

3-1-2009

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Recommended Citation

Sullivan, John and Hunter, M. Gordon, "Understanding the Principles of High Reliability in Health Care Systems: A proposed Research Design" (2009). *SAIS 2009 Proceedings*. 21.
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UNDERSTANDING THE PRINCIPLES OF HIGH RELIABILITY IN HEALTH CARE SYSTEMS: A PROPOSED RESEARCH DESIGN

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ABSTRACT

Healthcare professionals come to rely upon information systems for patient administration, medication distribution, and the scheduling of facility resources. The obvious consequence of a lack of reliability in these information systems could result in the injury or the untimely death of patients. Yet, in the organizational setting, the overall reliability of a system must include the influence of its people and the culture of the environment. The two most dominant theories surrounding High Reliability Organizations (HROs) are High Reliability Theory (HRT) and Normal Accident Theory (NAT). Once considered contradictory, more recent research has shown that they actually complement each other (Perrow, 1999; Weick, 2004). It is through the lens of these theories that this research seeks to determine the impact of different funding models on reliability in healthcare systems. The Sullivan-Beach Model (2004) is used to illustrate the impact of the relationships between component forces of reliability within the Canadian and the United States healthcare systems.

Keywords

High Reliability Organization, High Reliability Theory, Normal Accident Theory, funding models, critical success factors, complex systems, healthcare systems.

INTRODUCTION

Information systems in the healthcare field are devised to support the reliable delivery of medical services to individuals of all ages. These information systems may not be seen by the patients. But, healthcare professionals come to rely upon such information systems as patient administration, medication distribution, and the scheduling of facility resources. The consequence of a lack of reliability in these information systems could result in the tragic death of a patient or the provision of inadequate healthcare service to a number of individuals. Thus, it is important that these systems, the people who interact with them, and the environment within which they operate are not only reliable but that they are highly reliable.

Healthcare information systems in Canada and the United States share a common primary objective: to support the treatment of patients within the healthcare system. There is, however, one major environmental difference between the healthcare systems in these two countries. They differ in their approach to funding. In Canada healthcare is publically funded through the personal income tax system. In the United States, however, healthcare is privately funded through an individual's purchase of insurance or the direct payment for a service.

The question emerges, then, and is the focus of this proposed research; "Does the perspective of information system reliability differ between Canada and the United States in relation to culture or alternative funding models?" This question will be viewed through the theoretical lens of High Reliability Organizations (HROs) (Sullivan and Beach, 2004).

The remainder of this document is organized as follows. To begin, a theoretical context is presented followed by a description of HROs. Then, an overview of existing literature is employed to outline the context of a proposed investigation. The proposed research design is then described. The document concludes with a discussion of expected contributions.

HIGH RELIABILITY THEORY AND NORMAL ACCIDENT THEORY

The two most dominant theories surrounding HROs is High Reliability Theory (HRT) and Normal Accident Theory (NAT). These theories were once considered contradictory, but research has more recently shown that they actually complement each other (Perrow, 1999; Weick, 2004).

HRT states risks associated with high hazard environments can be identified and strategies developed to prevent them from materializing. Further, HRT focuses on the practices within the organization and the positive effects of a reliability-conscious culture (Tamuz and Harrison, 2006). HROs are known for placing higher priority on reliability than anything else, including efficiency. This is especially true where unreliability has a direct and adverse affect on safety (Roberts and Bea, 2001). HRT also incorporates mechanisms where the organization can learn from past failures thereby preventing future occurrences of the same problems. Examples of these mechanisms include the Challenger disaster. When the Space Shuttle

Challenger exploded shortly after launch, it triggered a comprehensive investigation of NASA and its contractors. The findings were documented in a public report of the causes of the disaster. As a result, the Shuttle's solid rocket booster underwent a complete redesign of the O-ring seals that secured the joints of the main sections of the booster. After nearly one hundred launches since the disaster, there have been no recurrences of the problems associated with the former design (Dombrowski, 1991).

NAT states that the accidents in high risk environments should be expected, and may even be considered "normal." This is due to the influence of tight coupling of activities and complexity of the system. Tight coupling exists when tasking sequences are highly interdependent with little room for error. Complexity is reflected in the myriad of combinations of outcomes of individual processes within the system, and the impact of those outcomes (Perrow, 1999). Sagan (1994) asserts that the effects of political influence in such environments make the problem worse.

Proponents of NAT suggest that some factors that HRT advocates point to for increasing reliability, such as redundancy, can actually reduce reliability. Specifically in the healthcare field, Tamuz and Harrison (2006) point out that overreliance on social redundancy (e.g., double-checking medications) breeds complacency. Healthcare professionals become less vigilant and rely on the "double-checker" to identify their mistakes. Over time, when no mistakes have been identified both individuals become complacent, thereby increasing the probability of an undetected error.

