DISASTER RELIEF SUPPLY CHAIN MANAGEMENT: THE EFFECT OF ORGANIZATIONAL FACTORS ON IMPROVISATION AND PERFORMANCE

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Joshua K. Strakos

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"…And by my God I can leap over a wall." - Psalm 18:29

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ABSTRACT

Within the past decade disasters have taken a tremendous humanitarian and economic toll globally. Providing effective relief to the victims of these disasters requires efficient management of a quickly formed supply chain in the context of a rapidly changing and extremely uncertain environment. Supply chain management under these circumstances requires both planning and improvisation. In an effort to help organizations use scarce time and resources more efficiently, this research examines the relationships between planning, capability factors, improvisation, and performance in disaster relief supply chains. Survey data from disaster relief practitioners is analyzed using the partial least squares method of structural equation modeling. Factors and capabilities which affect the effectiveness of planning and the incidence and effectiveness of improvisation in disaster relief supply chain management are presented. Incidence of Improvisation is found to have a positive effect on the performance of disaster relief supply chains. Creative capability, empowerment, and information focus are found to increase the incidence of improvisation. Information focus and empowerment are found to have a positive direct effect on performance. Overall, the factors studied show how planning, capabilities, improvisation, and performance are related in the realm of disaster relief supply chain management.

Table of Contents

LIST OF FIGURES

LIST OF TABLES

Chapter 1

INTRODUCTION

Introduction

In the past ten years, the cumulative toll of disasters to the world is staggering. For example, the statistics for meteorological disasters alone show the magnitude of the impact of this type of event on mankind[1]. Since 2002, there have been 950 meteorological disasters alone, with a death toll of over 171,000 people and over 381 million people affected. The cost of this type of disaster has been almost $475 billion during this same time frame, according to the Centre for Research on Epidemiology of Disasters (2011). The extent of the effects has ranged from minor property damage, power outages, and infrastructure degradation to total property loss, loss of business and government continuity, injury, and loss of life. For a more thorough discussion of disaster classification and reporting criteria, see the Centre for Research on the Epidemiology of Disasters' International Disaster Database website at http://www.emdat.be/.

Once a disaster (natural or man-made) occurs, there is usually a sudden surge of public support due to the media coverage of an event. This support may come from individual donations, non-governmental organizations (NGOs), governments, individual volunteer time, etc. This initial surge, while well-intentioned, places an extreme burden on the disaster relief supply chain by saturating available transportation capacity, storage space, and taking valuable labor hours for sorting and matching supplied items with

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[1] For a disaster to be entered into the database at least one of the following criteria must be fulfilled:
- Ten (10) or more people reported killed.
- Hundred (100) or more people reported affected.
- Declaration of a state of emergency.
- Call for international assistance.

demand. Recent examples of this surge and saturation effect can be found in popular press articles about the recent tornado in Joplin, MO ("Unsolicited goods hinder Joplin recovery efforts," 2011; "Unsolicited Goods May Overwhelm Recovery Efforts in Joplin," 2011).

Although the topic is widely expanding and receiving more research attention, there still remain the facts that (1) disaster relief supply chain management is an under researched and emerging topic, (2) humanitarian and/or not for profit (NFP) organizations seldom focus on supply chain management (SCM) improvements (Jahre, Jensen, & Listou, 2009; McLachlin, Larson, & Khan, 2009) because resources are tight, timing is unpredictable, and the cost of doing so may detract from fulfilling more immediate humanitarian needs, (3) approximately 80% of a disaster relief effort depends on logistics (Van Wassenhove, 2006), therefore (4) academic disaster relief supply chain management research and application of supply chain management best practices to disaster relief supply chain management will result in more effective and more efficient supply chains, at a relatively low cost to donor-dependent humanitarian and not-for-profit organizations.

This disaster relief supply chain is itself conceived and activated immediately following a disaster event. Better utilization of this support through management of the primary supply chain processes and flows of demand management, supply management, fulfillment management (Kovacs & Spens, 2007), and information flow, financial flows, and material (physical product) flows (Van Wassenhove, 2006) may enhance the ability of disaster relief supply to meet demand. Demand management involves identifying the customer (recipient) and assessing their needs. Supply management involves appealing

to donors or procurement of needed relief items from suppliers as well as the control and management of materials coming into an affected area. Fulfillment management involves the transportation and distribution of relief items to recipients. Information, financial, and material flows capture the movement of information, resources, and relief items within the supply chain system. Better management of these processes and flows may improve the speed by which essential supplies reach beneficiaries, reduce the cost associated with disaster recovery, and reduce the waste associated with an unmitigated push of material into an affected area and onto a disaster relief supply chain.

Most current research and practice focuses on planning before the disaster occurs (Altay & Green, 2006; Overstreet, Hall, Hanna, & Ranier, 2011), which leaves a gap for research which focuses on the combination of planning and improvisation, which is a spontaneous and creative solution to an unplanned problem.

The purpose of this research is to help disaster relief organizations achieve more effective relief by examining how organizational factors associated with planning and capabilities affect both the incidence of improvisation and disaster relief supply chain performance. The planning factors include strategic focus, operational focus, information focus, and technology utilization. The capability factors being studied are creative capability, empowerment, and technology capability. Finally the key relationship being examined in this research is the impact of improvisation on performance in this context. These factors and their proposed relationship to performance will be explained in-depth in the following chapter.

Although several papers have addressed organizational factors which affect performance in terms of innovation and new product development, there have been no

studies examining the role of improvisation in disaster relief supply chain management. This study will attempt to fill this gap by identifying the most important factors which lead to improvisation in disaster relief, determining the importance of these factors to performance, and testing of the importance of planning factors' direct impact on performance.

There is consensus amongst disaster relief supply chain management scholars of this fact as well as that academic disaster relief supply chain management research has much to contribute generally to practical disaster operations (Altay & Green, 2006; Jahre et al., 2009; Kovács & Spens, 2007; Van Wassenhove, 2006). Additionally, it is acknowledged that academic research in disaster relief supply chain management can fill the gap of improving processes and preparedness in-between disasters, where donor funding is lacking or aimed at front-line operational needs (Thomas & Fritz, 2006; Van Wassenhove, 2006). The end result of this type of research will be more timely and powerful aid to those in need.

Although the research in commercial supply chain management contributes to successful businesses and enhances stakeholders' wealth, research in disaster relief supply chain management enhances mankind's ability to survive and recover from inevitable and sometimes uncontrollable events. As stated by McLachlin et al:

> "Humanitarian assistance supply chains must be flexible and responsive to unpredictable events. They must also be efficient, and able to operate within limited budgets. In such supply chains, more effective SCM (i.e. improved customer service) can be the difference between life and death; and greater

efficiency means serving more people in dire need. While 'time is money' to the business logistician, time is life to the humanitarian" (McLachlin et al., 2009).

By gaining a better understanding of which factors improve the effectiveness of planning and improvisation on disaster relief SCM performance, more attention and (scarce) resources can be directed to enhancing the effectiveness of combined planning and improvisation, rather than a static focus on planning alone. This represents a contribution to the field of disaster relief SCM by improving our understanding of the use of processes which are the foundation of SCM.

Key Definitions

The concepts involved in disaster relief supply chain management have been referred to as disaster supply chain management, humanitarian logistics (Kovács & Spens, 2007, 2011), disaster operations management (Altay & Green, 2006), and public sector or humanitarian operations research (Ergun, Karakus, Keskinocak, Swann, & Villarreal, 2010). Humanitarian logistics is defined as "the process of planning, implementing and controlling the efficient, cost-effective flow and storage of goods and materials, as well as related information, from the point of origin to the point of consumption for the purpose of alleviating the suffering of vulnerable people" (Thomas & Kopczak, 2005).

However, for the purposes of this research, disaster relief supply chains are treated as a subset of humanitarian supply chains, with all aspects of supply chain management included, rather than just logistics functions. Disasters necessarily involve a rapid and sudden onset with no advance warning or advance information, whereas some

humanitarian supply chains deal with more of a steady state environment (such as food bank supply chains) (Kovács & Spens, 2009; McLachlin et al., 2009; Whybark, Melnyk, Day, & Davis, 2010). This research will focus on rapid onset disaster relief supply chains and will use the umbrella term of "disaster relief supply chain management" throughout this research.

Commercial supply chain management has been defined as a process which involves the flows of information, material, and finances and the management of these flows from raw material to the end user (Kovács & Spens, 2007). The term "commercial" supply chain management is used in this research to refer to supply chains whose primary motive is profit. Disaster relief supply chain management involves the management of these flows as well. However, in addition to the traditional role of procurement, raw materials also come from donors and the end user becomes the beneficiary rather than the traditional customer. Disaster relief supply chain management also encompasses preparedness, planning, transportation, warehousing, tracking and tracing, and customs clearance (Thomas & Kopczak, 2005). A disaster supply chain has been characterized as a set of well-executed and tightly coordinated tasks which include assessing victims' needs, fundraising, procurement, shipping, and distribution activities (Boin, Kelle, & Whybark, 2010) as well as ''the processes and systems involved in mobilizing people, resources, skills and knowledge to help vulnerable people affected by disaster'' (Van Wassenhove, 2006).

Supply chain processes are defined as the set of tasks, steps, and procedures used to manage activities related to the supply chain, its flows, and its relationships. Specific processes include demand management, supply management, and fulfillment

management. Demand management in the disaster environment is primarily concerned with needs assessment after a disaster strikes. Supply management is very complex in this environment – mixing the commercial practice of procurement from suppliers with the humanitarian practice of appeal to donors and matching donations to needs. Fulfillment management refers to how aid is delivered to the recipient from the point of procurement or donation to the most difficult "last mile". Flows related to these processes include information, financial, and material flows (Kovács & Spens, 2007; Van Wassenhove, 2006).

Purpose of Study

As stated earlier, the primary purpose of this research is to find ways in which disaster relief supply chain management performance can be improved by exploring factors which affect performance directly as well as those which influence the incidence and effectiveness of organizational improvisation. By identifying factors and relationships which improve the effectiveness of both planning and organizational improvisation, organizations will be able to identify ways in which disaster relief supply chain performance may be improved.

The secondary purpose of this research is to strengthen the notion that disaster relief supply chain management is a separate and distinct field apart from commercial supply chain management. By further delineating the differences in the two fields, the aim of this research is to deepen the understanding of this new field (Van Wassenhove, 2011). The research will add to the theoretical structure and allow more pointed research which will ultimately benefit disaster victims.

As noted by Jahre et al. (2009), disaster relief supply chains differ from commercial supply chains by their temporary structure and that they are set up for particular operations, rather than long-term business endeavors. In a sense, the processes of disaster relief supply chain management can never be fully formalized. They will always involve some element of newness and require some level of improvisation. Further, Kendra and Wachtendorf (2007) stated that "If an event doesn't require improvisation, it probably is not a disaster." However, factors influencing the extent and quality of improvisation in disaster relief supply chain management have not been addressed. The temporary and changing nature of disaster relief supply chain management will involve some combination of planning and improvisation. This leads to the following research questions:

1. What organizational factors are the most influential on disaster relief supply chain performance?
2. What organizational factors are the most influential on the incidence and effectiveness of improvisation in disaster relief supply chains?

These questions are represented by figure 1 below. Organizational factors referred to by question 1 above are represented by the areas of strategic focus, operational focus, information focus, and technology utilization in the upper left hand corner of figure 1. Their direct effect on both performance and incidence of improvisation will be tested.

Factors related to question 2 above include creative capability, empowerment, and technology capability, shown in the bottom left hand corner of figure 1. Their direct

relationship to improvisation will be tested as well as their moderating effect on the relationship between improvisation and performance.

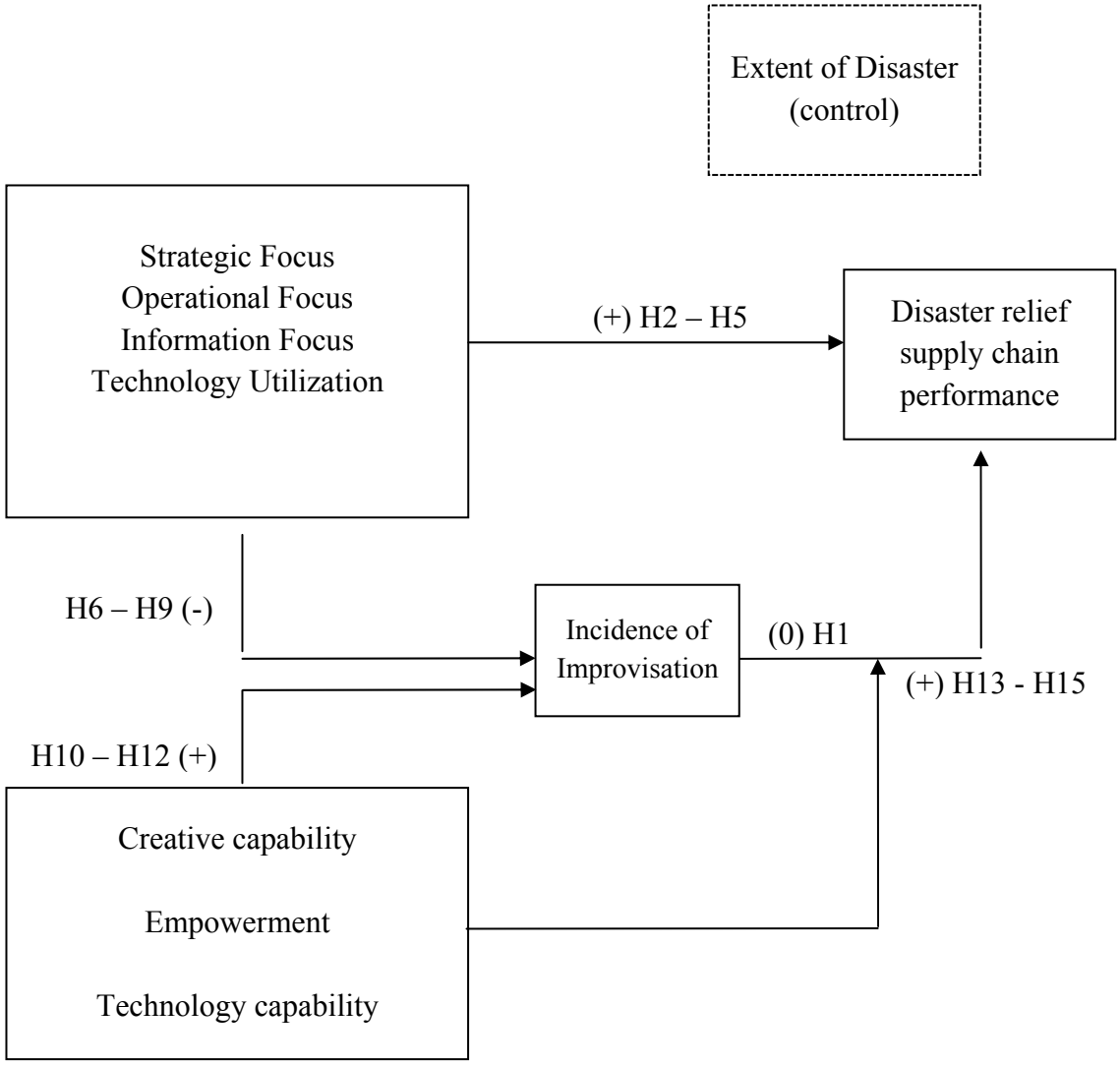


Figure 1: Research Model

The preceding model assumes that the more one plans, the less one improvises, by the hypothesized negative relationship between factors associated with planning and incidence of improvisation. It also assumes capability factors lead to incidence and effectiveness of improvisation. The basis of these assumptions will be developed and explained in the following chapter.

The following questions will be answered by empirical analysis of this model. Which planning factors play the greatest role in disaster relief supply chain performance? Which capability factors play the greatest role in the incidence and effectiveness of improvisation? Whether the relationships proposed later in this study are supported or not, the results will show how these planning and capability factors affect improvisation and performance. Practically, this means helping organizations find the right mix of planning activities, training, management, coordination, and using the right technology to enhance performance. In the end, this research is not about new technology, more advanced planning, or better management and coordination techniques (although the quality of these factors is important). It is about finding the right combination of what is already available. It is about using the knowledge and resources available to achieve the most effective performance possible in disaster relief.

Scope and Limitations of Study

The research questions posed earlier can be answered most effectively by examining the operating practices of organizations which participate in disaster relief operations. The questions themselves seek to explore the specific relationships between several key independent variables (strategic focus, operational focus, information focus,

technology utilization, creative capability, empowerment, and technology capability) and two dependent variables (improvisation and disaster relief supply chain performance).

The results will show how these variables are related to improvisation and disaster relief supply chain performance. The research study is framed in a disaster relief environment that includes organizations which undertake disaster relief operations. Such organizations may include not for profit humanitarian, government agencies, as well as for profit commercial enterprises. Although the outcome of this study should be most beneficial to organizations in the humanitarian sector, commercial supply chains may also benefit and be included in the population being studied because commercial supply chains also engage in disaster relief operations (Ergun, Heier Stamm, Keskinocak, & Swann, 2010; Horowitz & Dana, 2008; Rosegrant, 2007). Although their ultimate motives for doing so may be different from their humanitarian counterparts, the study of the organizational factors explored in this research should reveal the same relationships as it would in other organizational settings.

This study recognizes that the research into improvisation and disaster relief supply chain management is a new and emerging field, and that it would be impossible to cover the nuances and complexities of the disaster environment in any single piece of research. This should be seen as a starting point for more exploration into the relationships between organizational factors, improvisation, and performance in disaster relief supply chain management.

Given the theoretically immature nature of this field, it will be difficult to determine which performance measures should be used. Performance is discussed at length in the following chapter, and specific performance measures are drawn from the

literature, however, as the field develops and the body of research grows, the concept of performance which is specific to the field will mature and grow as well.

Finally, the time of disaster relief professionals is valuable. Asking them to complete surveys to gather data must be kept to a minimum. In order to advance research in this field, academics will need to find other data collection methods which are less time-intensive for disaster relief practitioners. As systems and practices in disaster relief mature and become more standard, perhaps data collection and availability will become more standard as well.

The remaining chapters will cover pertinent literature in disaster relief supply chain management, improvisation, supply chain performance, the development of theory and hypotheses represented by the proposed model, research design and methodology, analysis of the empirical data, results, discussion, and the conclusions and implications garnered from this research and data analysis.

Chapter 2

LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

Introduction

Disaster relief supply chain management research is quickly expanding, but little is written about how organizational factors used in the management of material, information, and financial flows affect disaster relief supply chain management outcomes. Outcomes in disaster relief supply chain management are themselves difficult to define and measure. However, the theory and performance measures associated with supply chain management in the commercial sector are a starting point for performance measurement and theory in disaster relief supply chain research.

There is evidence that disaster relief supply chain management has much to learn from commercial supply chain management, however, it is important to recognize the fact that the two systems are separated by some important differences (Kovács & Spens, 2007; Van Wassenhove, 2006). Major differences include the hasty formation of disaster relief supply chain networks, and the unknown demand characteristics such as when, where, how much, and how many times certain supplies will be needed (Ergun, Karakus, et al., 2010; Kovács & Spens, 2009). In short, disaster relief supply chains operate in turbulent and dynamic environments where the most important SCM questions are often unanswered until the moment of execution, and sometimes remain unanswered until sometime after execution of the relief operation. This is due to the fast moving and uncertain environment in which these systems must operate. Using this classification, we see some literature referring to disaster relief supply chains and their management as emergent systems or hyper-projects (Simpson, 2006; Simpson & Hancock, 2012; Simpson, Hancock, & Chuang, 2008). This literature supports the notion that systems such as these must be viewed outside the parameters of "business as usual" commercial,

or steady state supply chains. Therefore, while planning is important, the plan cannot encompass all these unknowns and will most likely be modified during the execution of a disaster relief operation.

Most recently, even the burgeoning structures presented to define disaster relief supply chain management as a separate field have been further delineated. Holguín-Veras, Jaller, Van Wassenhove, Pérez, and Wachtendorf (2012) treat the post-event phases of disaster relief with even more detail, examining the state of social networks and supporting systems and suggesting that there is different application of measures of effectiveness even within similar phases of response. One impact of this study is to provide a more granular definition of the field of disaster relief supply chain management along these same lines and to inform further research of the fact that even the current definition of disaster relief supply chain management may be too broad to effectively fit its dynamic nature.

There is evidence that logisticians and logistics processes in the disaster relief world are often times a neglected segment of the organization (McLachlin et al., 2009; Thomas & Kopczak, 2005). The typical organization's limited resources combined with a focus on pleasing the donors of those resources leads most resources to go directly to relief recipients (a difficult point to oppose). This leaves little time or money for relief capacity-building activities such as development and training of logistics processes and logisticians, respectively. Additionally, The majority of disaster relief supply chain management literature focuses on the mitigation and preparedness phases of disaster response (Altay & Green, 2006; Ergun, Karakus, et al., 2010; Kovács & Spens, 2007; Natarajarathinam, Capar, & Narayanan, 2009) which may focus on planning for

"expected" events. However, the ability to handle such a rapidly changing environment successfully is in part dependent on experience, training, and the ability to effectively improvise.

In an attempt to synthesize several related but separately studied fields, this review of current literature will examine traditional supply chain management, the emerging field of disaster relief supply chain management, improvisation as a theory, improvisation as applied to disaster relief supply chain management, and performance measurement as an evolving idea within both traditional and disaster relief supply chain management.

Literature Structure

Although the field of disaster relief supply chain management is still in its emergent phase, there is a wide body of literature which contributes to the explanation, exploration, and theory development in the field. Emergency management literature, also categorized as disaster management literature, contributes to the structure of the framework in which we examine disasters and our response to them. Emergency management literature explains characteristics, dimensions, and categorization of the disaster itself, including the temporal phases of response and recovery, geographic considerations, and the disaster's magnitude. Supply chain management literature, on the other hand, explains the processes involved in the management of a response effort which facilitate the flow of information, material and financial resources (Kovács & Spens, 2007; Van Wassenhove, 2006). Examples of the operational elements associated with these flows include transportation and shipping of goods, acquisition of supplies, the

delivery of items to individual customers or beneficiaries, the use of information systems to share assessment, procurement, and fulfillment actions, and the accurate accounting of resources both up and down the supply chain.

Supply chain management research itself is also closely related to (and sometimes synonymous with) operations management, operations research, and logistics. Although there are differences in the scope and focus of each of these fields, there are many overlapping elements which provide important insights into any new or emerging research. The two main streams of disaster relief and supply chain management literature merge to form what will be referred in this paper as disaster relief supply chain management. Many of the concepts involved in disaster relief supply chain management are referred to in literature which is characterized as disaster supply chain management, humanitarian logistics (Kovács & Spens, 2007, 2011), disaster operations management (Altay & Green, 2006), and public sector or humanitarian operations research (Ergun, Karakus, et al., 2010). The synthesized and emerging stream of disaster relief supply chain management is itself organized into two sub-streams which are continuous aid work and disaster relief. Continuous aid work, ongoing relief efforts, and general humanitarian operations such as those aimed at eradicating poverty, reducing world hunger, operating a food bank, or any type of ongoing endeavor fall under the category of continuous aid work. The environments in which these efforts exist and operate are relatively stable and established when compared to the turbulent environments which exist in the immediate wake of a disaster event, and are outside the scope of this study. Disaster relief is the other sub-dimension of disaster relief supply chain management, which examines the management of response and relief efforts immediately following

some unexpected or unplanned for event (Kovács & Spens, 2007). Disaster relief is characterized by rapid emergence of supply chains and processes and the rapid evolution of those elements that form the supply chain. The focus of this research is on the emergent systems view (Simpson & Hancock, 2012; Simpson et al., 2008) of disaster relief supply chains as described above.

Disaster Relief Supply Chain Management

Supply chain management has been defined in different ways by different authors over the years, and these differing definitions have been categorized into three areas: a management philosophy, implementation of a management philosophy, and as a set of management processes (Mentzer, DeWitt, Keebler, Min, & al., 2001). Within this category, SCM has been more specifically defined as the process of managing relationships, information, and materiel flow across enterprise borders (La Londe & Masters, 1994). This definition bears resemblance to literature on the study of disaster relief supply chain management in that the primary flows within disaster relief supply chain management have been identified as materiel, information, and resource (or financial) flows (Kovács & Spens, 2007; Van Wassenhove, 2006). This study focuses on the management of these three flows for emergent systems.

Literature in disaster relief supply chain management is growing. There are several pertinent literature reviews in this area. Reviews by Altay and Green (2006), Kovács and Spens (2007, 2009, 2011), Natarajarathinam et al. (2009), and Overstreet et al. (2011) are noted as the most comprehensive and applicable to understanding the state of the art in disaster relief supply chain management.

The first aspect examined by these authors is the temporal dynamics of disaster relief supply chain management. Natarajarathinam et al. (2009) provides an analysis of disaster relief supply chain management literature in terms of articles published by year. This simple historical analysis gives rise to an obvious turning point in the quantity of disaster relief supply chain management literature and that recent events have resulted in more research interest in this topic. Prior to 1990, there were 8 articles published in the 48 journals included in the analysis. Taken in 5 year periods after 1990, we see only a handful of articles published from 1990-1994 and the same from 1995-1999. However, in 2000-2004, we see a sharp increase, especially in 2004. Then in 2005-2008 (2008 was the year the bulk of the research was conducted for this study) we see a virtual explosion in articles published in disaster relief supply chain management. The authors attribute this rise in interest to several international crises which elevated interest to a fever pitch. Large-scale, high-impact Events like the 2001 World Trade Center attacks, the 2004 Tsunami, Hurricane Katrina, and Hurricane Rita are reasonably assumed to be at the root of this rise in interest. This detailed historical analysis is unique to Natarajarathinam et al. (2009) among the literature reviews visited here, although all of these reviews note the increase in disaster relief supply chain management interest and subsequent publication since the 2001-2004 time period and the "landmark" disasters taking place during that timeframe.

Kovacs and Spens (2007, 2009, 2011) take a slightly different approach in the method for their review in that their search is narrowed specifically to only include humanitarian logistics publications, whereas Natarajarathinam et al. (2009) used a much broader scope in their search to include literature classified as crisis management and

emergency management in general. Both authors' reviews searched out literature based on keywords, and included practitioner as well as mainstream operations management, operations research, supply chain management, and logistics publications in their search. Kovacs and Spens also included practitioner journals in their literature search, noting the rationale behind this strategy is that these articles "give insight into an emergent field and are helpful in gaining an initial understanding of this field" (Kovács & Spens, 2007). This statement is important to note because it infers a theme in the disaster relief supply chain literature in general. This theme is that the field is currently emerging from a synthesis of closely related disciplines and studies, and that while the subject matter being studied is not new, the emergence of the study of disaster relief supply chains as a field of its own is a recent development. This theme serves to call for a delineation of the borders of the field of disaster relief supply chain management. This shift in thought marks a departure from the scattered nature of this field in the past and is the beginning of a stand-alone structure for this discipline.

In another pertinent literature review, Altay and Green (2006) paint a slightly different picture by looking only at articles related to operations research and management science. Practitioner journals are, therefore, not included in this study and the focus of this study is on mainstream operations research and management science journals as well as operations research and management science related outlets. This review, much like the articles of Kovacs and Spens', has a focus on disaster operations management. This focus is more specific that Natarajarathinam's crisis management focus, and includes research related to any disaster categorized as such by the International Federation of the Red Cross and Red Crescent Societies. One of the main

contributions of this review is to point out and categorize the extent to which the analytical decision making tools used by the operations research and operations management communities are being applied to further the field of disaster response operations management. This is brought to light by highlighting the increase in disaster related material emerging within the mainstream research outlets that were examined.

The frameworks used or developed by these studies show unique ways of looking at how to classify disaster relief supply chain management research. They also bring out important aspects of the field that help to define it. The following discussion of the frameworks presented in previous studies helps one to understand where this particular research fits into the bigger picture.

Altay and Green (2006) use a four phase disaster management timeline to classify research. The four phases used here are mitigation, preparedness, response, and recovery – indicating only the temporal nature and maturity of the disaster operation at the time of study. Mitigation includes activities occurring pre-disaster which serve to reduce the risk and impact of potential disasters. Mitigation may include physical activities such as building structures to resist flooding, but may also include policy measures such as zoning to prevent building in high-risk areas. Preparedness includes activities such as planning, personnel employment, training and education, and budgeting to prepare for a potential response. Response includes activities to be accomplished immediately after the onset of a disaster, which include firefighting, search and rescue, evacuation, and establishing command and control where infrastructure has been degraded. The response phase is comprised typically of activities we associate with emergency response. Finally, the recovery stage is characterized by activities generally associated with cleanup and

restoration of "normalcy" to a given area or population. These activities include debris removal, mental health and pastoral counseling of those affected, and re-establishing basic infrastructure such as power systems, roads, and bridges.

Kovács and Spens (2007) framework primarily revolves around three temporal phases of disaster management as well (preparation, immediate response, and reconstruction). These phases are similar to the temporal phases presented by Altay and Green and encompass the same activities. The demarcation in any temporal phase model occurs at the onset of the disaster. In the Altay and Green phase model this takes place after the mitigation and preparedness phase and before the response and recovery phases. In the Kovacs and Spens model it takes place after the preparation phase and before the immediate response and reconstruction phases. The Kovacs and Spens phase model explicitly includes the perspectives of regional and extra-regional actors and the processes involved at each temporal phase of disaster management for each group of actors. This added dimension creates a more complex and detailed categorization of the environment and setting of the field of disaster relief supply chain management. In a later paper, Kovács and Spens (2011) take a slightly different approach to classifying the field of disaster relief supply chain management by identifying three domains in which it exists – practice, research, and education. The gaps existing in each of these domains are examined, as well as a brief discussion of the differences between the domains themselves. This serves to add further depth to the framework by which we understand disaster relief supply chain management as a separate and unique field of study. By creating boundaries between the different action areas in the field, and highlighting the complementary potential of actions that have thus far taken place separately in practice,

research, and education, the complementary and synergistic potential of these action areas is brought into light.

In what is the most exhaustive and complex review, Natarajarathinam et al. (2009) builds a classification framework which includes the source, scale, stage, research method, and respondent categories for the disaster relief supply chain literature reviewed. The source refers to internal or external sources of crisis. This includes risks that reside outside the scope of the supply chain such as political and exchange rate risk, for example. Internal sources of crisis include employee and information technology related factors. The scale here refers to the crisis itself, and is sub-categorized into single stage, supply chain, and regional – each indicating where the boundaries of the crisis exist. The stage dimension of this framework is the same as is used in Altay and Green, with each of four stages referring to the maturity or temporal nature of the disaster operation (mitigation, preparation, response, and recovery). Research method describes which technique was used to conduct the research and includes the methods of analytical, empirical, conceptual, or applied. Finally, respondent refers to whether the organization being studied or described resides in the for-profit or not-for-profit sector, with a note that all humanitarian logistics literature is classified in the not-for-profit realm.

