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Creating High Reliability Organizations: Merging Theory and Practice
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1.0 Introduction

Examination of High Reliability Organizations (HROs) has been sparse in the operations management literature despite their effectiveness in improving process reliability in industry. The HRO literature can benefit from operations research because prescriptive methods in how to implement processes, which is virtually non-existent in HRO studies, is available in the OM literature. HRO is a term which refers to organizations that typically operate in hazardous environments where the consequences of failures are extremely high [1]. They are extremely costly to develop and manage, and usually involve large technical systems like utilities, military institutions, healthcare, etc. Developing and operating HRO processes is challenging due to the extraordinary reliability demanded by its clients and the costs involved [2]. Over the long term, HRO investment pays-off by preventing the high costs of failure, which according to Deming (1986) are the highest costs of all and are often incalculable – unknown and unknowable. Wieck, Sutcliffe, and Obstfeld (2008) discuss several organizations that were severely harmed or destroyed by a single incident of external process failures. For example, since 2008 private healthcare providers are no longer fully compensated for patient care related to mistakes by their institutions, whose costs can run into the millions of dollars per incident (McLaughlin and Kaluzny, 2004). As the costs of failures rise, the greater the benefits of implementing HRO processes. The problem is that there is a dearth of research describing how the HRO five-aspects are implemented or why they work theoretically (LaPorte and Consolini, 1991). The purpose of this study is to demonstrate how and why HROs increase reliability. In doing so, this study is the first to describe a framework for creating HRO processes and why they work.

This case study is conducted in a regional healthcare center (RHC) in the United States. The RHC center was chosen as a convenience sample because managers allowed researcher access to their implementation of HRO. RHC decided to start the effort in one of its Critical Units (CUs) to address a
2.0 Literature Review

There is a paucity of HRO organizational studies in the operations literature even though they create highly reliable processes in high-risk environments such as healthcare and nuclear power (Lssel and Narasimha, 2007; Kaplan, 2002). HROs focus on delivering high quality outcomes to clients through very low failure rates. A few organizations that successfully compete on reliability demonstrate this (i.e. Schulman, 1996), but they are sparse in the literature because of a paradox in how and why they work (Weick, Sutcliffe, and Obstfeld, 2008; Laporte and Consolini, 1991). This means that there are no methods available to guide managers in implementing HRO or inform the literature on how and why they work to increase reliability.

In HRO’s the customers judge the success of the process and can be internal or external to the firm. In RHC, an external customer is a patient and an internal customer is the next person in a downstream process (Deming, 1986). HRO methods have increased reliability in several healthcare organizations (i.e. Issel and Narasimha, 2007; Kaplan, 2002). Since reliability is a key dimension of quality (Garvin, 1987) greater reliability can lead to greater organizational competitiveness.
The RHC chose to pursue being a HRO organization because of the benefits reported in Hines, Luna, Lofthus, Marquardt, and Stelmokas (2008), which include improving healthcare reliability performance. High reliability ultimately reduces legal liability and failure costs, which can be huge in healthcare. RHC administrators began the implementation in CU because it treats the most critically ill patients and incurs the greatest number of liability claims. Deming (1986) says that greater process reliability is achieved through reduction in process variance which suggests that the five aspects work to create HROs because they reduce process variance. In healthcare process variance can directly affect patient care (Issel and Narasimha, 2007). Reducing process variance in the operations literature involves activities performed systematically on a process until some target is achieved (Chakravorty, Hales, and Herbert, 2008). These improvement activities are implemented through Soft-Operations Research methods (Soft-OR) and address process problems that are difficult or impossible to quantify, and involve multiple objectives inappropriate for traditional analytical techniques (Checkland, 1983).

In reviewing the HRO literature we find that the five aspects found in HROs to be similar to many of the process activities described by Checkland (1983). Therefore, this study proposes they can be implemented using the Soft-OR approach he describes as “Checkland’s Soft System Methodology” (SSM). SSM involves the following steps:

1) Confronting/Identifying the Problem Situation (or Event)
2) Identifying the people, culture, or norms involved (i.e. the stakeholder’s and context)
3) Developing Root Definitions – a sentence that describes the ideal system (using CATWOE)
4) Building a Conceptual Model – a diagram of the system
5) Comparing Models with the Real World – Questioning each relationship in the model to assess its validity in the real-world
6) Identifying Changes – identifying changes to the current system that are feasible and related to the problem
7) Taking Action – using an action plan to implement the changes identified in Step 6
SSM has been used to guide problem-solving and research in operations (Omerod, 1998; Paucar-Caceres, 2010; Mingers, 2011).