Understanding how HRT and NAT relate to each other in high risk situations is valuable in that they identify organizational factors that are desirable and those that are detrimental when it comes to reliability. However, in order to understand the HRO, the relationships of the governing dynamics of the organization as a whole must be understood. This allows the research team to identify not only the origins of emerging threats, but also their effects, and processes of remediation and improvement. This risk → consequence → recovery → and growth cycle in the highest risk environments separates the HRO from the traditionally less critical organization. Thus, a framework that illustrates the interrelatedness of the high reliability environment is needed.

Tamuz and Harrison (2006) applied contributions from HRT and NAT in their study of patient safety in the health care industry (Table 1).

	HRT	NAT
Assumptions		
Main concern	Improve reliability in high-hazard settings (e.g., airlines, nuclear power)	Raise awareness of unavoidable risk of major system failures in industries using tightly coupled, interactively complex technologies (e.g., nuclear power)
Orientation	Optimistic and melioristic; focuses on internal organizational practices and culture	Pessimistic; focuses on industries and encourages political elites to abandon or radically restructure systems based on high risk technologies
Applications		
Objectives	Reliability is first priority	Safety competes with other objectives
Redundancy	Technical and social redundancies enhance reliability	Redundancy can contribute to accidents when: Lacks independence Increases complexity Obscures operating processes Diffuses personal responsibility Limited impact on rule enforcement and training
Structure and processes	Reliability enhanced by: Rules and SOPs Training in rule application Decision making migrates toward expertise Flexible structure enables rapid response	Decision making migrates toward the powerful Key structural concepts include: Interactive complexity Tight and loose coupling
Culture	HRO lacks discussion of complexity and interdependence	Interactive complexity and tight coupling create potential for catastrophic failure
Assumptions about risk	Cultural norms enhance reliability and safety	Safety culture is necessary but not sufficient for safety
Rewards	Managers assume that risk exists and that they can devise strategies to cope with risk	Politics and personal interests influence risk interpretation
	Rewards should be consistent with desired behavior	Reward system influences and is influenced by politics

	HRT	NAT
Cognition	Emphasizes cognition and developing a culture of mindfulness Top managers see the big picture Individuals engage in valid and reliable sense making	Limited treatment of cognition Organizational conditions can distort or undermine mindfulness Barriers to top managers gathering information from front lines History of success undermines current vigilance

Table 1. A Comparison between the HRT and NAT Perspectives (adapted from Tamuz and Harrison, 2006).

They suggest that these two perspectives make contributions in five prominent safety practice areas in the healthcare setting:

- double-checking medications (redundancy),
- crew resource management (flexible hierarchical organizational structures),
- computerized physician order entry (CPOE) (reduce systems complexity, increase tight coupling),
- incident reporting (accountability without cultural “blame game”),
- root cause analysis (value of organizational learning strategies).

HIGH RELIABILITY ORGANIZATIONS

Roberts and Bea (2001) suggest that some organizations have been very successful in their implementation of tightly-coupled complex systems (e.g., those controlling nuclear power stations and chemical processes.). These organizations, by the very nature of what they do require a high degree of reliability from their systems, procedures, and people. Roberts (1990) identifies what it means to be a HRO by posing the question, "How often could this organization have failed with dramatic consequences?" If failure could have occurred many thousands of times, but did not, the organization is considered highly reliable. Another characteristic of HROs is that, "performance reliability rivals productivity as a dominant goal" (Roberts, 1990).

Sullivan and Beach (2004) suggest that it is the ability to balance capability and risk in the face of high consequence that separate HROs from traditionally less critical organizations. The Sullivan-Beach Model (Figure 1) illustrates the dynamics of managing complex systems in HROs using a scale to represent the *weight* of risk and the required weight of capability to counteract that risk. Failure occurs when risk, comprised of expectations and risk factors, outweighs an organization's capability, comprised of resources and organizational competence. In such cases the scale tips out of balance, and consequences follow such as those outlined below.

Bilateral relationships in this model exist between expectations and consequences, as well as expectations and resources. Additionally, a one-way relationship between consequences and organizational competence exists. Expectations and consequences are related in that the consequences for failure are consistent with the degree of missed expectations. For example, a delay in launching the space shuttle by one day violates an expectation that the shuttle program stay on schedule. However, the consequences of failing to meet this expectation are minor. Failing to meet the expectation of returning the shuttle and its crew safely to earth involves severe consequences. The relationship between expectations and resources is evident when stakeholders (government agencies, for example) provide resources to a project. Certain expectations, or a return on investment, accompany those resource commitments. Conversely, if resources are withdrawn, project managers will insist that stakeholders lower their expectations, or failure will result. Similarly, if expectations increase, managers will demand additional resources. Finally, the one-way relationship between consequences and organizational competence is best described as organizational learning. When HROs fail, an investigation follows, and what is learned contributes to changes in policies and procedures that increase organizational competence so that a particular type of failure does not occur again (ibid).