The dimensions presented by the preceding literature review and framework research add up to a description of disaster relief supply chain management as a field which merits considerable study in its own right. Common conclusions which emerge from these pertinent reviews are that more research is needed in the area of humanitarian logistics and supply chain management, that commercial logistics practices can be applied to humanitarian logistics and disaster recovery in order to achieve desirable

results and increase effectiveness, and that humanitarian logistics, although bearing many common factors with commercial logistics, is itself a distinct and emerging field with a separate set of characteristics to be defined and studied.

The application of the frameworks described above to classify existing disaster relief supply chain management literature is not only relevant in that it gives us a common language and reference points from which to study the field, but it is also revealing in that while we strive to classify and define as researchers, the by-products of multiple classifications are a set of characteristics, that when consolidated, commonly addressed, and discussed, help to further define the field as distinct, and help us to adjust to a sharper focus of what it means when we say disaster relief supply chain management. The frameworks presented in the prominent literature reviews of the field do just that. They provide a starting point at which we can further enrich the definition of disaster relief supply chain management. It has been said that humanitarian logistics is a new science and that it is "not a matter of copying our normal techniques and saying they are valid" (Van Wassenhove, 2011). If this is the perspective in which we look at the field, then we must not simply study individual cases and point out the strengths and weaknesses of the organizations and responses involved, but we must relate all these studies and findings to some general structure around which the new field is being designed.

Framing the Environment of Disaster Relief Supply Chain Management

The environment of disaster relief supply chain management can be framed around a story-like scenario with a setting, characters, and action. Dividing disaster relief

supply chain management into these three elements provides a basis of understanding the environment in which disaster relief operations take place, and the complex nature of how the elements may interact with one another.

First is the description of the setting. In the realm of disaster relief supply chain management the setting is created by the disaster itself and the response effort. It refers to the temporal and physical elements around the disaster and response operations. Disasters have been categorized in several different ways. Ergun, Karakus, et al. (2010) describe three dimensions to the disaster – time, location, and magnitude. These dimensions in turn give rise to the nature of the response. In addition to the rather broad categorizations introduced above, a disaster typing matrix has been used by several descriptive studies (Ergun, Karakus, et al., 2010; Van Wassenhove, 2006) which places disasters in one of four categories based on the onset (sudden or slow) of the disaster as well as the origin of the disaster (natural or man-made).

The second part of the setting in which disaster relief supply chain management operates is determined by how far along the response effort is, usually categorized by a temporal phase designation. Several models of a phase designation system have been introduced and used, including a four phase system consisting of mitigation, preparedness, response, and recovery (Cottrill, 2002; De Silva, 2001; Long & Wood, 1995). Three phase models have been introduced as well, which include the phases of preparedness, during operations, and post operations (Lee & Zbinden, 2003) and preparation, immediate response, and reconstruction (Kovács & Spens, 2007; Long, 1997).

One of the most recently published response frameworks is the National Disaster Response Framework (FEMA, 2011). This framework also includes four phases – pre disaster or preparedness, short term recovery, intermediate recovery, and long term recovery. Each phase is represented by unspecific time periods and specific but sometimes overlapping tasks. The general nature of this framework makes it a good fit for the dynamic environment of disaster response. This framework represents an attempt at the formalization and standardization of previously presented frameworks. The National Disaster Response Framework preparedness phase is characterized by its ongoing nature and includes such activities as pre-disaster recovery planning, mitigation planning, community capacity, preparedness exercises, and partnership building. The short-term recovery phase is expected to last days and includes tasks such as mass care, sheltering, clearing primary transportation routes of debris, establishing needed infrastructure to support business reopening, identification of those in need of psychological counseling, emergency and temporary medical care, and assessment and understanding of risk and vulnerabilities. The next phase outlined by the National Disaster Response Framework is the Intermediate recovery phase, which could last from weeks to months. This phase includes the activities of providing interim housing, debris removal, planning infrastructure repair and restoration, reestablishment of businesses, engaging support networks for ongoing emotional and psychological care, ensuring continuity of health care through temporary facilities, and working with the community to take opportunities to rebuild stronger and more prepared for future disasters. The final phase described under the NDRF is the long term recovery phase which is expected to last from months to years. This phase includes activities such as developing permanent

housing solutions, rebuilding infrastructure to meet future needs, implementing economic revitalization strategies and facilitating funding for business rebuilding, continued provision, establishment and monitoring of emotional, psychological, and physical health care and facilities, and the implementation of mitigation strategies community wide.

This framework, like all those presented here, represent both the temporal phases and common tasks associated with each in a disaster response. They all include a period for planning (pre-disaster) and a period for reaction (post-disaster). The concept embodied by the convergence of the literature around this type of framework is that of the temporal and turbulent nature of a disaster response environment, and that the processes formed early in the recovery phase influence the entire recovery effort, such that a classification of the setting in terms of time and task accomplishment is useful in understanding the dynamic nature of a given response at a given point.

Within the setting framed above, there are many characters at work. Characters here can be defined as units representing network and supply chain components. These characters have been categorized as actors, roles, stakeholders, or organizations. These categories have overlapping components and they all refer in some way to network or supply chain elements. Actors (Kovács & Spens, 2007) include donors, logistics providers, military, governments, other NGOs, aid agencies, and customers. Roles (Van Wassenhove, 2006) include organizations, donors, media, academic, and not for profits. Stakeholders (B. M. Beamon & Balcik, 2008) include financial donors, aid recipients, organizational staff, and volunteers. Finally, sub-types of organizations include commercial, humanitarian, academic, government, and NGOs. These categorizations overlap, and in many instances, are just rewordings of the same concept or meaning,

however, they all point to a singular thematic concept. That concept is that a disaster relief scenario is filled with characters which individually represent pieces of a complex network structure with many interconnected relationships. Control structures for managing these complex networks of characters may range from loosely organized "minimal structures" (Cunha & Cunha, 2006) to rigid structures with set rules and patterns of behavior.

Also within the setting are the processes which guide the interactions amongst the characters. To phrase this in a story-like framework these processes could be referred to as the "action" of the story. Practically, this is demonstrated by the logistical processes and flows that serve as links between the phases of recovery, or serve as the "bridge between planning and response" (Thomas, 2003). Logistical processes (Ernst, 2003; Kovács & Spens, 2007) include demand management, supply management, and fulfillment management. Demand management involves identifying the customer (recipient) and assessing their needs. Supply management involves appealing to donors or procurement of needed relief items from suppliers as well as the control and management of materials coming into an affected area. Fulfillment management involves the transportation and distribution of relief items to recipients.

Information, financial, and materiel flows capture the movement of information, resources, and relief items within the supply chain system. These three processes are adapted from the commercial supply chain management literature by Kovacs and Spens, and are cited as the three major processes in structuring and analyzing logistics. Furthermore, the action and processes within the setting and between and among the actors is dependent on the movement created by materiel, information, and financial

flows (Van Wassenhove, 2006). These processes and flows represent the concept of movement within the system, without which the actors would not be able to interact, and move the response effort between the temporal phases described earlier.

So the theory set forth here is that the supply chain processes which facilitate information, material, and financial resource flows are the link between planning and response as well as the link between temporal phases of disaster response. They are the essential element in disaster relief supply chain management in that they convey the action of the characters involved in order to address the needs of the beneficiary. A summary of this framework is found in table 1 below.

Table 1: Framing Disaster Relief Supply Chain Management Literature

Major Components	"Setting" (the disaster itself, or the environment. Also, the phase of disaster management)	"Characters" (the network or supply chain components)	"Action" (the logistical processes and process flows)
Categories	Disaster type, disaster dimensions, phase of disaster management	Actors, roles, stakeholders, organizations	Logistical processes, process flows
Elements within categories	Type: sudden or slow onset, natural or man-made (Ergun et al, 2010; Van Wassenhove, 2006) Dimensions: time, location, and magnitude (Ergun et al, 2010) Phase models: (a) mitigation, preparedness, response, and recovery (Long, 1997; Nisha de Silva, 2001; Cottrill, 2002) (b) preparedness, during operations, and post ops (Lee & Zbinden 2003) (c) preparation, immediate response, and reconstruction (Long, 1997; Kovacs & Spens, 2007) (d) pre-disaster preparedness, short term recovery, intermediate recovery, and long term recovery (FEMA, 2011)	Actors: donors, logistics providers, military, governments, other NGOs, aid agencies, customers (Kovacs & Spens, 2007) Roles: organization, donor, media, academic, NFP (Van Wassenhove, 2006) Stakeholders: financial donors, recipients, staff, volunteers (Beamon, 2008) Organizations: commercial, humanitarian, academic, governments, NGO (both relief and development)	Logistical processes: demand management, supply management, fulfillment management (Kovacs & Spens, 2007; Ernst, 2003) Flows: materiel, information, and financial (Van Wassenhove, 2006)
Conceptual significance	Temporally changing, turbulent disaster management environment	Complex network structure and relationships	Movement within the system
Strategies / tools for management	Planning, improvisation	Just-in-case agreements	Coordination, information sharing, IT, software, systems
Questions	How are decisions made in different phases? What is the right balance of planning and improvising?	What is the appropriate control structure (centralized/decentralized)? How to organize? Who is the customer?	How are decisions made? How to measure success / performance?
Observation	Interactions between strategy, environment, and capabilities determine effectiveness	Control and planning structure must fit both phase & strategy	Decision processes are the link between planning and response; the link between phases of disaster management
Proposition	Improvisation is always part of the decision making process Capabilities enable improvisation	Planning and improvisation will effect performance differently, depending on organization activities and capabilities	Many disaster relief processes are improvised Effective improvisation enables performance Planning affects performance

Improvisation in disaster relief supply chain management

Improvisation has been studied in the management literature and in its essence is viewed as a path of creative departure from some original theme. Improvisation has been characterized as the balance of "making do" and "letting go" (Vera & Crossan, 2005), where the making do aspect refers to the creative process of trying to adapt to changing circumstances, and the letting go aspect involves the spontaneous nature of making decisions at a moment in time, or thinking on one's feet.

Weick (1998) describes improvisation in terms of a Jazz musician's departure from an original melody and theorizes that improvisation lies at the far right of a continuum consisting of interpretation, embellishment, and variation as lesser yet progressively more accurate emulations of the phenomenon (Berliner, 1994). Weick also points out the fact that although we are quick to pick up on the spontaneous creativity aspect of improvisation, we are also quick to forget the contribution of practice, listening, and study in the process of improvisation.

The intention of this research is to take this and others' definition of improvisation parsed in the language of Jazz and musicianship and to translate the action and mechanics of the phenomenon into a language befitting the description of what we see in supply chain management. So the contribution to the definition is that improvisation is distinct. It signifies a departure from an original process insomuch as the departure itself creates a new process while still preserving the elements of the original process.

Further, it is noted that improvisation involves both spontaneity and on-the-spot creativity as well as a foundational toolbox built up from familiarity with the tactics used in executing common processes. “You can’t improvise on nothing; you’ve gotta improvise on something” (Kernfeld, 1995). The discussion here involves the sometimes taken-for-granted nature of improvisation implied by the fact that improvisation is a departure from some original process. Improvisation is stated as a verb by Weick as “composing in real time that begins with embellishments of a simple model, but increasingly feeds on these embellishments themselves to move farther from the original melody and closer to a new composition.” To deconstruct this idea, we can focus on the phrase “departure from an original process.” It is this original process that must be present in the first place in order to spawn improvisation.

To take this discussion further in the direction of supply chain management, we can say there must be some ongoing process to improvise from. Naturally, one of the first questions that come to mind in disaster relief supply chain management is that if there is a lack of experienced logisticians managing a rapidly emerging and evolving supply chain, what is the basis of the initial process? There is a continuum of formality based both on the planning maturity and preparedness of the organization, and on the experience and expertise of the logistician(s) managing the process. In other words, the more mature the organization’s planning is and the more experienced the logisticians are, the more formally structured the beginning of the process of improvisation will be. The less evolved organization and less experienced logistician will begin the process of improvisation from a less formal process structure. This continuum can encompass the

extremes of a near non-existence of a structure to the opposite end of the spectrum where supply chain management processes are firmly established and well-documented as rules and procedures. This is not to make the assumption that a departure from a more formal process will result in higher levels of success than a "start from scratch" approach. In fact, the dynamic environment surrounding disaster relief supply chain management may lend itself to the more creative management approach taken with a start from near nothing than to management by trying to fit a dynamic and fast-evolving scenario into the "box" of a formalized, off the shelf, process.

To summarize the definitional elements of improvisation in supply chain management:

(1) An improvised process involves spontaneity, creativity, experience, and knowledge.
(2) An improvised process represents some departure from an original process. It is new, but retains the essence of the original. The pre-existing process can lie on a spectrum from loosely organized to formal.

Although the overall discussion of improvisation's definition can include the elements above, the intent of this study is to focus on the components of spontaneity and creativity for the purpose of this research. This study adopts the definition used by Vera and Crossan (2004b) which states improvisation is "…the spontaneous and creative process of attempting to achieve an objective in a new way."

To further define improvisation, it is important to understand some concepts related to improvisation, and how they differ from improvisation as defined here (Leone,

2010; Moorman & Miner, 1998b). These concepts include adaptation, innovation, interpretation, embellishment, and variation.

First, adaptation is the adjustment of a system to external conditions, can include the use of prior routines, does not need to include temporal and substantive convergence and can be planned (D. T. Campbell, 1965; Stein, 1989). Another related concept, innovation, can be defined as a deviation from existing practices or knowledge, but can be planned and designed apart from its execution, making it distinctly different from improvisation (Rogers, 1995; Zaltman, Duncan, & Holbek, 1973).

Another way to characterize related concepts is by defining a continuum consisting of interpretation, embellishment, variation, and finally improvisation, where degrees of spontaneous creativity are increased at each level along the continuum (Weick, 1998). Interpretation simply means taking "minor liberties" with the original but for the most part sticking to the plan (or musical piece in this instance) and playing what is written. Embellishment takes the liberty of the musician one step forward, allowing for the rephrasing of the original with imagination, while still maintaining the original's recognizability. Variation takes us one step closer to improvisation, and in this example, is the closest emulation of improvisation without improvising. Variation in this musical sense involves creating and inserting new material into the original, but doing so in a recognizable way.

Improvisation in this example is the complete transformation of the original into something new and creative which bears little or no resemblance to the original. Although these concepts are taken from the musical world, the same continuum exists

when defining improvisation in organizations. It is the creation of new processes and their simultaneous executions that make something improvised.

Managing disaster relief supply chains is not just a matter of applying best practices from commercial supply chain management. Since disaster relief supply chain management involves rapidly emerging systems in which all events cannot be planned for, it is evident that improvisation plays a major role and that effective disaster relief involves some mix of good planning and improvisation.

Relating disaster relief supply chain management to the definition of improvisation, we see the decision making process in disaster relief supply chain management takes a drastic departure from conventional decision making (Jianshe, Wang, & Yang, 1994) and many of the attributes on which supply chain decisions are based are unknown – such as nature, scale, and timing of events (Altay & Green, 2006) as well as the basic informational elements necessary to plan an effective supply chain response such as who, when, where, how much, and how many times (Ergun, Karakus, et al., 2010; Kovács & Spens, 2009).

The unusual challenges and the high number of unknowns faced in a disaster relief effort place practitioners into situations where quick decisions must be made sometimes without all needed information (Altay & Green, 2006), thus forcing the near-simultaneous formation and execution of a process or a plan, meaning that disaster relief supply chains need to be designed and deployed at once (B. M. Beamon, 2004; Kovács & Spens, 2007; Long & Wood, 1995; Tomasini & Van Wassenhove, 2004). This compression of design and execution captures spontaneity – one dimension of improvisation.

It may also be a challenge to pre-plan effective coordination mechanisms before an event occurs, leading to a large degree of improvisation in the execution of a response (Balcik, Beamon, Krejci, Muramatsu, & Ramirez, 2010). Improvisation often takes place in turbulent or constantly changing environments where the need to adapt is imminent, particularly where task complexity is high (Magni, Provera, & Prosperio, 2008). The complexity of a disaster supply chain also makes tasks such as inventorying the needs of a population, mapping the disaster area, raising money, procuring what is needed, and moving and distributing relief goods almost impossible to plan ahead of time. As a result, disaster relief supply chain must be created on the go (Boin et al., 2010). This captures another important dimension of improvisation – creativity. The literature also reflects how organizations deal with other difficulties caused by disasters. Disaster relief takes organizations out of the realm of their routine business, forcing flexibility, improvisation, redundancy, and the breaking of rules (Boin et al., 2010).

Quality Improvisation and Effective Improvisation

Effective Improvisation refers to the concept that improvisation is not inherently good or bad. Improvisation has often times been characterized as an always good phenomenon, however, the use of improvisation may create either chaos or order and may contribute to a problem's solution or may contribute to the problem itself (Vera & Crossan, 2005). Effective improvisation is defined by Moorman and Miner (1998a) as "the degree to which an action achieves instrumental outcomes of value for a firm".

In order to reach this definition of effective improvisation, it is helpful to look at the research background in what is referred to as quality improvisation. As the phrase implies, quality improvisation refers to whether the improvisation taking place has a positive or negative effect on outcomes of interest (performance of some type). Nemanich and Vera (2007) looked at antecedents (precursors) of improvisational capability, finding that the precursors to improvisation include technical expertise, knowledge stocks, external information gathering, internal information sharing, and communications skills.

Improvisational capability, although not explicitly defined in this paper, points to the ability of a group working together (team) to improvise and does not deal with the outcome or performance of the improvisation, therefore it does not address improvisation quality or effective improvisation. Improvisation quality is briefly mentioned by Miner, Bassoff, and Moorman (2001), being noted as something that may be beneficial at different levels of organizational action, but not discussed in detail or explicitly defined. Crossan (1998) discusses the structure in which improvisation takes place and the characteristics which may support quality improvisation, but does not explicitly define quality improvisation. Vera and Crossan (2005) also mention and discuss quality improvisation as it is related to innovative performance in teams, defining and testing five factors that act as moderators in the relationship of improvisation to innovative performance. Empirical testing found four of the five factors to be significantly linked to increased levels of innovative performance. The factors found to influence improvisation's relationship with innovative performance are expertise, teamwork skills,

experimental culture, and real-time information sharing. No explicit definition of quality improvisation is given. The implication is that quality improvisation is captured here by increased innovative performance – a specific outcome.

Crossan, Cunha, Vera, and Cunha (2005) examine time and improvisation. They take a closer look at factors proposed by Vera and Crossan (2004a) to have an influence on improvisation. The factors discussed: experimental culture, real-time information sharing and communication, memory, expertise, and teamwork skills - are hypothesized to enhance the quality of improvisation within groups and organizations. However, no explicit definition of quality improvisation is given in this paper.

Vera and Crossan (2004b) further discuss quality in terms of improvisational theater, where the outcomes and performance measures are the enjoyment and satisfaction of the audience, the actors' sense of accomplishment and fun, the originality of the pieces, and the appropriate use of resources at hand. This paper compares improvisation in business to this theatrical metaphor by comparing the customers to the audience and employees to the actors. The five factors later to be linked to innovative performance as moderators of the improvisation to innovative performance relationship are derived from the theatrical analogy.

Kamoche, Cunha, and Cunha (2003) extend the traditional view of improvisation through the jazz metaphor by looking at additional metaphoric factors from Indian music, music therapy, and role theory. Factors considered here are leadership style, individual characteristics, culture, memory, and group size. Leadership style is discussed and examples of a rotating leadership style increasing improvisational quality are discussed.

This rotating leadership style bears much resemblance to intuitive or experience based leadership, where no single authority rules the day, but leaders emerge based on expertise, intuition, and ability, and the process itself depends upon high levels of horizontal communication. Individual characteristics conducive to high quality of improvisation are centered on high levels of virtuosity skill, mutual trust, and creativity – which suggest "avoiding reliance on past routines" – further emphasizing the creative aspect of improvisation. Additionally, individual factors discussed are the ability to deal with the unknown and the stress associated with it. These individual characteristics thrive in an organic structure where a culture of experimentation is present. Memory is discussed as potentially having both positive and negative effects on quality improvisation. Positively, it can facilitate the ability to improvise by enabling group members' learning and calling on past information while understanding the context of the now. Negatively, memory can be detrimental if one simply begins to rely on past routines. A fine line is established between honing a skill and relying on the past, as practice is notably important in strengthening declarative (the "what") and procedural (the "how to") memory. This also equates to the organic structure in that formal routines in this structure are not the basis for work accomplishment. Finally, group size is discussed in that large groups have lower improvisational levels because of poor (either too little, or distorted) communication (Voyer & Faulkner, 1989).

Cunha, Cunha, and Kamoche (1999) also discuss factors affecting both the extent and quality of improvisation. These factors fall into the categories of leadership, group member characteristics, information flow and related factors, organizational

configuration and resources. Although these factors are grounded in the examination of extensive previous literature, the discussion leaves out an explicit definition of what quality improvisation is. The focus of their discussion is how these factors lead to improvisation. This research also discusses positive and negative potential outcomes of improvisation. Positively, these are flexibility, learning, motivation, and affective outcomes. Negative outcomes discussed are biased learning, opportunity traps, amplification of emergent actions, over reliance on/addictiveness to improvisation and increased anxiety.

Defining Effective Improvisation

Moorman and Miner (1998a) also discuss improvisational performance using the model of improvisation as a neutral construct in which performance is the determinant of improvisational effectiveness. In this context effective improvisation is characterized by coherent, novel, and speedy action. Organizational memory serves here as an enabler of effective improvisation (or the moderator of the improvisation – performance relationship), however, there is no explicit definition of effective improvisation given and no distinction made between effective and quality improvisation. Moorman and Miner also discuss improvisation effectiveness, investigate conditions which improvisation is likely to occur, and examine conditions when improvisation is likely to be effective. In review of research which points to and discusses improvisational effectiveness or improvisational quality, the performance outcome is always the determinant evidence of successful or effective improvisation. Organizational effectiveness is defined as “the

degree to which an action achieves instrumental outcomes of value for a firm." (Moorman & Miner, 1998a; Walker & Ruekert, 1987).

Two types of effectiveness outcomes are discussed in this literature - product and process. Process effectiveness is measured by cost efficiency, time efficiency, team functioning, and team learning. The Moorman and Miner study found that environmental turbulence, real-time information flow, and organizational memory level moderated the effectiveness of improvisation on product and process effectiveness. In most cases it reduced the negative effect of improvisation on these two outcomes. This study was restricted to improvisation and the new product development process. A contingent view on improvisation was found in which it could be positive or negative as determined by the moderating factors considered. The finding is that emergent processes might have value in uncertain or ambiguous conditions. This supports recent claims that improvisation represents an "important competency that can produce value for organizations in certain conditions." (Eisenhardt & Tabrizi, 1995; Moorman & Miner, 1998a; Weick, 1987, 1998).

Based on the discussion of the preceding improvisation research, the definition of effective improvisation is tied directly to organizational effectiveness. Effective improvisation is then defined for this research by the degree to which instrumental outcomes are achieved (measured through performance) given the level of improvisation in an organization.

Improvisation in Supply Chain Management

Disaster relief supply chain management, by its characteristics, may always involve some degree of improvisation. However, it is the overall performance of the disaster relief supply chain that matters in bringing relief to those in need and doing so in an effective manner. Improvisation has been linked to elements of performance, however, the incidence of improvisation as a neutral construct should not have a direct effect on performance, as evidenced in the following five studies of the relationship between improvisation and performance (Hmieleski & Corbett, 2008; Kyriakopoulos, 2011; Magni et al., 2008; Moorman & Miner, 1998a; Vera & Crossan, 2005).

Theoretical and empirical work has shown that under certain moderating conditions, improvisation results in higher levels of innovation (Magni et al., 2008; Vera & Crossan, 2005), product and process effectiveness (Moorman & Miner, 1998a), new venture performance (Hmieleski & Corbett, 2008), and cost efficiency, and market effectiveness (Kyriakopoulos, 2011). Although the incidence (extent to which it occurs) of improvisation itself is neither good nor bad, the presence of context-specific moderating factors is shown to influence its relationship with performance. In disaster relief supply chain management, we must recognize that the role of improvisation in the supply chain function is ever present. Therefore, we must look to improve the performance of these supply chains not only through the more traditional role of planning, but also by searching out factors which increase the effectiveness of improvisation in the context of disaster relief supply chain management.

H1: Incidence of improvisation alone will have no direct effect on disaster relief supply chain performance.

Performance measurement in disaster relief supply chain management

Specific research in developing performance measurement systems for disaster relief supply chains is scarce, even though performance measurement is recognized as a key to continually improving supply chain performance (Van Wassenhove, 2006). Several researchers have introduced systems and specific measures for disaster relief supply chain performance measurement (B. M. Beamon & Balcik, 2008; Davidson, 2006; Van Der Laan, De Brito, & Vergunst, 2009).

Table 2: Summary of performance measures and their categories

Category	Formative Measures
Speed	Procurement delivery time (Davidson, 2006) Average response time (Beamon & Balcik, 2008) Percent on-time deliveries (Beamon & Balcik, 2008)
Cost	Inventory holding cost (Beamon & Balcik, 2008) Number of relief workers employed per aid recipient (Beamon & Balcik, 2008) Total cost of distribution (Beamon & Balcik, 2008)
Quality (assessment)	Assessment accuracy (Davidson, 2006) Inventory obsolescence and spoilage (Beamon & Balcik, 2008) Supply availability (Beamon & Balcik, 2008)
Flexibility	Volume flexibility (Beamon & Balcik, 2008) Delivery flexibility (Beamon & Balcik, 2008) Mix flexibility (Beamon & Balcik, 2008) New product flexibility (Beamon & Balcik, 2008)

The classification of disaster relief supply chain metrics into the categories and measures in table 2 are supported by the studies discussed in this section. Van Der Laan et al (2009) develop a number of factors which must be present for both the organization

and the measures themselves. These factors are argued to be the groundwork necessary for effective performance measurement. Van Der Laan et al suggest that an organization must recognize the strategic importance of supply chain management, be willing to measure operational performance, and lastly to have the proper information systems to collect the required data for performance measurement. Van Der Laan et al argue effective measures must be future oriented, strategically aligned, balance financial and non-financial factors, and balance the quantitative and qualitative aspects of performance. In a case study of Medicines sans frontiers – Holland, Van Der Laan et al look at performance measures being used and find that none of them completely satisfy the criteria identified in their research. Suggestions for improved metrics including accuracy of stock records, realized service level, and stock efficacy are made.

Beamon & Balcik (2008) derive a disaster relief supply chain performance measurement framework from an earlier work in commercial supply chain performance measurement (B. M. Beamon, 1999). This adapted framework breaks performance measurement in to three factors which are resource performance, system output performance, and flexibility performance. Examples of specific metrics in these categories are cost of supplies, resources, and overhead, total dollars spent per aid recipient, and minimum response time. Davidson (2006) develops a set of performance measurement metrics tailored to the International Federation of the Red Cross in which specific metrics such as appeal coverage, donation-to-delivery time, financial efficiency, and assessment accuracy are introduced.

The examples provided above are some of over 40 individual performance measures identified between these three studies, as well as others used in practice, and

identified in case studies (Gatignon, Van Wassenhove, & Charles, 2010). In order to narrow these measures into a scale which reflects disaster relief supply chain performance, is of reasonable length for a questionnaire, and is likely to be most universal (as some of the measures were developed for specific organizations), the measures must be interpreted and integrated into categories. In more general terms, supply chain performance can be measured along different dimensions.

Although disaster relief supply chain performance is an emerging field, and there are no universally accepted measures, the overall performance of the supply chain can be conceptualized along the dimensions of competitive priorities (speed, cost, flexibility, and quality). The most common priorities discussed in the disaster relief literature are speed and cost.

The initial priority in a disaster relief effort is speed, which quickly shifts to cost efficiency as the relief effort matures, so these should be the most important performance factors in disaster relief supply chain management. Although the idea of competitive priorities stems from the commercial supply chain literature (Boyer & Lewis, 2002; Krause, Pagell, & Curkovic, 2001; Ward, McCreery, Ritzman, & Sharma, 1998) and is not explicitly addressed in the disaster relief supply chain literature, recent disaster relief research shows an implicit emergence of the factors. The disaster relief priorities of speed and cost, along with the shifting nature of these priorities' importance has been discussed in several prominent studies of disaster relief supply chain management (Day, Melnyk, Larson, Davis, & Whybark, 2012; Tomasini & Van Wassenhove, 2009; Van Wassenhove, 2006; Van Wassenhove & Pedraza Martinez, 2012; Whybark et al., 2010).

Quality as a priority is evident in the need for quality assessment of needs during the immediate aftermath of a disaster. This initial assessment has ripple effects that influence supply management, procurement, and fundraising activities throughout the relief effort. The importance of quality needs assessment is discussed in disaster relief performance measurement in terms of its effect on inventory obsolescence and initial needs assessment (B. M. Beamon & Balcik, 2008; Davidson, 2006). Assessment quality is the accuracy of the organizations initial assessment of what resources will be needed throughout the entire disaster relief effort.

Lastly, flexibility is discussed in terms of responsiveness and agility in recent disaster relief reviews (Ergun, Karakus, et al., 2010; Kovács & Spens, 2009) as well as being a direct factor in disaster relief performance measurement (B. M. Beamon & Balcik, 2008). Flexibility is divided into four elements as follows. Volume flexibility is the relief chain's ability to change the output level of products supplied. Delivery flexibility is the ability to change planned delivery dates. Mix flexibility is the relief chain's ability to change the variety of products supplied. New product flexibility is the ability to introduce and supply new products.

Planning Factors Affecting Performance

A variety of strategies have been developed in academic research to improve disaster relief supply chain management performance. These seem to converge around several categories including pre-positioning of supplies and inventory management (Balcik et al., 2010; A. M. Campbell & Jones, 2011; Kovács & Spens, 2009; Tomasini & Van Wassenhove, 2009; Whybark, 2007), collaboration, networking, and communication (Balcik et al., 2010; Carroll & Neu, 2009; Kovács & Spens, 2009; Long & Wood, 1995; Richey, 2009; Thomas & Fritz, 2006), use of information technology (Kovács & Spens, 2007; Overstreet et al., 2011; Tomasini & Van Wassenhove, 2003, 2004; Zhang, Zhou, & Nunamaker, 2002), and training of logisticians (Kovács & Spens, 2009; Thomas & Kopczak, 2005). Although this is not an exhaustive list of strategies for improving disaster relief supply chain performance, each listed strategy is generally agreed upon in the body of literature cited here.

