Are Lean Organizations Better Prepared for Disaster?

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ABSTRACT

9/11 was arguably the most horrifying terrorist attack ever carried out on U.S. soil. While the event was by no means a natural disaster, 9/11 qualifies as a disaster under Fritz (1961) and Kreps (1995) definitions. The magnitude of 9/11 terrorist attack was further amplified by the large number of civilian fatalities (2,973). The economic fallout from this disaster, however, is not limited to the zones of impact surrounding New York and Washington, D. C. Indeed, businesses throughout the U.S. are faced with economic challenges never before considered. Natural disasters, such as Hurricane Katrina, also have staggering consequences on organizations such as state and local governments and first responding firms. This study addresses questions about organization's abilities to deal with disasters with the overarching premise that principles associated with a lean enterprise will result in an organization that is better prepared to respond to disasters. This article suggests that core lean principles, identified as antecedents to a lean enterprise, create lean organizations. The study then theoretically addresses how lean principles can mitigate corporate disasters and better prepare organizations, particularly first responding organizations, for 9/11-type and other types of disasters.

INTRODUCTION

The terrorist attack of 9/11 was arguably the most horrifying terrorist event carried out on U.S. soil. On September 11, 2001, Al Qaeda terrorists hijacked four commercial aircraft bound for California from Logan International, Dulles International, and Newark airports and flew three of the four aircraft into both buildings at the World Trade Center (WTC) in New York and into the Pentagon in Washington DC. The fourth aircraft, thought to be headed for the United States' Capital Building, crashed into a field near Shanksville, Pennsylvania after passengers attempted to regain control of the airplane. There were 2,973 fatalities (not including the 19 hijackers) directly related to the hijackings and crashes, 246 of whom were passengers and crew members on the aircraft (CNN, 2001). The attacks of 9/11 created widespread confusion throughout the United States. All international air traffic was banned from landing in the United States for three days, and all aircraft already in domestic airspace was immediately grounded. Erroneous news reports about additional hijackings, car bombs, and fires were reported throughout the days following the attacks, and nearly all local law enforcement agencies went on high alert.

While the event was not a natural disaster, 9/11 qualifies as a disaster under Fritz's (1961) definition: "An *event* concentrated in time and space, in which society or one of its subdivisions undergoes physical harm and social disruption, such that all or some essential functions of the society or subdivision are impaired" (*cf* Kreps, 1995: 257). Kreps suggests that the boundaries of disaster research are broad and include any environmental, technological, or sociopolitical crisis that can be designated in social time. He expands Fritz's definition defining disaster as "non routine events in societies or their larger subsystems (e.g., regions, communities) that involve social disruption *and* physical harm" and identifies the key defining properties of such events as (1) length of forewarning, (2) magnitude of impact, (3) scope of impact, and (4) duration of impact (Kreps, 1995: 258). More recent disasters are situated in contexts of "socially produced vulnerability" versus strictly environmental forces (Oliver-Smith, 1998: 186). Man-made disasters, such as the terrorist attacks of 9/11, fall within these definitional purviews.

Terrorist attacks are not the only events that tax first responding agencies and other types of organization's economic and human resources. Natural and other man-made disasters can have staggering economic consequences on organizations and communities. The New Orleans Police Department continues to struggle with attrition rates as officers seek higher paying jobs in other cities in the wake of Hurricane Katrina. The pre-Katrina officer count peaked at 1,741 officers in New Orleans in 2005, but the city has since lost 482 officers and is now appealing to the federal government to help fight crime (Law Enforcement News, 2007). Indeed, the New Orleans police department, the City of New Orleans, and the State of Louisiana were unprepared for such a catastrophic event.

Other events are smaller-scale disasters which directly affect the focal organization and indirectly affect various communities. NASA's Hubble problems are eerily reminiscent of the Challenger, and more recently the Columbia, disasters where billions of dollars of equipment and, more importantly, the lives of the astronauts were tragically lost. These events highlight how organizations, when faced with many opportunities for things to go right, create an environment for things to go routinely – even predictably – wrong (Stein and Kanter, 1993). The question of whether critical flaws in the organizational structure of NASA were responsible for the replication of such disasters is of paramount importance. Similar questions have been asked of various U.S. Government agencies in the wake of the 9/11 attacks and departmental intelligence failures which led to the invasion of, and subsequent war with, Iraq and of the breakdown in communication between federal, state, and local government agencies in the wake of Hurricane Katrina. In each of these cases, lack of interdepartmental communication is identified as a critical factor leading to systemic failures affecting top decision makers. Specifically, lack of access to accurate, relevant, and timely information was a root problem associated with each of these events.