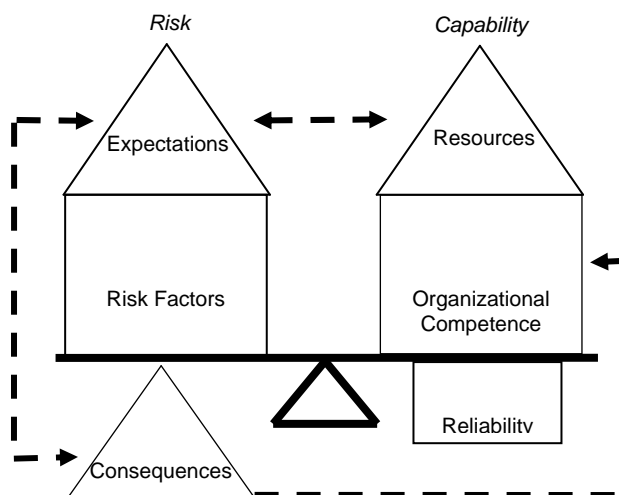


Figure 1: Conceptual Model for How HROs Manage Complex Systems.

HEALTHCARE SYSTEMS

Improving the reliability of healthcare systems would seem to be a natural objective in the healthcare industry. Placed in terms of the model (Sullivan and Beach, 2004) the healthcare industry certainly is capability-intense with considerable risk from many sources. In addition, there are high consequences for failure, particularly where patient safety is concerned.

There has been limited research surrounding the high reliability of healthcare systems. Much of the existing body of study surrounds patient safety (Kaplan and Barach, 2002; Roberts et al., 2004; Sutcliffe et al., 2004; Roberts et al., 2005) and medical errors (Koppel et al., 2005). Many studies that have addressed high reliability in healthcare have approached the topic by drawing parallels between healthcare environments and HRO environments. The problem with this approach is that there may be a considerable number of environmental variables that may unwittingly affect the research outcomes. In particular, there may be influential factors among national healthcare system funding models that would need to be identified in order to focus on those variables that affect reliability. Therefore it is the opinion of this research team that an empirical study of high reliability in healthcare systems is appropriate and necessary. For the purposes of this research, healthcare system reliability in Canada and the United States will be compared and contrasted to identify generic factors that contribute to reliability in healthcare systems as well as those that are specific to the particular funding models of each of the nations.

RESEARCH PROJECT DESIGN

Large scale health care systems are complex, with a broad range of interacting variables. It is recognized that the “system” is not solely comprised of technological components, but by including the interaction of its people (i.e., support, health care professionals, and users) may have a profound impact on reliability. Additionally, a second dimension to the research will be added to take into account the type of funding model applied in each type of environment. Thus, Canadian and the United States subjects will provide the empirical data for the research.

The model (Sullivan and Beach, 2004) will provide an appropriate framework from which to base the research, as it not only provides a comprehensive illustration of the factors that contribute to reliability but also reflects the dynamic relationships between those factors. Thus, it is believed that the Sullivan-Beach Model the most appropriate representation of high reliability principles of any model known to exist. From these observations, research questions that will drive the research include:

"What impact does the origins of funding have on the reliability of health care systems?"

"Do other factors such as national culture have an impact on reliability of health care systems?"

The proposed research plan will operationalize these questions through the development of an interview protocol based on the five prominent safety practice areas outlined above.

Interviews with Health Care Professionals

The interview process will provide a method of extracting the experiences and observations of the participants involved in developing these systems. While interviews provide limited breadth, they allow a high degree of depth and detail into this area of research. This process will involve a small number of participants, approximately twenty interviewees. Interview data will be processed in order to identify the emerging themes of the major issues that affect system related outcomes.

EXPECTED CONTRIBUTIONS FROM THIS RESEARCH

It is anticipated that this research will result in a better understanding of the relative effectiveness of different funding models in healthcare in relation to the concepts surrounding HROs. The Canadian healthcare system uses a funding model where taxpayer contributions fund the entire system. The United States healthcare system is funded by individual funds and insurance resources that are acquired by the individual. It is also expected that any phenomena related to national culture, if any, will be identified. While Canadian and the United States cultures share many similarities, there may be a potential for operational differences in the two systems that have their roots in cultural differences.

This research attempts to develop a better understanding of generic high reliability principles. It is believed that the model (Sullivan and Beach, 2004) is capable of reflecting generic principles of high reliability. Potential for additional contributions exist in that there has been limited study in areas of high reliability across national cultures. Further, there has been limited study in high reliability that resulted in recommendations for disparate healthcare environments.

RECOGNIZED LIMITATIONS

The research team approaches this research with the understanding that it is an ambitious undertaking. Known challenges include collecting a representative sample of participants from multiple organizations in different countries. Obtaining access to more than fifty interviewees, conducting the interviews, transcribing and analyzing the data will be a labor intensive effort. Another limitation of the research is that there have been no known studies of the affects of national culture on reliability. Thus it will be necessary to isolate factors that contribute to reliability from those that define each culture, yet be open to the possibility that some factors may exist that contribute to both.

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