In a similar attempt to converge upon factors influencing disaster relief supply chain performance, lists of critical success factors (CSF) have been introduced (Pettit & Beresford, 2009; Zhou, Huang, & Zhang, 2011). A critical success factor is defined as "the limited number of areas in which results, if they are satisfactory, will ensure successful competitive performance for the organisation" (Rockart, 1979). Many CSFs are similar to the categories listed above and these CSFs are derived from commercial supply chain research and their applicability to disaster relief supply chains is discussed by Pettit & Beresford (2009). The combination of CSFs and other strategies found in the literature results in four areas which represent emergent themes in disaster relief supply chain management improvement strategy.

These categories are:

1. Strategic Planning Focus – A focus on long-term decisions and planning factors which affect the structure, size, management, and relationships of the supply chain. These decisions affect the entire supply chain and include structural decisions concerning outsourcing, supply chain design (e.g. lean or agile), collaboration, and human resource management.
2. Operational Planning Focus – A focus on operational decisions and planning factors which affect specific material flows and transportation utilization. These decisions affect only a portion of the supply chain. This category includes planning decisions concerning inventory pre-positioning, transportation mode, transportation constraints, port constraints, and material handling constraints.
3. Information Focus – A focus on knowledge management which includes lessons learned, performance data collection, and continuous improvement. The extent of information focus affects how information is collected and used in the planning cycle.
4. Technology Utilization – The extent to which systems are used to integrate supply chain activity. This includes connecting customers, suppliers, and other value adding activities.

Table 3: Summary of the CSFs and categories

Category	Factors
Strategic Planning Focus	**Strategic Planning** (= Strategic Planning + Supply Chain Strategy) (Oloruntoba, 2010; Pettit & Beresford, 2009; Thomas & Kopczak, 2005) **Human Resource Management** (Pettit & Beresford, 2009; Thomas & Kopczak, 2005) **Collaboration** (Balcik et al., 2010; Carroll & Neu, 2009; Ergun, Karakus, et al., 2010; Kovács & Spens, 2007; Pettit & Beresford, 2009; Richey, 2009; Thomas & Fritz, 2006; Thomas & Kopczak, 2005)
Operational Planning Focus	**Inventory Management** (Balcik et al., 2010; Ergun, Karakus, et al., 2010; Pettit & Beresford, 2009; Tomasini & Van Wassenhove, 2009; Whybark, 2007) **Transportation Planning** (= Transport Planning + Capacity Planning) (Pettit & Beresford, 2009)
Information Focus	**Knowledge Management** (= Information Management + Continuous Improvement) (Pettit & Beresford, 2009; Thomas & Kopczak, 2005; Zhang et al., 2002; Zhou et al., 2011)
Technology Utilization	**Technology Utilization** (Ergun, Karakus, et al., 2010; Kovács & Spens, 2007; Long & Wood, 1995; Overstreet et al., 2011; Pettit & Beresford, 2009; Thomas & Kopczak, 2005; Zhang et al., 2002; Zhou et al., 2011)

Critical success factors, by definition, must have an effect on disaster relief supply chain performance. This effect has not been tested. In part due to the newness of the field, and in part due to the sparse research in disaster relief performance measurement. Due to the fact that these CSFs may influence many of the performance indicators discussed already, they should have a direct impact on the speed, efficiency, cost, and quality of assessment of the response. Although the implementation of planning does not negate the need for improvisation, these factors should decrease the incidence of improvisation due to the planned structure they lend to the relief effort. Based on the literature we can hypothesize the following disaster relief supply chain relationships.

H2: Higher levels of strategic focus will have a positive effect on disaster relief supply chain performance.

H3: Higher levels of operational focus will have a positive effect on disaster relief supply chain performance.

H4: Higher levels of information focus will have a positive effect on disaster relief supply chain performance.

H5: Higher levels of technology utilization will have a positive effect on disaster relief supply chain performance.

H6: Higher levels of strategic focus will have a negative effect on the incidence of improvisation.

H7: Higher levels of operational focus will have a negative effect on the incidence of improvisation.

H8: Higher levels of information focus will have a negative effect on the incidence of improvisation.

H9: Higher levels of technology utilization will have a negative effect on the incidence of improvisation.

Capabilities to Create Effective Improvisation

The planning factors discussed in the previous section are hypothesized to have a direct effect on performance as well as improvisation. However, planning is not the sole focus of this study. In order to effectively improvise, one must possess some type of capability to do so. Whether it is through training, experience, or intuition, the capabilities which influence one's ability to effectively improvise should be directly related to the definition of improvisation. This definition includes spontaneity and creativity, but effective improvisation also involves experience and knowledge gained through practice and study (Weick, 1998). These capabilities can be intentionally developed, as discussed by Crossan (1998). This intentional capability building may help to carry out an effective disaster response much like practice contributes to the experience and knowledge needed for effective musical and theatrical improvisation (Weick, 1998). In addition to building the capability to improvise in people, the technology infrastructure may contribute to the level of real-time information sharing (communication) needed to effectively improvise, which has previously been shown to affect effectiveness of improvisation (Kyriakopoulos, 2011; Moorman & Miner, 1998a; Vera & Crossan, 2005). Capabilities-based factors in this study are expressed as creative capability, empowerment, and technology capability. Creative capability and empowerment both influence a person's ability to act creatively and spontaneously. Technology capability facilitates real-time information sharing.

Creative capability is defined as having the necessary knowledge and experience to effectively devise new solutions to problems. This may be derived from a combination of training and experience. Training has been shown to influence the impact of improvisation on innovation, and expertise and teamwork skills (both similar to experience) have been shown to exert a similar effect on the impact of improvisation on innovation (Vera & Crossan, 2005).

Empowerment means having the authority to implement a solution on the spot, and captures the spontaneous nature of improvisation. This capability to implement a solution stems from organizational culture and structure. This factor is similar to experimental culture, which has also been shown to have an effect on the relationship of improvisation to innovative performance (Vera & Crossan, 2005).

Finally, technology capability is the adaptability, configurability, and deployability of the hardware used by an organization. Hardware that is usable in both pre and post disaster scenarios, and which is deployable to be used in the post-disaster response should increase the creative and spontaneous mechanism of improvisation by facilitating real-time information sharing and real time information flow, which have themselves been linked to improvisation's effect on performance (Moorman & Miner, 1998a; Vera & Crossan, 2005).

If these factors significantly influence improvisation and performance in disaster relief supply chains, the implications are validation of the relevance of improvisation to the disaster relief effort and identification of factors which represent organizational capabilities for good improvisation. If, in fact, a practitioner must choose which infrastructure elements of his or her organization to spend critical resources on, this will

help the practitioner make a decision which has a greater effect on performance during relief operations. In this research, the following hypotheses are presented in order to test the proposed relationships described in this section.

H10: Higher levels of creative capability will have a positive effect on the incidence of improvisation.

H11: Higher levels of empowerment will have a positive effect on the incidence of improvisation.

H12: Higher levels of technology capability will have a positive effect on the incidence of improvisation.

These capability factors' effect on the relationship between improvisation and performance is of interest for this research. These hypotheses present the ideas that the mere incidence (quantity) of improvisation does not directly impact performance. The idea presented by these relationships is when the level of one of the capability factors increases in combination with the level of improvisation, that the relationship between improvisation and performance will be positively impacted. These interactions are presented by the following hypotheses.

H13: Creative capability will moderate the relationship between improvisation and disaster relief supply chain performance such that higher levels of Creative

capability will increase the positive effect of improvisation on disaster relief supply chain performance.

H14: Empowerment will moderate the relationship between improvisation and disaster relief supply chain performance such that higher levels of Empowerment will increase the positive effect of improvisation on disaster relief supply chain performance.

H15: Technology capability will moderate the relationship between improvisation and disaster relief supply chain performance such that higher levels of Technology capability will increase the positive effect of improvisation on disaster relief supply chain performance.

Figure 2 below (figure 2 is a copy of figure 1 presented in this chapter for ease of reference) summarizes and illustrates the theoretical relationships proposed by hypotheses 1-15 as developed above.

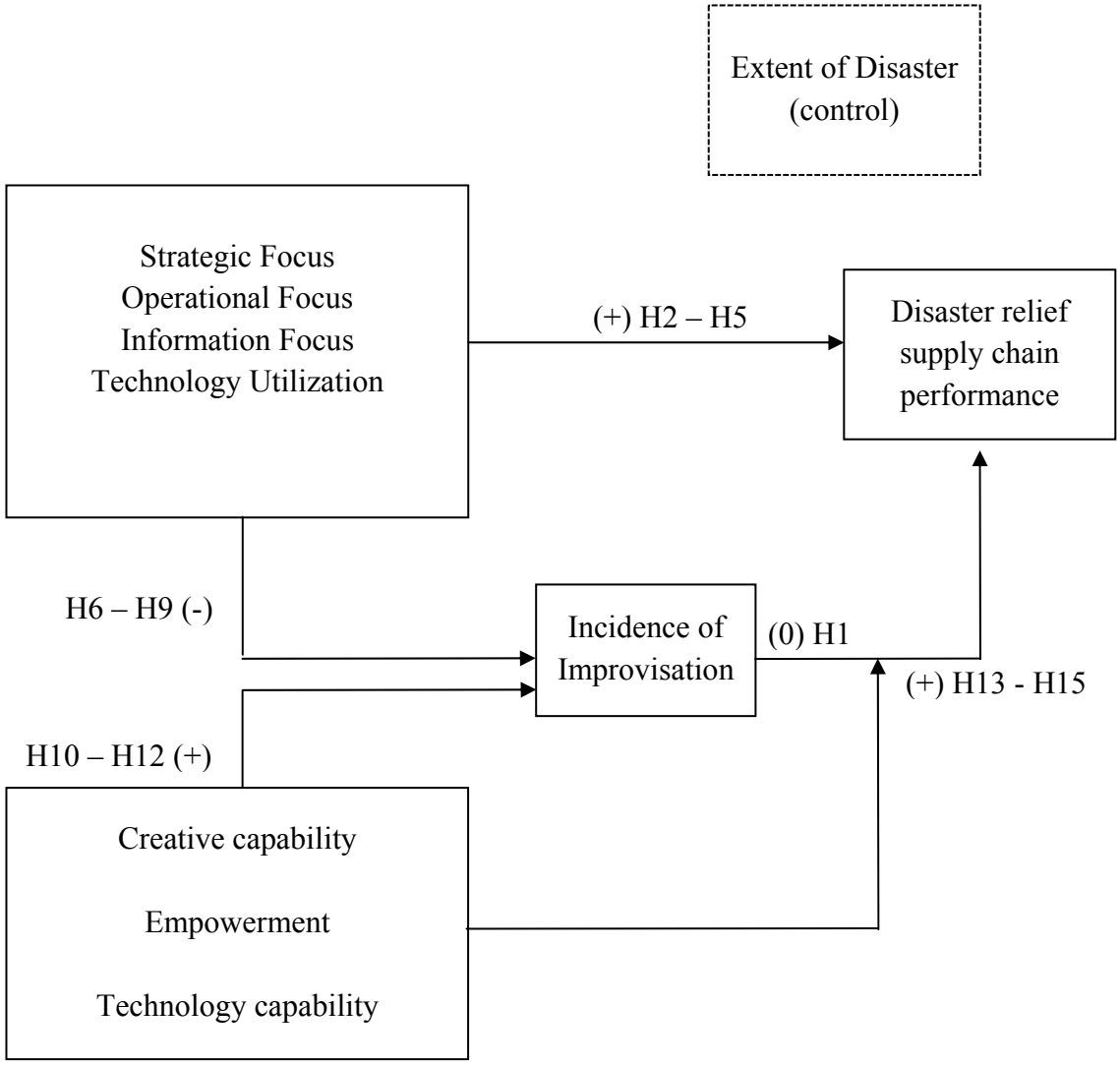


Figure 2: Theoretical Relationship Model

Summary

This chapter has presented an overview of the field of disaster relief supply chain management as well as how improvisation will play a part in the execution of any disaster relief effort. The framework presented to classify disaster relief supply chain management literature is similar to previously presented frameworks, and should be viewed as an extension of that work meant to focus the reader on the processes which enable the different phases of disaster relief to come together. The remainder of this study will focus on the empirical data collection process, testing of the hypotheses presented in this chapter, and the results of that testing.

Chapter 3

RESEARCH DESIGN AND METHODOLOGY

Introduction

The study explained in this chapter will introduce the methodology used for data collection, validation, and analysis. First, a survey instrument and its development is presented along with a preliminary test of the instrument conducted with practitioners and academics in order to identify major issues before proceeding to the pilot study. Next, a discussion, justification, and description of the methods chosen for data analysis in this study are presented.

A pilot test was conducted with the initial survey instrument before proceeding to the main study. The purpose of the pilot test was to validate the survey instrument to insure the data collected would meet the needs of the analysis at hand. The pilot test is presented by first describing the data collection method, process, and respondent population. Next, a measurement model is presented which serves to test the factorial validity of the constructs introduced in the study. Standards for assessing partial least squares measurement models are introduced which will be used for the remainder of the chapter. These standards for factorial validity include assessment of item loadings, average variance extracted (AVE), composite reliability scores, item cross loadings, and the comparison of AVE to squared construct correlations. Problem areas are identified and proposed solutions to the problems are presented and implemented. A summary of the results is presented as well as a brief power analysis to assess the ability of the sample size to detect different effect sizes at various levels.

The chapter concludes with a description of the main study data collection and validation process. This process is more rigorous than the pilot study analysis. Prior to

undertaking the same steps used to assess the factorial validity of constructs as described for the pilot study, the main study data validation includes several pre-screening steps. First, an analysis of the impact of missing values in the dataset and a procedure for replacing those missing values or screening unusable cases is presented. Next, a comparison of responses between paper-based survey respondents and electronic survey respondents is presented to test for potential bias introduced by using a mixed mode data collection strategy. Additionally, early and late respondent waves are compared to one another to test for the presence of non-response bias. Finally, a measurement model is presented to test for factorial validity using the same standards as described for the pilot study. The results of this data analysis are summarized and presented in the concluding section of this chapter.

Survey Instrument

A questionnaire was developed with scales to operationalize each of the variables listed in the previously described model. Global reflective measures for each construct were developed using conceptual definitions and the tailored design method (Dillman, Smyth, & Christian, 2008). Specific construct definitions and indicator names (by construct) are provided in table 4 below.

Table 4: Construct Definitions

Construct	Definition	Indicators
Improvisation	The spontaneous and creative process of attempting to achieve an objective in a new way. *aggregate construct used in hypothesis testing	SP4A, SP4B, SP4C, CR4D, CR4E, CR4F, CR4G (aggregate*) IM1, IM2, IM3 (global)
Performance: global	Organization members' indication of overall organizational performance during an actual disaster response.	P5, P6, P7, P8, P9, P10, P11
Speed	The speed of delivering aid, which includes procurement delivery time, average response time, and, percent on-time deliveries	S12, S13, S14
Flexibility	The supply chain's ability to change to meet situational needs as evidenced by volume, delivery, mix, and new product flexibility. Volume flexibility is the relief chain's ability to change the output level of products supplied. Delivery flexibility is the ability to change planned delivery dates. Mix flexibility is the relief chain's ability to change the variety of products supplied. New product flexibility is the ability to introduce and supply new products.	F16, F17, F18, F19
Assessment Quality	The organization's accuracy in its assessment of disaster relief requirements, as evidenced by supply availability and inventory usability.	AQ21, AQ22, AQ23

Construct	Definition	Indicators
Cost Performance	The supply chain's cost efficiency as evidenced by inventory holding cost, number of relief workers employed per aid recipient, and total cost of distribution.	C25, C26, C27
Strategic Planning Focus	A focus on long-term decisions and planning factors which affect the structure, size, management, and relationships of the supply chain. These decisions affect the entire supply chain and include structural decisions concerning outsourcing, supply chain design (e.g. lean or agile), collaboration, and human resource management.	SF29, SF30, SF31, SF32
Operational Planning Focus	A focus on operational decisions and planning factors which affect specific material flows and transportation utilization. These decisions affect only a portion of the supply chain. This category includes planning decisions concerning inventory pre-positioning, transportation mode, transportation constraints, port constraints, and material handling constraints.	OF34, OF35, OF36, OF37
Information Focus	A focus on knowledge management which includes lessons learned, performance data collection, and continuous improvement. The extent of information focus affects how information is collected and used in the planning cycle.	IF39, IF40, IF41
Technology Utilization	The extent to which systems are used to integrate supply chain activity. This includes connecting customers, suppliers, and other value adding activities.	TU43, TU44, TU45

Construct	Definition	Indicators
Creative Capability	Having the necessary knowledge and experience to effectively devise new solutions to problems. This may be derived from a combination of training and experience.	CC47, CC48, CC49, CC50
Empowerment	Having the capability to immediately implement or enact a solution, when provided.	E51, E52, E53, E54
Technology Capability	The adaptability, configurability, and deployability of the hardware used by an organization. Hardware that is usable in both pre and post disaster scenarios, and which is deployable to be used in the post-disaster response should increase the creative and spontaneous mechanism of improvisation by facilitating real-time information sharing.	TC55, TC56, TC57, TC58
Severity	The severity of the disaster referenced when answering previous questions on the survey.	SEV59, SEV61

The dependent variable, disaster relief supply chain performance, is operationalized by seven global questions which represent a self-reported measure of overall supply chain performance on a disaster relief effort.

The dependent variable, improvisation, is operationalized by seven items which form an aggregate of the reflective measures representing the dimensions of creativity and spontaneity. This approach to measuring improvisation has been used previously (Vera & Crossan, 2005). Modified versions of the established scales introduced by Vera & Crossan (2005) were used to form a seven item scale of improvisation for hypothesis testing.

The independent variables relating to the amount and type of planning being conducted by the organization (strategic focus, operational focus, information focus, and technology utilization) are also operationalized by self-reported measures based on conceptual definitions derived from the literature review. Global reflective measures for each variable are used. The three independent variables representing improvisational capabilities in the model (creative capability, empowerment, and technology capability) are operationalized by reflective global measures based on conceptual definitions derived from the literature review as well.

In addition to these main independent and dependent variables, demographic and control variables are included in the survey instrument as well. The control variable, severity of disaster, is operationalized by using global reflective measures. In order to establish a baseline for responses, participants were asked to classify their experience based on a common reference point of severity (Hurricane Katrina). Organizational demographic information on organization type, size, and the age of the organization was collected. Additionally, individual demographic information on age, gender, position in the organization, and tenure with the organization was collected. Detailed definitions of all constructs can be found in table 4 earlier in this chapter. Individual measurement scale items can be found in appendix 2.

The survey instrument was developed as a web-based survey designed and hosted on surveygizmo.com via an enterprise student edition account. The survey was also adapted to a paper-based format for administration as described later in this chapter.

Preliminary test of survey instrument

A preliminary test of the survey instrument was conducted with practitioners and academics. Practitioners were asked to take note of any issues with wording, question content, question meaning, spelling/grammar, and overall survey structure. The initial test participation request was followed up by a feedback request approximately one week later. The purpose of the preliminary testing was to expose obvious weaknesses and errors in the survey, as well as to ensure the wording was understandable and current to persons involved in the field being studied. Along with the feedback request, an interview questionnaire was provided as a standardized way to address specific areas for practitioner feedback. The request was sent to a total of ten practitioners within a government agency who all have experience in disaster relief operations. Seven responses were received and for each of the seven, either an interview questionnaire was returned or a personal interview was conducted to gather direct feedback (three personal interviews were conducted and four questionnaires were returned by email). The request was sent to a total of six academic reviewers, all of whom responded with feedback on clarity of questions, grammar, style, and other substantive issues as discussed.

Overall, there were no issues noted with accessibility, grammar, wording (use of jargon), technical presentation of the online survey, length of survey, all-inclusive answers, or overall use of terminology. One interviewee noted that a more accurate response from respondents may be possible by providing greater explanation on some of the questions. The questions were reviewed and some definitions were added for clarity. Another interviewee noted that some of the questions seemed redundant. This issue was also noted by the academic reviewers (committee members).

Although multiple global reflective measures are preferred to establish reliability (consistency) of the scale for each construct, the wording on some items was changed after the preliminary test in order to try and minimize the respondents' feeling of "answering the same question over and over again". Another issue noted by the academic review was that some terms (such as volume, mix, new product, and delivery flexibility) were undefined in the survey and may not be understood by survey respondents. Definitions were added where noted by the reviewers and all terminology throughout the survey was checked for clarity of definition. Another issue noted by the academic review was the unclear wording of some items, which was addressed by reviewing and rewording the items in question.

Another issue brought up by the academic review was the use of hurricane Katrina as a benchmark, and the possibility that using a benchmark such as this could ignore all the cultural, social, and economic differences between diverse geographic locations (e.g. New Orleans and Afghanistan). These issues may be present, however, the intent is to focus on the severity of the disaster in terms of a global measure as well as the measures presented (number of people killed, number of people injured, number of people left homeless, overall number of people affected, estimated damage in dollars, number of organizations involved in relief, and length of recovery period). These items are used in current global disaster classification systems such as the Center for Research on Epidemiology of Disasters, and are accepted as standard measures of disaster severity. Although the social, cultural, and economic differences in geographic disaster locations are very important, the complexity they bring to the issue of disaster extent is outside the

scope of this study and remains fruitful ground for future research as more actual disaster data is collected and made available to researchers.

Lastly, it was noted that the responses for the question referring to the respondent's position in the organization did not fit the typical disaster response organizational profile and was more suited to commercial businesses. The response options were changed for this question to try and accurately address the respondent population.

Data Analysis Method and Tools

The data will be analyzed using the partial least squares (PLS) method of structural equation modeling (SEM). PLS is one of two alternatives in the SEM approach, the other being covariance based SEM (CBSEM). Each has its benefits and drawbacks, and particular factors must be taken into consideration when choosing one method over another. Of particular importance is consideration of the assumptions of CBSEM when choosing to use this method over PLS (Peng & Lai, 2012).

First, the study at hand is based on newly developed theory and the model presented is quite complex. CBSEM (e.g. AMOS) seeks to fit the overall model to the data by considering covariances of all indicators and constructs together. Model fit is emphasized, and the importance of proper model specification is high. This technique is appropriate where the model is either very simple or is based on well-established theory, or both. The model presented in this research is neither. In this CBSEM full information approach, model misspecification has a more dramatic impact on the path outcomes. In

the PLS model, path weights are constrained to take into account only information from the explicitly linked constructs and indicators, thus reducing the risk of the overall model being largely skewed by model misspecification where theory development is a tenet of the research being conducted, which is the case here.

Next, the CBSEM approach, by its full information approach as explained in the previous paragraph, is uniquely suited for confirmatory research where the assumption of a correct model is made, and where the model complexity is low. Exploratory research where the exact model specification is unknown and the model is complex is best handled by PLS based methods.

Additionally, sample size and scale development considerations are important to choosing the best method. Since it does not take all item covariances into account when fitting the model, PLS is not as demanding in terms of sample size for a large or complex model. PLS sample size determinations are made based only on the dependent variable with the most indicators, thus making analysis of a more complex model possible with a smaller more reasonable sample size, especially when survey responses come at a premium. Scale development is handled most readily by PLS. The results of the principal components analysis as conducted in PLS measurement modeling are easily interpretable and intuitively show which indicators are most important to the constructs being identified.

To summarize, The PLS method is being used more frequently in operations management research, although CBSEM is still the most widely used technique. PLS may be a better choice, however, for research where the model is not dependent upon

explaining the covariance of all measurement items, where model misspecification is a higher risk due to new theory development and exact relationships among constructs are untested, where the research in not purely confirmatory in nature, where smaller sample sizes are desired for testing of higher complexity models, and finally where scale development is part of the research being conducted (Chin, 2010; Kocabasoglu & Suresh, 2006; Peng & Lai, 2012).

While PLS was used for testing the factorial validity and structural relationships in the data, covariance based SEM was used to evaluate the difference between paper and electronic respondent groups. The use of AMOS enabled the use of a well-established technique for testing the factorial equivalence of instrument scores (Byrne, 2010) in order to establish invariance between data collection modes. This procedure is explained later in this chapter.

Pilot Test

After receiving feedback and making changes in the preliminary testing phase, and after review and final approval by the University of Houston Committee for Protection of Human Subjects, the survey instrument was subjected to a pilot test. This pilot test was conducted on a population consisting of practitioners from organizations affiliated with National Voluntary Organizations Active in Disasters (NVOAD) as well as practitioners from organizations associated with the rebuild Joplin movement and from social media groups (on LinkedIn) focusing on disaster response. A total of 197 direct emails were sent to recipients on lists associated with NVOAD and Rebuild Joplin.

Additionally, the survey request was posted on 12 LinkedIn groups whose focus is on disaster relief and disaster relief research. The groups are Crisis, Emergency, and Disaster Recovery Professionals; Disaster and Emergency Management; Disaster Management and Crisis Response Summit; Disaster Relief Experts Think Tank; Disaster Relief Innovation; Disaster Researchers and Disaster Management Professionals; Innovations in Disaster Management and Emergency Response; Masters of Disaster; Northeast Disaster Recovery Information Exchange; Spurting Innovation; Voluntary Organizations Active in Disaster; and International Disaster Conference and Expo.

The initial distribution of surveys began with the direct email campaign on October 29th, 2012. Follow up emails were sent approximately one week later, and requests were posted on LinkedIn beginning November 6th, 2012. A total of 40 completed responses were received as of November 13th, 2012. An effective response rate based on the direct email campaign is 20%. There is no way to calculate the response rate of LinkedIn group members. However, based on voluntary messages from group members stating they had completed the survey, it is estimated approximately 25% of the responses came from these groups. Based on this estimation, the actual response rate for the direct email campaign is approximately 15%.

Although the campaigns were designed to be universally distributed, modifications were made to try and avoid direct email contact with anyone in the Northeast United States, as a full-scale response to Hurricane Sandy was being conducted on the day the campaign began. Overall practitioner/respondent feedback was positive and the population showed interest in the study and in seeing the results upon its completion. Several requests for a copy of the completed study as well as some general

comments and suggestions for improvement were received during the pilot test phase. The disaster relief community in general is a very considerate and helpful group, as would be expected of a group whose primary mission is to help others in need.

As explained, the partial least squares method of structural equation modeling was used to analyze the initial pilot test data. A measurement model was constructed using PLS-Graph alpha, version 3.12, build 1. In order to test the reflective constructs representing the dependent variables (improvisation and disaster relief supply chain performance – hereafter referred to as performance) and representing the independent variables related to planning factors (strategic focus, operational focus, information focus, and technology utilization) and the independent variables related to improvisational capabilities (creative capability, empowerment, and technology capability). The control variable (severity of disaster) and its reflective measures were also included in the measurement model. In all, the pilot test measurement model contains 10 constructs representing latent variables and 38 measured scale items from the survey. Sample size for the pilot measurement model is 40 cases.

The purpose of the measurement model is to assess the factorial validity (convergent and discriminant) and reliability of the measures being used. The construction of the measurement model consists of linking all constructs and performing pairwise correlations on all variables. The first result is a test of discriminant validity (Chin, 1998), or how the average variance extracted compares with correlations between latent variables. Average variance extracted (AVE) is a measure that attempts to capture the amount of variance in a latent variable that is due to its indicators as opposed to the amount due to measurement error (Chin, 2010).

$$AVE = \frac{(\sum \lambda_i{}^2)\, var\ F}{(\sum \lambda_i{}^2)\, var\ F + \sum \Theta_{ii}}$$

Figure 3: Formula for Average Variance Extracted

Where λ_i, F, and , Θ_{ii} are the factor loading, factor variance, and unique/error variance respectively. AVE can be interpreted as a measure of reliability for the latent variable and should be greater than 0.50, meaning that at least 50% of the variance in the latent variable component score can be attributed to the latent variable measures as opposed to measurement error (Fornell & Larcker, 1981).

Composite reliability (ρ_c), also presented here, is a measure of internal consistency and is calculated as follows.

$$\rho_c = \frac{(\sum \lambda_i)^2\ var\ F}{(\sum \lambda_i)^2\ var\ F + \sum \Theta_{ii}}$$

Figure 4: Formula for Composite Reliability

Composite reliability measures the consistency of the scales, or the extent to which the latent construct indicators share in their measurement of a common construct, and should be considered acceptable if greater than 0.70 (Hair, Black, Babin, Anderson, & Tatham, 2010; Nunnally & Bernstein, 1994).

For the measures presented in the model, pilot test data is used to calculate reliability scores as well as correlations between latent variables. Below is table 5 with both the AVE and the composite reliability score for each latent variable as well as the squared correlation matrix. As can be seen from table 5, all variables meet or exceed the minimum cutoffs suggested for composite reliability (at least 0.70) and AVE (at least 0.50) with the exception of one: operational focus. In addition to the calculated reliability tests, the AVE of each latent construct should be greater than the squared correlation (representing amount of variance shared) with any other latent construct. A shared variance with another construct greater than a construct's AVE is an indicator of a discriminant validity issue (Chin, 2010).

Table 5: Squared Correlations of Latent Variables (Pilot Test)

Composite Reliability	AVE	Construct	Improv	Perf	Strat Foc	Op Foc	Info Foc	Tech Util	Cr Cap	Emp	Tech Cap	Sev
0.883	0.718	Improv	1.000									
0.974	0.841	Perf	0.183	1.000								
0.973	0.900	Strat Foc	0.112	0.191	1.000							
0.699	0.445	Op Foc	0.119	0.209	0.780	1.000						
0.943	0.847	Info Foc	0.079	0.096	0.541	0.523	1.000					
0.950	0.864	Tech Util	0.051	0.099	0.275	0.165	0.203	1.000				
0.919	0.741	Cr Cap	0.021	0.367	0.093	0.069	0.141	0.120	1.000			
0.942	0.804	Emp	0.006	0.125	0.090	0.099	0.250	0.059	0.485	1.000		
0.893	0.677	Tech Cap	0.014	0.151	0.260	0.210	0.250	0.615	0.247	0.232	1.000	
0.932	0.872	Severity	0.010	0.005	0.124	0.072	0.110	0.195	0.012	0.001	0.135	1.000

Taking these guidelines into account, the operational focus construct seems to have issues in both areas. All other constructs meet or exceed the recommended cutoff values for AVE and composite reliability.

