windows unprotected from being broken	50	2.84	1.3	1	19	12	10	5	3	142
2	Financial	Unplanned workmen's compensation increase	41	2.83	1.4	3	12	14	4	3	5	166
1	Legal	Lawsuit – intellectual property rights	52	2.83	1.8	12	12	5	8	8	7	147
1	Financial	Building insurance lapsed	52	2.83	1.7	10	14	6	7	9	6	147
1	Legal	Lawsuit – product liability	52	2.79	1.9	12	14	4	6	5	11	145
1	Supply Chain	Key supplier goes out of business	52	2.79	1.6	8	11	13	8	6	6	145
1	Utility	Natural gas supply unusable	48	2.79	1.6	7	12	12	4	7	6	134

R	Risk Category	Text	N	MEAN	S.D.	5	4	3	2	1	0	W'
1	Technology/ Data	Insufficient software licenses for temporary location	50	2.78	1.4	2	18	12	7	7	4	139
1	Financial	Lack of new product development	53	2.77	1.7	9	15	8	5	8	8	147
1	Financial	Inaccurate market intelligence	52	2.77	1.5	4	17	12	6	8	5	144
2	Supply Chain	Changes in vendor terms	41	2.76	1.4	5	8	9	12	5	2	161
1	Security	Windows unprotected from intrusion	50	2.76	1.5	7	10	15	5	8	5	138
1	Weather	Severe drought in area	50	2.76	1.2	4	8	19	11	7	1	138
1	Financial	Lack of succession planning	53	2.75	1.5	5	17	9	8	10	4	146
1	Legal	Use of pirated software for key purposes	51	2.75	1.7	6	19	5	5	9	7	140
2	Supply Chain	Changes in global raw material supply, price, or availability	41	2.68	1.6	6	10	7	7	5	6	157
1	Government	Local government not functioning	52	2.63	1.6	6	11	14	7	7	7	137
1	Financial	Lowering of financial rating/credit score	53	2.62	1.6	7	11	14	6	6	9	139
1	Legal	Copyright infringement	52	2.62	1.7	6	15	9	7	5	10	136
1	Financial	State tax audit	52	2.62	1.4	4	10	18	7	8	5	136
1	Supply Chain	Lack of spare parts	51	2.61	1.7	6	17	6	5	7	10	133
1	Flood	Second floor becomes flooded	52	2.60	2.0	16	6	6	1	11	12	135

R	Risk Category	Text	N	MEAN	S.D.	5	4	3	2	1	0	W'
1	Government	Government shutdown	52	2.60	1.5	6	11	9	14	6	6	135
1	Legal	Credit card processing is not PCI compliant	51	2.59	1.8	9	11	9	4	8	10	132
1	Supply Chain	Strategic Partner goes out of business	49	2.57	1.6	6	11	11	5	9	7	126
1	Supply Chain	Priority service contracts not established to repair equipment	50	2.56	1.6	6	10	11	9	7	7	128
1	Financial	Federal tax audit	53	2.55	1.4	4	11	14	11	7	6	135
1	Government	Breach of HIPAA compliant data	52	2.54	1.8	9	11	7	8	6	11	132
1	Legal	Publishing false product claims	52	2.54	1.9	9	15	5	1	10	12	132
1	Financial	Errors and Omissions Insurance inadequate	53	2.53	1.6	5	11	16	3	11	7	134
1	Flood	Basement becomes flooded	52	2.52	1.7	9	8	11	7	7	10	131
1	Flood	Mudslide blocks building access	51	2.39	1.8	10	7	7	4	15	8	122
2	Financial	Customer loans not repaid	40	2.38	1.7	4	10	5	7	6	8	136
1	Financial	Stock market plunges	53	2.38	1.5	4	9	14	9	10	7	126
1	Product	Process machinery breakdown	50	2.38	1.9	8	12	5	4	8	13	119
1	Supply Chain	Not having alternate supply sources for raw materials	51	2.35	1.8	7	13	5	4	10	12	120

R	Risk Category	Text	N	MEAN	S.D.	5	4	3	2	1	0	W'
1	Legal	Trademark infringement	51	2.33	1.8	7	13	5	3	11	12	119
1	Financial	Product launch delays	52	2.29	1.6	4	11	11	5	12	9	119
2	Product	Natural gas shortage	41	2.24	1.5	1	8	11	10	2	9	131
1	Product	Product requires constant electricity	49	2.24	1.9	8	8	7	4	9	13	110
1	Legal	Patent infringement	52	2.17	1.8	5	15	3	5	9	15	113
1	Transportation	Buses unavailable	49	2.14	1.2	3	4	9	16	15	2	105
1	Transportation	Trains unavailable	49	2.14	1.2	2	5	12	11	17	2	105
1	Financial	Loss of learning accreditation	53	2.13	1.5	1	14	9	6	13	10	113
2	Utility	Utilities unavailable to prepare food	41	2.12	1.7	5	7	4	7	8	10	124
1	Product	Outsourcing creates non-competitive pricing environment	49	2.12	1.8	5	10	9	2	8	15	104
1	Government	Community help limited	52	2.06	1.4	3	4	14	10	14	7	107
1	Financial	Currency fluctuations affect pricing	53	2.02	1.5	2	9	10	7	17	8	107
1	Flood	Extra high tide surges due to weather	52	2.02	1.7	4	10	7	5	14	12	105
1	Product	Formulation details destroyed	50	2.02	1.8	6	8	6	4	13	13	101
1	Product	Product in transport destroyed	50	2.00	1.8	4	13	5	2	9	17	100
1	Legal	Violation of export control restrictions	50	1.98	1.8	6	9	5	3	12	15	99

