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Integrated business continuity and disaster recovery planning: Towards organizational resilience

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ABSTRACT

Businesses are increasingly subject to disruptions. It is almost impossible to predict their nature, time and extent. Therefore, organizations need a proactive approach equipped with a decision support framework to protect themselves against the outcomes of disruptive events. In this paper, a novel framework is proposed for integrated business continuity and disaster recovery planning for efficient and effective resuming and recovering of critical operations after being disrupted. The proposed model addresses decision problems at all strategic, tactical and operational levels. At the strategic level, the context of the organization is first explored and the main features of the organizational resilience are recognized. Then, a new multi-objective mixed integer linear programming model is formulated to allocate internal and external resources to both resuming and recovery plans simultaneously. The model aims to control the loss of resilience by maximizing recovery point and minimizing recovery time objectives. Finally, at the operational level, hypothetical disruptive events are examined to evaluate the applicability of the plans. We also develop a novel interactive augmented ε-constraint method to find the final preferred compromise solution. The proposed model and solution method are finally validated through a real case study.

1. Introduction

Organizations are increasingly facing with various types of disruptions that could take place individually or simultaneously. Each disruption might have different effects on organizational resources. Traditionally, Business Continuity Planning (BCP) and Disaster Recovery Planning (DRP) as the main contingency plans are carried out separately in different time horizons within organizations (Wunnava, 2011). BCP aims to develop appropriate plans at pre-disaster in order to resume key business operations to a minimum acceptable predefined level (i.e., Minimum Business Continuity Objective (MBCO)) immediately after a disruptive event within the so-called Maximum Tolerable Period of Disruption (MTPD) through invoking appropriate BC plan(s). On the other hand, DRP strives to ensure the full recovery (restoration) of all disrupted operations to their normal business state at post-disaster (ISO:22310, 2012). The concept of *organizational resilience* is attracting growing attention among academicians and practitioners. In short, it enquires organizations to develop effective plans for both short-term resuming (i.e., BC plans) and long-term restoration (i.e., DR plans) of their disrupted operations following disruptive events (Riolli & Savicki, 2003). Being prepared for disruptive events requires proactive planning of internal and external resources of the organization so that it can cope with disasters effectively and efficiently. However, lack of proactive BC and DR planning may lead to loss of reputation and market share, customer service and business process failure, regulatory liability and increased resuming and restoring times (Herbane, Elliott, & Swartz, 2004; Hiles, 2010; Losada, Scaparra, & O'Hanley, 2012). There might be several alternate BC and/or DR plans for the same disruptive event (for example hot sites versus cold sites) each of which has its own resource requirements and utilization rates. Nevertheless, by taking into account different limitations such as available budget and shared resources, such contingency plans should be implemented in an integrated manner. Without such integral planning, managers would not have known when and how to switch from continuity phase to recovery phase, while making a trade-off between continuity and recovery plans, and arranging resources after happening disruptive incidents. To the best of our knowledge, it is the first time in the literature that an integrated BC and DR planning model is proposed.

In this paper, a novel Integrated Business Continuity and Disaster Recovery Planning (IBCDRP) framework is developed. Subsequently, an interactive Multi-Objective Mixed Integer Linear Programming (MOMILP) model is formulated to find efficient

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(i.e., Pareto-optimal) resource allocation patterns among candidate BC and DR plans while considering the main features of the organizational resilience. To solve the proposed model, a novel Interactive AUGmented ε-CONstraint method (named IAUGCON) is developed. Finally, the proposed IBCDRP model is validated through application to a real case study in a manufacturing company. The main contributions of this paper can be outlined as follows:

- Proposing a new conceptual framework for IBCDRP.
- Formulating a novel MOMILP model to address the resource allocation problem within the IBCDRP framework while accounting for the main features of the organizational resilience.
- Developing a novel interactive augmented ε-constraint method to find compromise solutions.
- Validating the proposed model and solution technique through application in a real case study.

2. Literature review

The literature of disaster management dates back to the 1980s. It is intertwined in a multi-disciplinary research area bringing together academics and practitioners from several disciplines such as public administration and organizational crisis management. Unfortunately, DRP for businesses still lacks a methodological direction (Altay & Green, 2006). For years, many organizations have ignored the significance of disaster management and continuity planning (Herbane, 2010). Based on reports, 43 percent of companies influenced by severe disasters never reopened, and about 30 percent of them failed within 2 years (Cerullo & Cerullo, 2004). Such statistics emphasize the need for proactive approach by organizations equipped with a decision support framework to effectively protect their processes against disruptions and reduce their negative impacts.