Weick, Sutcliffe, and Obstfield (2008) review the HRO literature and their own experiences to identify “five aspects” they argue increase process reliability in HROs, but they don’t characterize the aspects as a complete model nor relate them to Soft-OR. Instead, their aspects are tied to a cultural outcome called Mindfulness that encourages a continuous attention to potential failures. Their aspects are:

1) A preoccupation with failure (PWF) - PWF suggests that an HRO’s objective is to prevent failures by preoccupying itself with discovering them and their causes. PWF focuses on points of failure rather than success-focused techniques (Weick and Sutcliffe, 2008).

2) A reluctance to simplify interpretations (RTS) - RTS promotes a thoughtful process that considers the uniqueness of a problem before applying a solution. It discourages the form-fitting application or popular solutions to problems without thorough consideration of the problem’s context. RTS is data-driven, treating each problem as unique. Over-simplification is difficult to overcome because simplification is easier - limiting the number of solutions that must be considered.

3) A sensitivity to operations (STO) – STO recognizes that a solution to one problem may create another and therefore process-wide measurement is essential to avoid this. STO is similar to the concept of a “bubble” in Navy terminology that refers to the awareness of a ship’s overall condition in the moment.

4) A Commitment to resilience (CTR) – CTR encourages the use of individual initiative to maintain process improvements long-term. It encourages activities to prevent failures and relies on the expertise of front-line workers to reduce response time and counter immediate, evolving threats or “absorb” as much of the threat as possible at the lowest levels of the organization.

5) An Under-specification of structures” (USS) - USS refers to using of the highest level of expertise in improving reliability through the use of recognized experts, not necessarily the
higher-ranking “boss”. USS discourages excessive formal ranks because the ranking individual may not be in the proximity when the event occurs, may be too detached from the event to quickly respond, possess the requisite knowledge or contextual understanding necessary for offering an effective solution.

Based on the general definitions of SSM and HRO aspects, we argue conceptually that HRO aspects are present in HRO organizations because they are an application of the SSM activities that have shown to improve processes in operational contexts. Linking the steps of SSM to inform theory in other programs has been used in well-respected OR journals. For example, Davies (2005) used SSM techniques to inform the literature in the “theory of constraints”. Table 1 summarizes how each aspect is conceptually linked to problem-solving.

**Table 1 – Conceptual Linkages between HRO Aspects and SSM Activities**

<table>
<thead>
<tr>
<th>HRO Five-Aspects</th>
<th>SSM Seven-Activities</th>
<th>Conceptual relationship between HRO &amp; SSM</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Preoccupation With Failure</td>
<td>1) Confronting the Problem Situation</td>
<td>Preoccupation with finding potential failure points in a process is the same activity as identifying and confronting problems to solve.</td>
</tr>
<tr>
<td></td>
<td>2a) Identifying the people in the situation</td>
<td>To identify failure points in HRO, the activities leading to client/customer outcomes are identified first.</td>
</tr>
<tr>
<td>2) Reluctance To Simplify Interpretations</td>
<td>2b) Identifying the culture and norms in the situation</td>
<td>Identifying context prevents oversimplification of a problem through unsupported/traditional assumptions that may not apply contextually.</td>
</tr>
<tr>
<td></td>
<td>3) Developing CATWOE (Customer, Actor, Transformation, Worldview, Owner, Environment)</td>
<td>Identifying the context of the problem is part of this step which begins with identifying the Customer, Actors (participants), Transformation process (link inputs into outputs), Worldview (strategic place in the situation), process Owner, Environmental factors (constraints of the process)</td>
</tr>
<tr>
<td>3) Sensitivity To Operations</td>
<td>4) Building a conceptual model</td>
<td>To gain consensus and better understand the transformation process, and the impact of a change (sensitivity) on other activities in the process, a diagram is developed of the CATWOE showing the key players and their relationships through links. This allows what-if scenarios (sensitivity analysis) to be developed to validate the model.</td>
</tr>
<tr>
<td></td>
<td>5) Comparing models to the real world</td>
<td></td>
</tr>
</tbody>
</table>
Both SSM and HRO specify that process performance must be measured to ensure that solutions to improve reliability work. The healthcare literature identifies 1,475 measures (NQMC, 2009) classified by Efficiency, Outcome, Patient Satisfaction, Process, and Structure/Access measures. The majority are in 584 Outcome and 769 Process measures.