R	Risk Category	Text	N	MEAN	S.D.	5	4	3	2	1	0	W'
1	Product	Product requires other temperature control	50	1.96	1.8	5	8	7	6	8	16	98
1	Transportation	Airports not open	49	1.92	1.1	1	3	11	14	16	4	94
1	Transportation	Seaports not open	48	1.90	1.5	5	3	8	6	18	8	91
1	Supply Chain	Raw materials contaminated	50	1.78	1.7	4	9	5	2	14	16	89
1	Personnel	Workforce unavailable due to strike	50	1.76	1.8	5	10	1	5	10	19	88
1	Product	Validated manufacturing environment spoiled	49	1.71	1.8	3	10	5	1	12	18	84
1	Financial	Directors insurance inadequate	50	1.68	1.5	1	5	13	4	12	15	84
1	Supply Chain	Private stores not available	50	1.68	1.5	0	9	7	8	11	15	84
1	Product	Product requires refrigeration	49	1.65	1.8	4	8	4	2	13	18	81
1	Personnel	Union grievance process too long	50	1.52	1.6	1	8	7	3	12	19	76

APPENDIX O

FULL ROUND 1 PLUS ROUND 2 CONSOLIDATED ACTION RESULTS ACROSS ALL CATEGORIES

This appendix shows the results of all actions as voted by the participants in Round 1 and 2. The rows are sorted by columns MEAN, W', and 2.

Table O.1 Table Legend for Action Data by Category

Column Title	Meaning
R	Round number, either 1 or 2
Action Category	The original category for the action item
Text	Survey text
N	Number of respondents
MEAN	Average value
S.D.	Standard Deviation
2	Applies to my business
1	Applies only to other businesses
0	No Judgment
W'	Normalized Weighted Value (See calculation, Figure 4.2)

R	Action Category	Text	N	MEAN	S.D.	2	1	0	W'
1	Financial	Broaden customer base	51	1.80	0.6	45	2	4	92
1	Financial	File taxes on time	51	1.78	0.6	45	1	5	91
1	Financial	Lower expenses	51	1.78	0.6	44	3	4	91
1	Technology/ Data	Add virus protection	52	1.77	0.6	44	4	4	92
1	Financial	Pay required taxes	51	1.73	0.7	43	2	6	88
1	Technology/ Data	Update virus protection	51	1.73	0.6	40	8	3	88
1	Financial	Create business continuity plan	52	1.69	0.6	39	10	3	88
1	Personnel	Create contact list	52	1.67	0.6	40	7	5	87
1	Technology/ Data	Add adequate surge protection	51	1.67	0.7	40	5	6	85
1	Financial	Strengthen cash flow/lessen debt	51	1.65	0.7	38	8	5	84
1	Technology/ Data	Use wireless connections	51	1.65	0.7	38	8	5	84

R	Action Category	Text	N	MEAN	S.D.	2	1	0	W'
1	Fire	Buy fire extinguishers	51	1.59	0.7	38	5	8	81
1	Legal	Buy legitimate licenses	51	1.57	0.7	36	8	7	80
1	Technology/ Data	Improve backup procedures	51	1.57	0.7	36	8	7	80
1	Product	Buy reputable equipment	51	1.57	0.7	34	12	5	80
1	Technology/ Data	Add software firewall	52	1.56	0.7	36	9	7	81
1	Health	Create emergency first aid pack	50	1.52	0.7	32	12	6	76
1	Technology/ Data	Create backups for emergency procedure execution	52	1.50	0.8	35	8	9	78
1	Weather	Buy flash lights	51	1.47	0.8	32	11	8	75
1	Technology/ Data	Add real time backup software	50	1.46	0.8	31	11	8	73
1	Financial	Add alternate revenue sources	51	1.45	0.8	33	8	10	74
1	Technology/ Data	Install hardware firewall	51	1.45	0.7	31	12	8	74
1	Transportation	Plan home office	52	1.44	0.7	31	13	8	75
1	Technology/ Data	Add offsite backup	51	1.43	0.8	31	11	9	73
1	Financial	Negotiate better payment terms	50	1.42	0.8	32	7	11	71
1	Product	Store vital documentation	51	1.41	0.8	31	10	10	72
1	Technology/ Data	Add multi-tiered backup strategy	51	1.39	0.8	30	11	10	71
1	Fire	Buy smoke alarms	51	1.37	0.8	30	10	11	70
1	Financial	Create succession plan	50	1.36	0.8	27	14	9	68
1	Weather	Buy extra batteries	50	1.34	0.8	28	11	11	67
1	Financial	Find alternate insurance	50	1.34	0.8	27	13	10	67
1	Product	Revise marketing materials.	51	1.33	0.8	29	10	12	68
1	Financial	Create continuous audit system	51	1.33	0.8	26	16	9	68