According to the disaster management's life-cycle, two main phases are commonly distinguished as *pre-disaster phase* and *post-disaster phase* (Tufekci & Wallace, 1998). In pre-disaster phase, emergency managers have moved their focus beyond the immediate response and short-term recovery and are now re-focusing their efforts more on the continuity of organizations. In this phase, professionals are placing greater emphasis on the resilience of organizations (Labadie, 2008). Organizational resilience is concerned with the development of suitable BC plans to resume disrupted Critical Operations (COs) of an organization to their minimum acceptable operating levels as quickly and efficiently as possible and DR plans to restore all disrupted operations to their normal operating levels following any disruptive event (Losada et al., 2012). Many scholars argue that recovery is not only a process with short term resumption, but also long-term restoration to get back to initial state of disrupted processes/operations (Olshansky & Chang, 2009). In this manner, we propose a novel IBCDRP model that involves introducing a management process dedicated to selection and implementation of the most appropriate business continuity (i.e., resuming) and recovery (i.e., restoring) plans.

There is a limited literature on developing decision models for business continuity and recovery planning. These include some research works such as recovery of computer networks (Ambs et al., 2000), and selection of disaster recovery alternatives for organizational crisis management (Bryson, Millar, Joseph, & Mobolurin, 2002). Despite of little work on developing integrated BCP/DRP models for organizational crisis management, many researchers have addressed immediate response and recovery planning for society/urban areas mostly in response to natural disasters in the context of Humanitarian Logistics (HL) and Disaster Operations Management (DOM) (Das & Hanaoka, 2014; Edrissi, Poorzahedy, Nassiri, & Nourinejad, 2013; Eiselt & Marianov, 2012; Preece, Shaw, & Hayashi, 2013; Wex, Schryen, Feuerriegel, & Neumann, 2014). For more details on HL models and DOM from the Operational Research/Management Science (OR/MS) point of view, the interested readers may refer to Altay and Green (2006) and Galindo and Batta (2013).

While the field of integrated BC and DR planning has attracted the interests of information technology scholars for a number of years, OR/MS research in this area is so limited. Albores and Shaw (2008) argued that OR/MS research plays an essential role in the improvement of decision models for emergency activities in post-disaster phase. Furthermore, as indicated by Altay and Green (2006), just 6.4 percent of surveyed papers were related to OR/MS outlets in recovery phase. Recently, Galindo and Batta (2013) emphasized that there has been no extreme growth for application of OR/MS methodologies/tools in the field of DOM since the review of Altay and Green (2006).

Based on above discussion, we were able to conclude that the main focus of researchers has ever been on developing the general features of an integrated BC and DR planning framework rather than devising decision support models. Decision making about how to resume and restore critical operations of an organization at post-disaster phase is inherently complex. Organizations may lose some of their resources partially or completely after disruptive events (Jackson, 1997). Consequently, there will be a natural discrepancy between plans and real situations most of the times. An effective integrated BC and DR planning framework should rely on a systematic assessment of all features of each possible incident. Furthermore, such planning decisions are usually restricted by limited and changeable resources, organizational complexities, and the need to search effective plans for resumption and restoration of organizational critical operations (Snediker, Murray, & Matisziw, 2008).

To alleviate the complexity and difficulty of DOM, Bryson et al. (2002) presented a mathematical model by using of formal OR/MS techniques. They believed that the proposed model could guarantee effectiveness of the selected plans when put into operation. However, their model did not account for the continuity of the organization's operations at early post-disaster phase. Losada et al. (2012) presented a bi-level mixed integer linear program for protecting an incapacitated median type facility by considering system resilience. However, they focused on the problem of reducing the impact of component failures on service and supply systems. According to Altay and Green (2006), ensuring the continuity of critical operations at pre-defined levels in post-disaster is a critical issue for any organization. More recently, as a continuation of earlier review of DOM by Altay and Green (2006), Galindo and Batta (2013) reviewed recent OR/MS research in DOM and concluded that most of the research gaps highlighted by Altay and Green (2006) have been remained without any drastic changes. Following the research directions and gaps identified by Bryson et al. (2002), Altay and Green (2006) and Galindo and Batta (2013), we address a comprehensive resource allocation problem faced by organizations who try to protect themselves against various business disruptions through integrating the BC and DR plans into an novel IBCDRP framework.

3. The proposed IBCDRP framework

We first present the theoretical foundation of the proposed IBCDRP framework from different perspectives and then go through the developed IBCDRP model addressing the resource allocation problem when selecting the best portfolio of BC and DR plans simultaneously.

3.1. Theoretical foundation

The conceptual framework of our IBCDRP model is illustrated in Fig. 1 which is based upon the concept of operational resilience. Fig. 1a shows an organization equipped with an IBCDRP model and Fig. 1b depicts an organization with a stand-alone DRP model. When a disruptive event strikes at time t_1, it may lead to disruption of some critical operations. Consequently, the current operating level