A more detailed item-level look at discriminant validity is obtained by examining the loading of each measurement item on its respective latent variable construct as well as the loading of that same item on all other latent variable constructs (cross load). This is also referred to as indicator reliability. The loadings shown in table 6 below represent how much of an indicator's variance is explained by the latent construct (thus, a loading of 0.70 indicates approximately 50% of an indicator's variance is explained by the latent construct). Generally, a value of 0.70 or greater is acceptable for this measure (Götz, Liehr-Gobbers, & Krafft, 2010), however, items with weaker loadings are often observed in empirical research with newly developed scales (Hulland, 1999). Taking the nature of the scales into consideration, and also the overall construct reliability, items may be retained with loadings of at least 0.5 if other measures are adequate (Barclay, Higgins, & Thompson, 1995; Chin, 1998).

The item should also load more heavily on the latent construct it is measuring than any other construct. Although some of the items seem relatively close in the magnitude of their loadings, the overall results presented by the examination of cross loadings ultimately support the same discriminant validity issues raised by examining the correlations, AVE, and internal consistency measures. Additionally, table 6 allows one to pinpoint specific item measures where the validity issues originate. The item numbers in question are OF36 and OF37. These items relate to the latent variable, operational focus (OF).

Table 6: Loadings and Cross-Loadings (Pilot Test)

indicator	Improv	Perf	Strat Foc	Op Foc	Info Foc	Tech Util	Cr Cap	Emp	Tech Cap	Severity	indicator
IM1	**0.960**	-0.525	-0.391	-0.419	-0.325	-0.279	-0.206	-0.085	-0.189	0.058	IM1
IM2	**0.764**	-0.314	-0.035	-0.038	-0.007	0.065	-0.150	-0.130	0.168	0.301	IM2
IM3	**0.805**	-0.060	-0.241	-0.204	-0.222	-0.181	0.078	0.005	-0.079	0.021	IM3
P5	-0.345	**0.910**	0.447	0.425	0.306	0.228	0.500	0.287	0.348	0.170	P5
P6	-0.357	**0.954**	0.386	0.398	0.335	0.336	0.548	0.314	0.379	0.160	P6
P7	-0.346	**0.931**	0.378	0.388	0.187	0.159	0.580	0.391	0.323	-0.007	P7
P8	-0.379	**0.948**	0.411	0.434	0.271	0.336	0.601	0.342	0.366	0.076	P8
P9	-0.384	**0.944**	0.333	0.382	0.206	0.206	0.595	0.321	0.338	-0.014	P9
P10	-0.496	**0.775**	0.359	0.403	0.326	0.355	0.536	0.301	0.363	-0.055	P10
P11	-0.425	**0.945**	0.472	0.489	0.341	0.366	0.522	0.313	0.366	0.121	P11
SF29	-0.394	0.470	**0.932**	0.852	0.623	0.476	0.255	0.228	0.484	0.291	SF29
SF30	-0.302	0.477	**0.950**	0.818	0.720	0.548	0.362	0.340	0.545	0.355	SF30
SF31	-0.315	0.375	**0.956**	0.823	0.689	0.451	0.274	0.293	0.438	0.292	SF31
SF32	-0.264	0.331	**0.957**	0.858	0.755	0.510	0.258	0.273	0.465	0.394	SF32
OF34	-0.332	0.433	0.836	**0.924**	0.739	0.339	0.227	0.341	0.369	0.259	OF34
OF35	-0.292	0.396	0.816	**0.907**	0.595	0.468	0.252	0.201	0.470	0.241	OF35
OF36	-0.016	0.109	0.008	**0.163**	0.128	-0.076	0.169	0.204	0.054	0.091	OF36
OF37	-0.157	0.138	0.159	**0.278**	0.125	-0.088	-0.003	0.137	0.148	-0.009	OF37
IF39	-0.285	0.207	0.657	0.665	**0.903**	0.410	0.280	0.371	0.396	0.227	IF39
IF40	-0.175	0.248	0.593	0.528	**0.919**	0.377	0.320	0.412	0.390	0.306	IF40
IF41	-0.299	0.376	0.756	0.770	**0.938**	0.447	0.418	0.568	0.564	0.366	IF41
TU43	-0.207	0.306	0.535	0.344	0.415	**0.921**	0.308	0.205	0.777	0.441	TU43
TU44	-0.225	0.290	0.466	0.407	0.384	**0.943**	0.338	0.240	0.716	0.403	TU44
TU45	-0.199	0.279	0.459	0.383	0.457	**0.924**	0.319	0.233	0.692	0.387	TU45
CC47	-0.242	0.412	0.208	0.144	0.363	0.257	**0.896**	0.658	0.441	0.114	CC47
CC48	-0.178	0.585	0.381	0.317	0.453	0.358	**0.932**	0.592	0.415	0.109	CC48
CC49	0.142	0.342	0.048	0.076	0.170	0.288	**0.711**	0.535	0.441	-0.031	CC49
CC50	-0.151	0.689	0.338	0.311	0.270	0.290	**0.888**	0.620	0.435	0.142	CC50
E51	-0.148	0.341	0.355	0.405	0.602	0.206	0.531	**0.870**	0.398	0.107	E51
E52	-0.130	0.246	0.250	0.238	0.454	0.147	0.556	**0.945**	0.398	-0.028	E52
E53	-0.075	0.437	0.270	0.268	0.426	0.272	0.747	**0.907**	0.499	-0.059	E53
E54	0.090	0.202	0.181	0.196	0.281	0.236	0.647	**0.863**	0.422	0.085	E54
TC55	-0.180	0.368	0.526	0.411	0.572	0.659	0.536	0.441	**0.853**	0.314	TC55
TC56	-0.154	0.317	0.369	0.387	0.345	0.705	0.321	0.265	**0.818**	0.386	TC56
TC57	-0.089	0.368	0.500	0.416	0.432	0.701	0.452	0.460	**0.872**	0.303	TC57
TC58	0.102	0.181	0.202	0.258	0.216	0.482	0.265	0.425	**0.745**	0.183	TC58
SEV59	0.075	0.098	0.388	0.310	0.406	0.444	0.144	0.089	0.373	**0.960**	SEV59
SEV61	0.120	0.022	0.244	0.164	0.168	0.371	0.036	-0.071	0.305	**0.907**	SEV61

In order to address the specific issues represented by the loadings and cross loadings, it is helpful to examine the wording of the items in question. By comparing the wording of the items in question to other items in the group and to the conceptual definition of the construct, we can reword the questions to capture the construct more accurately. This proposed fix is an attempt to insure the item has a high level of

qualitative consistency with other items reflecting the same construct. For example the two items from the operational focus scale (OF36 and OF37) are listed below with old and new wording.

Original wording:

OF36) The majority of our effort in planning is toward activities which affect only a portion of the supply chain for a limited duration.

Revised to reflect same concepts as other items as well as conceptual definition:

OF36) The majority of our effort in **operational** planning is toward activities which affect only a portion of the supply chain.

Original wording:

OF37) Planning for a disaster relief involves a focus on operational elements which relate to specific tasks rather than the structure or design of the supply chain.

Revised to reflect same concepts as other items as well as conceptual definition:

OF37) **Most of our operational** planning focuses on operational elements which relate to specific tasks rather than **all aspects** of the supply chain.

With this attempt to correct validity issues by rewording of the item questions, items OF36 and OF37 were kept in the survey for the main study. After collection of the main study data, the factorial validity testing procedure was conducted to validate the results found with the pilot test data, and any problematic items were dropped from the analysis.

Summary of Pilot Study Results

Except as noted, all other item and construct measures fell within the guidelines discussed above for composite reliability, factor loadings, cross loadings, and average variance extracted, and thus exhibit an acceptable level of internal consistency, reliability, convergent, and discriminant validity. Except for the two items (OF36, OF37) noted earlier for specific discriminant validity issues, all items were in the acceptable range.

The reflective measures presented in the initial questionnaire adequately capture the constructs to be tested. The pilot test results give reason to confidently continue with the full study as planned, with minor modifications to the questionnaire items. The pilot test data was not used to test or confirm any of the formative measures proposed, nor was it used to construct or test a structural model (in which will reside testing of the hypotheses). The remainder of this chapter consists of a brief power analysis, followed by the discussion of the main study data collection, missing value analysis, between-groups comparison, and finally assessment of measurement models for factorial validity testing.

Power Analysis

Following the recommendations of Peng and Lai (2012) and Hair, Ringle, and Sarstedt (2011), the reporting of PLS analyses should include a power analysis to explain the how the sample size affects the study's ability to detect effect sizes of different magnitudes. Using Cohen's power tables as a guide (Cohen, 1988), the sample size needed for a statistical power (the probability of rejecting the null hypothesis when the null hypothesis is false) can be approximated as follows. Using 0.80 as the threshold for power, a very small effect size (0.02) can be detected with a sample size of 311. Cohen considers a small effect size to be 0.02, medium is 0.15, and a large effect size is 0.35. Figure 3 was constructed using G-Power version 3.1.3 and illustrates the sample size needed for the corresponding power levels and effect sizes listed above.

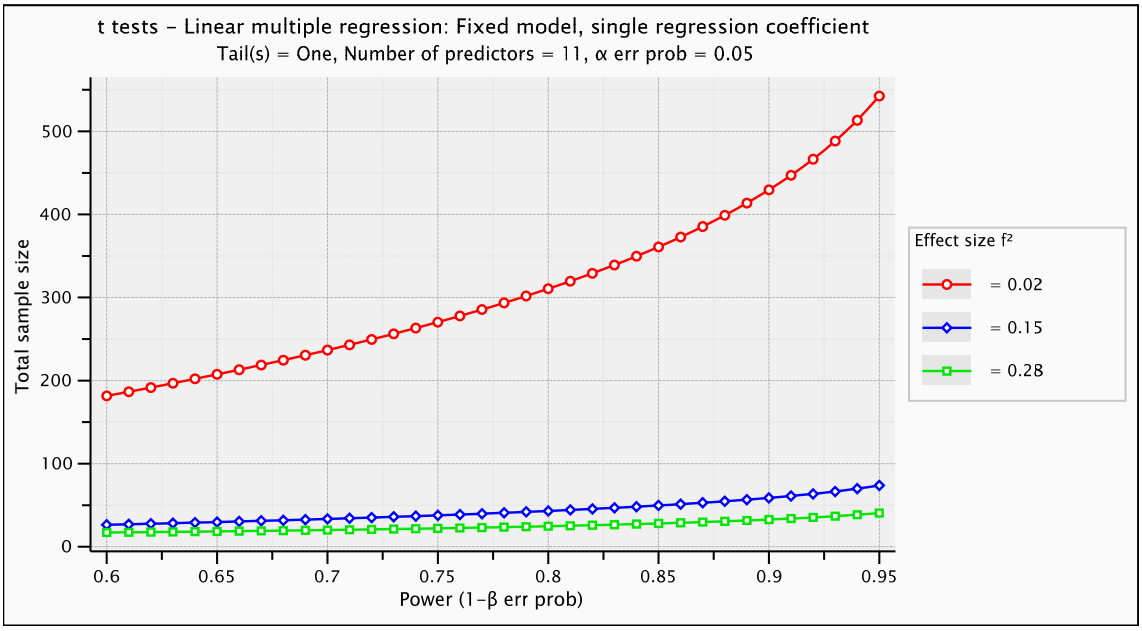


Figure 5: Sample Size, Effect Size, and Statistical Power Comparison

Using this as a guideline for an analysis of the power of this study, a sample size of 229 will have a power of approximately 0.70 to detect a small effect size (of 0.20). Many operations management studies (less than 5% reviewed in top-tier OM outlets) have been published with either no analysis of statistical power or by using a "rule of thumb" (Peng & Lai, 2012). This rule of thumb calls for a sample size 10 times that of the dependent variable with the largest number of independent variables influencing it. In this case, the rule of thumb sample size would be 120 (12 indicators influencing performance x 10). So, the ideal sample size for this study would contain at least 311 cases, which is noted in the limitations of this study discussed in the final chapter.

Main Study Survey Administration

The main campaign for data collection using the final survey took place in two phases. In order to improve response rates and potentially improve coverage, the survey administration and data collection used a mixed mode strategy (De Leeuw, 2005). The advantage of gaining a higher response rate is met with the disadvantage of the potential for varying responses across modes. This phenomenon, however, is more pronounced in data collection schemes where mode switching involves a switch from aural to visual or vice-versa (e.g. mixing mail and telephone survey modes) (Dillman et al., 2009) and should not have a significant effect on the data collected here, as both modes of this survey (paper and web-based) rely strictly on visual rather than aural media.

The data collection process used a sequential wave strategy, where the use of one mode was employed, followed by a second phase in which another mode was employed in multiple waves in order to reach more members of the same population. This sequential mode-switching design strategy has been used to improve response rates in other studies (Griffin & Obenski, 2002; Shettle & Mooney, 1999) where multiple phases were employed.

The first data collection phase took place on-site at the International Disaster Conference and Expo (IDCE), January 8-10, 2013 in New Orleans, Louisiana. In coordination with the conference manager, paper-based surveys were distributed to all conference attendees and responses were collected on-site. The IDCE conference had 1,797 registered attendees from the disaster response and relief population. According to the conference website, “Public Sector attendees included over 1000 government policy decision makers from over 27 countries, as well as leadership from Federal, State and

Municipal Emergency Management / Homeland Security offices (IDCE, 2012). Each attendee to the conference received a copy of the paper survey and was asked to fill out the survey and return it to a drop box in the conference registration area via verbal announcement at the conference opening each day. A total of 140 surveys were collected during the conference, making the response rate for this phase of data collection 7.8%.

In addition to on-site collection, a listing of attendees and their email addresses was obtained from conference management for an online follow-up campaign via direct email, which was the second phase of the data collection process. Emails were sent to the remaining IDCE attendees in order to solicit responses and improve overall response rate (those who had already responded to the survey at the conference were excluded from the email campaign). The emails directed respondents to the web-based version of the survey. The first email was sent to 1,657 people on January 25, 2013. Four follow up emails were sent between the initial email and February 27, 2013. A total of five messages were sent directly to potential respondents, creating five response waves. Respondents were removed from the mailing list as they completed the survey or if they chose to opt out of the campaign via an "unsubscribe" link included in the request messages. A total of 110 responses were received during the email portion of the campaign, for a response rate of 6.6%. Overall, 250 responses were collected for a combined response rate of 13.9%. A summary of the data collection is presented in table 7 below.

Table 7: Response Rate Summary

Mode	Number of Requests	Responses Received (%)
Paper-based at conference	1,797	140 (7.8)
Web-based follow-up	1,657	110 (6.6)
Combined	1,797	250 (13.9)

Missing Value Analysis

Of the 250 survey responses, missing values amounted to 1.15% of the total possible data points. All missing values occurred in the paper-based responses due to the fact that the web survey required answers for all questions in order for the survey to be considered complete. The missing values were a result of unanswered questions or indistinguishable responses (e.g. two answers circled on the same question). The maximum likelihood estimates of missing data were used to impute the missing values by use of the estimation maximization (EM) algorithm (Dempster, Laird, & Rubin, 1977). However, before any missing values were imputed, an analysis of the missing data was conducted as described below. A summary of the item level statistics for the 250 responses collected can be found in table 8 below.

Table 8: Item level Statistics (prior to MVA)

Item Statistics	Mean	S.D.	Missing	Percent Missing
IM1	41.61	24.89	2	0.80%
IM2	41.18	26.77	3	1.20%
IM3	41.92	28.44	4	1.60%

Item Statistics	Mean	S.D.	Missing	Percent Missing
SP4A	1.79	1.27	0	0.00%
SP4B	1.03	1.62	1	0.40%
SP4C	1.78	1.36	0	0.00%
CR4D	1.40	1.30	0	0.00%
CR4E	1.66	1.22	1	0.40%
CR4F	1.10	1.48	1	0.40%
CR4G	1.40	1.27	1	0.40%
P5	1.54	1.15	1	0.40%
P6	1.53	1.23	1	0.40%
P7	1.73	1.14	15	6.00%
P8	1.70	1.14	19	7.60%
P9	1.76	1.19	13	5.20%
P10	1.54	1.07	18	7.20%
P11	1.56	1.17	17	6.80%
S12	1.45	1.22	0	0.00%
S13	1.51	1.22	0	0.00%
S14	1.39	1.26	1	0.40%
S15A	1.06	1.17	8	3.20%
S15B	1.14	1.21	6	2.40%
S15C	1.29	1.15	5	2.00%
S15D	1.25	1.23	5	2.00%
F16	1.48	1.16	4	1.60%
F17	1.42	1.29	1	0.40%
F18	1.44	1.26	2	0.80%
F19	1.39	1.29	1	0.40%
F20A	1.11	1.22	6	2.40%
F20B	1.12	1.22	6	2.40%
F20C	0.98	1.18	7	2.80%
F20D	0.85	1.20	7	2.80%
AQ21	1.42	1.13	1	0.40%
AQ22	1.15	1.30	2	0.80%
AQ23	1.21	1.33	2	0.80%
AQ24A	0.25	1.43	6	2.40%
AQ24B	0.40	1.34	7	2.80%
AQ24C	0.62	1.41	5	2.00%
C25	0.92	1.17	2	0.80%
C26	0.87	1.29	2	0.80%
C27	0.84	1.30	3	1.20%

Item Statistics	Mean	S.D.	Missing	Percent Missing
C28A	0.61	1.53	7	2.80%
C28B	0.74	1.23	8	3.20%
C28C	0.69	1.31	7	2.80%
C28D	0.72	1.26	8	3.20%
SF29	4.26	1.54	1	0.40%
SF30	1.11	1.40	2	0.80%
SF31	1.13	1.39	3	1.20%
SF32	1.08	1.36	2	0.80%
OF34	4.47	1.49	0	0.00%
OF35	1.29	1.38	1	0.40%
OF36	0.52	1.60	2	0.80%
OF37	0.92	1.55	1	0.40%
IF39	4.63	1.26	0	0.00%
IF40	4.54	1.38	0	0.00%
IF41	4.50	1.37	0	0.00%
TU43	4.19	1.58	0	0.00%
TU44	4.01	2.99	0	0.00%
TU45	3.65	1.70	0	0.00%
CC47	1.64	1.18	1	0.40%
CC48	1.78	1.13	1	0.40%
CC49	1.81	1.12	2	0.80%
CC50	1.81	1.10	3	1.20%
E51	1.40	1.33	1	0.40%
E52	1.36	1.35	1	0.40%
E53	1.21	1.44	1	0.40%
E54	1.21	1.46	1	0.40%
TC55	1.13	1.39	1	0.40%
TC56	1.08	1.45	0	0.00%
TC57	1.03	1.50	0	0.00%
TC58	0.96	1.52	0	0.00%
SEV59	2.43	1.88	1	0.40%
SEV60A	0.42	2.13	0	0.00%
SEV60B	0.82	2.09	0	0.00%
SEV60C	1.70	2.24	0	0.00%
SEV60D	2.44	2.02	0	0.00%
SEV60E	2.56	2.01	0	0.00%
SEV60F	2.64	1.90	2	0.80%
SEV60G	2.42	2.03	2	0.80%

Item Statistics	Mean	S.D.	Missing	Percent Missing
SEV61	-0.65	2.18	1	0.40%
LM1	1.47	1.48	2	0.80%
LM2	1.01	1.60	1	0.40%
LM3	-0.75	1.80	1	0.40%
LM4	1.91	1.34	1	0.40%
LM5	1.78	1.21	2	0.80%

Missing data may be classified into several categories, including missing completely at random (MCAR), missing at random (MAR), or not missing at random (NMAR). The MCAR classification assumes that missing data are neither dependent upon other reported values nor on the values which would have been reported. For example, married couples are less likely to report their income (dependent upon other reported values) and those with higher incomes are more likely to not report their income (dependent upon values not reported). A key assumption of the EM imputation is that data be missing at random or missing completely at random. Although there is no test for data missing at random, R. J. Little (1988) presents a test for missing completely at random. The MCAR classification is more stringent and inclusive of the MAR condition, however, the data need only meet the requirements of MAR for the use of EM imputation procedure. In addition to the test for MCAR proposed by Little, the data can be examined simply by observing the patterns of the missing data.

Upon examination the data set, the highest percentages (greater than 5% in each indicator, which does not occur in any other items) of missing values occur in indicators P7 – P11, which are indicators of the global performance construct intended to capture overall disaster relief supply chain performance. Upon further examination, it appears

that respondents were either confused or repelled by the survey design with respect to these particular indicators. It does not appear that the respondents were avoiding response to performance related questions in general because in each of the 20 cases where at least 3 of 5 P7 – P11 indicators were missing, P5 and P6 were not missing, so that the missing values do not seem to depend on other reported values or on the values not reported as explained above. This appears to be merely a case of confusion on the part of respondents rather than an instance of data not being reported because of the values which are missing or because of other values reported. Both P5 and P6 were indicators of the same performance construct, however, they were presented to respondents as individual questions, whereas P7 – P11 were presented as a semantic differential table, where respondents were asked to rate performance on a scale with bipolar endpoints represented by words describing those bipolar conditions. However, it is impossible to determine the exact reason for the relatively high proportion of missing data in these specific indicators in these 20 cases. Although the deletion of these cases from the dataset will result in a loss of statistical power, their inclusion cannot be justified because a majority (at least 3 of 5) of the indicators in question is missing in each case, which does not occur in other cases in the dataset. This issue was not identified in the pilot study because the pilot study was web-based and responses for all questions were required for a survey to be considered complete.

With this cursory analysis of the data complete, the 20 unusable cases containing most of the missing values within the P5 – P11 indicators were dropped from the dataset. Indicators for other constructs were examined in a similar fashion, and one additional

case was dropped from the dataset because it included missing values for CC49 and CC50, both indicators of creative capability.

In many instances, the assumption of randomness of missing data is made a priori without thorough analysis. In order to test for this randomness, Little's missing completely at random (MCAR) test was performed on the data (R. J. Little, 1988) using SPSS. For purposes of the missing value analysis, only the data obtained through the paper survey collection mode were used, since none of the electronically collected data contained missing values, so none of the interdependencies tested for in the missing value analysis would be the result of this electronically collected data set.

Table 9: Little's MCAR Test

Construct Indicators	Little's MCAR test: χ^2	d.f.	p-value
Improvisation Global: IM1, IM2, IM3	2.555	3	0.465
Improvisation Aggregate: SP4A, SP4B, SP4C, CR4D, CR4E, CR4F, CR4G	1.025	4	0.906
Performance: P5, P6, P7, P8, P9, P10, P11	8.251	5	0.143
Speed: S12, S13, S14, S15A, S15B, S15C, S15D	18.120	20	0.580
Flexibility: F16, F17, F18, F19, F20A, F20B, F20C, F20D	19.891	22	0.590
Assessment Quality: AQ21, AQ22, AQ23, AQ24A, AQ24B, AQ24C	7.334	8	0.501
Cost: C25, C26, C27, C28A, C28B, C28C, C28D	30.361	32	0.550
Strategic Focus: SF29, SF30, SF31, SF32	0.080	4	0.999
Operational Focus: OF34, OF35, OF36, OF37	0.995	1	0.318
Information Focus: IF39, IF40, IF41	No missing values	-	-
Technology Utilization: TU43, TU44, TU45	No missing values	-	-
Creative Capability: CC47, CC48, CC49, CC50	7.640	3	0.054
Empowerment: E51, E52, E53, E54	No missing values	-	-
Technology Capability: TC55, TC56, TC57, TC58	No missing values	-	-
Severity: SEV59, SEV60A, SEV60B, SEV60C, SEV60D, SEV60E, SEV60F, SEV60G, SEV61	56.350	30	0.002

Little's MCAR presents the null hypothesis that data are not missing completely at random, so if the chi-square statistic is significant ($p<0.05$) then the null hypothesis cannot be rejected and the data are assumed not MCAR. The results in table 9 above show that data for all constructs can be classified as MCAR, with the exception of the severity indicators ($p=0.002$). However, data need only meet the MAR standard (not the more stringent MCAR standard tested for here) in order for the expectation maximization procedure proposed by Dempster et al. (1977) to be effective. The more stringent MCAR test was used because there is no explicit test for the condition of MAR, since it is

impossible to know what the missing values are (would be, if present). When the formative indicators of this construct are subjected to Little's test without the reflective indicators, they are shown to be MCAR. The reflective indicators cannot, however, produce a meaningful MCAR chi-square alone, because there are only two variables and only two missing values, yielding 0 degrees of freedom and a meaningless chi-square value. However, upon further examination of these two indicators, they still meet the requirements of factorial validity testing presented later in this chapter, and each of the two items within the construct was missing only one data point, giving little reason for concern that the Dempster et al. (1977) EM procedure mentioned earlier in this chapter would result in biased construct scores from these indicators. Qualitatively, if the literature does not suggest significant relationships exist between missing values and other variables, then one can expect, a priori, no bias (Tsikriktsis, 2005). This is the case here. Therefore, the Dempster et al. EM imputation procedure was performed on variables grouped at the construct level (as in table 9 above) with SPSS in order to replace missing values, resulting in a dataset consisting of 119 cases with no missing values in the construct indicators.

In summary, missing data is ideally avoided in the design and administration of surveys, however, where missing data exists, the imputation of missing values is an accepted way to deal with the issue. Although not ideal, the imputation procedure preserves to some extent the statistical power which would be lost if all cases with missing data were dropped from the analysis. The weakness of this approach is the potential for bias in the way the values are imputed or from dropping cases altogether which is duly noted as a limitation here. Future survey research in this area should be

designed to alleviate or minimize missing data in the collection process, which will strengthen the results without the potential for bias introduced by using imputation techniques. The following section describes a comparison between paper and electronic respondent groups. The comparison was made after the missing value imputation process described in this section.

Comparison between Collection Modes

The resulting data set after the missing value analysis and imputation of missing values includes a total of 229 cases (110 electronically collected and 119 from the paper surveys). Organizational demographic statistics for the data from the two modes of collection is shown in table 10 below, and individual demographics are shown in table 11 below.

Table 10: Between Groups Organizational Demographics

Organization Type	Paper		Electronic	
Commercial business	26	22%	32	29%
Not-for-profit/humanitarian	8	7%	12	11%
Government (federal, state, local, other)	76	64%	58	53%
Academic	7	6%	8	7%
Missing / Not Answered	2	1%	0	0%
Organization Size				
1 - 10	15	13%	24	22%
11-100	28	24%	28	25%
101-300	17	14%	13	12%
301-500	10	8%	5	5%
501-1000	9	8%	7	6%
1000-5000	21	18%	16	15%
5001+	19	16%	17	15%
Missing / Not Answered	0	0%	0	0%
Age of Organization				
Average (yrs)	36.94		27.86	
Missing / Not Answered	1		< 1%	

Table 11: Between Groups Individual Demographics

Respondent's Position	Paper		Electronic	
Manager	26	22%	36	33%
Logistics Officer	5	4%	5	5%
Administrative / Support professional	8	7%	14	13%
Academic	6	5%	6	5%
Director / Deputy Director	36	30%	32	29%
"In the field" professional	23	19%	17	15%
N/A - Unemployed/Retired/Homemaker	2	2%	0	0%
Other	12	10%	0	0%
Missing / Not Answered	1	< 1%	0	0%
Gender				
Male	78	66%	83	75%
Female	39	33%	27	25%
Missing / Not Answered	2	1%	0	0%
Age Group				
Under 18	0	0%	0	0%
18-24	5	4%	0	0%
25-34	20	17%	15	14%
35-54	64	54%	56	51%
55+	29	24%	39	35%
Missing / Not Answered	1	<1%	0	0%
Seniority				
Average (yrs)	8.74		10.47	
Missing / Not Answered	0		0	

In the modern landscape of survey research, it is common for a mixed mode strategy to be used (Biemer & Lyberg, 2003). According to these authors as well as others, there is little guidance on how to ensure quality of mixed mode data. However, several issues that are likely to affect mixed mode designs are known and can be tested for, including non-response error and measurement error (Biemer & Lyberg, 2003; De

Leeuw, 2005; Groves, 2004). A researcher mixing data collected by multiple modes must assess the invariance across groups to ensure that the collection mode does not cause undue measurement error.

Since the primary interest here is to determine if combining the data from the two mode groups will cause measurement error in the structural model, a method of testing for invariance between latent variable structures is employed (Byrne, 2010) using AMOS. This test uses the group analysis function of AMOS to simultaneously test the model fit between groups in models which are first constrained to the same factor loading weights across groups and then allowed to vary according to observed data in each of the groups. The chi squared statistic is then computed for both models (the unconstrained and the constrained). A comparison between the two model chi-square results can be made where significance of the difference in chi-square values (between the models) indicates significant differences between different groups being tested.

Following Byrne's procedure, a difference test was performed separately for each of the 16 constructs represented in the combined data set. Using a Bonferroni –corrected alpha level of p_c=p/m, where p is the desired cutoff value (p=0.05 in this case) and m is the number of separate hypotheses being tested using the same data (Hochberg & Tamhane, 1987). The resulting adjusted p-value for this series of testing is then calculated to be p_c= 0.05/16 = 0.003. According to Hochberg and Tamhane, as long as none of the individually tested hypotheses falls below this adjusted threshold, then the overall probability of falsely rejecting the null hypothesis is the desired level of 0.05.

The Bonferroni adjustment guards against the commission of a type one error, which is the false rejection of the null hypothesis (that groups being tested are different in this case). If a non-adjusted p-value were to be used in this testing procedure, the probability of committing a type one error would be equal to $1- (1-p)^m$, which in this case would be equal to $1- (1-0.05)^{16}$, or 55.99%. The use of the adjusted p-value reduces the chance of a false finding of this nature.

Using the adjusted p-value, the results of the between groups comparison testing in AMOS show that the construct scores are not different across the paper and electronic collection mode groups, meaning there is no evidence that bias will be generated in the results of hypothesis testing using a data set comprised of combining the different collection modes. Results from the difference testing procedure can be found in table 12 below.

