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Maintaining robust decision capabilities: An integrative human–systems approach

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Abstract

The purpose of this paper is to examine how to maintain robust and effective decision capabilities for organizations involved in critical operations. Following a multidisciplinary review of the literature, we propose an integrative and cumulative view that is articulated threefold. First, we present an operations resource management, or ORM, framework. Second, we suggest an integrative approach for decision capabilities as they rest on the interaction between humans and systems. Third, we derive a decision model. We show that careful consideration must be given to the interplay among humans, systems, and the environment in which they operate.

Keywords: Critical operations management; Human–system interaction (HSI); Operations resource management; Information management

1. Introduction

On July 1, 2002, at 21:35:32, a Tupolev 154 M collides with a Boeing 757-200 in midair near the city of Ueberlingen, Germany, killing 71 people [9]. While for most people this accident represents a single catastrophic event, the trained operations resources management (ORM) professional will see this as a consequence of a chain of errors that was not stopped in time. Operating in critical environments calls for good resources management. Piloting airplanes, controlling air traffic, navigating ships, and conducting military operations are just a few examples of critical operations. To most a 9-1-1 call center represents the most critical type of operations one will face. While to them, the operation of these facilities remains conceptually simple, in reality, it is anything but. They deal with few information channels and the decision is limited to a small range of possible responses. This is unlike the previously mentioned operations that have to deal with a wide array of information channels and numerous possible responses. The complexity of the decision process is clearly higher. Maintaining a robust decision capability within these environments is a challenge, and when there are failures, crises occur. From such situations, our research question comes to mind immediately: How is a robust decision capability maintained through critical operations?

The purpose of this paper is to shed light on this extremely important question. First, we lay the ground for an ORM framework. We examine and define what is a critical operations environment, linking it to ORM, and explain its constituent elements before discussing some challenges. Second, we move on to present an integrative view of issues related to the interaction of humans and

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systems in such an environment. This view is built on the interrelationship of the psychology of decision-making, issues related to decision support systems (DSS), human–system interaction (HSI), and queuing. Third, we put forward a decision model. We consider the impact of task loading on decision capabilities and suggest a decision matrix based on the criticality of events and the slack time remaining before a crisis (STRC). We conclude by pointing out to some implications for academics and practitioners.

2. Context of critical operations: Framing the problem

2.1. Definitions and environments

Critical operations are operations that have a great degree of exposure to risk, where failure leads to loss of life and/or crisis. In the literature, the names of high-reliability industry [23]; time-critical/high-risk operations [66] as well as high-pressure/high-risk environment [7] have also been used to describe such and environment.

We operationalize the term "critical operations" as operations that consistently have a small STRC, having a value that could be as low as zero or even negative. We use Pauchant and Mitrof's [[51]: 15] definition of a crisis as a "disruption that physically affects a system as a whole and threatens its basic assumptions, its subjective sense of self, its existential core" and for the STRC we adapt a classic definition of "the time remaining before the due date minus the processing time remaining" [[12]: 624], where the processing time refers to the time it takes to make a decision and accordingly coordinate an appropriate response. The STRC is important information for critical operations management. In the context of the operations manager having their workstation capacity considered infinite, it is the only practical way tasks can get prioritized and queued for their criticality.

Critical operations require more than technical expertise, they require teams to work well together as a cohesive unit. The pioneer in good resources management research within critical operations was the aviation industry through cockpit resource management. This later evolved into crew resource management (CRM) that reflected the change to include the entire crew onboard the aircraft as a cohesive team. The advent of the concept of CRM had as an objective to address the issues arising in the late 1960s–early 1970s which were common problem to crew performance leading to accidents such as preoccupation with minor mechanical problems; inadequate leadership; failure to delegate tasks and assign responsibilities; failure to set priorities; inadequate monitoring; failure to utilize available data; and failure to communicate intent and plans [65].

Following the success of CRM in aviation, other industries adapted the concept to their own operational needs. Bridge resource management (BRM) first appeared in the early 1990s mainly to respond to the issue of the development of chains of errors on ships. Since maritime accidents are seldom the cause of a single catastrophic event but rather the result of a series of non-serious incidents, the concept of BRM was developed and relied upon one main principle to avoid chains of errors: situational awareness [58]. Two core objectives of the International Maritime Organization sanctioned BRM course are (1) to gain "a greater understanding and awareness of efficient bridge procedures and bridge teamwork during watch keeping and ship handling, in normal and in emergency situations [and (2) to gain] greater awareness and understanding of a good interactive communication style by building a common shared mental model of the planned passage" [31: 3–4]. Engine room resource management (ERRM) share the same principles as BRM but applied to the ship's engine control room. The ERRM and BRM principles are bridged during training to emphasize seamless integration of the two teams that have to closely work together even though they are situated in different locations aboard the ship. Yet another field that benefited from CRM-type training is offshore oil exploration. Marine centers that offer BRM courses also offer courses for offshore oil platform personnel. These courses developed specifically for the offshore oil industry are composed of four modules: decision-making, communication, assertiveness, and stress [22].

Within the critical operation environment of hospitals, team resource management (TRM) training is emphasised while there previously was a paucity of research in this field [7]. This goes to show the broad applicability of the first theoretical approaches developed in CRM. In this line of research, four critical domains were identified by Kohn et al. [35]. They contend that the key elements in improving safety in an operating theatre involve creating (1) effective teamwork; (2) a blame-free environment for reporting and investigating near misses; (3) relationships between individual and system errors; and (4) an environment designed for the safe use of equipment.

The validity of this was demonstrated in another study from Hugh [29], where TRM principles were applied to laparoscopic bile duct surgery. It was found that such principles significantly contributed to reduce injury incurred during surgery and went from 1 injury per 200 cases to no injury per 2000 surgeries. The conclusion was that these new principles contributed greatly to achieving this improvement.