The central questions addressed in this paper focus on whether organizations are prepared to respond to a 9/11 or other type of disaster and whether a "lean" organization would be better prepared to contend with, or mitigate, such events. Specifically, do lean principles directly affect organizational functioning and/or viability in the face of disaster? Such questions have important implications in light of 9/11, the Challenger and Columbia space shuttle events, and other disasters such as Hurricane Katrina. This study addresses such questions with the overarching premise that principles associated with a lean enterprise will result in an organization that is better prepared to respond to disasters. As such, this article identifies critical lean principles which are elemental to creating a lean enterprise. The following sections define lean production and the lean enterprise. Based upon existing lean literature, antecedents to a lean system are identified and discussed. The study then theoretically addresses how lean principles can mitigate disasters and better prepare organizations for 9/11-type and other types of disasters. Finally, conclusions and suggestions for future research are posited.

DEFINING LEAN

In this section lean production is contrasted with two other production methods – craft production and mass production. The craft producer offers the customer exactly what he/she wants by manufacturing one item at a time to precise customer specifications using highly skilled labor and simple, flexible tools. The primary drawback to a craft production is the cost associated with this highly labor and time intensive method of production. Mass production, designed at the turn of the 20th century, overcomes the expense and time involved in custom, craft-based manufacturing and entails the use of limited- or semi-skilled workers who perform narrow jobs tending expensive, single-purpose machines. To avoid costly disruption and ensure smooth production, the mass-producer buffers the system with inventories, workers, and excess capacity. Workers are relegated to highly repetitive, boring work often resulting in dispirited work efforts. High volume, long production runs, and standardization characterize the mass production system in which the customer is offered low costs at the expense of product variety.

The term "lean", coined by John Drafcik, refers to using less of everything during production – less labor, less manufacturing space, less equipment, less inventory, and less engineering inputs during development and processing – all of which results in fewer defects and more variety. Lean production systems take advantage of the best of both craft and mass production while avoiding high costs and rigidity associated with each. They do so by using multi-skilled work teams and highly flexible, increasingly automated machines. The result is the ability to produce a large variety of products in increasing volumes (Womac, Jones, & Roos, 1990). Some authors contend that lean manufacturing is an outgrowth of other manufacturing processes which precede lean and contend that lean manufacturing's roots can be traced back to Japan and their use of just-in-time production in the 1930's (Smeds, 1994). Other researchers suggest that lean manufacturing is not an extension of traditional thinking or techniques and that lean is neither "an instant transition nor is it an extension of traditional thinking or techniques" but rather a "revolutionary thought process that requires abandonment of some old paradigms" (VerDuft, 1999: 375).

Lean manufacturing has been defined in a number of ways depending upon the researcher's goals and operationalization of the constructs involved. Lean has been defined as multifaceted best practices and processes which optimize resources to produce low cost, high quality products quickly and efficiently (Verduft, 1999); as a systematic approach to identifying and eliminating waste focusing on continuous improvement, pull production, pursuit of perfection, and elimination of waste (National Institute of Science and Technology (NIST) Manufacturing Extension Partnership (MEP)); as a set of initiatives focused on eliminating all waste in production processes (Rooney & Rooney, 2005); as a business system for organizing and managing operations that requires less human effort, space, capital, and time to make products with fewer defects (Chapman, 2005); as a mechanism in which complex production processes can be organized to encourage flow and reduce waste (Ben-Tovim, Bassham, Bolch, Martin, Dougherty, and Szwarcbord, 2007); and as a five-step process including defining customer value, defining the value stream, making it flow by pulling from the customer, and striving for excellence (Womack & Jones, 2003).

The purpose of this paper is to identify core lean principles and discuss how these principles affect an organization facing disaster. Lean is a philosophy requiring a sustained company-wide effort the outcomes of which are fast, flexible production systems, satisfied customers, better employees, better managers, high quality, and affordable costs achieved through cost reduction, quality improvement and faster delivery through the elimination of waste and employee empowerment (Abdulmalek, Rajgopal, & Needy, 2006).