In summary, Weick, Sutcliffe, and Obstfeld discovered five aspects in organizations that had reputations as HROs, and argued that the five aspects contributed to an organizational culture of Mindfulness, that leads to high process reliability. But, their study is primarily conceptual and provides little empirical evidence. They don’t describe 1) how organizations implement the five factors, 2) why they work, 3) the degree to which reliability was increased, nor 4) how the organizations measured success.

### 3.0 Method

This study uses a multi-method approach by using Action-Research to gather the data and SSM to guide managers in implementation, thereby informing the theory and practice of HRO. The multi-method approach has been used to guide managers in other contexts (i.e. Franco, 2011). Examining “how” and “why” HROs achieve greater reliability requires exploratory research because control over the behavioral elements is not possible, not all of the variables are known, or the causal-links between the variables are ill-defined (Yin, 2009). Participant-observer studies are formalized in a method called Action-Research. Action-research methods differ from traditional case studies where researchers act only as observers. Action-research methods are especially important to “…explain the presumed causal links in real-life interventions that are too complex for surveys or experimental designs.” (Yin, 2009, pg. 19).
RHC Administrators hired a consultant experienced in working with HRO organizations, and taught nursing courses for a local university. The objective was to improve patient care reliability and thus reduce the number of complaints and medical failures, which had been increasing since the unit expanded in January 2009.

This RHC facility was chosen by the researchers as a convenience sample because managers allowed the researchers to use the Action-research method and publish the results. The criteria for conducting meaningful Action-Research studies include 1) the effort is conducted as a program with observable strategic and operational elements, where the researchers are actively involved in implementation; 2) the firm allows unfettered observation of the workers and managers by the researchers, and agrees to provide objective and subjective performance data; 3) the results can be published; and 4) the researchers agree to protect the name of the organization during publication. Since the study involved human subjects, confidentiality of the participants is required by the institute’s Internal Review Board.

3.1 The Organization

The implementation began in the summer of 2010 in the CU unit of RHC. The unit treats 4,000 patients annually. CU typically receives its patients from other units of the RHC when more intense and specialized treatment is required. The majority of patients come from the Emergency Center (EC), the Trauma/Burn Unit (TU), and the Operating Recovery Unit (ORU). The CU is a 20-room facility occupying a whole floor of RHC with rooms around the perimeter of the floor, and open facing a central nurse’s station for visual monitoring of patient care. Administrative functions are performed in the nurse’s station with files of the patient’s medical chart, medication and treatment instructions, and incident report logs. The CU nurse supervisor, HRO consultant, researchers, stand-by equipment, and volunteerhelpers called “candy-stripers” are located in the nurses’ station. Nurses involved in treatment rotate between the 20 patient rooms, returning to the station only to complete periodic paperwork.
3.2 Data Collection

Baseline performance information was collected in the spring of 2010 for the period January, 2010 – June, 2010, a full 12 months during which patient care reliability had followed a worsening trend. Data collection included direct participation and observation of CU operations, CU log books, and interviews with patients, nurses, supervisors, and RHC managers (Yin, 2009). Data collection continued through the summer of 2012. The interviews began with semi-structured questions developed in advance and then revised based on the responses and feedback from participants, following the interview method proposed by Kvale and Brinkmann (2009). According to Kvale and Brinkmann, this differentiates semi-structured interviews from fully-structured interviews or online surveys where both the questions and answers are standardized. The researchers participated in the implementation, CU staff meetings, and reviewed incident logs, as well as documented nurse and supervisor observations of HRO efforts. The incident logs included nurse observations of a) RHC policies that they feel interfere with patient care, b) activities of supervisors/others in CU that harmed or improved patient care reliability, c) suggestions for improving reliability, and d) ideas or observations about how the five-aspects were implemented.