R	Action Category	Text	N	MEAN	S.D.	2	1	0	W'
1	Fire	Create building evacuation plan	51	1.33	0.8	26	16	9	68
1	Security	Add access security system	50	1.32	0.8	27	12	11	66
1	Weather	Buy snow shovels	50	1.32	0.8	27	12	11	66
1	Supply Chain	Identify alternate suppliers	48	1.31	0.8	25	13	10	63
1	Product	Brainstorm new products	52	1.29	0.8	26	15	11	67
1	Financial	Improve insurance renewal procedures	50	1.28	0.8	24	16	10	64
1	Product	Innovate new products	52	1.27	0.8	26	14	12	66
1	Transportation	Use ground-based transportation	51	1.27	0.8	26	13	12	65
1	Product	Add preventive maintenance program	51	1.25	0.8	25	14	12	64
1	Security	Add security cameras	51	1.25	0.8	25	14	12	64
1	Utility	Add power generators	50	1.24	0.8	23	16	11	62
1	Technology/ Data	Update operating system during upgrade grace period	49	1.24	0.8	25	11	13	61
1	Technology/ Data	Use alternate communication services such as mail or courier	51	1.22	0.9	26	10	15	62
1	Financial	Self-finance operation	51	1.20	0.9	25	11	15	61
1	Transportation	Use alternate transportation	51	1.20	0.8	24	13	14	61
1	Fire	Add sprinkler system	51	1.20	0.8	23	15	13	61
1	Security	Improve security protection	50	1.20	0.8	22	16	12	60
1	Weather	Fill vehicle gas tanks	51	1.18	0.8	23	14	14	60
1	Fire	Improve fireproofing	51	1.18	0.8	22	16	13	60
1	Financial	Increase insurance coverage	49	1.18	0.8	20	18	11	58

R	Action Category	Text	N	MEAN	S.D.	2	1	0	W'
1	Product	Test business continuity plan	51	1.14	0.8	21	16	14	58
1	Technology/ Data	Encrypt/password protect hard drive	51	1.14	0.8	21	16	14	58
1	Technology/ Data	Upgrade hardware and run old software under emulation.	48	1.13	0.8	20	14	14	54
1	Technology/ Data	Create data deletion plan	51	1.08	0.8	18	19	14	55
1	Security	Add check-in / check-out property procedures	50	1.08	0.8	18	18	14	54
1	Supply Chain	Add alternate contractors	48	1.08	0.8	18	16	14	52
1	Personnel	Change management team	52	1.06	0.8	19	17	16	55
1	Technology/ Data	Increase number of software licenses	51	1.06	0.8	19	16	16	54
1	Product	Use manual procedures	51	1.04	0.9	20	13	18	53
1	Technology/ Data	Add remote destruction of data	50	1.04	0.8	17	18	15	52
1	Legal	Take legal action	51	1.02	0.9	19	14	18	52
1	Government	Lobby government for lesser regulations	51	1.02	0.8	17	18	16	52
1	Technology/ Data	Create hot site alternate location	51	1.02	0.8	17	18	16	52
1	Property	Obtain proper permits	51	1.00	0.8	17	17	17	51
1	Fire	Schedule a fire protection audit	50	1.00	0.8	18	14	18	50
1	Technology/ Data	Rebuild data from source documentation	49	1.00	0.8	17	15	17	49
1	Personnel	Use replacement personnel	49	1.00	0.8	16	17	16	49
1	Health	Move employees to safe area	50	0.98	0.8	16	17	17	49
1	Personnel	Recruit new manager	51	0.96	0.8	17	15	19	49
1	Legal	Report to government officials	50	0.96	0.8	15	18	17	48

R	Action Category	Text	N	MEAN	S.D.	2	1	0	W'
1	Product	Create new products with proprietary technology	52	0.94	0.8	15	19	18	49
1	Weather	Freeze food	50	0.94	0.8	13	21	16	47
1	Supply Chain	Create alternate supply chain	48	0.94	0.8	13	19	16	45
1	Property	Coordinate volunteer group	51	0.92	0.8	15	17	19	47
1	Supply Chain	Increase spare part inventory	49	0.92	0.8	13	19	17	45
1	Supply Chain	Find alternate partner	48	0.92	0.8	14	16	18	44
1	Property	Renovate building to new code	51	0.90	0.8	14	18	19	46
1	Property	Create community response	51	0.88	0.8	15	15	21	45
1	Product	Revalidate equipment	51	0.88	0.8	14	17	20	45
1	Legal	Take PCI compliance audit	51	0.88	0.8	13	19	19	45
1	Property	Plan alternate building access	51	0.88	0.8	13	19	19	45
1	Weather	Add lightning rods to building	51	0.88	0.8	12	21	18	45
1	Supply Chain	Reorder new raw materials	48	0.88	0.8	12	18	18	42
1	Product	Move operations to secondary site	51	0.86	0.8	13	18	20	44
1	Health	Inoculate employees against infection	50	0.86	0.8	13	17	20	43
1	Security	Seal windows and doors	50	0.86	0.8	12	19	19	43
1	Flood	Raise electrical equipment above flood stage	50	0.84	0.8	11	20	19	42
1	Technology/ Data	Create hot spares	51	0.82	0.7	10	22	19	42
1	Legal	Create notification for customers to cancel credit cards	50	0.82	0.8	13	15	22	41
1	Legal	Draft cease/desist letter	51	0.80	0.8	11	19	21	41