Identification of core lean principles requires a comprehensive working definition of lean consistent with the research questions addressed. For the purpose of this paper, lean is defined as a “multi-dimensional approach that encompasses a wide variety of management practices, including just-in-time, quality systems, work teams, cellular manufacturing, supplier management, etc. in an integrated system” (Shaw and Ward, 2003: 129). The central tenet of lean production is the synergistic integration of these practices to create a system of production matching customer demand in both variety and quantity with little or no waste. As depicted in Figure 1 below, discrete, process, service, and other organizations can benefit from lean principles. As the theoretical model suggests, lean organizations are more likely to be better prepared for disaster.

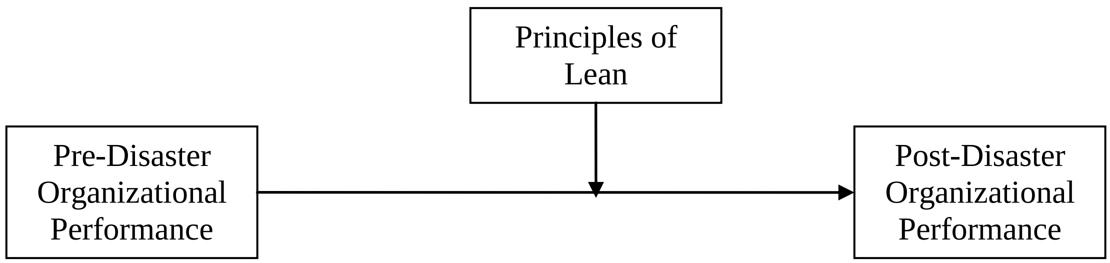

Figure 1: Critical Principles of Lean – Theoretical Model

METHODOLOGY & RESULTS

The research cited in this study encompasses all aspects of lean practices and principles. These stem from purely process practices for implementation of lean in manufacturing organizations (Abjulmalek, Raigopal, & Needy, 2006) to more philosophical principles (Ben-Tovim et al., 2007; VerDeft, 1999; Womack & Jones, 2003). A review of 12 established works of literature provides a basis from which agreement and consensus of lean principles can be analyzed (Abjulmalek, Rajgopal, & Needy, 2006; Ben-Tovim et al., 2007; Doolen & Hacker, 2005; Hayes & Wheelwright, 1984; Leitner, 2005; Liker, 2004; Pascal, 2002; Schonburger, 1982; Shah & Ward, 2003; Sugimori et al., 1977; VerDuft, 1999; Womack & Jones, 2003).

Based upon the literature, a total of 56 principles and practices were initially identified. Each of these was then evaluated to determine if there was consensus agreement, majority agreement, or lack of agreement among the authors as to whether the element was considered a lean principle/practice (White & Ruch, 1990). In keeping with practice established by White and Ruch, the principle/practice had to be discussed in detail by at least one author and at minimum referenced by another to be included in the analysis. If the technique was not discussed in detail, a clear theoretical trail stemming back to the original body of research had to be evident, or theoretical justification had to be evident for inclusion. Unique principles/practices were omitted leaving 26 elements for further analysis. Lack of agreement occurred when less than half of the authors agreed on an element. Majority agreement required that at least half of the authors discuss the element, and the principle or practice must be either discussed or directly implied by all 12 authors in order to achieve consensus agreement status.

As indicted in Table 1 below, only two of the lean principles/practices included in this study reached consensus status, although both continuous improvement and elimination of waste were implied by one author respectively who did not discuss it directly (Doolin & Hacker, 2005; Hayes & Wheelwright, 1984). Three of the principles/practices, however, achieved majority agreement status. There was a lack of consensus regarding the remaining 21 principles/practices. For the purpose of further discussion, majority agreement will serve as the threshold to determine whether an element is considered a critical lean principle. Majority agreement was reached on process (continuous) flow, pull systems, and JIT as core principles associated with lean firms. Each of these principles will be discussed in further detail below.