3.3 Analysis

The data are evaluated through an iterative process using an eleven-person panel of healthcare experts comprised of the two researchers, the nursing HRO consultant, CU supervisors, the RHC Chief Financial Officer (CFO) and three external members from other RHC units. All members of the panel were taught the Weick, Sutcliffe, and Obstfeld (2008) HRO five-aspects model by the nurse consultant over a three-day period in June 2010, and shared her experience in implementing the HRO model in two hospitals and a doctor’s office over the previous 24 months. The researchers had assisted the HRO consultant on one of the hospital efforts and recognized the similarities in how she implemented the five-aspects and their experience with Checkland’s Soft-OR method. The rudimentary descriptions of the HRO aspects provided in Weick, Sutcliffe, and Obstfeld and the HRO consultant’s experience appeared to follow Checkland’s SSM Seven-stages model because the consultant had to perform additional
activities not included in the five-aspects. The researchers requested to examine this proposition in RHC. To examine the relationship between the five aspects and SSM, an iterative discussion took place between the members of the expert panel and then the Q-sort method was used to classify their opinions. Q-sort is conducted by placing each individual panel’s observations on 3x5 cards and classifying them by similarities into fewer and fewer groups, in an iterative, multi-round process, until a consensus is reached. While Yin (2009) suggests a qualitative study’s reliability and validity are strengthened if an independent panel perform the Q-sort, the Health Insurance Portability and Accountability Act of 1996 (HIPAA) laws inhibited the sharing of patient information outside of the RHC. The panel members were given the article by Checkland (1983) to understand the seven stages of the SSM. The objective of the panel was to compare the activities used to implement the five-aspects to the seven SSM stages and develop consensus on their similarity. This approach is consistent with previous qualitative research in process improvement using Q-sort (i.e. Chakravorty and Hales, 2008).

3.4 Cost of Failure Data

Since HROs are designed to minimize process failures, estimating the costs of these failures is important to this study. While Deming (1986) argues that the total internal and external costs of process failures are unknown and unknowable, this study reports the available data on RHC failure costs. In the CU, 10% of healthcare cost is for medical malpractice insurance, plus additional liability costs for high-risk treatment when an anesthesiologist, neurosurgeon or obstetrician is involved. Therefore, 90% of the external failure costs are built-in through insurance premiums that average $500/day/patient. RHCs share of liability claims is 10%, with the average malpractice award in the U.S. of $1.81 Million, with roughly 77% of all claims in this award range (Karpoff and Lott, 1999). RHC’s share for each claim is estimated at $90,500. In the U.S. malpractice claims occur in 3.7% of admissions, with 27.6% of these resulting in paid claims (Brennan, et al, 2004). In the U.S., 1.23/1,000 claims receive awards. With 4,000 patients per year, approximately five CU claims receive awards. Using an average $1.81 Mil/award, payouts due to CU are estimated at $9 Mil/year plus $410,000/claim in co-pays. This equals $2.5 Mil/year for CU failure.
costs, but more importantly it equates to $11.5 Million in losses to the system. Implementing HRO aspects could save RHC $2.5 Mil/year, with system-wide savings of $11.5 Mil.

3.5 Performance Measures

Table 2 reports the RHC’s Efficiency, Process, and Outcome measures. Column 1 lists the type of measure. Column 2 lists the specific metrics that comprise the measure. Column 3 reports the benchmark performance data taken in the first six months of 2010. Column 4 reports the data for the year, including six months during the implementation. While an argument could be made on the appropriateness of these measures to CU, these measures were chosen by RHC managers based on national reporting requirements and organizational goals, not by the researchers. The RHC have used these measures since 1999. It is beyond the scope of this study to evaluate the efficacy, completeness, or the appropriateness of these measures. Instead, this study evaluates the impact of HRO aspects on their relative improvement. The data for some measures were not provided to the researchers for a variety of reason. These are shown as (NR) in the Table.