Table 12: Between Groups Difference Test

	χ^2 equal loadings	χ^2 Unconstrained loadings	χ^2 difference	χ^2 number at $\alpha = 0.05$	Estimated p-value
Improvisation: IM1, IM2, IM3	3.070	0	3.070	7.815	0.381
Spontaneity: SP4A, SP4B, SP4C	8.097	0	8.097	7.815	0.044
Creativity: CR4D, CR4E, CR4F, CR4G	29.170	16.754	12.416	9.488	0.015
Performance: P5, P6, P7, P8, P9, P10, P11	216.056	208.736	7.320	14.067	0.396
Speed: S12, S13, S14	1.337	0	1.337	7.815	0.720
Flexibility: F16, F17, F18, F19	5.857	3.235	2.622	9.488	0.623
Assessment Quality: AQ21, AQ22, AQ23	0.633	0	0.633	7.815	0.889
Cost: C25, C26, C27	2.771	0	2.771	7.815	0.428
Strategic Focus: SF29, SF30, SF31, SF32	28.045	25.989	2.056	9.488	0.726
Operational Focus: OF34, OF35, OF36, OF37	126.750	128.066	1.316	9.488	0.859
Information Focus: IF39, IF40, IF41	1.924	0	1.924	7.815	0.588
Technology Utilization: TU43, TU44, TU45	7.003	0	7.003	7.815	0.072
Creative Capability: CC47, CC48, CC49, CC50	59.983	51.856	8.127	9.488	0.087
Empowerment: E51, E52, E53, E54	21.933	20.947	0.986	9.4878	0.912
Technology Capability: TC55, TC56, TC57, TC58	59.566	50.937	8.629	9.488	0.071
Severity: SEV59, SEV61	38.180	37.084	1.096	9.488	0.895

According to De Leeuw (2005), another potential pitfall of using mixed mode data is non-response bias, which can be tested for as well. Several common methods exist to test for this bias in business research, including comparing demographic characteristics of non-respondents to respondents, sampling non-respondents, and extrapolation (Wagner & Kemmerling, 2010). One of the most common techniques is the extrapolation method proposed by Armstrong and Overton (1977), which uses a comparison of early respondents to late respondents, with the assumption that late respondents are most similar to, and serve as a proxy for, those who did not respond (Pace, 1939). This is the most appropriate method for use with data in which demographic characteristics of non-respondents is unknown.

In using Armstrong and Overton's procedure for assessing differences in early and late respondents, "early" and "late" may be classified by response wave, if this information is known. A wave is defined as the responses gathered between reminders. This comparison uses the first wave of responses (those gathered at the IDCE) as the early group and waves 4, 5 and 6 as the late group. Typically, the first wave is compared with the last wave, however, in order to have the recommended minimum group size of 30, multiple "late" waves may be combined (Lindner, Murphy, & Briers, 2001).

Table 13: Nonresponse Test Results

Categorical Variables		
Variable	χ^2	p-value
TYPE	4.462	0.216
SIZE	3.279	0.773
POSITION	10.785	0.148
GENDER	0.687	0.407
AGE BUCKET	2.602	0.457
Continuous Variables		
Variable	t-test for equality of means	p-value
SENORITY	-1.802	0.073
ORGAGE	0.971	0.333

The results of the nonresponse testing can be found in table 13 above. The two groups (paper and electronic respondents) were compared in variables of interest, to assess whether the early and late respondents were demographically indistinguishable. The variables of interest are organization type (TYPE), organization size (SIZE), individual's position in organization (POSITION), gender (GENDER), age group (AGE BUCKET), individual's seniority in the organization (SENIORITY), and the age of the organization (ORGAGE). For the categorical variables type, size, position, gender, and age bucket, a chi square test was used to compare the groups. For the continuous nominal variables of seniority and orgage, a t-test was used to compare the means of the variables between the early and late groups. Using this extrapolation technique

(Armstrong & Overton, 1977), no significant differences were found between the early and late groups of respondents, indicating that the study has not been impacted by nonresponse bias (Wagner & Kemmerling, 2010).

In summary, analyses were conducted on the collected dataset to address the potential issues associated with missing values, multiple mode strategy, and non-response bias. Potential limitations associated with each area were noted and addressed, however, no issues were identified that would prevent the data from being used for testing factorial validity with measurement models. The following section presents the results of this factorial and construct validity testing in order to validate the data and constructs which will be used in hypothesis testing presented in chapter 4.

Main Data Set Measurement Model Results for Assessing Factorial Validity

A measurement model was constructed in PLS graph alpha with the 229 cases collected and screened from the main study to validate the results of the discriminant and convergent validity testing done with the pilot data as described earlier in this chapter. The same analytic techniques and standards as referenced for the pilot test for factor loadings, average variance extracted, and composite reliability were used to assess the main data set.

In general the main study factorial validity testing followed the same pattern of results as the pilot study. The measures included in the main study were more expansive and included the four sub dimensions of performance (speed, cost, assessment quality, and flexibility) and the aggregate measures of improvisation (spontaneity and creativity)

in addition to all the same constructs included in the pilot study. With the full data set, the constructs exhibited strong discriminant and convergent validity with the exception of two indicators of Operational Focus (OF36 and OF37) and one indicator of improvisation (SP4B). The cross loadings table for measurement model 1 (Table 14) shows that the loadings for items OF36 and OF37 are below the recommended cutoff value for a construct based on a new scale (0.394 and 0.378, respectively). When the other measures of validity are examined, we see that AVE is also below the recommended cutoff of 0.5 for the OF construct (composite reliability = 0.765 and AVE = 0.485). Given that multiple measures used to test for factorial validity are below recommended cutoffs for this construct, as well as the recommendation that items with very low loading below 0.40 should always be deleted from reflective scales (Hair et al., 2011), items OF36 and OF37 were dropped.

The loading of item SP4B on aggregate improvisation was 0.511. As a reminder, the rule of thumb is that factor loadings be at least 0.7, with exceptions noted below, and that they load more heavily on the construct they are measuring than on any other construct (Chin, 1998). All other item loadings for the improvisation construct fell above the recommended cutoff of 0.7, the constructs AVE was 0.577, and the composite reliability was 0.903. Subsequent testing of the construct without SP4B only slightly improved AVE and composite reliability for the construct (AVE=0.63 and composite reliability=0.910, respectively). According to Hair et al. (2011), items with loadings between 0.40 and 0.70 should only be deleted from scales if the deletion increases the composite reliability above the recommended threshold value. It is also suggested that items with factor loadings of at least 0.5 may be retained if items measuring the same

construct still have high reliability scores and other measures of reliability are acceptable (Barclay et al., 1995; Chin, 1998). Recent studies using PLS (Duarte & Raposo, 2010) have retained items with loadings as low as 0.523 when other loadings were high and other measures of reliability were acceptable, or when the items were "deemed important to the domain of the construct" (Golicic, Fugate, & Davis, 2012). Item SP4B was therefore retained.

Table 14: Loadings and Cross Loadings (Measurement Model 1)

indicator	IM Global	IM Agg	Perf	Speed	Flex	AQ	Cost	SF	OF	IF	TU	CC	Emp	TC	Sev
IM1	**0.795**	0.096	-0.056	-0.082	0.032	-0.154	-0.079	-0.226	-0.254	-0.137	-0.095	-0.068	-0.056	-0.191	0.070
IM2	**0.854**	0.111	-0.185	-0.092	-0.077	-0.277	-0.152	-0.232	-0.093	-0.139	-0.141	-0.035	-0.041	-0.157	0.086
IM3	**0.808**	0.047	-0.141	-0.165	-0.090	-0.183	-0.115	-0.173	-0.140	-0.110	-0.071	-0.061	-0.088	-0.099	0.063
SP4A	0.131	**0.698**	0.206	0.266	0.290	0.149	0.069	0.103	0.157	0.138	-0.054	0.238	0.305	0.109	0.084
SP4B	0.382	**0.511**	0.061	0.029	0.062	-0.053	-0.074	-0.094	-0.024	-0.063	-0.023	0.078	0.175	-0.016	0.073
SP4C	0.144	**0.731**	0.282	0.254	0.299	0.161	0.123	0.132	0.167	0.134	0.092	0.216	0.272	0.040	0.115
CR4D	0.078	**0.840**	0.244	0.216	0.337	0.177	0.071	0.172	0.174	0.251	0.152	0.293	0.318	0.136	0.171
CR4E	0.031	**0.822**	0.285	0.293	0.333	0.273	0.247	0.329	0.253	0.353	0.199	0.337	0.293	0.187	0.169
CR4F	0.047	**0.795**	0.254	0.270	0.344	0.190	0.141	0.206	0.172	0.240	0.146	0.279	0.291	0.104	0.105
CR4G	0.067	**0.863**	0.348	0.412	0.520	0.318	0.255	0.310	0.190	0.288	0.181	0.369	0.366	0.263	0.240
P5	-0.162	0.338	**0.846**	0.612	0.667	0.571	0.425	0.401	0.407	0.472	0.381	0.474	0.458	0.395	0.285
P6	-0.124	0.327	**0.851**	0.634	0.687	0.555	0.394	0.408	0.376	0.467	0.402	0.493	0.465	0.378	0.315
P7	-0.196	0.281	**0.916**	0.588	0.626	0.610	0.421	0.354	0.314	0.398	0.292	0.404	0.352	0.336	0.265
P8	-0.128	0.336	**0.923**	0.620	0.628	0.569	0.426	0.330	0.303	0.432	0.317	0.399	0.375	0.324	0.297
P9	-0.168	0.293	**0.914**	0.569	0.601	0.548	0.399	0.341	0.317	0.366	0.288	0.386	0.366	0.318	0.265
P10	-0.072	0.263	**0.836**	0.580	0.584	0.523	0.418	0.285	0.323	0.353	0.263	0.341	0.353	0.312	0.281
P11	-0.121	0.270	**0.895**	0.563	0.584	0.562	0.406	0.322	0.278	0.362	0.246	0.359	0.310	0.299	0.276
S12	-0.115	0.381	0.624	**0.942**	0.739	0.555	0.523	0.334	0.365	0.328	0.233	0.505	0.443	0.317	0.248
S13	-0.133	0.347	0.651	**0.958**	0.748	0.627	0.509	0.302	0.335	0.346	0.276	0.472	0.421	0.378	0.298
S14	-0.136	0.313	0.655	**0.954**	0.740	0.597	0.506	0.312	0.330	0.319	0.263	0.440	0.422	0.328	0.277
F16	-0.029	0.471	0.604	0.745	**0.901**	0.532	0.402	0.378	0.334	0.426	0.274	0.539	0.517	0.405	0.282
F17	-0.048	0.372	0.682	0.718	**0.933**	0.617	0.437	0.380	0.376	0.442	0.290	0.545	0.500	0.397	0.303
F18	-0.092	0.432	0.698	0.716	**0.942**	0.633	0.424	0.456	0.371	0.467	0.321	0.535	0.570	0.450	0.307
F19	-0.031	0.398	0.632	0.694	**0.906**	0.568	0.445	0.395	0.346	0.403	0.230	0.528	0.529	0.355	0.302
AQ21	-0.252	0.316	0.629	0.625	0.643	**0.901**	0.519	0.388	0.363	0.479	0.339	0.419	0.355	0.406	0.285
AQ22	-0.258	0.197	0.557	0.567	0.561	**0.933**	0.569	0.366	0.387	0.399	0.274	0.377	0.337	0.421	0.208
AQ23	-0.181	0.229	0.550	0.502	0.533	**0.895**	0.504	0.382	0.389	0.438	0.307	0.329	0.299	0.414	0.175
C25	-0.132	0.246	0.459	0.521	0.496	0.523	**0.898**	0.376	0.381	0.333	0.255	0.317	0.292	0.321	0.230
C26	-0.149	0.125	0.406	0.468	0.369	0.576	**0.928**	0.328	0.388	0.351	0.248	0.256	0.151	0.282	0.227
C27	-0.107	0.170	0.407	0.477	0.392	0.493	**0.901**	0.378	0.397	0.352	0.260	0.330	0.196	0.288	0.195
SF29	-0.309	0.175	0.382	0.308	0.387	0.368	0.305	**0.816**	0.657	0.557	0.345	0.349	0.311	0.401	0.186
SF30	-0.253	0.217	0.371	0.285	0.401	0.350	0.363	**0.904**	0.629	0.549	0.364	0.391	0.269	0.395	0.191
SF31	-0.193	0.292	0.352	0.303	0.383	0.395	0.389	**0.939**	0.657	0.571	0.443	0.472	0.329	0.484	0.232
SF32	-0.172	0.291	0.319	0.291	0.395	0.373	0.361	**0.910**	0.612	0.536	0.394	0.472	0.341	0.446	0.207
OF34	-0.194	0.237	0.409	0.361	0.418	0.425	0.395	0.672	**0.910**	0.626	0.358	0.439	0.337	0.455	0.237
OF35	-0.172	0.225	0.316	0.301	0.328	0.371	0.415	0.697	**0.902**	0.630	0.339	0.475	0.336	0.479	0.208
OF36	-0.048	0.040	0.090	0.140	0.080	0.091	0.127	0.164	**0.394**	0.172	0.168	0.127	0.115	0.196	0.067
OF37	-0.045	-0.042	0.024	0.099	0.032	0.056	0.047	0.083	**0.378**	0.140	0.145	0.152	0.112	0.096	0.075
IF39	-0.115	0.275	0.440	0.318	0.458	0.458	0.377	0.607	0.657	**0.914**	0.531	0.456	0.373	0.515	0.164
IF40	-0.161	0.304	0.452	0.382	0.469	0.486	0.370	0.579	0.638	**0.945**	0.522	0.515	0.426	0.536	0.208
IF41	-0.162	0.257	0.395	0.260	0.380	0.393	0.303	0.531	0.548	**0.916**	0.607	0.474	0.351	0.495	0.167
TU43	-0.104	0.161	0.309	0.254	0.260	0.288	0.256	0.419	0.377	0.583	**0.908**	0.365	0.220	0.578	0.229
TU44	-0.136	0.178	0.347	0.263	0.296	0.345	0.286	0.417	0.361	0.555	**0.947**	0.352	0.241	0.542	0.295
TU45	-0.109	0.101	0.329	0.224	0.278	0.293	0.223	0.352	0.321	0.496	**0.888**	0.355	0.265	0.561	0.239
CC47	-0.091	0.362	0.426	0.427	0.548	0.378	0.272	0.477	0.461	0.500	0.399	**0.902**	0.603	0.436	0.221
CC48	-0.055	0.379	0.460	0.497	0.590	0.408	0.327	0.412	0.435	0.486	0.383	**0.937**	0.613	0.388	0.198
CC49	-0.033	0.312	0.392	0.453	0.502	0.369	0.337	0.405	0.430	0.437	0.312	**0.902**	0.549	0.337	0.229
CC50	-0.057	0.295	0.422	0.437	0.486	0.357	0.278	0.432	0.463	0.478	0.326	**0.911**	0.600	0.425	0.230
E51	-0.066	0.344	0.436	0.478	0.571	0.353	0.243	0.365	0.333	0.403	0.231	0.680	**0.914**	0.389	0.089
E52	-0.047	0.368	0.397	0.418	0.543	0.336	0.253	0.332	0.371	0.404	0.249	0.607	**0.929**	0.424	0.158
E53	-0.047	0.375	0.387	0.364	0.508	0.318	0.167	0.303	0.321	0.365	0.237	0.561	**0.943**	0.370	0.073
E54	-0.113	0.355	0.399	0.400	0.504	0.341	0.209	0.294	0.320	0.364	0.263	0.542	**0.921**	0.403	0.097
TC55	-0.122	0.162	0.342	0.361	0.403	0.409	0.312	0.415	0.405	0.456	0.527	0.421	0.406	**0.862**	0.264
TC56	-0.202	0.182	0.355	0.311	0.384	0.385	0.261	0.471	0.468	0.509	0.631	0.435	0.384	**0.920**	0.260
TC57	-0.174	0.190	0.338	0.316	0.410	0.424	0.323	0.418	0.475	0.527	0.504	0.368	0.391	**0.917**	0.296
TC58	-0.162	0.145	0.355	0.307	0.382	0.425	0.289	0.444	0.473	0.521	0.544	0.346	0.366	**0.912**	0.262
SEV59	0.066	0.202	0.355	0.313	0.375	0.275	0.233	0.269	0.260	0.221	0.286	0.267	0.147	0.307	**0.954**
SEV61	0.111	0.130	0.174	0.165	0.140	0.130	0.188	0.092	0.137	0.093	0.191	0.125	0.020	0.206	**0.820**

Factor loadings for all items tested in measurement model 1 can be found in table 14. All the factors in table 14 meet these requirements with the exception of OF36, OF37, and SP4B which are discussed at length above.

Table 15: Composite Reliability, AVE, and Squared Correlations (Meas. Model 1)

CR	AVE	Construct	IM Glob	IM Agg	Perf	Speed	Flex	AQ	Cost	SF	OF	IF	TU	CC	Emp	TC	Sev
0.860	0.672	IM Glob	1.000														
0.903	0.577	IM Agg	0.011	1.000													
0.961	0.781	Perf	0.025	0.118	1.000												
0.966	0.905	Speed	0.018	0.133	0.457	1.000											
0.957	0.847	Flex	0.003	0.206	0.506	0.609	1.000										
0.935	0.828	AQ	0.065	0.075	0.407	0.389	0.409	1.000									
0.934	0.826	Cost	0.020	0.040	0.219	0.290	0.215	0.341	1.000								
0.940	0.798	SF	0.067	0.075	0.159	0.110	0.192	0.174	0.158	1.000							
0.765	0.485	OF	0.038	0.054	0.143	0.131	0.151	0.173	0.183	0.512	1.000						
0.947	0.855	IF	0.025	0.091	0.216	0.121	0.223	0.234	0.144	0.384	0.444	1.000					
0.939	0.837	TU	0.016	0.026	0.129	0.073	0.092	0.114	0.078	0.188	0.150	0.356	1.000				
0.953	0.834	CC	0.004	0.137	0.217	0.247	0.340	0.172	0.110	0.224	0.240	0.272	0.152	1.000			
0.960	0.859	Emp	0.005	0.151	0.192	0.203	0.331	0.133	0.056	0.123	0.132	0.173	0.070	0.420	1.000		
0.946	0.815	TC	0.034	0.035	0.148	0.128	0.191	0.207	0.107	0.235	0.254	0.311	0.374	0.189	0.184	1.000	
0.883	0.791	Sev	0.008	0.038	0.104	0.083	0.105	0.061	0.057	0.053	0.057	0.038	0.078	0.058	0.013	0.090	1.000

Composite reliability, AVE, and correlations for all constructs can be found in table 15. The values for composite reliability should be at least 0.7 (Hair et al., 2010; Nunnally & Bernstein, 1994), which indicates the internal consistency of the scale. Constructs should have an average variance extracted of no less than 0.5 (Fornell & Larcker, 1981). This level of AVE, along with the fact that no construct's squared correlation with another construct is higher than its own AVE indicates an acceptable level of discriminant validity. Operational Focus is the only construct suffering from an AVE below the suggested limit, which will be corrected in measurement model 2 with the elimination of items OF36 and OF37, as noted above.

Table 16: Loadings and Cross Loadings (Measurement Model 2)

indicator	IM Global	IM Agg	Perf	Speed	Flex	AQ	Cost	SF	OF	IF	TU	CC	Emp	TC	Sev
IM1	**0.791**	0.095	-0.056	-0.082	0.032	-0.154	-0.079	-0.226	-0.234	-0.137	-0.095	-0.068	-0.056	-0.191	0.070
IM2	**0.857**	0.111	-0.185	-0.092	-0.077	-0.277	-0.152	-0.232	-0.112	-0.139	-0.141	-0.035	-0.041	-0.157	0.086
IM3	**0.809**	0.046	-0.141	-0.165	-0.090	-0.183	-0.115	-0.173	-0.147	-0.110	-0.071	-0.061	-0.088	-0.099	0.063
SP4A	0.131	**0.699**	0.206	0.266	0.290	0.149	0.069	0.103	0.188	0.138	-0.054	0.238	0.305	0.109	0.084
SP4B	0.382	**0.510**	0.061	0.029	0.062	-0.053	-0.074	-0.094	-0.048	-0.063	-0.023	0.078	0.175	-0.016	0.073
SP4C	0.145	**0.731**	0.282	0.254	0.299	0.161	0.123	0.132	0.166	0.134	0.092	0.216	0.272	0.040	0.115
CR4D	0.078	**0.840**	0.244	0.216	0.337	0.177	0.071	0.172	0.181	0.251	0.152	0.293	0.318	0.136	0.171
CR4E	0.030	**0.822**	0.285	0.293	0.333	0.272	0.247	0.329	0.280	0.353	0.199	0.337	0.293	0.187	0.169
CR4F	0.047	**0.795**	0.254	0.270	0.344	0.190	0.141	0.206	0.173	0.240	0.146	0.279	0.291	0.104	0.105
CR4G	0.067	**0.863**	0.348	0.412	0.520	0.318	0.255	0.310	0.205	0.288	0.181	0.369	0.366	0.263	0.240
P5	-0.163	0.338	**0.846**	0.612	0.666	0.571	0.425	0.401	0.416	0.472	0.381	0.474	0.458	0.395	0.285
P6	-0.125	0.327	**0.851**	0.634	0.687	0.555	0.394	0.408	0.389	0.467	0.402	0.493	0.465	0.378	0.315
P7	-0.197	0.281	**0.916**	0.588	0.626	0.610	0.421	0.354	0.331	0.398	0.292	0.404	0.352	0.336	0.265
P8	-0.129	0.336	**0.923**	0.620	0.628	0.569	0.426	0.330	0.323	0.432	0.317	0.399	0.375	0.324	0.297
P9	-0.168	0.293	**0.914**	0.569	0.601	0.548	0.399	0.342	0.336	0.366	0.288	0.386	0.366	0.318	0.266
P10	-0.073	0.263	**0.835**	0.580	0.584	0.523	0.418	0.285	0.312	0.353	0.263	0.341	0.353	0.312	0.281
P11	-0.122	0.270	**0.895**	0.563	0.584	0.562	0.406	0.322	0.288	0.362	0.246	0.359	0.310	0.299	0.276
S12	-0.115	0.381	0.624	**0.942**	0.739	0.555	0.523	0.334	0.366	0.328	0.233	0.505	0.443	0.317	0.248
S13	-0.133	0.348	0.651	**0.958**	0.748	0.627	0.509	0.303	0.328	0.346	0.276	0.472	0.421	0.378	0.298
S14	-0.137	0.313	0.654	**0.954**	0.740	0.597	0.506	0.312	0.325	0.319	0.263	0.440	0.422	0.328	0.277
F16	-0.030	0.472	0.604	0.745	**0.901**	0.532	0.402	0.378	0.349	0.426	0.274	0.539	0.517	0.405	0.282
F17	-0.049	0.372	0.682	0.718	**0.933**	0.617	0.437	0.380	0.387	0.442	0.290	0.545	0.500	0.397	0.303
F18	-0.093	0.432	0.697	0.716	**0.942**	0.633	0.424	0.456	0.382	0.467	0.321	0.535	0.570	0.450	0.307
F19	-0.032	0.398	0.632	0.694	**0.906**	0.568	0.445	0.395	0.361	0.403	0.230	0.528	0.529	0.355	0.302
AQ21	-0.252	0.316	0.629	0.625	0.643	**0.901**	0.519	0.388	0.366	0.479	0.339	0.419	0.355	0.406	0.285
AQ22	-0.258	0.197	0.557	0.567	0.561	**0.933**	0.569	0.366	0.402	0.399	0.274	0.377	0.337	0.421	0.208
AQ23	-0.182	0.229	0.550	0.502	0.533	**0.895**	0.504	0.382	0.404	0.438	0.307	0.329	0.299	0.414	0.175
C25	-0.132	0.247	0.459	0.521	0.496	0.523	**0.898**	0.376	0.387	0.333	0.255	0.317	0.292	0.321	0.230
C26	-0.150	0.125	0.406	0.468	0.369	0.576	**0.928**	0.328	0.394	0.351	0.248	0.256	0.151	0.282	0.227
C27	-0.107	0.170	0.407	0.477	0.392	0.493	**0.901**	0.378	0.408	0.352	0.260	0.330	0.196	0.288	0.195
SF29	-0.309	0.175	0.382	0.308	0.387	0.368	0.305	**0.817**	0.692	0.557	0.345	0.349	0.311	0.401	0.186
SF30	-0.253	0.217	0.371	0.285	0.401	0.350	0.363	**0.903**	0.641	0.549	0.364	0.391	0.269	0.395	0.191
SF31	-0.193	0.292	0.352	0.303	0.383	0.395	0.389	**0.939**	0.677	0.571	0.443	0.472	0.329	0.484	0.232
SF32	-0.172	0.291	0.319	0.291	0.395	0.373	0.361	**0.909**	0.621	0.536	0.394	0.472	0.341	0.446	0.207
OF34	-0.194	0.237	0.409	0.361	0.418	0.425	0.395	0.672	**0.931**	0.626	0.358	0.439	0.337	0.455	0.237
OF35	-0.171	0.226	0.316	0.301	0.328	0.371	0.415	0.697	**0.927**	0.630	0.339	0.475	0.336	0.479	0.208
IF39	-0.115	0.275	0.440	0.318	0.458	0.458	0.377	0.607	0.658	**0.913**	0.531	0.456	0.373	0.515	0.164
IF40	-0.161	0.304	0.452	0.382	0.469	0.486	0.370	0.579	0.650	**0.945**	0.522	0.515	0.426	0.536	0.208
IF41	-0.162	0.258	0.395	0.260	0.380	0.393	0.303	0.531	0.563	**0.916**	0.607	0.474	0.351	0.495	0.167
TU43	-0.104	0.161	0.309	0.254	0.260	0.288	0.256	0.419	0.368	0.583	**0.908**	0.365	0.220	0.578	0.229
TU44	-0.137	0.178	0.347	0.263	0.296	0.345	0.286	0.417	0.352	0.555	**0.947**	0.352	0.241	0.542	0.295
TU45	-0.109	0.101	0.329	0.224	0.278	0.293	0.223	0.352	0.308	0.496	**0.888**	0.355	0.265	0.561	0.239
CC47	-0.091	0.362	0.426	0.427	0.548	0.378	0.272	0.476	0.468	0.500	0.399	**0.902**	0.603	0.436	0.221
CC48	-0.055	0.379	0.460	0.497	0.590	0.408	0.328	0.412	0.436	0.486	0.383	**0.937**	0.613	0.388	0.198
CC49	-0.033	0.312	0.392	0.453	0.502	0.369	0.337	0.405	0.431	0.437	0.312	**0.902**	0.549	0.337	0.229
CC50	-0.057	0.295	0.422	0.437	0.486	0.357	0.278	0.432	0.461	0.478	0.326	**0.911**	0.600	0.425	0.230
E51	-0.066	0.344	0.436	0.478	0.571	0.353	0.243	0.365	0.336	0.403	0.230	0.680	**0.914**	0.389	0.089
E52	-0.047	0.368	0.397	0.418	0.543	0.336	0.253	0.332	0.371	0.404	0.249	0.607	**0.929**	0.424	0.158
E53	-0.047	0.375	0.387	0.364	0.508	0.318	0.167	0.303	0.314	0.365	0.237	0.561	**0.943**	0.370	0.073
E54	-0.113	0.355	0.399	0.400	0.504	0.341	0.209	0.294	0.317	0.364	0.263	0.542	**0.921**	0.403	0.097
TC55	-0.122	0.162	0.342	0.361	0.403	0.409	0.312	0.415	0.405	0.456	0.527	0.421	0.406	**0.862**	0.264
TC56	-0.202	0.183	0.355	0.311	0.384	0.385	0.261	0.471	0.474	0.509	0.631	0.435	0.384	**0.920**	0.260
TC57	-0.173	0.191	0.338	0.316	0.410	0.424	0.323	0.418	0.470	0.527	0.504	0.368	0.391	**0.917**	0.296
TC58	-0.162	0.145	0.355	0.307	0.382	0.425	0.289	0.444	0.463	0.521	0.544	0.346	0.366	**0.911**	0.262
SEV59	0.066	0.202	0.355	0.313	0.375	0.275	0.233	0.269	0.261	0.221	0.286	0.267	0.147	0.307	**0.954**
SEV61	0.112	0.130	0.174	0.165	0.140	0.130	0.188	0.092	0.136	0.093	0.191	0.125	0.020	0.206	**0.820**

Table 17: Composite Reliability, AVE, and Squared Correlations (Meas. Model 2)

CR	AVE	Construct	IM Global	IM Agg	Perf	Speed	Flex	AQ	Cost	SF	OF	IF	TU	CC	Emp	TC	Sev
0.860	0.672	IM Global	1.000														
0.903	0.577	IM Agg	0.011	1.000													
0.961	0.781	Perf	0.025	0.118	1.000												
0.966	0.905	Speed	0.018	0.133	0.457	1.000											
0.957	0.847	Flex	0.003	0.207	0.506	0.609	1.000										
0.935	0.828	AQ	0.065	0.075	0.407	0.389	0.409	1.000									
0.934	0.826	Cost	0.020	0.040	0.219	0.290	0.215	0.341	1.000								
0.940	0.798	SF	0.067	0.075	0.159	0.110	0.192	0.174	0.158	1.000							
0.927	0.863	OF	0.039	0.062	0.153	0.127	0.162	0.184	0.190	0.543	1.000						
0.947	0.855	IF	0.025	0.091	0.216	0.121	0.223	0.234	0.144	0.384	0.457	1.000					
0.939	0.837	TU	0.016	0.026	0.129	0.073	0.092	0.114	0.078	0.188	0.141	0.356	1.000				
0.953	0.834	CC	0.004	0.137	0.217	0.247	0.340	0.172	0.110	0.224	0.242	0.272	0.152	1.000			
0.960	0.859	Emp	0.005	0.151	0.192	0.203	0.331	0.133	0.056	0.123	0.131	0.173	0.070	0.420	1.000		
0.946	0.815	TC	0.033	0.036	0.148	0.128	0.191	0.207	0.107	0.235	0.252	0.311	0.374	0.189	0.184	1.000	
0.883	0.791	Sev	0.008	0.038	0.104	0.083	0.105	0.061	0.057	0.053	0.058	0.038	0.078	0.058	0.013	0.090	1.000

Items OF36 and OF37 were dropped from the model. After the adjustments, the convergent and discriminant validity of all items was strong and met or exceeded the recommended values as discussed above. The full results for item loadings and cross loadings for the adjusted model (measurement model 2) are found in table 16. Full results for composite reliability, AVE, and inter-construct squared correlations are found in table 17. Note in table 17 the vastly improved levels of composite reliability (0.927) and AVE (0.863) for the operational focus construct after dropping items OF36 and OF37.

The analyses presented in this chapter addressed several minor concerns. First, of the constructs presented in the pilot test measurement model, one (OF) did not meet the requirements for AVE due to two of the item loadings being extremely low. Upon further assessment and rewording in the main study, these items were still problematic and were dropped. After this adjustment, all constructs met validity requirements. Also of concern was missing data due to incomplete surveys. The missing data was analyzed and where appropriate, imputations of values were made to form a complete dataset for

further analysis. Further analysis was conducted to assess the potential for differing responses from respondents who completed the paper survey versus those who completed the survey online. No significant overall difference in between groups responses were found. Finally, the data was assessed for non-response bias by a demographic comparison of early wave to late wave respondents. These tests also concluded that there was little concern for the presence of non-response bias, as the early and late response groups were not significantly different demographically.