R	Action Category	Text	N	MEAN	S.D.	2	1	0	W'
1	Legal	Hire public relations firm	51	0.80	0.7	10	21	20	41
1	Personnel	Increase offer to make company attractive	51	0.76	0.8	12	15	24	39
1	Product	Provide strong certification process	51	0.76	0.7	8	23	20	39
1	Utility	Rent port-a-johns	51	0.76	0.7	8	23	20	39
1	Flood	Raise product inventory above flood stage	50	0.76	0.8	11	16	23	38
1	Utility	Store additional gasoline	50	0.76	0.7	9	20	21	38
1	Weather	Buy gas/propane grill	50	0.76	0.7	8	22	20	38
1	Financial	Value product in strong currency	51	0.75	0.9	14	10	27	38
1	Product	Spread production over larger geographic area	51	0.75	0.7	9	20	22	38
1	Utility	Install natural gas generator	51	0.75	0.7	9	20	22	38
1	Weather	Buy extra coolers	51	0.75	0.7	9	20	22	38
1	Utility	Host own gas supply	51	0.75	0.7	8	22	21	38
1	Flood	Build containment walls	49	0.73	0.7	7	22	20	36
1	Technology/ Data	Buy password cracking software	52	0.71	0.7	7	23	22	37
1	Legal	Maintain export compliance	51	0.71	0.8	10	16	25	36
1	Property	Fortify building structure	51	0.71	0.7	8	20	23	36
1	Weather	Store additional propane	51	0.71	0.7	8	20	23	36
1	Personnel	Improve union relations	51	0.71	0.7	6	24	21	36
2	Legal	Hire lobbying firm	35	0.70	0.6	3	20	12	37
1	Security	Add metal bars to windows	50	0.70	0.6	5	25	20	35
1	Personnel	Create union / management team building	51	0.69	0.7	6	23	22	35

R	Action Category	Text	N	MEAN	S.D.	2	1	0	W'
1	Financial	Place stop loss stock orders	50	0.68	0.8	10	14	26	34
1	Government	Increase safety of building codes	50	0.68	0.8	10	14	26	34
1	Flood	Add building flood walls around property	50	0.66	0.6	4	25	21	33
1	Product	Provide own inspectors	51	0.65	0.7	7	19	25	33
1	Product	Buy non-electrical dehumidification equipment	50	0.64	0.6	4	24	22	32
1	Property	Hire heavy equipment for removal	51	0.63	0.7	5	22	24	32
1	Weather	Install storm shutters	50	0.62	0.6	4	23	23	31
1	Flood	Raise building above ground level	50	0.62	0.6	3	25	22	31
1	Product	Hire new market research firm	52	0.60	0.7	5	21	26	31
1	Flood	Fortify flood levies	50	0.60	0.6	3	24	23	30
1	Technology/ Data	Rebuild formulation	51	0.59	0.7	5	20	26	30
1	Product	Limit customer order quantities	51	0.59	0.6	4	22	25	30
1	Health	Add filtration facility	50	0.56	0.6	4	20	26	28
1	Product	Prepare food offsite	51	0.55	0.7	5	18	28	28
1	Weather	Build storm shelter	51	0.55	0.6	2	24	25	28
1	Weather	Buy dry ice	50	0.54	0.6	4	19	27	27
1	Government	Buy out vulnerable properties	50	0.52	0.6	4	18	28	26
1	Technology/ Data	Disassemble and rewrite source code	50	0.50	0.6	3	19	28	25
1	Weather	Buy charcoal grill	51	0.49	0.6	2	21	28	25
1	Weather	Buy charcoal	51	0.45	0.5	1	21	29	23

APPENDIX P

ADJACENCY MATRIX FOR $|C_{IJ}| > 0.80$

The table shown on the following page is the adjacency matrix for those events with $|C_{ij}| > 0.80$.

EVENTS		I1	I2	I3	I4	I5	DE1	DE2	DE3	DE4	DE5	DE6	DE7	DE8	DE9	DE10	DE11	DE12	DE13	DE14	DE15	C1	C2	C3	C4	C5	I1	I2	I3	I4	I5	DE1	DE2	DE3	DE4	DE5	DE6	DE7	DE8	DE9	DE10	DE11	DE12	DE13	DE14	DE15	C1	C2	C3	C4	C5
NUMBER		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	-1	-2	-3	-4	-5	-6	-7	-8	-9	-10	-11	-12	-13	-14	-15	-16	-17	-18	-19	-20	-21	-22	-23	-24	-25
I1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I5	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE1	6	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE2	7	0	1	1	0	0	1	0	0	0	0	1	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE3	8	0	0	0	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE4	9	0	1	1	0	1	1	0	0	0	0	0	1	1	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE5	10	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE6	11	0	1	1	1	0	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE7	12	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE8	13	0	1	1	0	0	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE9	14	0	1	1	0	0	1	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE10	15	0	0	1	1	0	1	0	1	0	0	0	1	1	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE11	16	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE12	17	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE13	18	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE14	19	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE15	20	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C1	21	1	1	1	1	0	1	1	1	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C2	22	1	0	1	1	0	1	0	1	1	1	1	1	0	1	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C3	23	1	0	1	1	0	1	0	1	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C4	24	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C5	25	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I1	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I2	-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I3	-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I4	-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I5	-5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE1	-6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
DE2	-7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	1	0	1	1	0	1	0	0	0	0	0	0	0	0	0
DE3	-8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE4	-9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	0	0	0	0	0	1	1	0	0	1	1	0	1	0	0	0	0	0	0
DE5	-10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
DE6	-11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0
DE7	-12	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
DE8	-13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE9	-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE10	-15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	1	0	0	0	1	1	0	0	1	1	0	0	1	0	0	0	0	0
DE11	-16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE12	-17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
DE13	-18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
DE14	-19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
DE15	-20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C1	-21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	1	1	1	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
C2	-22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	1	0	1	1	1	1	1	0	1	1	0	0	0	1	1	0	0	0	0	0
C3	-23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	1	0	1	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
C4	-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
C5	-25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