Insert Table 2 About Here

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficiency</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) Total Cost for the CU Unit</td>
<td>Not Report (NR)</td>
<td>Not Report (NR)</td>
<td>NR</td>
</tr>
<tr>
<td>b) Total Cost per patient/day</td>
<td>$5,350</td>
<td>$5,500</td>
<td>$5,400</td>
</tr>
<tr>
<td>c) Number of patients/year admitted to CU</td>
<td>1,997</td>
<td>3,998</td>
<td>4,020</td>
</tr>
<tr>
<td>d) Average number of hours in the CU/patient</td>
<td>73 hours</td>
<td>75 hours</td>
<td>70 hours</td>
</tr>
<tr>
<td>e) Average bed occupancy/utilization</td>
<td>87%</td>
<td>92%</td>
<td>94%</td>
</tr>
<tr>
<td>Process</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) # of negative interactions between nurse and patient’s family</td>
<td>965</td>
<td>1,302</td>
<td>911</td>
</tr>
<tr>
<td>b) # of negative interactions between Dr. and patient’s family</td>
<td>NR</td>
<td>NR</td>
<td>144</td>
</tr>
<tr>
<td>c) reliability of patient care measured as the percentage of patients discharged alive – and stable (EPAS)</td>
<td>1,875/1,997=93.8%</td>
<td>3,974/3,998= 99.4%</td>
<td>3,998/4,020=99.5%</td>
</tr>
<tr>
<td>d) number of incidents of improper medication, dosage, or timeliness by CU</td>
<td>341</td>
<td>510</td>
<td>120</td>
</tr>
</tbody>
</table>
### Table 1: Outcome Measures

<table>
<thead>
<tr>
<th>Outcome</th>
<th>a) accidental patient lacerations by nurse or physician</th>
<th>b) mortality rate of AMI (Acute Myocardial Infarction) measured as [# of AMI deaths/# of AMI live discharges]</th>
<th>c) acute stroke mortality rate measured as [# of stroke deaths/# of stroke live discharges]</th>
<th>d) central-line associated blood stream infections (CLABSI)</th>
<th>e) death of surgical patients with STCs (Serious Treatable Complications)</th>
<th>f) live discharge [# of deaths/# of admissions]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>10/642 = 1.5%</td>
<td>NR</td>
<td>0</td>
<td>7</td>
<td>22/1,997 = 1.10%</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>14/1,310 = 1.1%</td>
<td>NR</td>
<td>0</td>
<td>9</td>
<td>24/3,998 = .60%</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>13/1,312 = .9%</td>
<td>NR</td>
<td>0</td>
<td>11</td>
<td>22/4,020 = .55%</td>
</tr>
</tbody>
</table>

### 4.0 Results of the Action Research Study

While Weick, Sutcliffe, and Obskfeld do not prescribe order to their aspects, the SSM method does. In the following discussion each aspect and the activities involved in implementing it are discussed. A description of each aspect is included in Table 1. Then, the 2012 results of the follow-up study are reported. It is important to understand that there were multiple examples of each stage of the five aspects and SSM encountered during the Action research study period. The examples chosen to publish were based on recommendations of the expert panel and RHC managers that adequately describe the way HRO aspects were implemented, their similarities to SSM stages, and the length of the descriptions.

#### 4.1 A Preoccupation with Failure (PWF)

In HROs, improvement efforts are targeted where failures are likely to occur, with constant attention (preoccupation) given by process workers identifying potential failure points. Using PWF in healthcare is conceptually appealing because health problems are first identified through failures in physiological indicators, such as blood pressure, pulse rate, and temperature, as well as behavioral indicators such as alertness, coherence, and agitation. One role of CUs is to stabilize vital signs so treatment can be administered. Before implementing HRO aspects, CU viewed failure only as the death of
a patient, and did not consider unstable vital signs or improper treatment, corrected prior to serious harm, as failure points. However, PWF treats any activity that threatens or temporarily harms patient care, regardless of the recoverability, as a failure. Identifying potential failures in CU began with the shift supervisor inspections. Traditionally these inspections were conducted somewhat informally at the beginning and end of each rotation to ensure the physical condition of the CU met minimum standards, but were formalized as part of the PWF effort. A form of this report has been used by the consultant in other HRO implementations in healthcare. A copy of the 17 items in the inspection report is reported in Table 3. Using this report, it was simple to enter the problem situations and identify the people, culture, and norms because they were primarily confined to the CU unit, as well as the principle stakeholder – the patient. In this simple unit designed to maximize patient care visualization, the co-called “rich pictures” in SSM to help visualize a process, were not necessary because all major activity could be seen first-hand from anywhere in the CU. Failed items on the inspection report were discussed at staff meetings and the owners of the failure were identified. This demonstrates how SSM Stages 1 and 2 are evident in implementing PWF. The report is used to encourage a PWF culture, focusing on processes in CU that have failed in the past or could fail in the future.