Although there were some minor issues as noted, adjustments were made to address these issues. After the adjustments, the main study data is consistent with that of the pilot test data, and on the whole, the data and constructs presented are acceptable for further analysis. Consistency across the two data sets was found in factor loadings, cross loadings, average variance extracted, correlations, and composite reliability scores. The constructs from both data sets exhibit strong discriminant and convergent validity.

Table 18: Data Used in Hypothesis Testing

Construct and Indicators	Used in Hypothesis Testing	Reason (if not used)
Improvisation: IM1, IM2, IM3	N	Construct does not capture conceptual definition of improvisation (discussed in chapter 4)
Improvisation Aggregate: SP4A, SP4B, SP4C, CR4D, CR4E, CR4F, CR4G	Y	
Performance: P5, P6, P7, P8, P9, P10, P11	Y	
Speed: S12, S13, S14	N	Intended for future research, outside scope of hypothesis testing presented in chapter 4
Flexibility: F16, F17, F18, F19	N	
Assessment Quality: AQ21, AQ22, AQ23	N	
Cost: C25, C26, C27	N	
Strategic Focus: SF29, SF30, SF31, SF32	Y	
Operational Focus: OF34, OF35, OF36, OF37	Y	
Information Focus: IF39, IF40, IF41	Y	
Technology Utilization: TU43, TU44, TU45	Y	
Creative Capability: CC47, CC48, CC49, CC50	Y	
Empowerment: E51, E52, E53, E54	Y	
Technology Capability: TC55, TC56, TC57, TC58	Y	
Severity: SEV59, SEV61	Y	

The validity testing presented in this chapter gives sufficient evidence that the main study data can be used to test the hypotheses presented by this research. Not all constructs presented will be used in hypothesis testing here, as shown in table 18 above. Specifically, four performance sub-dimensions were introduced per a review of pertinent literature on disaster relief supply chain performance (speed, flexibility, assessment quality, and cost). These items all exhibited strong levels of factorial validity as explained in the previous chapter, however, the use of these sub-dimensions to test the

hypotheses put forward in this research is outside the scope of the original hypotheses, and will be the subject of post-dissertation research using the gathered data. Additionally, the global improvisation construct did not adequately capture the conceptual definition of improvisation presented for this research (as discussed in chapter 4). The results of the hypothesis testing using the constructs indicated in table 18 above are presented in chapter 4.

Chapter 4

ANALYSIS

Introduction

In order to test the theory and hypotheses presented in this research, structural models were constructed using PLS graph which included the hypothesized relationships as well as the control variable. The following guidelines and measures are used when assessing the results of the structural models presented in this chapter. Significance calculations are estimated via bootstrapping and the p-values are obtained using the percentile method from the bootstrap output with the number of samples set to 1000, exceeding the recommendation of 200 (Chin, 1998).

Bootstrapping is a non-parametric approach (the p-value is a direct proportion of the bootstrapping results) to obtaining PLS estimate precision, and is the standard for evaluating PLS path estimate significance (Chin, 2010). The bootstrap method uses a resampling procedure which estimates parameters by sampling with replacement from the original dataset until the number of cases are identical to the original dataset (Chin, 1998). The literature, whether in favor of or opposition to the use of PLS, consistently recommends this method for estimating significance values (Hair et al., 2011; Peng & Lai, 2012), and it is the method used for significance estimation in articles using PLS published in major OM outlets as reviewed by Peng and Lai (2012).

The assessment of the structural model is made by examination of the explained variance (R^2) of the endogenous constructs (Peng & Lai, 2012), which is also noted as the primary PLS structural model evaluation criteria by Hair et al. (2011). Where noted, the effect size, f^2 is used to compare models (Cohen, 1988). Effect size shows the amount

(percentage) of change in a model's R^2 when given constructs are removed from the structural model, and is calculated by formula in figure 6 below.

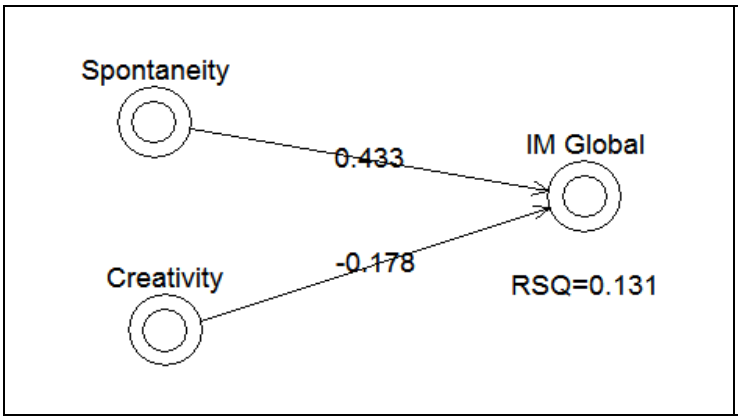
$$f^2 = \frac{R^2_{incl} - R^2_{excl}}{1 - R^2_{incl}}$$

Figure 6: Formula for Cohen's Effect Size

Where R^2 (*incl*) is the R^2 for the model containing the construct(s) being tested, and (*excl*) is the R^2 for the model with the construct(s) being tested excluded. This technique is used to assess the effect of introducing interaction terms into the model in addition to the main effects relationships. This effect size along with the significance of the interaction terms will determine the value of the interaction model over the main effects model (Wilson, 2010).

As noted in the previous chapter, the dependent variable, improvisation, was operationalized in two ways. First, by three global indicators which were intended to represent the overall construct without explicitly breaking it into the sub-dimensions of creativity and spontaneity. The second representation of this construct is an aggregate of seven indicators which represent both creativity and spontaneity. This aggregate approach is established and has been used in previous improvisation research (Vera & Crossan, 2005). The intent of using global indicators was to characterize the aggregate construct with fewer, simpler questions, thus establishing a more concise scale for future research.

Prior to using the construct in hypothesis testing, a structural model was used to assess whether the global construct adequately captured both the creative and spontaneous dimensions of improvisation as defined for this research. The model regresses the global improvisation construct (reflected by the three overall indicators IM1, IM2, and IM3) on the dimensions of creativity (using indicators CR4D, CR4E, CR4F, and CR4G) and spontaneity (using indicators SP4A, SP4B, and SP4C) separately. Figure 5 below shows the model and results.



Relationship	Path	p-value
Spon:IM	0.433	0.000
Creativity:IM	-0.178	0.073

Figure 7: Relationship of Creativity and Spontaneity to the Global IM Construct

This model (figure 7) indicates that the new global reflective measure is not adequately capturing both dimensions of improvisation as defined by this research and previously established scales. In fact, most of the significance is being contributed by the spontaneity scale. In a test of the effect size of the creativity construct, it was found to be small ($f^2 = 0.024$ for the difference in models with and without the creativity construct). This small effect size does not necessarily mean the construct is unimportant to the

model, but combined with the negative (and weakly significant) path coefficient, we can make the following inference. The concept of creativity was not captured as intended in the global improvisation scale items. The creativity construct is based directly on published scales for creativity, which have passed the scrutiny of improvisation scholars, so the likelihood that this is the source of the non-significant path is low. Simply, the IM construct is more a measure of spontaneity than of improvisation as intended for this study. Therefore, this research will not use the global IM measures. Instead, creativity and spontaneity will be combined to form an aggregate improvisation construct which will be used.

In a similar vein, performance was operationalized by a global seven-item scale created to capture the overall self-reported concept of disaster relief supply chain performance. The global measure of performance met all standards for factorial validity as presented in the previous chapter and is directly related to the "overall" performance concept embodied by the hypotheses presented here, therefore all representations of performance presented in this research are based on this global construct.

Structural Model Results

The data set described in table 18 (chapter 3) was analyzed using PLS graph alpha version 3.12 build 01. Two structural models (main effects model and interaction model) were estimated to test the relationships between dependent and independent variables, to include moderating variables such as creative capability, empowerment, and technology capability, and the control variable severity. The structural models presented here will

examine the predictive relationships between the exogenous (independent) and endogenous (dependent) constructs.

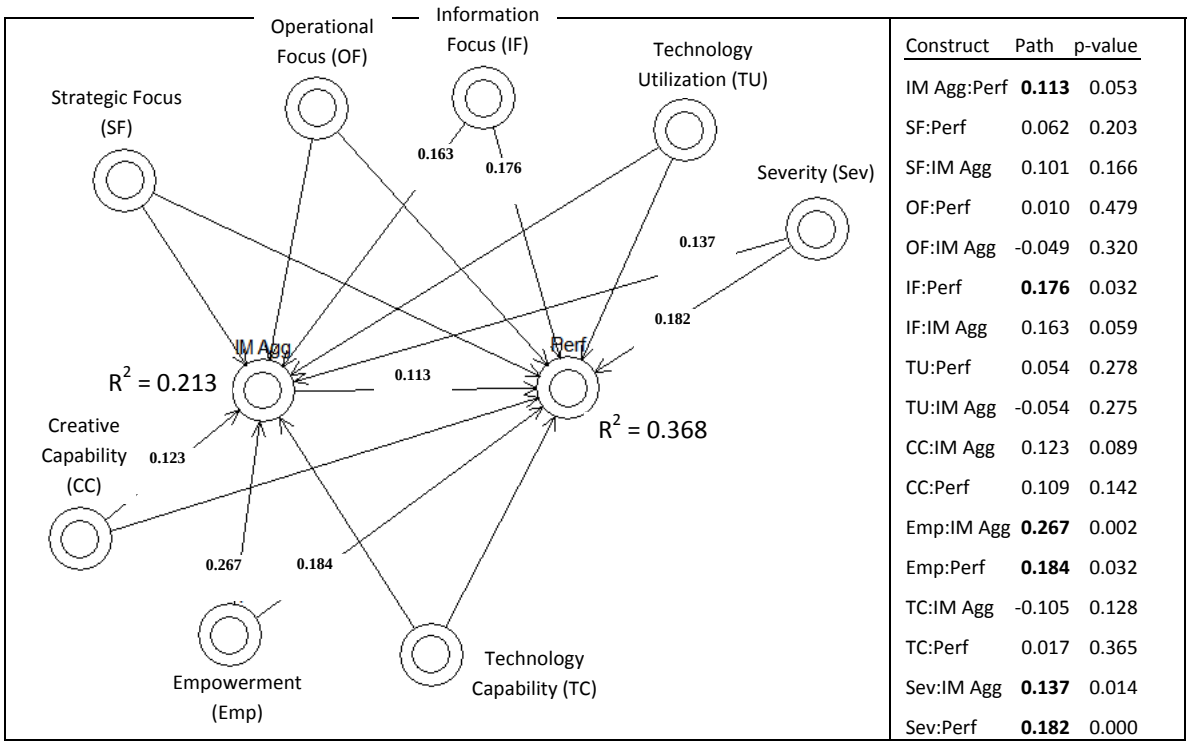
The method for testing the interaction effects follows a hierarchical process similar to multiple regression in which two models (one with and one without the interaction terms) are compared to one another (Limayem, Hirt, & Chin, 2001). The difference in R-squares is then calculated between the two models to assess the effect size. This effect size along with the significance of the interaction terms determines the "utility of the interaction model over the main effects model" (Wilson, 2010). This is the rationale for constructing two models, as subsequently discussed in this chapter. The models will be used to test the hypothesized relationships represented by the model presented in figure 1 (chapter 1).

The first PLS model was constructed with all main effects between the dependent and independent variables, as well as with the control variable severity. The paths between the control variable severity and the two endogenous variables, improvisation and performance, were significant. Therefore, the variable will be included in both models tested as its inclusion affects the outcomes of model.

Table 19: Relationships Tested

Exogenous (Independent) Variable(s)	Endogenous (Dependent) Variable
Improvisation Strategic Focus Operational Focus Information Focus Technology utilization Creative Capability Empowerment Technology Capability Creative Capability (moderator) Empowerment (moderator) Technology Capability (moderator)	Performance
Strategic Focus Operational Focus Information Focus Technology utilization Creative Capability Empowerment Technology Capability	Improvisation

Table 19 represents all relationships (representing the hypotheses presented earlier in this research) to be tested in the folowing sections. The main effects model (model 1), as represented in figure 8 below, tested a total of 17 relationships between exogenous and endogenous variables. The results show that the paths for 5 of those relationships are significant at the $p<0.05$ level or less, with 3 more relationships worthy of discussion and exhibiting p-values of $p<0.10$. All non-labeled paths in figure 8 are non-significant at the level indicated.



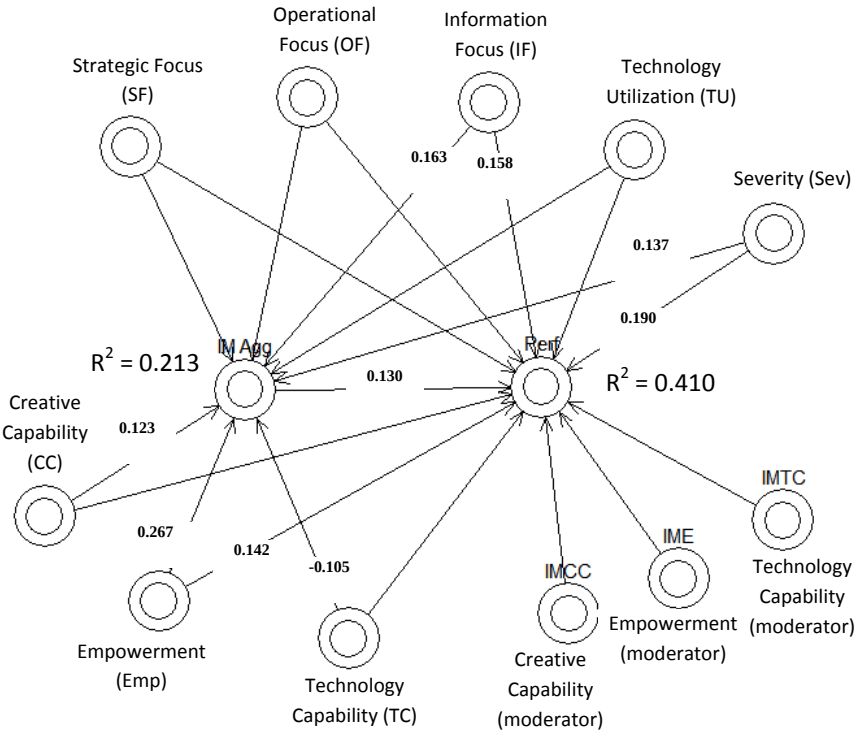
Construct	Path	p-value
IM Agg:Perf	**0.113**	0.053
SF:Perf	0.062	0.203
SF:IM Agg	0.101	0.166
OF:Perf	0.010	0.479
OF:IM Agg	-0.049	0.320
IF:Perf	**0.176**	0.032
IF:IM Agg	0.163	0.059
TU:Perf	0.054	0.278
TU:IM Agg	-0.054	0.275
CC:IM Agg	0.123	0.089
CC:Perf	0.109	0.142
Emp:IM Agg	**0.267**	0.002
Emp:Perf	**0.184**	0.032
TC:IM Agg	-0.105	0.128
TC:Perf	0.017	0.365
Sev:IM Agg	**0.137**	0.014
Sev:Perf	**0.182**	0.000

Figure 8: Main Effects Model

The interaction model was constructed using the same variables as the main effects model with the addition of the three interaction terms. There are several methods available to assess interaction effects in PLS path modeling . The selection of the "best" method for the research at hand depends on several factors including number of indicators per construct, number of observations in the dataset, and the objective of the research. In a comparison of the various methods, Henseler and Chin (2010) advocate the general use of the orthogonalizing approach over the others available. Additionally, the approach is deemed recommendable when the objective of the research is prediction

or description of the interaction effect, which is the case here. The orthogonalizing approach, introduced by T. D. Little, Bovaird, and Widaman (2006), involves a procedure which eliminates any correlation between the calculated interaction terms and the respective first order effect terms (Henseler & Chin, 2010; T. D. Little et al., 2006).

The orthogonalizing procedure involves creating product terms from all combinations of the main effect variable indicators and the interaction variable indicators. Each of the resulting product terms is then regressed on all indicators of the main effect and moderator variable. The residuals of the regressions are then used as indicators of the interaction term, much like the product-indicator approach adapted for PLS (Chin, Marcolin, & Newsted, 2003). A more detailed explanation of the procedure can be found in Henseler and Chin (2010). The three interaction terms in the interaction model (IMCC, IME, IMTC) are formed from the main effect variable improvisation and the moderating variables creative capability, empowerment, and technology capability, respectively. The interaction model tested a total of 20 relationships. The model and a table of complete results can be found below in figure 9.



Relationship	Path	p-value
IM Agg:Perf	**0.130**	0.055
SF:Perf	0.048	0.191
SF:IM Agg	0.101	0.136
OF:Perf	0.054	0.386
OF:IM Agg	-0.049	0.347
IF:Perf	**0.158**	0.045
IF:IM Agg	0.163	0.065
TU:Perf	0.068	0.239
TU:IM Agg	-0.054	0.288
CC:IM Agg	0.123	0.087
CC:Perf	0.104	0.134
Emp:IM Agg	**0.267**	0.003
Emp:Perf	0.142	0.073
TC:IM Agg	-0.105	0.094
TC:Perf	-0.003	0.532
Sev:IM Agg	**0.137**	0.012
Sev:Perf	**0.190**	0.000
OIME:Perf	0.196	0.17
OIMCC:Perf	-0.141	0.165
OIMTC:Perf	-0.124	0.226

Figure 9: Interaction Model

As advocated by Peng and Lai (2012), the use of PLS in operations management should include a rigorous assessment of the structural models' quality by reporting appropriate measures. The measures supported by the PLS literature for model quality assessment include the R^2 value (amount of variance explained by the model), Cohen's effect size (a measure of the difference in variance explained between models) for model comparison, f^2 (Cohen, 1988), significance of paths (interpreted the same as standardized regression coefficients) and loadings (Chin, 1998), and the predictive relevance (how well the model is able to predict) or Stone-Geisser test, Q^2 (Chin, 1998,

2010; Hair et al., 2011). Additionally, the change in Q^2 can be assessed and interpreted in the same way as the effect size comparison in order to "assess the relative impact of the structural model on the observed measures for each dependent latent variable" (Chin, 1998). This comparison, indicated by q^2, is calculated as shown in figure 10 below:

$$q^2 = \frac{Q^2_{incl} - Q^2_{excl}}{1 - Q^2_{incl}}$$

Figure 10: Formula for Stone-Geisser Effect Size

The structural model results for the main effects model and the interaction model are presented in table 20 below for comparison. The coeffecients indicated can be interpreted the same way as standardized regression coefficients.

Table 20: Structural Model Results

Predictive Relevance Measures				
	Main Effects Model		Interaction Model	
Endogenous Construct	R^2	Q^2	R^2	Q^2
Performance	0.368	0.6942	0.410	0.6957
Improvisation	0.213	0.4395	0.213	0.4395
Model Comparison Measures				
f^2 (between main effects and interaction models)				0.071
q^2 (between main effects and interaction models)				0.005
Path Values and Significance Levels				
	Main Effects Model		Interaction Model	
Relationship	Path	p-value	Path	p-value
IM Agg:Perf*	**0.113**	0.053	**0.130**	0.055
SF:Perf	0.062	0.203	0.048	0.191
SF:IM Agg	0.101	0.166	0.101	0.136
OF:Perf	0.010	0.479	0.054	0.386
OF:IM Agg	-0.049	0.320	-0.049	0.347
IF:Perf**	**0.176**	0.032	**0.158**	0.045
IF:IM Agg*	0.163	0.059	0.163	0.065
TU:Perf	0.054	0.278	0.068	0.239
TU:IM Agg	-0.054	0.275	-0.054	0.288
CC:IM Agg*	0.123	0.089	0.123	0.087
CC:Perf	0.109	0.142	0.104	0.134
Emp:IM Agg**	**0.267**	0.002	**0.267**	0.003
Emp:Perf**	**0.184**	0.032	0.142	0.073
TC:IM Agg	-0.105	0.128	-0.105	0.094
TC:Perf	0.017	0.365	-0.003	0.532
Sev:IM Agg**	**0.137**	0.014	**0.137**	0.012
Sev:Perf**	**0.182**	0.000	**0.190**	0.000
OIME:Perf			0.196	0.17
OIMCC:Perf			-0.141	0.165
OIMTC:Perf			-0.124	0.226

**indicates a significant path in the main effects model ($p<0.05$).

*indicates a weakly significant path in the main effects model ($p<0.10$).

First, a comparison of the main effects model can be made to the interaction model in order to assess the value of the moderating variables. As noted earlier, the measures used to assess the interaction or moderating terms are the value and significance of the paths from the moderating terms to the endogenous construct, as well as a measure of the effect size created by adding the interaction terms to the main efffects model. First, we see that none of the paths from any of the three interaction terms is significant in the interacton model. Second, the effect size of adding the moderators to the main effects model is between the weak (0.02) and modearate (0.15) levels described by Cohen (f^2=0.071). Additionally, the q^2 showing the relative effect (for predictive relevance) of adding the interaction terms to the model is well below the weak level (q^2=0.005). Although the effect size is not negligible, it must be noted that this is the combined effect of the three interaction terms on the R^2 value, which will increase as more exogenous terms are added to the model. Given these measures, particularly the lack of a significant path from any moderator to the endogenous variable, it can be determined that the interaction terms have a non-significant effect on the relationship between improvisation and performance.

Next, the main effects model can be examined for quality and predictive relevance. First, the R^2 for the endogenous constructs can be looked at to determine the quality of the model in terms of variance accounted for by the exogenous constructs. The first endogenous construct examined is improvisation, with an R^2 value of 0.213. Although the absolute value of R^2 is of varying significance based on the field of study (Hair et al., 2011) and the theoretical maturity of the relationships being tested, values of

0.67, 0.33, and 0.19 have been suggested for use in opeartions management research as substantial, moderate, and weak R^2 values (Peng & Lai, 2012). Given this standard, the model quality for the improvisation construct is between the weak and moderate levels. The performance construct's R^2 value is 0.368, falling into the moderate range according to the aforementioned recommended levels.

To assess the predictive relevance, the Stone-Geisser Q^2 statistic was obtained using PLS graph version 3.00 build 1130, which includes the blindfolding functionality needed for this operation not found in the later "alpha" version of the software used for other aspects of structural model estimation. An omission distance, *D*, of 7 was used in the blindfolding procedure, as recommended by Hair et al. (2011). The Stone-Geisser measure is calcualted as shown in figure 11 below:

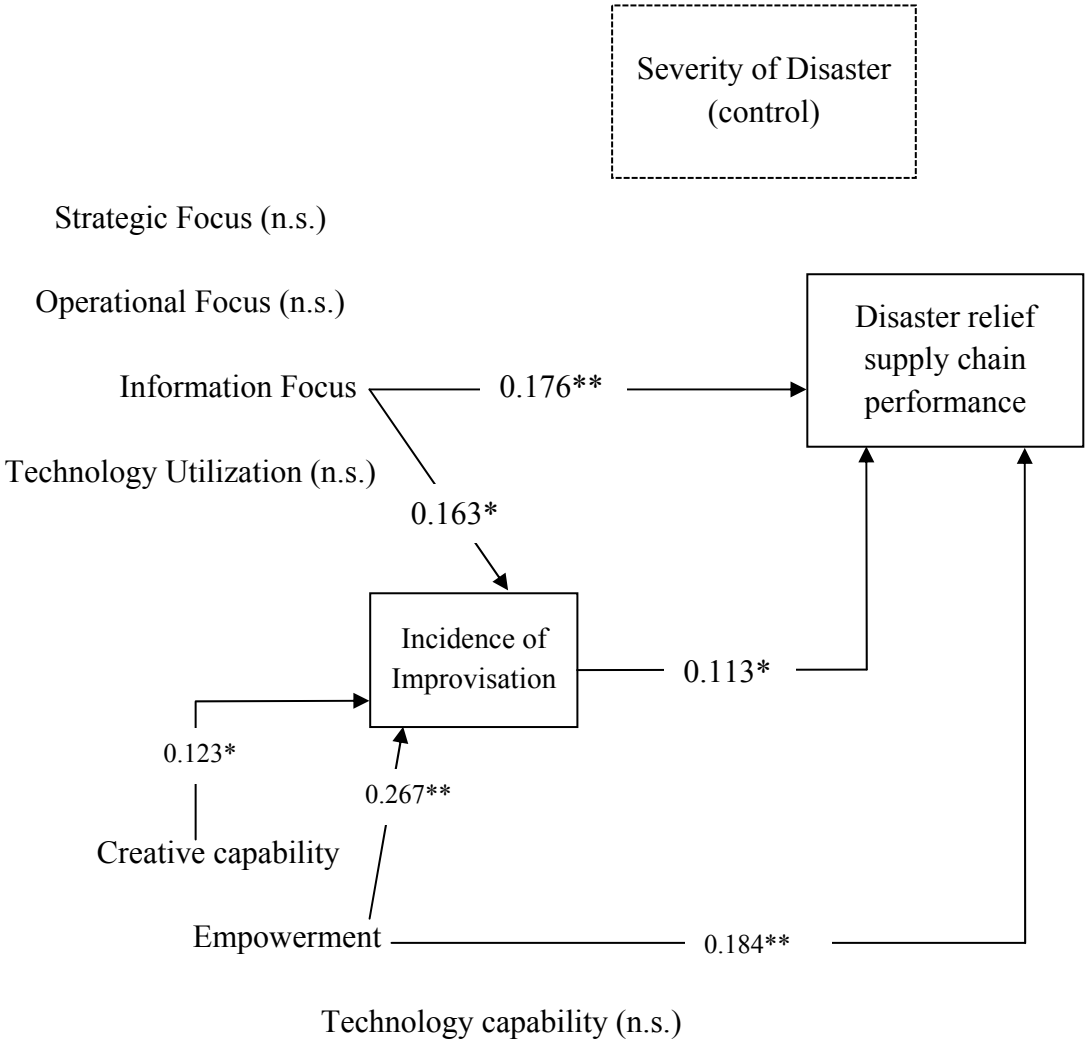
$$Q^2 = 1 - \frac{\sum_D E_D}{\sum_D O_D}$$

Figure 11: Formula for Stone-Geisser Predictive Relevance Measure

Where *E* is the sum of squares of prediction error, *O* is the sum of squares errors using the mean for prediction, and *D* is the omission distance. The blindfolding procedure eliminates every *D* data point in a matrix of cases and indicators, and then uses the model parameter estimates to predict those omitted values. The resulting Q^2 is a measure, without any loss of freedom, of how well the model predicts the missing values (Chin,

1998). There are no standards for the level of this measure as far as "weak, moderate, or strong" in the literature, however, values of $Q^2 > 0$ are reported as having "predictive relevance", whereas a $Q^2 < 0$ represents a "lack of predictive relevance" (Chin, 1998, 2010; Hair et al., 2011; Peng & Lai, 2012). The model shows predictive relevance for both the improvisation and performance constructs ($Q^2=0.4395$ and $Q^2=0.6942$, respectively). Given the theoretical immaturity of the model being tested here, the measures for variance explained and predictive relevance are promising. However, the individual path relationships and their significance must be analyzed in order to further explore the usefulness of the model with respect to hypothesized relationships between exogenous and endogenous variables.

The relationships shown to be either significant ($p<0.05$) or weakly significant ($p<0.10$) are improvisation to performance, information focus to performance, information focus to improvisation, creative capability to improvisation, empowerment to improvisation, empowerment to performance, and the control variable severity to both improvisation and performance. A representation of these results as applied to the research model presented in chapter one is found in figure 12 below. The control variable is expected to have an effect on performance and improvisation, so it is included in the model. The significance and direction of these relationships will be discussed in the follwing chapter along with a discussion of support for the hypotheses and a discussion of the potential reasons for non-findings.



*p<0.10; **p<0.05; n.s. – non-significant

Figure 12: Results Applied to Research Model

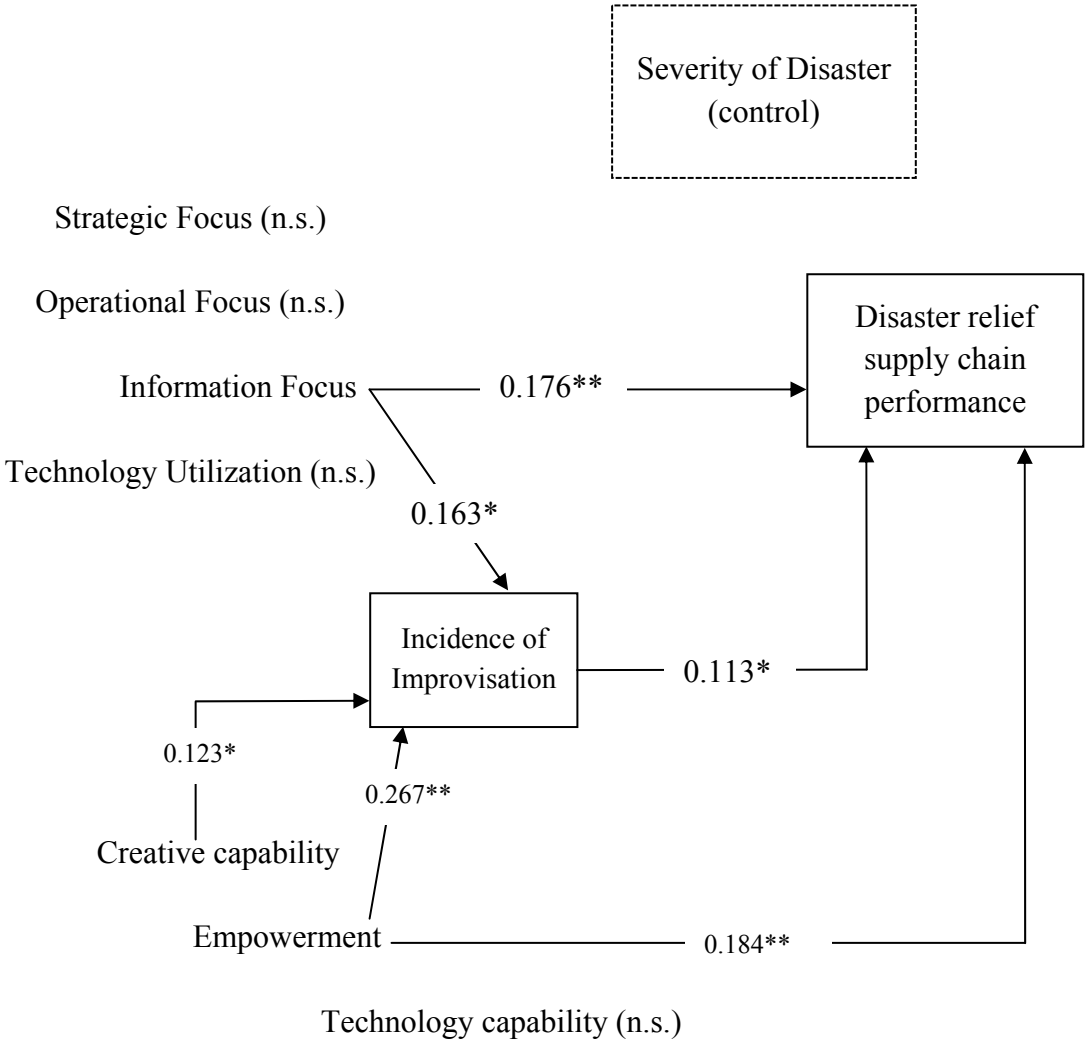
Although several path significance levels changed from the interaction model to the main effects model due to the exclusion of the effects of the interaction terms, the general values of paths and significance was similar. Since the influence of the interaction terms is non-significant to the model, the main effects model will be used to discuss support for the hypotheses in the following chapter. The final chapter will focus on presenting the limitations of this research, research and practical implications, and topics for future research in this area.