Insert Table 1 about here

Flow

Process flow, continuous flow, or simply "flow" describes how a product is produced or the service delivered in a lean organization. In the traditional sense, continuous flow occupies one specialized end of the production continuum (Hayes & Wheelwright, 1984). Examples of traditional continuous flow processes include chemical producers, oil refineries, and food processors such as flour mills. In lean terms, the ideal batch size is constant at one because one-piece continuous flow production does not attempt to optimize utilization of people and equipment in each respective department. Instead, lean thinking optimizes the flow of material to move quickly through the factory via work cells grouped by product rather than process. Benefits of creating a continuous flow include built-in quality, real flexibility, improved productivity, freed-up floor space, improved safety, improved morale, and reduced inventory costs (Liker, 2004). When problems are revealed, solved, and not repeated (because flow encourages stopping production and employing all employee innovation and knowledge to solve it) waste is minimized. Thus, quality, employee satisfaction, and customer satisfaction all improve (Abjulmalek, Rajgopal, & Needy, 2006; Ben-Tovim et al., 2007; Liker, 2004; Shah & Ward, 2003; Womack & Jones, 2003).

Pull

The result of shifting production processes from departments and batches to flow is a compression of time throughout the system (VerDuft, 1999). Products are conceived and launched more quickly. Sales are delivered more quickly. Indeed, time throughout the entire process from conception, to raw materials, to customer delivery falls dramatically as through-put time for production and order processing is reduced from months to just minutes or days. Shifting demand is easily and immediately accommodated because a true lean producer can manufacture products currently in production in multiple combinations. This enables the lean firm to allow the customer to pull the product from the firm as opposed to being pushed to purchase what has been produced. When pull is initiated, goods or services upstream are not produced until downstream customers request the item (Liker, 2004; Pascal, 2002; Sugimori et al., 1977; Shah & Ward, 2003; VerDuft, 1999; Womack & Jones, 2003).

JIT

JIT, distinctive of a pull system, was identified by the majority of researchers in this study as a core principle of lean production. Some researchers suggest that the pull system, including Kanban, is a critical antecedent to JIT (Liker, 2004; Pascal, 2002) while others consider the Kanban system a critical element of JIT (White & Ruch, 1990). White and Ruch (1990) suggest that the definition of JIT lies somewhere between the broadest view inclusive of nearly all practices in the industrial cycle and a very narrow perspective including only one or two techniques involved in specific inventory reduction or production control. While there is debate over the scope of JIT, there is some agreement that the elimination of waste and respect for people are central to the application of both the JIT and lean philosophies (Liker, 2004; Sigumori et al., 1977; White & Ruch, 1990). The simple philosophy that drives the JIT production management system revolves around two principles – "continual productivity and quality improvement in the pursuit of excellence in all phases of the industrial cycle" (White & Ruch, 1990: 9). White and Ruch identified ten JIT management techniques including focused factory, reduced setup times, group technology, Total Productive Maintenance (TPM), multi-function employees, uniform workloads, JIT purchasing, Kanban, Total Quality Control, and Quality Circles. Researchers have identified many of these practices as lean practices (Abjulmalek, Rajgopal, & Needy, 2006; Doolen & Hacker, 2005; Hayes & Wheelwright, 1984; Leitner, Liker, 20042005; Schonburger, 1982; Shah & Ward, 2003; Sugimori et al., 1977) lending support to the contention that lean is an outgrowth of JIT (Smeds, 1994).

Continuous Improvement

Continuous improvement achieved consensus among the researchers in this study through either direct or implied inclusion in their respective articles about lean (Abjulmalek, Rajgopal, & Needy, 2006; Ben-Tovim et al., 2007; Doolen & Hacker, 2005; Hayes & Wheelwright, 1984; Leitner, 2005; Liker, 2004; Pascal, 2002; Schonburger, 1982; Shah & Ward, 2003; Sugimori et al., 1977; VerDuft 1999; Womack & Jones 2003). Early lean research on the Toyota Production System (TPS) by Sugimori et al. (1977) suggests that workers at this firm are directly involved in improvements. In addition, the use of Jidoka (autonomation), where workers can actually stop the production line to solve problems, contests to management's confidence in, and reliance upon the workers ability to solve problems and continuously improve the production process.