In Table 3, most items on the report are self-explanatory. Potential failure points are in Column 1. The desired situation is bolded under each point. The Corrective Actions are shown in Column 4. For example, in Column 1, the activity “Patient Charts Updated” means that out-of-date charts are problematic because they don’t reflect current patient condition and are therefore failure points. Any expectation listed as “100%” indicates all patients are affected. The term “All 20 checked” means that all units were checked. In one example, the shift’s refrigerator had food items left for days which created unhealthy conditions such as mold, and odors in the CU. This encouraged incoming staff to store their food items outside the unit which meant they left the unit frequently, temporarily reducing the number of nurses. This is counter to PWF because it takes the focus off of patient care. Through the report, the refrigerator is cleaned each shift, and nurses store their items stay within the unit.
### Table 3. Supervisor Inspection Report

<table>
<thead>
<tr>
<th>Date/Time</th>
<th>Current Shift Pass (P)</th>
<th>Next Shift (P)</th>
<th>Discrepancy/Failure Point</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient Charts Updated</td>
<td>100%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>On-shift Oral Medicine Administered</td>
<td>100%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>New Admissions Paperwork Completed &amp; Charts at station</td>
<td>100%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Central Station Appearance/Order</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All desks cleaned</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waste/Hazardous-containers checked/emptied</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All 20 checked</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Correct new patient names posted on unit</td>
<td>All 20 checked</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weekly work schedule preferences filled out</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All nurses were on schedule</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nurses on Station on-time</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit Equipment Operational Check</td>
<td>All 20 checked</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Oral Medication Administered</td>
<td>100%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit Floor Space Appearance/Clean</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General Appearance</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patient IV levels checked</td>
<td>100%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patients Bathed/Appearance</td>
<td>100%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nurse’s Appearance/Dress</td>
<td>Clean and Pressed with nametags</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discharge Paperwork Completed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Staff refrigerator cleaned/shift items removed</td>
<td>Nothing left at the end of the shift</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In-unit Pharmaceuticals Inventory</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All 20 checked</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4.2 A Reluctance to Simplify Interpretations (RTS)

RTS encourages the consistent collection of fresh data on each failure point to prevent oversimplification of its causes and proposed solutions. RTS can be counter to the “best practice” approach often promoted in the Operations literature, where standard solutions are applied in a variety of contexts. In SSM, this oversimplification can be avoided by applying a “root definition” method known as CATWOE, defined in Table 1. In root definition, the ideal system for all CATWOE players is articulated – usually with brief statements, as seen in the following a-f. Consideration of how each player affects the process when threats to system reliability occur encourages targeted and robust solutions.

a) Customers in CU are primarily the patients, and secondarily the patient’s family. SSM characterizes the Customers as benefactors and well as potential victims when treatment reliability is low. In CU, the ideal condition for the patient is to leave the unit alive with stable vital signs. This is one example of a root definition.
b) The SSM Actors are the participants in the CU, such as the nurses, doctors, orderlies, volunteers, and supervisors who contribute directly to patient care and can influence treatment reliability. The ideal condition is that all Actors are in the unit when needed, able to respond instantly to a threat to a patient.
c) The SSM Transformation Process in CU is reflected in its performance measures, with the primary objective measure as EPAS. The inputs into the system are critically-ill patients with unstable vital signs. The outputs are “transformed” patients who leave the unit, and the ideal transformation process is when they leave alive with stable vital signs (EPAS), and whose treatments have been demonstrated as effective.
d) The SSM Worldview in CU is the holistic view of patient care. This is interpreted in healthcare as ensuring that patient treatment to stabilize a vital sign or condition does not cause harm to another vital sign or condition, or risk others in the unit. For example, some medication that stabilizes blood pressure can cause heart arrhythmias in some patients, and radiation treatment for cancer patients can contaminate others in the unit. The ideal root definition is that there are no harmful interactions for the patient among multiple treatments, or risk for the caregiver.
e) The SSM Owner process identifies who can ultimately stop the system. In RHC, the President can stop any
treatment and along with healthcare insurers, ultimately control and can stop patient care. Ideally, Physicians who prescribe care should be the final authority on patient care, but they are ultimately answerable to RHC managers and insurers. f) The SSM Environmental constraints in CU are the conditions that limit the reliability of a treatment, and for which the Owners have limited or no immediate control. This includes the capacity of the unit and capability of the Actors, as well as characteristics of the Customers such as age and overall health of the patient, the patient’s condition relative to others in CU and RHC, and the willingness of the insurer to cover the cost of care. Constraints are usually identified by the events that are extremely difficult, or sometimes impossible to control by the process Owners and Actors, at least in the short term. Ideally the patients with greatest need should have no constraints on receiving care first. It is important to note that initially the root definitions do not need to be practical. They need only to state the ideal condition.