Chapter 5

DISCUSSION OF RESULTS

Introduction

The previous chapter presented the results of the analysis using structural models to test relationships between the independent and dependent variables in the study. Following is a discussion of the hypotheses of this research and how the analysis results support the hypotheses as well as potential reasons for non-findings. A representation of the findings is illustrated in figure 13 below (figure 13 is a copy of figure 12 presented here for ease of reference). A summary of the findings as they relate to the hypotheses is presented in table 20 below. In the following (final) chapter, a discussion of the research and practical implications of these results is presented along with limitations and directions for future research.



*p<0.10; **p<0.05; n.s. – non-significant

Figure 13: Results of Analysis

Table 21: Summary of hypotheses and related results

Hypothesis	Hypothesized Relationship	Support / Result
1	Improvisation to Performance No relationship exists	Not supported Positive (p=0.053)
2	Strategic Focus to Performance Positive Relationship	Not supported Non-significant (p=0.203)
3	Operational Focus to Performance Positive Relationship	Not supported Non-significant (p=0.479)
4	Information Focus to Performance Positive Relationship	Supported Positive (p=0.032)
5	Technology Utilization to Performance Positive Relationship	Not supported Non-significant (p=0.278)
6	Strategic Focus to Improvisation Negative Relationship	Not Supported Non-significant (p=0.166)
7	Operational Focus to Improvisation Negative Relationship	Not Supported Non-significant (p=0.320)
8	Information Focus to Improvisation Negative Relationship	Weak Opposite Relationship Positive (p=0.059)
9	Technology Utilization to Improvisation Negative Relationship	Not Supported Non-significant (p=0.275)
10	Creative Capability to Improvisation Positive Relationship	Weakly Supported Positive (p=0.089)
11	Empowerment to Improvisation Positive Relationship	Supported Positive (p=0.002)
12	Technology Capability to Improvisation Positive Relationship	Not Supported Non-significant (p=0.365)
13	Creative Capability moderates Improvisation to Performance Positive Relationship	Not Supported Non-significant (p=0.170)
14	Empowerment moderates Improvisation to Performance Positive Relationship	Not Supported Non-significant (p=0.165)
15	Technology Capability moderates Improvisation to Performance Positive Relationship	Not Supported Non-significant (p=0.266)

Direct impact of improvisation on performance

The following discussion of support provided for the research hypotheses is based on the results of the main effects model presented in the previous chapter and as summarized in table 21.

Hypothesis 1: Incidence of improvisation alone will have no direct effect on disaster relief supply chain performance.

This hypothesis was based on previous research which held improvisation as a neutral construct, meaning that the mere presence or level of improvisation had no direct impact on performance (the studies referenced performance in terms of innovation and new product design). In these previous studies, as discussed in chapter 2, improvisation was linked to a performance outcome by the presence of a moderator such as real-time information sharing, organizational memory, experimental culture, teamwork skills, market information, or entrepreneurial self-efficacy. The moderators here (creative capability, empowerment, and technology capability) were developed because of their perceived conceptual relation to these previous moderators and the positive effect this should have on the improvisation – performance relationship. However, the relationship between incidence of improvisation and performance in this study was positive and weakly significant, with a path coefficient of 0.113 ($p=0.053$). Therefore, hypothesis 1 is not supported in the model.

Interestingly, the positive relationship, although not strong here, may be unique to the field of disaster relief supply chain management, or other fields in which supply chain operations take place in an environment of high uncertainty where planning is difficult.

As discussed in chapter two, disaster relief supply chains can be categorized as emergent systems which form and are implemented rapidly. The relationship of improvisation to performance could indicate that those organizations which are successful in disaster relief supply chain management must rely on improvisation to a greater extent than planning, and that in some cases a lack of improvisation could simply equate to inaction.

Direct impact of planning factors on performance and improvisation

> Hypothesis 2: Higher levels of strategic focus will have a positive effect on disaster relief supply chain performance.

This hypothesis would be supported by a positive direct relationship between strategic focus and the performance construct. There was no significant relationship found between strategic focus and performance. This hypothesis is not supported. Strategic focus is defined as the focus on long-term decisions and planning factors which affect the structure, size, management, and relationships of the supply chain. These decisions may affect the entire supply chain and include structural decisions concerning outsourcing, supply chain design (e.g. lean or agile), collaboration, and human resource management. If performance in disaster relief chain management is dependent upon improvisation more than on planning, as is potentially indicated by the relationship between improvisation and performance, then much effort in the realm of strategic planning may not be of great benefit. This cannot be confirmed by this model, but is suggested as a potential reason for this finding.

Hypothesis 3: Higher levels of operational focus will have a positive effect on disaster relief supply chain performance.

No significant relationship between operational focus and performance was detected in the model, giving no support to this hypothesis. Operational focus is defined as a focus on operational decisions and planning factors which affect specific material flows and transportation utilization. These are decisions which affect only a portion of the supply chain. This may include decisions inventory pre-positioning, transportation mode, transportation constraints, port constraints, and material handling constraints. If improvisation, being the spontaneous and creative process of attempting to achieve an objective in a new way, has more impact on disaster relief supply chain performance than planning, we may expect to see this non-relationship.

Hypothesis 4: Higher levels of information focus will have a positive effect on disaster relief supply chain performance.

Information focus was shown to have a significant direct positive relationship with performance in the main effects model with a path coefficient of 0.176 ($p=0.032$), giving support to this hypothesis. This indicates that lessons learned and continuous improvement has a direct effect on performance. This fits with the previous results that while strategic and operational aspects of planning may not be of great impact during an emergent disaster relief scenario, a specific knowledge of past successes and failures may help an organization to navigate the uncertain environment.

Hypothesis 5: Higher levels of technology utilization will have a positive effect on disaster relief supply chain performance.

Technology utilization is defined as the extent to which systems are used to integrate supply chain activity, to include connecting customers, suppliers, and other value adding activities. This construct showed a non-significant relationship with the performance construct. This relationship does not lend support to hypothesis 5. This concept is intended to measure the use of systems in planning activities as described above. Given the relationships of strategic and operational focus to performance being non-significant, one might expect that this construct (in its being supportive to the two planning levels) would not have a significant effect on performance either.

Hypothesis 6: Higher levels of strategic focus will have a negative effect on the incidence of improvisation.

Strategic focus, as defined above, did not have a significant relationship with improvisation. Given this information, hypothesis 6 is not supported. This result is surprising, given that strategic focus does not have a direct relationship with performance and that improvisation does directly and positively affect performance. Given these relationships, one may conclude that this hypothesis should hold true, and that a departure from a strategic focus would imply more improvised action. However, if improvisation is a main driver of disaster relief performance, it may be true that regardless of the level of strategic planning focus an organization has, that the organization will be "forced" into improvised scenarios during disaster relief operations. This would imply that improvisation takes place in organizations with both high and low levels of strategic planning focus, thus giving one potential explanation of this non-finding.

Hypothesis 7: Higher levels of operational focus will have a negative effect on the incidence of improvisation.

Operational focus, as defined earlier, is similar to the concept of strategic planning. However, this "more specified" level of planning did not have a significant impact on the incidence of improvisation. Hypothesis 7 is not supported. The resulting reason for non-support would follow the same explanation as discussed for hypothesis 6 above.

Hypothesis 8: Higher levels of information focus will have a negative effect on the incidence of improvisation.

Information focus is the focus on knowledge management which includes lessons learned, performance data collection, and continuous improvement. The extent of information focus affects how information is collected and used in the planning cycle. The relationship found between this construct and the incidence of improvisation was positive (opposite the hypothesized direction). Although not a highly significant relationship ($p=0.059$), this is an interesting result. Hypothesis 8 is not supported. However, since the path from improvisation to performance is also positive and the direct effect of information focus on performance is positive, this could indicate that improvisation is partially mediating the relationship of information focus to performance. Additionally, since the relationship is opposite the hypothesized direction, it may mean that the focus on lessons learned and continuous improvement indicated by higher levels of information focus, is a facilitator of improvisation. This is in line with previous studies linking memory and expertise to improvisation and performance (Kamoche et al., 2003; Vera & Crossan, 2004b).

Hypothesis 9: Higher levels of technology utilization will have a negative effect on the incidence of improvisation.

Technology utilization showed no significant effect on the incidence of improvisation. Therefore, hypothesis 9 is not supported. The lack of significant results for technology utilization's effect on both performance and improvisation may be that the construct was conceptually linked to the two planning focus areas (strategic and operational focus) which did not have a significant effect on either endogenous construct.

Direct impact of capability factors on improvisation

Hypothesis 10: Higher levels of creative capability will have a positive effect on the incidence of improvisation.

Creative capability, which is having the necessary knowledge and experience to effectively devise new solutions to problems, had a weak significant relationship with the incidence of improvisation ($p=0.089$). Hypothesis 10 is weakly supported by this evidence, however, this relationship should be subjected to further testing in order to determine the role of improvisation as a potential mediator between creative capability and performance, since the results indicate there is no direct link between creative capability and performance.

Hypothesis 11: Higher levels of empowerment will have a positive effect on the incidence of improvisation.

Empowerment, or the capability to immediately implement or enact a solution, when provided, had a strong positive relationship with the incidence of improvisation (path coefficient=0.267, $p=0.002$). This lends strong support to the theorized relationship

indicated by hypothesis 11. Although not hypothesized, empowerment also exhibited a significant direct relationship to performance (p=0.032). Empowerment as tested, which is conceptually linked to the spontaneity aspect of improvisation, is the strongest predictor of either improvisation or performance in the model. This also lends support to the notion that heavy focus on planning activities (strategic and operational planning focus) had little effect of disaster relief performance.

Hypothesis 12: Higher levels of technology capability will have a positive effect on the incidence of improvisation.

Technology capability, defined as the adaptability, configurability, and deployability of the hardware used by an organization was hypothesized to have a positive relationship with the incidence of improvisation. There was no significant relationship between technology capability and improvisation, however, the result was interesting nonetheless. The path coefficient was negative, which indicates an opposite relationship than what was hypothesized, although it does not meet the cutoff for significance (p=0.128). Although, hypothesis 12 is unsupported in this research, further testing of this construct in future research is necessary.

Moderating effects of capability factors on improvisation

The moderating effects were tested using the orthogonalizing approach as described in the previous chapter. In the case of the following hypotheses, the moderating effects of creative capability, empowerment, and technology capability are represented in the models by the constructs IMCC, IME, and IMTC, respectively. These

constructs are comprised of the indicators as explained in chapter 4. A significant relationship between the moderating terms and the performance construct would indicate support of moderation as hypothesized.

Hypothesis 13: Creative capability will moderate the relationship between improvisation and disaster relief supply chain performance such that higher levels of Creative capability will increase the positive effect of improvisation on disaster relief supply chain performance.

Hypothesis 14: Empowerment will moderate the relationship between improvisation and disaster relief supply chain performance such that higher levels of Empowerment will increase the positive effect of improvisation on disaster relief supply chain performance.

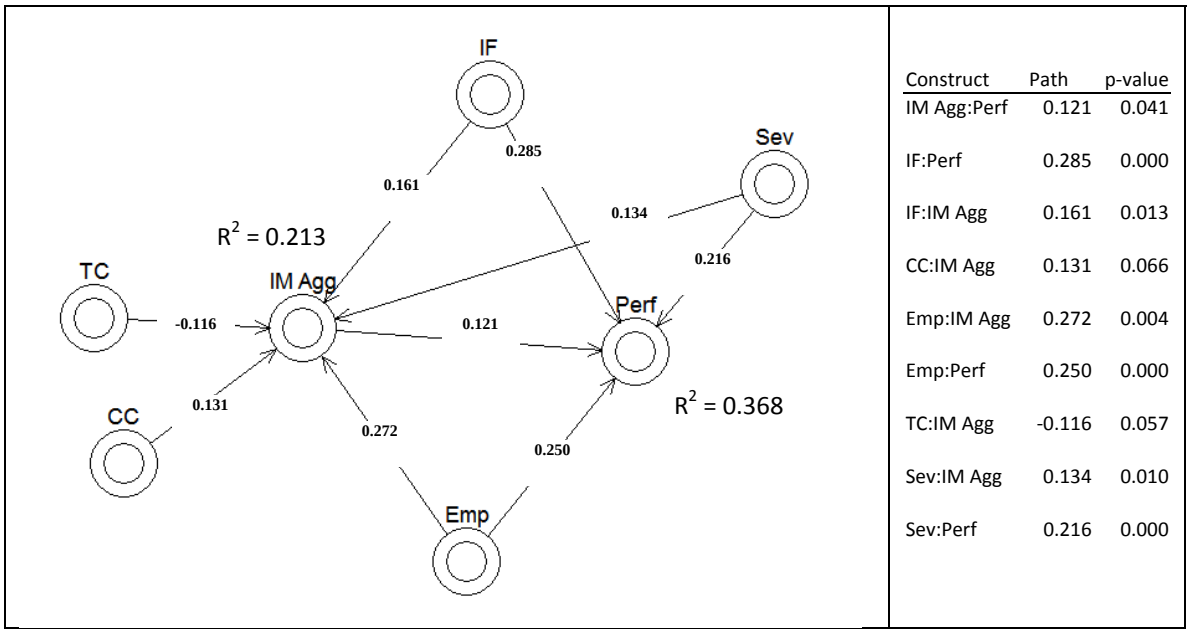
Hypothesis 15: Technology capability will moderate the relationship between improvisation and disaster relief supply chain performance such that higher levels of Technology capability will increase the positive effect of improvisation on disaster relief supply chain performance.

In the interaction model, there were no significant relationships found between any of the interaction terms and performance. Further evidence is given against the hypothesized relationships by the positive direct relationship between improvisation and performance. This indicates that for the purposes of this research, improvisation is not a neutral

construct, and may be partially mediating the relationships between empowerment, information focus, and the endogenous construct performance. This warrants further research, however, does not lend support for hypotheses 13, 14 or 15.

Post hoc analysis and model

Given the results of the initial model and hypothesis testing, a post-hoc analysis was conducted using the same procedures, except dropping all relationship paths that did not meet the minimum p-value of 0.10. This liberal value was chosen because of the theoretical immaturity of the hypotheses being presented here. One exception was made to this cutoff rule. The path between technology capability and improvisation was kept in the model because of the direction of the relationship and its potential negative impact on incidence of improvisation and performance. The post-hoc model was constructed as illustrated in figure 14 below.



Construct	Path	p-value
IM Agg:Perf	0.121	0.041
IF:Perf	0.285	0.000
IF:IM Agg	0.161	0.013
CC:IM Agg	0.131	0.066
Emp:IM Agg	0.272	0.004
Emp:Perf	0.250	0.000
TC:IM Agg	-0.116	0.057
Sev:IM Agg	0.134	0.010
Sev:Perf	0.216	0.000

Figure 14: Post-hoc structural model.

The results of this post-hoc model are compared to the structural model results in table 22 below.

Table 22: Post-hoc Structural Model Results

Predictive Relevance Measures				
	Main Effects Model		Post-hoc Model	
Endogenous Construct	R^2	Q^2	R^2	Q^2
Performance	0.368	0.6942	0.354	0.6942
Improvisation	0.213	0.4395	0.207	0.4399
Model Comparison Measures				
Performance f^2 (between main effects and interaction models)				0.022
Performance q^2 (between main effects and interaction models)				0.000
Improvisation f^2 (between main effects and interaction models)				0.008
Improvisation q^2 (between main effects and interaction models)				0.001
Path Values and Significance Levels				
	Main Effects Model		Post-hoc Model	
Relationship	Path	p-value	Path	p-value
IM Agg:Perf*	**0.113**	0.053	0.121	0.041
SF:Perf	0.062	0.203		
SF:IM Agg	0.101	0.166		
OF:Perf	0.010	0.479		
OF:IM Agg	-0.049	0.320		
IF:Perf**	**0.176**	0.032	0.285	0.000
IF:IM Agg*	**0.163**	0.059	0.161	0.013
TU:Perf	0.054	0.278		
TU:IM Agg	-0.054	0.275		
CC:IM Agg*	**0.123**	0.089	0.131	0.066
CC:Perf	0.109	0.142		
Emp:IM Agg**	**0.267**	0.002	0.272	0.004
Emp:Perf**	**0.184**	0.032	0.250	0.000
TC:IM Agg	-0.105	0.128	-0.116	0.057
TC:Perf	0.017	0.365		
Sev:IM Agg**	**0.137**	0.014	0.134	0.010
Sev:Perf**	**0.182**	0.000	0.216	0.000
OIME:Perf				
OIMCC:Perf				
OIMTC:Perf				

**indicates a significant path in the main effects model ($p<0.05$).
*indicates a weakly significant path in the main effects model ($p<0.10$).

All the relationships included in the post-hoc model became either greater in magnitude, more significant, or both, however, the changes in magnitude are not necessarily significantly different from the main effects model to the post-hoc model. The significance of each relationship, however, reinforces the relationships tested by the main effects model and discussed as related to each hypothesis in this chapter. Of particular note is the effect size q^2, of the difference in the Stone-Geisser predictive relevance measure from the main effects model to the post-hoc model. The values of q^2 for both endogenous constructs, improvisation and performance are essentially zero, meaning there is no change in the predictive relevance (Q^2) between the two models after eliminating the non-significant paths. The f^2, however, shows a small effect size for the performance construct (0.022), and a negligible effect for the improvisation construct (0.008), indicating the contribution to the change in R^2 after eliminating the non-significant paths. A decrease in the R^2 value is expected with fewer contributors in any case. With essentially no loss in predictive relevance from the main effects model, the post-hoc model serves as a reinforcement of the hypothesis testing discussion presented in this chapter. Limitations, future research possibilities, theoretical implications, and implications for practice are presented in the final chapter.

Chapter 6

SUMMARY, IMPLICATIONS, AND CONCLSUION

Introduction

The previous chapter discussed how the results of this study related to the hypotheses developed and presented in chapter two. The results showed moderate support of some of the hypothesized relationships, although the surprising relationships which were opposite what was expected are also of interest. This concluding chapter will present the theoretical and practical implications of this study as well as a summary of the limitations of this research, contributions, and future research possibilities.

Research Implications

The research and results presented in the preceding chapters is based on synthesized theory developed and adapted from supply chain management, improvisation, performance measurement, and disaster relief literature. The theorized relationships are based on the view that disaster relief supply chain management is a separate field from commercial supply chain management and disaster management, with its own set of performance measures and performance-influencing factors. This separation of the field from commercial supply chain management and more general disaster response literature is one of the aims of this study, and was developed in chapter two. The following theoretical implications show relationships between planning, improvisation, and performance which may be unique to disaster relief supply chain management.

First, the positive direct relationship between improvisation and performance is empirically unique to this research. Former research between improvisation and

performance has characterized improvisation as a neutral construct which affected performance only in the presence of a moderating variable. This research also characterized improvisation as neutral in its hypotheses, predicting no direct significant relationship between improvisation and performance. However, the positive relationship identified by the model suggests that the mere level of improvisation (incidence of improvisation) is positively related to performance in this context. It is important to note that this does not weaken the prior research cited. If a disaster relief supply chain is truly to be examined in its own right, this type of "surprising" result shouldn't be a surprise at all. So then, what does this relationship suggest ? Perhaps the environment of disaster relief supply chain management is more filled with unknowns, operates at a faster pace, and calls for immediate action (whether planned or not) more so than any other environment in which improvisation has been studied. The emergent systems view of disaster relief supply chain management seems to fit with this possibility. Planning in this context is particularly difficult as it paradoxically calls for the creation of a "plan for the unexpected" (Simpson, 2012).

This brings the discussion into the next set of relationships, those direct relationships between planning and improvisation and planning and performance. First it was hypothesized that planning would reduce the incidence of improvisation. Of the 4 planning-related factors discussed (strategic focus, operational focus, information focus, and technology utilization), information focus had a significant relationship with improvisation and performance. The implication here is not that planning is ineffective, but in how we view planning with respect to disaster relief. The planning factors were

derived from commercial supply chain literature, where differing levels of planning are undertaken in order to prepare for expected events, events that have occurred in the past, or events that are likely to occur in a given situation. Disaster relief almost always presents the responder with the unexpected, so that these various levels of planning may be rendered null and overcome by improvised action. The use of technology for communication is no doubt important to the relief effort, however, in this context technology utilization was conceptualized as something that occurred prior to the disaster event in the planning phase. Finally the significant relationships from this set of factors (as shown in figure 13) occur from information focus to improvisation and from information focus to performance. First, the information focus construct has a positive relationship with improvisation, which is opposite from what was expected. This could be due to the fact that this construct was conceptually linked to the constructs of strategic and operational focus when developing the hypothesis that it would have a negative effect on the incidence of improvisation. The idea was that the use of lessons learned and continuous improvement techniques would facilitate these planning focus areas and therefore reduce the need for or incidence of post-event improvisation. However, the focus on lessons learned may have the effect of developing a shared knowledge base among practitioners which may lead to more effective decentralized decision making (see discussion of empowerment) and a more robust capability to effectively improvise.

Information focus also had a positive direct relationship with performance, which was the expected result. What remains to be seen, however, is how improvisation may mediate this relationship, since improvisation also has a positive significant effect on

performance. Regardless, information focus or the focus on lessons learned and continuous improvement plays a significant role in disaster relief supply chain performance and on improvisation in this context.

The role of capability factors on the incidence and effectiveness of improvisation is shown by the relationships that creative capability, empowerment, and technology capability have with improvisation. The role of these capabilities in moderating the improvisation-performance relationship is shown by the relationships between the interaction of these terms with improvisation and the resulting product-indicator constructs' relationship with performance. First, the strongest (in terms of path coefficient) and most significant result from the model was the relationship between empowerment and improvisation. As expected, empowerment had a positive relationship with the incidence of improvisation. This relationship suggests that the most important capability required for improvisation is the ability to implement a decision at lower levels. Although not part of the hypotheses, a positive direct relationship was also found between empowerment and performance. Empowerment should be taken as a key capability for both improvisation and performance in disaster relief supply chain management, which points to the importance of decentralization in decision making structures.

Creative capability was also positively (although weakly) related to improvisation. This relationship supports the two-dimension view of improvisation which includes both spontaneity and creativity. The third capability factor, technology capability was not shown to have a significant relationship with improvisation. The

hypothesis stemmed from the use of technology systems to foster real-time information flow, which has been linked to incidence of improvisation. This absence of a relationship may simply indicate that the organization's hardware usability may be less important than a simple open-forum communication system (classified as all-channel communication networks) such as a short-wave radio channel open to all involved in the effort (Simpson, 2012).

In summary, these theoretical contributions highlight the importance of continuous improvement, empowerment, and creative capability to improvisation and disaster relief supply chain performance more so than a focus on planning at the strategic or operational level. Although the role of technology is not clear in this study, the role of learning and knowledge management (indicated by the information focus construct) is shown to have significance beyond just the planning phase.

Practical Implications

A better understanding of the relationship between organizational planning factors, capabilities which influence improvisation, and the relationship of improvisation in disaster relief supply chain management will enable relief organizations to gear their planning processes toward factors which have the most impact on their primary performance concerns. Organizations which invest considerable time and resources developing plans, procedures, supply chain structure, and training of personnel, can more efficiently use those resources by devoting time to activities which have the most impact on overall performance.

One of the characteristics of humanitarian and disaster relief logistics as identified in the literature is constrained resources as well as the lack of experienced, trained logisticians. The dynamic, complex, and unpredictable nature of the environment of disaster relief supply chain management calls for practitioners who can think on their feet as well as organizations which have a structure and planning focus geared specifically to benefit performance in this unique field. Simply applying practices from commercial supply chain management is a trial and error process in the realm of disaster relief, and the difference between success and failure in a critical area of performance such as speed can mean the difference between life and death for an individual. Although organizations may spend many resources on planning and preparation for disaster response, the time and resource constraints most likely don't allow for extensive planning for all scenarios. A better understanding of how improvisation and planning work together to enhance performance in this area is a step toward a better system for organizations. This will enable more effective use of resources and more effective training of personnel up front, before a disaster event. So, as with any research, the end goal of this study is to provide, at a minimum, some practical possibilities which will inform decision makers and guide further investigation into the relationships explored here.

Practically, improvisation's positive impact on performance coupled with the non-significant impact of planning factors may indicate that despite the best efforts to plan for disaster response, it is the ability to improvise that has the most impact of disaster relief performance. Although the relationship here is not particularly strong, the implication is that the resources devoted to extensive planning may be better placed in developing improvisational capabilities such as creative capability, or in determining the best

decentralized decision-making structure and preparing personnel to make and implement decisions in this context.

In such a decision making structure, empowerment is essential to successful improvisation and thus to higher levels of performance. Empowerment captures the spontaneous nature of improvisation in that practitioners at lower levels (those closest to victims) are able to implement solutions to problems as they arise. The effect of empowerment on both improvisation and performance is the strongest and most significant of any factor studied here. Devoting more resources to develop practitioners who are prepared to make decisions on the fly (both in terms of creative capability and empowerment) should reap more benefits than extensive planning efforts at the strategic or operational level.

Information focus draws our attention to lessons learned and continuous improvement efforts prior to a disaster. The positive relationships between this construct and both improvisation and performance may indicate, as discussed, that it is more of an enabler of effective improvisation than of planning. Regardless of the theoretical underpinnings, it appears as if the practical impact of evaluating lessons learned and improving processes has a potential to enhance performance, either directly or through improvisation.

The clear picture painted by the data is that improvisation has a greater impact on performance than a strategic or operational planning focus. Further, there are three factors organizations can focus on in order to increase both improvisation and performance. Those are empowerment, information focus, and creative capability.

Limitations

Disaster relief supply chains are unpredictable by nature. Although empirical research into the nature *and cause* of relationships between planning, improvisation, and performance in disaster relief supply chain management is important, researchers cannot be too quick to say that a model is correct or that it will be generalizable. Thus is the case with this research. The conclusions drawn from the hypothesized and surprising relationships should be viewed in the context of the dynamic disaster relief environment, and taken with the appropriate weight in terms of generalizability. Disasters themselves are all different. Focusing on the common elements present in a disaster environment helps to narrow the problems faced into empirically researchable questions, however, results of this and other disaster relief studies are disaster-specific to an extent.

The scope of this study is large and general. This is not necessarily negative, however, it prevents a more in-depth look at specific relationships simply due to the complexity of the model involved and the amount of data needed. Given the assumption that research into complex topics will never find the "true model", the exploratory nature of PLS is a well-fitting tool for this type of environment. As these research hypotheses are further developed and tested, and as more confidence is placed in their validity, model specification becomes less of an issue and CBSEM techniques may then be used to serve as more of a confirmatory test. This becomes more appropriate as theory in this field is developed, refined, and strengthened by exploratory studies such as this one. This research, however, serves as a starting point for many topics of more specificity and

theory building in this area, such as better defining performance and performance measures, and the role of complexity in disaster relief.

Performance measurement in disaster relief supply chain management is broad enough to be a stand-alone topic. Due to time and resource constraints, along with the availability of primary data and the difficulty of collecting survey data, including even a small element of performance measurement in this research adds considerable complexity. Additionally, primary performance data is preferable to the self-reported measures of performance used in this study, however, the existence of this data on a large scale and its availability are difficult to confirm. The tradeoff here is a large scale collection of data across a wide spectrum of organizations versus a small sample of more exact data from a limited number of organizations (which would make results more objective, but less general).

The global measures for improvisation still need refinement in the context of disaster relief research. The established scales yielded an aggregate scale with strong validity to test the hypotheses. The global measures should be refined to accurately capture the conceptual definition of improvisation. However, the two-dimensional nature of the construct can lead to interesting future research on the singular relationships between spontaneity, creativity, and performance in disaster relief supply chain management, a topic yet to be explored.

Overall construct definitions for this research were broad. The focusing of these definitions, narrowing of concepts, and developing of more theoretical groundwork will make research in this area stronger and more generalizable. This study lays the

groundwork for further, more specific integration of improvisation, disaster relief supply chain management, and performance measurement research.

In this type of research, it seems beneficial to establish strong, long term relationships with organizations performing disaster relief operations. The research should never detract from a relief effort, as time is of the essence to any disaster relief practitioner. Although a partnership was established with a large disaster relief conference, the payoff for survey respondents' time is general (in the form of a report of the findings of this research). Disaster relief seems a fertile ground for action research, where the results of field studies are immediately implemented by the partner organization, and feedback is then incorporated into the research to further refine the study at hand. This type of symbiotic relationship between research and practice seems the most beneficial for both disaster relief practitioner and researcher, however, it takes the researcher out of the office and demands more personal involvement in the effort being studied. This paradigm may be the most fitting, although not the most convenient, for disaster relief research. As one researcher/practitioner stated at the 2011 Decision Sciences conference (humanitarian logistics session), the best way to conduct research with this type of organization is for an academic to "infiltrate" the organization.

Future Research

Practical disaster relief research is of great value. Although many relationships were explored in this study, some are more worthy of further investigation. A closer look into whether improvisation is always "good" in disaster relief is warranted. This

relationship should be of primary concern to any researcher in this field. A more exact specification of the model of how this occurs, and how improvisation interacts with other factors to influence performance (to include mediating and moderating roles of capabilities and planning factors) is outside the scope of this research, but should be the goal of future empirical studies in this area.