APPENDIX Q

REACHABILITY MATRIX FOR $|C_{IJ}| > 0.80$

The table shown on the following page is the reachability matrix for those events with $|C_{ij}| > 0.80$.

EVENTS		I1	I2	I3	I4	I5	DE1	DE2	DE3	DE4	DE5	DE6	DE7	DE8	DE9	DE10	DE11	DE12	DE13	DE14	DE15	O1	O2	O3	O4	O5	I1	I2	I3	I4	I5	DE1	DE2	DE3	DE4	DE5	DE6	DE7	DE8	DE9	DE10	DE11	DE12	DE13	DE14	DE15	O1	O2	O3	O4	O5
NUMBER		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	-1	-2	-3	-4	-5	-6	-7	-8	-9	-10	-11	-12	-13	-14	-15	-16	-17	-18	-19	-20	-21	-22	-23	-24	-25
I1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I2	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I3	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I4	4	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I5	5	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE1	6	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE2	7	0	1	1	0	0	1	1	0	0	0	1	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE3	8	0	0	0	0	0	1	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE4	9	0	1	1	0	1	1	0	0	1	0	0	1	1	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE5	10	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE6	11	0	1	1	1	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE7	12	0	1	1	0	0	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE8	13	0	1	1	0	0	1	1	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE9	14	0	1	1	0	0	1	1	1	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE10	15	0	0	1	1	0	1	0	1	0	0	0	1	1	0	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE11	16	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE12	17	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE13	18	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE14	19	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE15	20	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
O1	21	1	1	1	1	0	1	1	1	1	0	1	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
O2	22	1	0	1	1	0	1	0	1	1	1	1	1	0	1	1	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
O3	23	1	0	1	1	0	1	0	1	1	0	1	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
O4	24	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
O5	25	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I1	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I2	-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I3	-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I4	-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I5	-5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE1	-6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
DE2	-7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1	0	0	0	1	0	1	1	0	1	0	0	0	0	0	0	0	0	0
DE3	-8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE4	-9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	0	0	1	0	0	1	1	0	0	1	1	0	1	0	0	0	0	0	0
DE5	-10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
DE6	-11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0
DE7	-12	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0
DE8	-13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
DE9	-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1	1	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
DE10	-15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	1	0	0	0	1	1	0	1	1	1	0	0	1	0	0	0	0	0
DE11	-16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
DE12	-17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
DE13	-18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0
DE14	-19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0
DE15	-20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
O1	-21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	1	1	1	1	0	1	0	0	1	0	0	0	0	0	0	1	0	0	0	0
O2	-22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	1	0	1	1	1	1	1	0	1	1	0	0	0	1	1	0	1	0	0	0
O3	-23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	1	0	1	1	0	1	0	0	1	0	0	0	0	0	0	0	0	1	0	0
O4	-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0
O5	-25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

APPENDIX R

REACHABILITY MATRIX FOR $|C_{IJ}| > 1.00$

The table shown on the following page is the reachability matrix for those events with $|C_{ij}| > 1.00$.

EVENTS		I1	I2	I3	I4	I5	DE1	DE2	DE3	DE4	DE5	DE6	DE7	DE8	DE9	DE10	DE11	DE12	DE13	DE14	DE15	O1	O2	O3	O4	O5	I1	I2	I3	I4	I5	DE1	DE2	DE3	DE4	DE5	DE6	DE7	DE8	DE9	DE10	DE11	DE12	DE13	DE14	DE15	O1	O2	O3	O4	O5
NUMBER		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	-1	-2	-3	-4	-5	-6	-7	-8	-9	-10	-11	-12	-13	-14	-15	-16	-17	-18	-19	-20	-21	-22	-23	-24	-25
I1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I2	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I3	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I4	4	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I5	5	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE1	6	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE2	7	0	0	1	0	0	1	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE3	8	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE4	9	0	0	1	0	0	1	0	0	1	0	0	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE5	10	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE6	11	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE7	12	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE8	13	0	0	1	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE9	14	0	0	1	0	0	1	1	1	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE10	15	0	0	1	0	0	1	0	1	0	0	0	1	1	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE11	16	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE12	17	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE13	18	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE14	19	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE15	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
O1	21	1	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
O2	22	1	0	0	1	0	1	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
O3	23	1	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
O4	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
O5	25	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I1	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I2	-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I3	-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I4	-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I5	-5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE1	-6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE2	-7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
DE3	-8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE4	-9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	0	0	1	1	0	0	1	1	0	0	0	0	0	0	0	0
DE5	-10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE6	-11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE7	-12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
DE8	-13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
DE9	-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	1	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
DE10	-15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0	1	1	0	1	0	1	0	0	1	0	0	0	0	0
DE11	-16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
DE12	-17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
DE13	-18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
DE14	-19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
DE15	-20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
O1	-21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0
O2	-22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0
O3	-23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
O4	-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
O5	-25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