Continuous improvement is not a tool, but a philosophy which must be embraced by the entire organization. Management must support both the continuous improvement effort and the people who engage in the effort on a daily basis. Employees must buy into the philosophy as they are critical to identifying areas for necessary improvements, suggesting what improvements should be made, and implementing necessary improvements. Continuous improvement is exactly as the name implies – improving constantly. Continuously solving root problems drives organizational learning which results in higher quality, lower costs, shorter lead times, improved safety, and better employee morale. Continuous improvement can occur in incremental or radical stages. While radical improvements can and do occur, often in the initial stages of lean implementation, incremental improvements over time are central to attaining and sustaining lean objectives.

Elimination of Waste

Elimination of waste is central to lean production and is an often referred to through discussions involving muda – the Japanese word for waste (Abjulmalet, Rajgopal, & Needy, 2006; Ben-Tovim et al., 2007; Chapman, 2005; Liker, 2004; Pascal, 2002; Rooney & Rooney, 2005 Shah & Ward, 2003).

While the North American auto manufacturers were investing ever more heavily in massive capital equipment after WWII, Toyota's post-war market in Japan was very small.

Producing a variety of vehicles within the same production line was essential to provide Japanese customers with the variety they desired and flexibility became a key factor. These factors coupled with Japanese culture, lack of natural resources, and limited work force (Sugimori et al., 1977) led to the discovery that shorter lead times and flexible production lines lead to higher quality, better customer responsiveness, better productivity, and better utilization of capacity and equipment (Liker, 2004). Toyota focused on reducing waste in the 1940's and 1950s to address the very problems that plague most companies today. As a result, they were then, and are now, able to give customers what they want, when they want it, at the right price, with the highest quality. All of this stems directly from an obsession with the elimination of waste. Streamlining processes by eliminating waste, whether manufacturing or service, is central to lean thinking.

DISCUSSION & FUTURE RESEARCH

Organizations who fail in their lean endeavors often do so because they fail to adopt lean as a system (Liker, 2004), and retrenchment and recovery strategies often mitigate effects of failures. Time, however, obviates and magnifies failure, but many firms give up on lean endeavors before they are able to reap the full benefits. Failure in a first responding organization is often highly consequential, and the results tend to be more immediate and evident, particularly if exposed because of a disaster. Because they provide a vital public service, first responding organizations are under constant scrutiny. As demonstrated in the Senate hearings after 9/11, failure to identify critical elements of performance, such as inter- and intra-organization communication and information sharing can result in the loss of human life and can have devastating economic consequences for the organizations and communities involved. In disasters such as terrorist attacks, the security of the organization, the community, and even the nation can be put at risk.

Disasters are also compounded when organizations providing critical mitigating and post-disaster services fail before, during, or after disaster onset. For example, the failure of the levy system and subsequent flooding greatly compounded the effects of Hurricane Katrina in New Orleans. The failure of so many first responders to show up for duty during and after the hurricane made landfall further compounded the already unprecedented disaster. A lean organization would likely have been in a position to notice many of the potential problems before failure because the implementation of lean principles and the pursuit of continuous improvement and elimination of waste would have exposed many of the problems before the hurricane hit. These failures could have been avoided, or at least mitigated, if the organizations had adopted lean principles, exposed potential concerns, and solved problems in advance of the disaster. A lean first responding organization almost certainly would have been better prepared to deal with such a disaster.

Researchers warn that the journey to lean is a long one (Holweg, 2007; Lietner, 2005; Liker, 2004; Pascal, 2002).The multifaceted nature of lean requires that core lean principles be adopted as a system. Failure, or at least not achieving maximum success, is likely for organizations which ignore the core principles that make a lean organization structurally sound. As lean principles are systematically adopted by a lean enterprise, the organization will develop and increase organizational efficiency to its advantage as a distinctive competence. The leaner the organization becomes, the more evident problems previously buried in organizational waste will become. This is an opportunity for organizations to focus on systematically addressing problems that have the potential to hinder performance. In the case of a first responding organization, problems that would hinder response to a disaster can be addressed before a disaster strikes. While this may not prevent a disaster, it can go a long way in mitigating the effects of such an event. An organization is much better prepared to deal with an impending situation if its response does not compound the disaster.