4.3 A Sensitivity to Operations (STO)

Some STO activities in healthcare overlap somewhat with the CATWOE definition of Worldview because the purpose is to ensure HRO operations meant to increase reliability in one area does not harm reliability in another. But, STO activities can extend beyond the immediate customer to include system-wide, organizational, or social operations. In order to evaluate effects on other operations SSM-Stage 4- “Building Conceptual Models” encourages building conceptual models of how the system works, showing activities and causal links so that there is common understanding among the Actors in how the operations work. This can facilitate sensitivity analysis, where the impact of a change in one operation can be can be evaluated for its effect on others. This is related to SSM-Stage 5- “Comparing Models with the Real World” because it is inconceivable that STO could be properly conducted unless the conceptual models in SSM-Stage 4 generally agree with what is actually happening. Therefore, SSM Stages 4 and 5 are techniques of conducting STO. For example, in CU, STO data include a patient’s physiological vital signs plus behavioral evaluations such as a patient’s degree of independence, responsiveness, and communication skills, among others. Because many patients in CU enter the unit with impaired cognitive
function, they typically can’t communicate well or participate in their own care. This means that the actors - nurses and physicians use conceptual models from their medical education and experience to evaluate how a treatment to correct a medical condition will adversely affect the patient in other areas. In CU drug interactions create the majority of operational conflicts, especially the use of blood thinners to reduce the effects of clots that cause heart attacks and strokes. Blood thinners also create unwanted internal bleeding that is difficult to discover and treat. During the implementation of STO, physicians were encouraged to share their treatment models with nurses, especially where the interactions can reduce the treatment reliability. It is generally assumed that physician models are accurate, although patient individuality can create unique characteristics that don’t match general medical models. These are typically revealed through nurse interaction, or challenged through insurers.

4.4 An Under-specification of Structures (USS)

When a change to a process is needed to improve reliability or respond to a failure, USS is a control model that suggests that control in HRO organizations should be relatively flat, not hierarchical. This is based on the premise that front-line workers and supervisors will be the first to recognize a failure and are in the best position to respond quickly. USS also encourages the use of process experts to recommend changes instead of hierarchical command structures. In SSM – Stage 6 – “Identifying Changes”, USS encourages that identifying “feasible and desirable changes” to counter immediate threats are best generated at the lowest level of the organization. In RHC, as in all healthcare organizations, this begins with the physician for recommending initial patient care, but then is transferred to the nurse – who is responsible for implementing the care. Both are in direct contact with the patient. When a CU nurse executes a physician’s treatment protocol, this is identified as SSM-Stage 7- “Taking Action”. In USS, the initial physician-prescribed treatment is actually only a minority of treatment changes. In CU, the majority of requests to change/adjust treatment are generated by a nurse who is the first to identify treatment ineffectiveness or harm. So, most actions in CU are generated by the nurse, at the low end of the organizational structure, not the physician – in supporting USS. The inhibiting factor in implementing
USS in RHC has been the managed-care structures, which have become over-specified meaning control is held in hierarchical structures well above the nurse and physician level – typically at the managerial level responding to insurer coverage. This was done to increase the efficiency of healthcare but has often resulted less reliable care. USS refers to deferring the decision on which changes to make to those with expertise, and who first recognize the need to change, instead of those with higher rank. Unlike other RHC units, nurses in CU are given the authority to stop any treatment that appears to harm patient care until a physician can review treatment.

4.5 A Commitment to Resilience (CTR)

CTR encourages monitoring a solution and contextual condition to ensure the process continues to work. In doing so, it prevents a failure from reoccurring or quickly recovers from failures that do occur. It encourages developing system capacity to allow flexibility to change a solution in the face of changing threats. There is no SSM stage that specifically addresses resilience. However, SSM Stages 1 and 2 imply resilience by encouraging actors to enter the problem, which should identify when a new threat is emerging or a solution/treatment needs abandoning or revising.