REFERENCES

Aberfan Tribunal. (1967). Report of the Tribunal Appointed Into the Disaster at Aberfan on October 21, 1966. (Her Majesty's Stationery Office) (pp. 151). London, England.

American Society of Civil Engineers. (2013). 2013 Report Card for America's Infrastructure. Retrieved June 8, 2014, from http://www.infrastructurereportcard.org

Bañuls, V. & Salmeron, J. (2007). A Scenario-based Assessment Model - SBAM. *Technological Forecasting & Social Change, 74*(6), 750-762.

Bañuls, V. & Turoff, M. (2011). Scenario Construction Via Delphi and Cross Impact Analysis. *Technological Forecasting & Social Change, 78*(9), 1579-1602.

Bañuls, V., Turoff, M., & Hiltz, S. R. (2013). Collaborative Scenario Modeling In Emergency Management Through Cross Impact. *Technological Forecasting & Social Change, 80*(9), 1756–1774.

Bañuls, V. & Turoff, M. (2007). *Scenario Construction via Cross Impact*. Paper presented at the The Network Nation and Beyond, New Jersey Institute of Technology.

Benbunan-Fich, R. (2001). Using Protocol Analysis to Evaluate the Usability of a Commercial Website. *Information & Management, 39*(2), 151-163.

Bentley, S., Davies, M., & Gallup, M. (1998). The Cilfynydd Flow Slide of December 1939. *Quarterly Journal of Engineering Geology and Hydrogeology, 31*(4), 273-289.

Borade, A. & Bonsad, S. (2012). Interpretive Structural Modeling-based Framework for VMI Adoption in Indian Industries. *International Journal of Advanced Manufacturing Technology, 58*(9-12), 1227-1242.

Brady, S. (2015). Utilizing and Adapting the Delphi Method for Use in Qualitative Research. *International Journal of Qualitative Methods, 14*(5), 1-6.

Chatterjee, S. (2013). Simple Rules for Designing Business Models. *California Management Review, 55*(2), 97-124.

Chen, H., Chiang, R., & Storey, V. (2012). Business Intelligence and Analytics: From Big Data To Big Impact. *MIS Quarterly, 36*(4), 1165-1188.

Chen, J. (2011). Modern Disaster Theory: Evaluating Disaster Law as a Portfolio of Legal Rules. *Emory International Law Review, 25*(3), 1121-1143.

CMNews. (1968). Hixon Crash Report. *Commercial Motor, 128*.

Cuoto, R. (1989). Catastrophe and Community Empowerment: The Group Formulations of Aberfan's Survivors. *Journal of Community Psychology, 17*(3), 236-248.

Dalkey, N. (1975). An Elementary Cross Impact Model. In H. Linstone & M. Turoff (Eds.), *The Delphi Method: Techniques and Applications* (1 ed., pp. 620). Reading, MA: Addison-Wesley Publishing Company.

Danes, S., Lee, J., & Amarapurkar, S. (2009). Determinants of Family Business Resilience After a Natural Disaster by Gender of Business Owner. *Journal of Developmental Entrepreneurship, 14*(4), 333-354.

Dobrian, J. (2013). Hurricane Sandy. *Journal of Property Management, 78*(4), 28-32.

Dynes, R. & Quarantelli, E. (1977). Organizational Communications and Decision Making in Crises. In University of Delaware (Ed.), (pp. 58). Newark, DE: University of Delaware.

FEMA. (2013). Mitigation Assessment Team Report: Hurricane Sandy in New Jersey and New York (pp. 223). New York, NY: Federal Emergency Management Agency.

Gantt, P. & Gantt, R. (2012). Disaster Psychology: Dispelling the Myths of Panic. *Emergency Planning, 57*(8), 42-49.

Goldstein, N. (1975). A Delphi on the Future of the Steel and Ferroalloy Inductries. In H. Linstone & M. Turoff (Eds.), *The Delphi Method: Techniques and Applications* (pp. 210-226). Reading, MA: Addison-Wesley

Gordon, G. (1978). *System Simulation* (2nd ed.). Englewood Cliffs, NJ: Prentice-Hall.

Gordon, T. (1994). *Cross Impact Method*. New York, NY: United Nation University Millennium Project.

Gouldner, A. (1954). *Patterns of Industrial Bureaucracy*. Glencoe, IL: Free Press.

Gray, P. & Helmer, O. (1976). The Use of Futures Analysis for Transportation Research Planning. *Transportation Journal, 16*(2), 5-12.