The scope of a lean system extends from suppliers to customers (VerDeft, 1999). In the case of first responding organizations, the system extends from suppliers to the general public (which are the ultimate customer of this type of organization). As each facet of the system adopts lean philosophies, efficiency reverberates throughout the entire system. This system becomes a structure within a structure as the entire service chain integrates to become not just a lean enterprise, but a lean industry. Central to lean thinking is the ability to empirically evaluate the antecedents of a lean enterprise, and this study has taken a first step by evaluating lean literature to identify widely accepted antecedents to a lean organization which can then be empirically validated. Future research is needed to determine if these principles extend to service organizations, particularly to first responding organizations. A logical next step in the research process is the development of an instrument that will allow the first part of this model to be validated.

Future research should address such issues as those posited in this paper. Issues of gender and family among first responders (many of whom are now women and the head of household of a family) also require further evaluation. These first responders are particularly vulnerable to the concerns outlined within this paper. First responding agencies are the perfect forum for testing hypothesis regarding the research questions proposed above. Future research should seek to develop hypotheses associated with these research questions and implement quasi-experimental designs which would better assess organizational disaster preparedness. Comparisons of pre- and post-disaster preparedness levels and first responder perceptions of preparedness levels in disaster training events using experimental and control samples will neutralize many contaminants associated with many disaster studies (Drabek, 1997). Indeed, government entities such as FEMA and both state and local first responding agencies conduct dozens of technological, training, and procedural exercises that are natural experiments for the ambitious researcher.

CONCLUSION

Organizations, like individuals, are affected by disasters. Of particular interest to this study are first responding organizations and their ability to respond to, or potentially compound, large-scale disasters. As first responding organizations systematically apply lean techniques and principles that have been successfully used in private industry, they become leaner and more efficient. This efficiency will translate to better disaster preparedness as problems such as lack of communication and infrastructure weaknesses are exposed and corrected. The ability to respond to large-scale disasters, such as 9/11, Hurricane Katrina, and forewarned pandemics such as Bird Flu is directly related to the level of preparedness of the responding organization and the first responders on the front lines.

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Table 1: Principles of lean manufacturing.
(Adapted from White & Ruch, 1999)

	Authors												
Principles of Lean	1	2	3	4	5	6	7	8	9	10	11	12	Summary
5S	X		X										L
Autonomation - Stop When There is a Quality Problem (Jidoka)	X		X		X	X				X			L
Cellular Manufacturing	X		X						X				L
Customer Focus			X				X						L
Cycle Time Reduction			X						X				L
Employee Participation/Evaluation			X	X			X						L
Focus Factory Production/Manufacturing-Engineering Focus			X	X					X				L
Level Out the Workload/Line Balancing (Smoothing)	X					X			X	X			L
Multi-functional Work Force			X						X				L
Reingeneered Production Process									X	X			L
Respect, Challenge, and Help Your Suppliers/Long-Term Relationships			X			X							L
Respect, Develop and Challenge Your People and Teams				X		X				X		X	L
Safety Improvements									X	X			L
Small Lot Sizes			X						X				L
SMED/Set-up Time Reduction	X		X		X				X	X			L
Standardization	X		X		X		X						L
Total Productive Maintenance (TPM)	X		X		X				X				L
Total Quality Focus (TQM)	X			X				X	X				L
Use Visual Control So No Problems are Hidden	X					X							L
Value Specification		X	X								X	X	L
Value Stream Mapping	X	X									X		L
Eliminate Waste	X	X	X	*	X	X	X	X	X	X	X	X	C
Continuous Improvement	X	X	*	X	X	X	X	X	X	X	X	X	C
Create Process "Flow" to Surface Problems (Heijunka)	X	X			X	X					X	X	M
JIT	X				X		X	X	X	X			M
Pull Systems to Avoid Overproduction		X	X		X	X			X	X	X	X	M

Degree of Agreement on JIT Technique:
C = Consensus agreement (all authors agree) **M** = Majority agreement (at least half of the authors agree) **L** = Lack of agreement (less than half of the authors agree)
* Implied

(1) Abjulmalek, Rajgopal, & Needy (2006); (2) Ben-Tovim et al., (2007); (3) Doolen & Hacker (2005); (4) Hayes & Wheelwright (1984); (5) Leitner (2005); (6) Liker (2004); (7) Pascal (2002); (8) Schonburger (1982); (9) Shah & Ward (2003); (10) Sugimori et al., (1977); (11) VerDuft (1999); (12) Womack & Jones (2003).