The data collected in this study can be used to run many other models. The models tested in this write up are a starting point for the many combinations of factors possible with this data set, although the nature of such research will be more exploratory than confirmatory. The opportunity to drill deeper into specific conceptual relationships exists along with the further development of scales for the constructs used in this study.

Measurements and definitions of capabilities and planning factors need more refinement such that the measurement constructs and items more closely match definitions. Definitions also need to be made more parsimonious, clear, and focused. This will lead to more confidence in the results of future examinations of the constructs and relationships presented here.

Model results show great promise in terms of relationships of capabilities to performance and improvisation -particularly the relationships between empowerment, creative capability, improvisation, and performance. A look at organizational structure and how it affects some of these variables (empowerment, for example) should be considered as a future topic. Questions arise as to what the right level of empowerment is and are there disaster relief scenarios where it is harmful rather than beneficial? In part, this may be explored by a dissection of improvisation into its components (creativity and

spontaneity) and the subsequent testing of these component parts' relationship to performance. Additionally, the relationship of creative capability to performance and disaster relief is of interest. There is a relationship in which creative capability contributes to performance, and the logical implication would be to train employees in creativity/creative capability. Therefore, research as to how this may be done in the context of disaster relief is also of interest.

Severity was used as a control variable in this study. However, severity may not be the correct measure for determining the environment of a disaster relief effort. Complexity may have a more dynamic and significant impact on how we respond to disasters. As stated by Admiral Thad Allen in a speech at the IDCE, complexity has a more dramatic impact on a disaster relief environment than does severity. In his words, it is where "complexity intersects complexity" that the environment of any response turns to chaos. The example given was the intersection of a Tsunami event and a nuclear meltdown in Japan. These two relatively complex disasters intersected and formed a totally new level of complexity. In addition to severity, the concept of complexity (which is not dependent solely on the magnitude of the disaster itself, but includes many other environmental and external factors) should be added to the study of future disaster relief efforts. Future research may also explore the application of these theories to the military context, which is similar to the disaster relief environment in complexity and dynamism. A comparison of the two environments may be of benefit to both.

Although the data collected will give further opportunity for study, its usefulness is limited. In order to collect more data of this type, a shorter more focused survey

instrument is needed. The partnership formed with IDCE was invaluable to the collection of the survey responses for this study, however, it is known that the length of the study was probably prohibitive to receiving more responses. The continued partnership with IDCE and the development of relationships with other worldwide and national conferences may prove a fruitful medium for data collection, but the strategy should be used with caution as not to cause burnout on the part of participants.

Based on the main study and the data collected thus far, there are several potential or planned future studies that can be carried out with the data on-hand. First a performance measurement scale development study is planned using the available formative and reflective indicators together in redundancy models.

Next, the main model can be broken down to smaller relationship pieces as follows (and the results of each examined with more focus): capabilities to improvisation, capabilities to performance (and all sub dimensions), and improvisation to performance. Additionally, improvisation will be broken down into its component parts (creativity and spontaneity) and the relationships of these component parts with performance and its sub dimensions will be examined. The relationships may be studied as follows: creativity on performance (and its sub-dimensions), spontaneity on performance (and its sub-dimensions), and planning factors and capabilities on improvisation and performance. There are enough combinations of relationships here to compose a substantial secondary study.

In addition to these planned studies, a singular focus on information based constructs may yield interesting results and model refinements. This includes refining the

constructs for information focus, technology utilization, and technology capability, and studying how they relate to one another. Finally, a methodology based study is planned to compare the modes of survey administration (paper versus electronic). This study will be an update / follow up to a previous study published in the Journal of Business Logistics (Griffis, Goldsby, & Cooper, 2003).

Contributions and Conclusion

The field of disaster relief supply chain management is emerging as a stand-alone research category, and most research to date is descriptive, case study based, commentary, or focused on a particular aspect of disaster relief supply chains such as inventory management. This is the first study to date that attempts to develop and test a generalized theory of management-based factors which bear significance on disaster relief supply chain performance.

This is the first large-scale empirical study of improvisation and planning factors in disaster relief supply chain management. Not only do the results have practical significance, but the byproducts of such a study will include use of the data for performance scale development, further empirical validation of improvisation scales, and proof of the feasibility of using survey tools in this area of research.

This is also the first attempt to synthesize improvisation theory and disaster relief supply chain management in an empirical study. There have been no previous studies examining the role of improvisation in disaster relief supply chain management. This study partially filled this gap by identifying the most important factors leading to

improvisation in disaster relief, the importance of these factors to performance, and by the testing of the importance of multiple planning factors' impact on disaster relief supply chain performance.

The standout contribution to both research and practice is the singular effect of empowerment on improvisation and performance. Levels of this factor may influence not just the way a disaster relief scenario is played out, but also the organizational management style and structure. The way resources are allocated within an organization may shift as focus is placed on the importance of empowerment. Additionally, this factor and its relationship to the other factors should be addressed as the focus of future research in this area.

To reiterate an earlier statement, as much as 80% of disaster relief cost is logistics cost. This fact along with the notion that disaster relief supply chains are rapidly conceived, designed, and executed in practice gives relevance to the examination of the factors presented in this study. This research effort sought to reveal which of these factors have the greatest effect on performance of disaster relief supply chains. This has potential for great benefit to the entire relief effort through resource savings (primarily in the planning phase) and increased relief performance. Organizations will benefit from knowing important factors leading to improvisation, the relative relationships of planning factors to performance, and the impact of planning and capability related factors to the incidence and effectiveness of improvisation. The hope is that organizations with very limited time and resources may have the opportunity to use some of the information learned in this research effort in order to refocus their critical planning and training

efforts on areas which will have the most impact on the success of a relief effort, which means delivering help at the right moment to those people who need it most.

REFERENCE MATERIAL

Appendix 1 – Survey Instrument

UNIVERSITY of HOUSTON
C. T. BAUER COLLEGE of BUSINESS

Disaster Response Operations Survey

Please complete this survey

Thank You!

An effort to better understand how we can prepare for an effective disaster response

Hi,

I am studying how organizations deal with uncertainties in a disaster response operation. As a military logistics officer and a Ph.D. student who is personally interested and involved in the humanitarian mission, I am striving to uncover some practical relationships between planning, improvisation, and performance in disaster relief. I hope this study will shed light on how the disaster response community can better use scarce resources to prepare their organization and people to make the best decisions possible while helping those in need. Your participation will greatly benefit this goal.

You are invited to take a few minutes to complete this anonymous questionnaire. It is essential that you mark an answer to every question in order for your response to be usable, although your participation is voluntary and you may choose to withdraw at any time. You may refuse to answer any question. Your individual responses will not be shared, nor will I collect any personally identifiable information during this process.

If you have any questions about the study, or would like a copy of the results, please contact me at disaster.survey@gmail.com (Expected study completion date is May 2013).

You are one of approximately 3,000 subjects asked to participate in this project. I will personally respond to each of your questions.

There are no foreseeable risks to you due to your participation. Participation is voluntary and you may choose not to participate if so desired. The results of this study may be published in professional journals. It may also be used for educational purposes or for professional presentations. However, no individual subject will be identified.

Any questions regarding your rights as a research subject may be addressed to the University of Houston Committee for the Protections of Human Subjects (713-743-9204).

Many Thanks,
Joshua Strakos
Ph.D. Candidate
Department of Decision & Information Sciences
University of Houston

Faculty Supervisor: Dr. Robert Bregman

Please answer the following questions about **Improvisation**

Think of a time when your organization was involved in a recent disaster relief operation. This could be any response or relief effort following a disaster event like a tornado, hurricane, earthquake, terrorist attack, or other natural or man-made disaster. Please answer the following questions based on your organization's actions within this relief or response operation.

Write 0%-100% in the space to the right of each question.

	%
1) How much of your organization's relief activity would be labeled as improvised versus according to plan?	
2) During the period your organization was involved in the disaster relief, what percentage of your plans had to either be modified or completely redone?	
3) How much of your organization's relief activity would you say was based on new original plans developed as they were being implemented?	

PLEASE CIRCLE A NUMBER FOR ALL REMAINING QUESTIONS

4) During this relief operation, my organization as a whole:

	Strongly Disagree -3						Strongly Agree +3
a. Dealt with unanticipated events on the spot.	-3	-2	-1	0	+1	+2	+3
b. Devised process steps on the fly when carrying out actions/activities.	-3	-2	-1	0	+1	+2	+3
c. Responded in the moment to unexpected problems.	-3	-2	-1	0	+1	+2	+3
d. Tried new approaches to problems.	-3	-2	-1	0	+1	+2	+3
e. Identified opportunities for new work processes.	-3	-2	-1	0	+1	+2	+3
f. Took risks in terms of producing new ideas in doing the job well.	-3	-2	-1	0	+1	+2	+3
g. Demonstrated originality in work.	-3	-2	-1	0	+1	+2	+3

Please answer the following questions about **Performance**

Think of a time when your organization was involved in a recent disaster relief operation. This could be any response or relief effort following a disaster event like a tornado, hurricane, earthquake, terrorist attack, or other natural or man-made disaster. Please answer the following questions based on your organization's actions within this relief or response operation.

	Inferior -3						Outstanding +3
5) How would you rate your organization's performance on your recent relief activity?	-3	-2	-1	0	+1	+2	+3

	Strongly Disagree -3						Strongly Agree +3
6) My organization performed extremely well during the relief effort.	-3	-2	-1	0	+1	+2	+3

7-11) I would rate my organization's performance on our recent relief effort as:

Poor	-3	-2	-1	0	1	2	3	Well
Low Performing	-3	-2	-1	0	1	2	3	High Performing
Bad	-3	-2	-1	0	1	2	3	Good
Complete Failure	-3	-2	-1	0	1	2	3	Complete Success
Inferior	-3	-2	-1	0	1	2	3	Outstanding

Please answer the following questions about the **SPEED** of your organization's actions

	Inferior -3						Outstanding +3
12) I would rate my organization's speed in delivering aid during our recent relief effort as	-3	-2	-1	0	+1	+2	+3

	Strongly Disagree -3						Strongly Agree +3
13) My organization performed very well in quickly delivering aid during our recent relief effort.	-3	-2	-1	0	+1	+2	+3
14) The timeliness of my organization's aid delivery was outstanding.	-3	-2	-1	0	+1	+2	+3

15) Please rate the level of your organization's performance in the following areas:

	Inferior -3						Outstanding +3
a. Speed of getting an item from donor to recipient	-3	-2	-1	0	+1	+2	+3
b. Speed of getting an item from supplier to recipient	-3	-2	-1	0	+1	+2	+3
c. Quickness of delivering supplies after realizing need	-3	-2	-1	0	+1	+2	+3
d. Making on-time deliveries	-3	-2	-1	0	+1	+2	+3

Please answer the following questions about the **FLEXIBILITY** of your organization's actions

	Inferior -3						Outstanding +3
16) I would rate my organization's flexibility in delivering aid during our recent relief effort as:	-3	-2	-1	0	+1	+2	+3

	Strongly Disagree -3						Strongly Agree +3
17) My organization's flexibility during the relief effort was outstanding.	-3	-2	-1	0	+1	+2	+3
18) Our ability to respond to changing needs in aid delivery was outstanding.	-3	-2	-1	0	+1	+2	+3
19) We were able to effectively adjust our delivery of products according to the changing requirements of the operation.	-3	-2	-1	0	+1	+2	+3

20) Please rate the level of your organization's performance in the following areas:

	Inferior -3						Outstanding +3
a. Volume flexibility - the relief chain's ability to change the output level of products supplied.	-3	-2	-1	0	+1	+2	+3
b. Delivery flexibility - the ability to change planned delivery dates.	-3	-2	-1	0	+1	+2	+3
c. Mix flexibility - the relief chain's ability to change the variety of products supplied.	-3	-2	-1	0	+1	+2	+3
d. New product flexibility - the ability to introduce and supply new products.	-3	-2	-1	0	+1	+2	+3

Please answer the following questions about the **ASSESSMENT QUALITY** of your organization's actions**. ASSESSMENT QUALITY** is the accuracy of the organization's initial assessment of what resources will be needed throughout the entire disaster relief effort.

	Inferior -3						Outstanding +3
21) I would rate my organization's assessment quality during our recent relief effort as:	-3	-2	-1	0	+1	+2	+3

	Strongly Disagree -3						Strongly Agree +3
22) My organization's initial assessment of operational needs throughout the relief effort was very accurate.	-3	-2	-1	0	+1	+2	+3
23) We were able to estimate early on which resources were going to be needed throughout the operation.	-3	-2	-1	0	+1	+2	+3

24) Please rate your level of agreement with the following statements:

	Strongly Disagree -3						Strongly Agree +3
a. The original operations budget was very close to the revised operations budget.	-3	-2	-1	0	+1	+2	+3
b. The difference in total inventory cost and usable inventory cost was small.	-3	-2	-1	0	+1	+2	+3
c. Supplies were immediately available when needed for the relief effort.	-3	-2	-1	0	+1	+2	+3

Please answer the following questions about the **COST PERFORMANCE** of your organization's actions**.**

	Inferior -3						Outstanding +3
25) I would rate my organization's cost performance in delivering aid during our recent relief effort as:	-3	-2	-1	0	+1	+2	+3

	Strongly Disagree -3						Strongly Agree +3
26) My organization effectively controlled cost during our recent relief effort.	-3	-2	-1	0	+1	+2	+3
27) The cost of our relief effort met or exceeded our performance standards.	-3	-2	-1	0	+1	+2	+3

28) Please rate your level of agreement with the following statements:

	Strongly Disagree -3						Strongly Agree +3
a. The total cost of transportation was low when compared to the total cost of relief items.	-3	-2	-1	0	+1	+2	+3
b. We performed well in controlling the total cost of holding inventory.	-3	-2	-1	0	+1	+2	+3
c. We performed well in employing fewer relief workers per aid recipient.	-3	-2	-1	0	+1	+2	+3
d. We performed well in controlling the cost of transportation and handling of items from the donor or supplier to the recipient.	-3	-2	-1	0	+1	+2	+3

Please answer the following questions about **Planning**

Think of the time your organization spends developing plans, personnel, systems, and infrastructure between disaster response operations. Please answer the following questions based on your organization's actions within this time of planning and preparation.

The following questions relate to your level of **strategic focus** prior to disaster relief operations.

	Not at all 0						To a great extent 6
29) My organization focuses on strategic planning before a disaster event:	0	1	2	3	4	5	6

	Strongly Disagree -3						Strongly Agree +3
30) My organization spends a great deal of time focusing on long-term decisions which affect the entire supply chain.	-3	-2	-1	0	+1	+2	+3
31) Our organization puts a great deal of effort into planning the structure, size, and design of our supply chain.	-3	-2	-1	0	+1	+2	+3
32) Our organization is strategically focused on developing the supply chain in terms of its size, design, and structure.	-3	-2	-1	0	+1	+2	+3

The following questions relate to your level of **operational focus** prior to disaster relief operations.

	Not at all 0						To a great extent 6
33) My organization focuses on operational planning before a disaster event:	0	1	2	3	4	5	6

	Strongly Disagree -3						Strongly Agree +3
34) My organization focuses on planning activities such as transportation utilization, inventory pre-positioning, and transportation constraints.	-3	-2	-1	0	+1	+2	+3
35) The majority of our effort in operational planning is toward activities which affect only a portion of the supply chain.	-3	-2	-1	0	+1	+2	+3
36) Most of our operational planning focuses on operational elements which relate to specific tasks rather than all aspects of the supply chain.	-3	-2	-1	0	+1	+2	+3

The following questions relate to your level of **information focus** prior to disaster relief operations.

	Not at all 0						To a great extent 6
37) My organization focuses on continuous improvement:	0	1	2	3	4	5	6
38) My organization uses performance information from prior efforts to make changes and improvements in our disaster response plans:	0	1	2	3	4	5	6
39) We focus on collecting and sharing information which will help improve future relief efforts:	0	1	2	3	4	5	6

The following questions relate to your level of **technology utilization** prior to disaster relief operations.

	Not at all 0						To a great extent 6
40) My organization uses technology to track and share information across the organization.	0	1	2	3	4	5	6
41) My organization uses information systems to track data and make it available to all employees.	0	1	2	3	4	5	6
42) Everyone in my organization has access to data and information needed for planning and coordinating through the use of a common system.	0	1	2	3	4	5	6

Please answer the following questions about **Improvisational Capabilities**.

The following questions relate to the **CREATIVE CAPABILITY** of the people in your organization. **Creative Capability** is defined as having the necessary knowledge and experience to effectively devise new solutions to problems.

	Strongly Disagree -3						Strongly Agree +3
43) My organization's people have the ability to devise new effective solutions to unplanned problems during a disaster response.	-3	-2	-1	0	+1	+2	+3
44) People in my organization have the capabilities necessary to come up with good new plans when faced with a surprise during a disaster response.	-3	-2	-1	0	+1	+2	+3
45) People in my organization have the skills necessary to come up with good new plans when faced with a surprise during a disaster response.	-3	-2	-1	0	+1	+2	+3
46) People in my organization have the knowledge it takes to successfully react to surprises during a disaster response.	-3	-2	-1	0	+1	+2	+3

The following questions relate to the **EMPOWERMENT** of the people in your organization. **Empowerment** is defined as having the authority to immediately implement or enact a solution, when provided.

	Strongly Disagree -3						Strongly Agree +3
47) People in my organization are able to immediately implement new solutions during a disaster response [in unplanned for situations].	-3	-2	-1	0	+1	+2	+3
48) My organization allows individuals to carry out new solutions when needed in unplanned for situations.	-3	-2	-1	0	+1	+2	+3
49) People in my organization are empowered to use new, unplanned solutions when called for.	-3	-2	-1	0	+1	+2	+3
50) People in my organization have the power to carry out unplanned courses of action when called for.	-3	-2	-1	0	+1	+2	+3

The following questions relate to the **TECHNOLOGY CAPABILITY** of the people in your organization. **Technology Capability** is defined as the adaptability, configurability, and deployability of the hardware used by an organization.

	Strongly Disagree -3						Strongly Agree +3
51) The technology used by my organization works well in a disaster response.	-3	-2	-1	0	+1	+2	+3
52) My organization's information systems are useful when deployed in a disaster response.	-3	-2	-1	0	+1	+2	+3
53) The communications technology employed by my organization facilitates coordination in the field during a disaster response.	-3	-2	-1	0	+1	+2	+3
54) The communications technology used by my organization adapts well to the needs of field responders.	-3	-2	-1	0	+1	+2	+3

General Information

The following questions relate to the severity of the disaster you referenced when answering the previous survey questions. Please rate the severity of the disaster you referenced from "very low" to "very high", with a severity of "very high" being equal or greater in severity to Hurricane Katrina or a similar disaster.

	Very Low -3						Very High +3
55) The severity of the disaster I referenced was:	-3	-2	-1	0	+1	+2	+3

56) For each category below, please rate the severity of the disaster you referenced in terms of:

	Very Low -3						Very High +3
a. Number of people killed	-3	-2	-1	0	+1	+2	+3
b. Number of people injured	-3	-2	-1	0	+1	+2	+3
c. Number of people left homeless	-3	-2	-1	0	+1	+2	+3
d. Overall number of people affected	-3	-2	-1	0	+1	+2	+3
e. Estimated damage in $$	-3	-2	-1	0	+1	+2	+3
f. Number of organizations involved in relief	-3	-2	-1	0	+1	+2	+3
g. Length of the recovery period	-3	-2	-1	0	+1	+2	+3

	Strongly Disagree -3						Strongly Agree +3
57) Once again, the severity of the disaster I referenced was as great or greater than that of Hurricane Katrina or a similar disaster.	-3	-2	-1	0	+1	+2	+3

58) My organization type is:

Commercial business	Not-for-profit / humanitarian	Government (federal, state, local, or other)	Academic

59) The number of people in my organization is:

1-10	11-100	101-300	301-500	501-1000	1000-5000	5001 +

60) My position in the organization can be best described as:

Manager	Logistics Officer	Administrative / Support professional	Academic
Director / Deputy Director	"In the field" professional	N/A - Unemployed/Retired/Homemaker	Other

61) My gender is:	Male	Female

62) My age is:	Under 18	18-24	25-34	35-54	55+

63) The number of years and months I have worked with this organization:

Years: _____ Months: _____

64) The number of years (to the nearest year) my organization has been involved in disaster relief:

Years: _____

The following questions may seem out of place. They will be used to reduce statistical bias in the analysis of the disaster relief data collected.

	Strongly Disagree -3						Strongly Agree +3
65) Music is important in my life.	-3	-2	-1	0	+1	+2	+3
66) Air Travel is a better mode of transportation than by car.	-3	-2	-1	0	+1	+2	+3
67) I find rugby interesting.	-3	-2	-1	0	+1	+2	+3
68) University education is a good value.	-3	-2	-1	0	+1	+2	+3
69) People should shop at locally owned stores.	-3	-2	-1	0	+1	+2	+3

Thank You!

Thank you for taking our survey. Your response is very important to us.

For questions about this survey contact:
Joshua K. Strakos
Disaster.survey@gmail.com

By completing this survey, you will help in the research on how to make disaster responses more effective through both planning and reacting to unplanned situations.

This study is one of the requirements for my completion of a Ph.D. in Supply Chain Management at the University of Houston. I am an active-duty Air Force Logistics Officer with 17 years of time in service. After completion of this degree, I will transfer to Wright-Patterson AFB, Ohio, where I will be an instructor at the Air Force Institute of Technology.

Once again, thank you for your support.

Sincerely,

Appendix 2 – Survey Item Codebook

Improvisation

Item	Statement	Mean	S.D.
IM1	How much of your organization's relief activity would be labeled as improvised versus according to plan? (%)	41.61	24.89
IM2	During the period your organization was involved in the disaster relief, what percentage of your plans had to either be modified or completely redone? (%)	41.18	26.77
IM3	How much of your organization's relief activity would you say was based on new original plans developed as they were being implemented? (%)	41.92	28.44

Spontaneity

Item	Statement	Mean	S.D.
	Seed: During this relief operation, my organization as a whole:		
SP4A	Dealt with unanticipated events on the spot.	1.79	1.27
SP4B	Devised process steps on the fly when carrying out actions/activities.	1.03	1.62
SP4C	Responded in the moment to unexpected problems.	1.78	1.36

Creativity

Item	Statement	Mean	S.D.
	Seed: During this relief operation, my organization as a whole:		
CR4D	Tried new approaches to problems.	1.40	1.30
CR4E	Identified opportunities for new work processes.	1.66	1.22
CR4F	Took risks in terms of producing new ideas in doing the job well.	1.10	1.48
CR4G	Demonstrated originality in work.	1.40	1.27

Performance

Item	Statement	Mean	S.D.
P5	How would you rate your organization's performance on your recent relief activity?	1.54	1.15
P6	My organization performed extremely well during the relief effort.	1.53	1.23
	Seed: I would rate my organization's performance on our recent relief effort as:		
P7	Poor, Well	1.73	1.14
P8	Low Performing, High Performing	1.70	1.14
P9	Bad, Good	1.76	1.19
P10	Complete Failure, Complete success	1.54	1.07
P11	Inferior, Outstanding	1.56	1.17

Speed

Item	Statement	Mean	S.D.
S12	I would rate my organization's speed in delivering aid during our recent relief effort as	1.45	1.22
S13	My organization performed very well in quickly delivering aid during our recent relief effort.	1.51	1.22
S14	The timeliness of my organization's aid delivery was outstanding.	1.39	1.26
	Seed: Please rate the level of your organization's performance in the following areas:		
S15A	Speed of getting an item from donor to recipient	1.06	1.17
S15B	Speed of getting an item from supplier to recipient	1.14	1.21
S15C	Quickness of delivering supplies after realizing need	1.29	1.15
S15D	Making on-time deliveries	1.25	1.23

Flexibility

Item	Statement	Mean	S.D.
F16	I would rate my organization's flexibility in delivering aid during our recent relief effort as:	1.48	1.16
F17	My organization's flexibility during the relief effort was outstanding.	1.42	1.29
F18	Our ability to respond to changing needs in aid delivery was outstanding.	1.44	1.26
F19	We were able to effectively adjust our delivery of products according to the changing requirements of the operation.	1.39	1.29
	Seed: Please rate the level of your organization's performance in the following areas:		
F20A	Volume flexibility - the relief chain's ability to change the output level of products supplied.	1.11	1.22
F20B	Delivery flexibility - the ability to change planned delivery dates.	1.12	1.22
F20C	Mix flexibility - the relief chain's ability to change the variety of products supplied.	0.98	1.18
F20D	New product flexibility - the ability to introduce and supply new products.	0.85	1.20

Assessment Quality

Item	Statement	Mean	S.D.
AQ21	I would rate my organization's assessment quality during our recent relief effort as:	1.42	1.13
AQ22	My organization's initial assessment of operational needs throughout the relief effort was very accurate.	1.15	1.30
AQ23	We were able to estimate early on which resources were going to be needed throughout the operation.	1.21	1.33
	Seed: Please rate your level of agreement with the following statements:		
AQ24A	The original operations budget was very close to the revised operations budget.	0.25	1.43
AQ24B	The difference in total inventory cost and usable inventory cost was small.	0.40	1.34
AQ24C	Supplies were immediately available when needed for the relief effort.	0.62	1.41

Cost

Item	Statement	Mean	S.D.
C25	I would rate my organization's cost performance in delivering aid during our recent relief effort as:	0.92	1.17
C26	My organization effectively controlled cost during our recent relief effort.	0.87	1.29
C27	The cost of our relief effort met or exceeded our performance standards.	0.84	1.30
	Seed: Please rate your level of agreement with the following statements:		
C28A	The total cost of transportation was low when compared to the total cost of relief items.	0.61	1.53
C28B	We performed well in controlling the total cost of holding inventory.	0.74	1.23
C28C	We performed well in employing fewer relief workers per aid recipient.	0.69	1.31
C28D	We performed well in controlling the cost of transportation and handling of items from the donor or supplier to the recipient.	0.72	1.26

Strategic Focus

Item	Statement	Mean	S.D.
SF29	My organization focuses on strategic planning before a disaster event:	4.26*	1.54
SF30	My organization spends a great deal of time focusing on long-term decisions which affect the entire supply chain.	1.11	1.40
SF31	Our organization puts a great deal of effort into planning the structure, size, and design of our supply chain.	1.13	1.39
SF32	Our organization is strategically focused on developing the supply chain in terms of its size, design, and structure.	1.08	1.36

Operational Focus			
Item	**Statement**	**Mean**	**S.D.**
OF34	My organization focuses on operational planning before a disaster event:	4.47*	1.49
OF35	My organization focuses on planning activities such as transportation utilization, inventory pre-positioning, and transportation constraints.	1.29	1.38
OF36	The majority of our effort in operational planning is toward activities which affect only a portion of the supply chain.	0.52	1.60
OF37	Most of our operational planning focuses on operational elements which relate to specific tasks rather than all aspects of the supply chain.	0.92	1.55

Information Focus			
Item	**Statement**	**Mean**	**S.D.**
IF39	My organization focuses on continuous improvement:	4.63*	1.26
IF40	My organization uses performance information from prior efforts to make changes and improvements in our disaster response plans:	4.54*	1.38
IF41	We focus on collecting and sharing information which will help improve future relief efforts:	4.50*	1.37

Technology Utilization			
Item	**Statement**	**Mean**	**S.D.**
TU43	My organization uses technology to track and share information across the organization.	4.19*	1.58
TU44	My organization uses information systems to track data and make it available to all employees.	4.01*	2.99
TU45	Everyone in my organization has access to data and information needed for planning and coordinating through the use of a common system.	3.65*	1.70

Creative Capability			
Item	**Statement**	**Mean**	**S.D.**
CC47	My organization's people have the ability to devise new effective solutions to unplanned problems during a disaster response.	1.64	1.18
CC48	People in my organization have the capabilities necessary to come up with good new plans when faced with a surprise during a disaster response.	1.78	1.13
CC49	People in my organization have the skills necessary to come up with good new plans when faced with a surprise during a disaster response.	1.81	1.12
CC50	People in my organization have the knowledge it takes to successfully react to surprises during a disaster response.	1.81	1.10

Empowerment

Item	Statement	Mean	S.D.
E51	People in my organization are able to immediately implement new solutions during a disaster response [in unplanned for situations].	1.40	1.33
E52	My organization allows individuals to carry out new solutions when needed in unplanned for situations.	1.36	1.35
E53	People in my organization are empowered to use new, unplanned solutions when called for.	1.21	1.44
E54	People in my organization have the power to carry out unplanned courses of action when called for.	1.21	1.46

Technology Capability			
Item	**Statement**	**Mean**	**S.D.**
TC55	The technology used by my organization works well in a disaster response.	1.13	1.39
TC56	My organization's information systems are useful when deployed in a disaster response.	1.08	1.45
TC57	The communications technology employed by my organization facilitates coordination in the field during a disaster response.	1.03	1.50
TC58	The communications technology used by my organization adapts well to the needs of field responders.	0.96	1.52

Severity

Item	Statement	Mean	S.D.
SEV59	The severity of the disaster I referenced was:	2.43	1.88
SEV61	Once again, the severity of the disaster I referenced was as great or greater than that of Hurricane Katrina or a similar disaster.	-0.65	2.18
	Seed: For each category below, please rate the severity of the disaster you referenced in terms of:		
SEV60A	Number of people killed	0.42	2.13
SEV60B	Number of people injured	0.82	2.09
SEV60C	Number of people left homeless	1.70	2.24
SEV60D	Overall number of people affected	2.44	2.02
SEV60E	Estimated damage in $$	2.56	2.01
SEV60F	Number of organizations involved in relief	2.64	1.90
SEV60G	Length of the recovery period	2.42	2.03

Demographics

Item	Statement	Mean	S.D.
TYPE	My organization type is:	-	-
SIZE	The number of people in my organization is:	-	-
POSITION	My position in the organization can be best described as:	-	-
GENDER	My gender is:	-	-
AGE BUCKET	My age is:	-	-
SENORITY	The number of years and **months** I have worked with this organization:	116.4	102.9
ORGAGE	The number of years (to the nearest year) my organization has been involved in disaster relief:	32.00	41.07

Measured Latent Marker Variables

Item	Statement	Mean	S.D.
LM1	Music is important in my life.	1.47	1.48
LM2	Air Travel is a better mode of transportation than by car.	1.01	1.60
LM3	I find rugby interesting.	-0.75	1.80
LM4	University education is a good value.	1.91	1.34
LM5	People should shop at locally owned stores.	1.78	1.21

***** scale of 0-6; all other items scale of -3 to +3, except where noted in question text

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