Guo, Z., Li, Y., & Stevens, K. J. (2012). Analyzing Students’ Technology Use Motivations: An Interpretive Structural Modeling Approach. *Communications of the Association for Information Systems, 30*(14), 199-224.

Han, S. & Diekmann, J. (2004). Judgment-based Cross Impact Method For Predicting Cost Variance For Highly Uncertain Projects. *Journal of Construction Research, 5*(2), 171-192.

He, W., Yuan, X., & Yang, L. (2013). Supporting Case-based Learning in Information with Web-based Technology. *Journal of Information Systems Education, 24*(1), 31-40.

Henry, A. (2006). Developing a Business Continuity Plan. *Rural Telecommunications, 25*(6), 14-20.

Herrmann, K. (2011). The Comprehensive ICF Core Sets for Spinal Cord Injury from the Perspective of Occupational Therapists: A Worldwide Validation Study Using the Delphi Technique. *Spinal Cord, 49*(5), 600-613.

Hsu, E. (1989). Role Event Gaming Simulation in Management Education. *Simulation & Games, 20*(4), 409-438.

Huega, M., Bañuls, V., & Turoff, M. (2015). A CIA–ISM Scenario Approach for Analyzing Complex Cascading Effects in Operational Risk Management. *Engineering Applications of Artificial Intelligence, 46*(2015), 289-302.

Johnes, M. & McLean, I. (2001). Echoes of Injustice, the Political Aftermath of the Aberfan Disaster. *History Today, 50*(12), 28-30.

Karns, J., Burton, G., & Martin, G. (1983). Learning Objectives and Testing: An Analysis of Six Principles of Economics Textbooks, Using Bloom's Taxonomy. *Journal of Economic Education, 14*(3), 16-20.

Keller, J. & Von der Gracht, H. (2014). The Influence of Information and Communication Technology (ICT) on Future Foresight Processes - Results from a Delphi Study. *Technological Forecasting & Social Change, 85*(5), 81-92.

Kemp, R. (2008). The Infrastructure of America's Cities. *Contemporary Review, 290*(1690), 331-336.

Lendaris, G. (1980). Structural Modeling - A Tutorial Guide. *IEEE Transactions on Systems, Man, and Cybernetics, 10*(12), 807-840.

Linstone, H. & Turoff, M. (1975). *The Delphi Method: Techniques and Applications*. Reading, MA: Addison-Wesley.

Linstone, H. & Turoff, M. (2011). Delphi: A Brief Look Backward and Forward. *Technological Forecasting & Social Change, 2011*(78), 1712–1719.

Malone, D. (1975). An Introduction to the Applications of Interpretive Structural Modeling. *Proceedings of the IEEE, 63*(3), 397–404.

Mamdouh, A., Saleh, M., & El-Hadi Ahmed, A. (2015). *Dynamic Cross Impact Analysis with Markov Chain*. Paper presented at the International Conference on Industrial Engineering and Operations Management (IEOM), Dubai, UAE.

Manuel, J. (2013). The Long Road to Recovery. *Environmental Health Perspectives, 121*(5), 153-159.

March, S. & Smith, G. (1995). Design and Natural Research on Information Technology. *Decision Support Systems, 15*(4), 251-266.

Martin, J. (2008). *Disaster Phases and Earthquake Policies*. Washington, DC: Fedearl Emergency Management Agency.

McFadzean, E., Ezingeard, J., & Birchall, D. (2011). Information Assurance and Corporate Strategy: A Delphi Study of Choices, Challenges, and Developments for the Future. *Information Systems Management*, *28*(1), 102–129.

Miller, G. (1956). The Magical Number Seven, Plus or Minus Two: Some Limitations on Our Capacity for Processing Information. *Psychology Review, 63*(2), 81-87.

Mingers, J. (2001). Combining IS Research Methods: Towards a Pluralist Methodology. *Information Systems Research, September 2001*(12), 240-259.

Ministry of Transport. (1968). *Report of the Public Inquiry Into The Accident At Hixon Level Crossing*. London, England: Her Majesty's Stationery Office,.

Moore, H. (1956). Toward a Theory of Disaster. *American Sociological Review, 21* (6), 733-737.

Nakatsu, R. & Iacovou, C. (2009). A Comparative Study of Important Risk Factors Involved in Offshore and Domestic Outsourcing of Software Development Projects: A Two-Panel Delphi Study. *Information & Management*, *46*(1), 57–68.

NFPA. (2013). *NFPA 1600® Standard on Disaster/Emergency Management and Business Continuity Programs* Quincy, MA: National Fire Protection Association.

Nicoll, S. & Owens, R. (2013). Emergency Response & Business Continuity. *Professional Safety, 58*(9), 50-55.

Nunamaker, J., Chen, M., & Purdin, T. (1991). Systems Develpoment in Information Systems Research. *Journal of Management Information Systems, 7*(3), 89-106.

Paré, G., Sicotte, C., Jaana, M., & Girouard, D. (2008). *Prioritizing Clinical Information System Project Risk Factors: A Delphi Study.* Paper presented at the 41st Hawaii International Conference on System Sciences, Hawaii.

Pedamallu, C., Ozdamar, L., Kropat, E., & Weber, G. (2012). A System Dynamics Model for Intentional Transmission of HIV/AIDS Using Cross Impact Analysis. *Central European Journal of Operations Research*, *20*(2), 319-336.

Phillips, I. (2009). *From 21st Century Leisure to 20th Century Holiday Catastrophe: the Isle of Man Summerland Fire Disaster*. Birmingham, UK: Oxford University.

PlanNYC. (2013). *A Stronger, More Resilient New York*. New York, NY: Retrieved from http://www.nyc.gov/html/sirr/html/report/report.shtml.

Rajaprasad, S. & Chalapathi, P. (2015). Factors Influencing Implementation of OHSAS 18001 in Indian Construction Organizations: Interpretive Structural Modeling Approach. *Safety and Health at Work*, *6*(3), 200-205.

Ravi, V. (2015). Analysis of Interactions Among Barriers of Eco-Efficiency in Electronics Packaging Industry. *Journal of Cleaner Production, 101*(1), 16-25.

Reeves, M. (1990). An Application of Bloom's Taxonomy to the Teaching of Business Ethics. *Journal of Business Ethics, 9*(7), 609-616.

Sasirekha, V. (2013). Requirements Analysis for Disaster Recovery Plan at Integral Coach Factory, Chennai. *The Journal of Institute of Public Enterprise, 36*(1/2), 117-127.

Scotti, R. (2003). *Sudden Sea: The Great Hurricane of 1938* (1st ed.). Boston, MA: Little Brown and Company.

Selic, B. (2003). The Pragmatics of Model Driven Development. *IEEE Software*, *20*(5), 19-25.

Simon, H. (1991). Bounded Rationality and Organizational Learning. *Organization Science, 2*(1), 125–134.

Singh, A., Singh, M., & Sharma, B. (2013). Modeling of Knowledge Management Technologies: An ISM Approach. *The IUP Journal of Knowledge Management, 11*(3), 41-55.

Smith, D. & Sutter, D. (2013). Response and Recovery After the Joplin Tornado. Lessons Applied and Lessons Learned. *The Independent Review*, *18*(2), 165-188.

Snedaker, S. (2013). *Business Continuity and Disaster Recovery Planning for IT Professionals* (pp. 602).

Sohl, L. & Ohl, T. (2012). Land-Use Change In The Atlantic Coastal Pine Barrens Ecoregion. *Geographic Review, 102*(2), 180-201.

Sushil. (2012). Interpreting the Interpretive Structural Model. *Global Journal of Flexible Systems Management*, *13*(2), 87-106.

Thorleuchter, D. & Van den Poel, D. (2014). Quantitative Cross Impact Analysis With Latent Semantic Indexing. *41*(2), 406–411.

Turner, B. (1976). The Organizational and Interorganizational Development of Disasters. *Administrative Science Quarterly*, *21*(3), 378-397.

Turoff, M. (1970). The Design of a Policy Delphi. *Technology Forecasting and Social Change, 2*(2), 149-171.

Turoff, M. (1972). An Alternative Approach to Cross Impact Analysis. *Technology Forecasting and Social Change, 3*(3), 309-339.

Turoff, M., Bañuls, V., Plotnick, L., & Hiltz, S. R. (2014). *Development of a Dynamic Scenario Model for the Interaction of Critical Infrastructures.* Paper presented at the 11th International ISCRAM Conference, University Park, PA.

Turoff, M., Bañuls, V., Plotnick, L., Hiltz, S. R., & Huega, M. (2015). *Collaborative Evolution of a Dynamic Scenario Model for the Interaction of Critical Infrastructures.* Paper presented at the 12th International Conference on Information Systems for Crisis Response and Management, Kristiansand, Norway.

Turoff, M., Hiltz, S. R., Bañuls, V., & Van den Eede, G. (2013). Multiple Perspectives on Planning for Emergencies: An Introduction to the Special Issue on Planning and Foresight for Emergency Preparedness and Management. *Technology Forecasting and Social Change, 80*(9), 1647-1656.

Vaishnavi, V. & Kuechler, B. (2004). Design Research in Information Systems. Retrieved 4 August 2007, from http://www.isworld.org/Researchdesign/drisISworld.htm

Valmohammadi, C. & Dashti, S. (2015). Using Interpretive Structural Modeling and Fuzzy Analytical Process to Identify and Prioritize the Interactive Barriers of E-Commerce Implementation. *Information & Management, 53*(1), 157-168.

Van der Walle, B., Turoff, M., & Hiltz, S. R. (2010). *Information Systems for Emergency Management*. Armonk, NY: M.E. Sharpe, Inc.

Warfield, J. (1973). *Societal Systems*. New York, NY: Wiley.

Wilensky, H. (1967). *Organizational Intelligence*. New York, NY: Basic Books.

Wu, W., Yang, C., Chang, J., Chateau, P., & Chang, Y. (2015). Risk Assessment by Integrating Interpretive Structural Modeling and Bayesian Network, Case of Offshore Pipeline Project. *Reliability Engineering and System Safety, 142*(1), 515-524.

Yang, X., Zeng, L., & Zhang, R. (2012). Cloud Delphi Method. *International Journal of Uncertainty, 20*(1), 77-97.