In CU, CTR is easier to execute than other areas of the RHC because the actors, nurses and physicians, have more resources and flexibility to treat patients due to the critical nature of CU patients and the unit’s objective to stabilize life-threatening conditions, which are more difficult to address than typical illnesses. In CU, one key to building resilience is the USS promotion of the empowerment of individuals at the lowest level of an organization with expertise to quickly respond. For CU, the lack of fully functional life-support equipment was identified as a critical obstacle to creating resilience. The RHC recently hired a local company to maintain its equipment, instead of in-house technicians, which increased response time to a repair request from 15-20 minutes to 1 – 2 hours. Sixty-percent of CU patients rely on life support, versus the 15% for the RHC as a whole. To improve repair reliability, the HRO consultant recommended that a repair technician be contracted for the CU that could service the
equipment within 20 minutes. While more expensive, the potential external losses due to poor equipment reliability could run much higher.

4.6 12-month Follow-up Visit

The researchers conducted a follow-up visit June 2011 - June 2012 to estimate the impact of the implementation on CU reliability. These values are reported in the last column in Table 2.

5.0 Discussion

This study uses the operations literature to apply Soft-OR, Soft-Systems Methodology to implement the HRO aspects and address many of the issues in HRO research, namely the theoretical grounding for its success, suggest a sequence of implementation for the five aspects, and provide additional stages for creating HRO organizations. In doing so, this study contributes toward resolving the HRO paradox (LaPorte and Consolini, 1991) by describing how and why the five aspects work theoretically. This study finds that HRO aspects work because they are an application of the stages of SSM to improving process reliability and create an HRO organization. Additionally, this study finds that there are other aspects to implementing HROs in healthcare, including a suggested order to the five aspects (Table 1) and two additional aspects not found in previous literature.

First, the expert panel found that the five aspects are similar characterizations of the SSM stages of process improvement. The two models have objectives to improve process reliability, but conceptually linking the SSM to the five aspects shown in Table 1 show that the order in which the five aspects are implemented may be important. There is insufficient detail in previous HRO studies to make this claim, but it is evident in this study of the RHC-CU that the aspects were implemented in an order resembling those of SSM. This order is logical because sufficient detail about the problems and stakeholders must be identified before solutions are developed and implemented. While not in specified by order, these stages are common to both models. In CU, PWF was used to confront the problem and identify the stakeholders from SSM. RTS was used to develop a robust context for the problem (using SSM- CATWOE) to
develop targeted and robust solutions and discourage applying preconceived solutions. Developing a STO was accomplished through SSM conceptual models of the system and the validation of these models to adequately represent the real-world phenomenon. Organizational sensitivity and what-if scenarios can only be useful with adequate models. USS encourages the decision-making in HROs to be held at the lowest level practical, at the front-line level of the organization where threats are first encountered. In SSM, USS is one organizational characteristic that can encourage identifying changes that are practical and effective and implementing those changes in a timely fashion, although SSM studies show that not all organizational decisions need to be made in response to immediate threats as assumed in USS. CTR suggests that organizations should develop robust solutions and maintain some level of capacity to change direction if a new threat is identified. This creates process resilience that leads to improved long-term process and system reliability.

Conclusion

As previously discussed, the five aspects theoretically improve process reliability because they are re-characterizations of the SSM technique which has been employed to improve processes in a number of operational contexts. The SSM model informed the HRO literature by suggesting an order to the five aspects, shown in Table 1 that may improve implementation in a healthcare context and identifying tools that support the five aspects. Though not needed in CU, the SSM “rich pictures” is a visual technique that can help focus PWF efforts and identify failure points in a system. The CATWOE technique can help establish the proper context for potential failures and identify process stakeholders to prevent oversimplification of a problem and its solution. The express development of a conceptual model of a system and validating the model to the real world can improve the STO activities by enabling what-if scenarios to test the sensitivity of failures or potential solutions on other parts of the system. Identifying feasible changes and implementing those changes support USS by encouraging decision-making at the lowest level of the system. The SSM suggests that these stages can be added to the HRO aspects, or listed as sub-elements to existing aspects, to improve the chances of success. The HRO literature also informs
the SSM model by suggesting a CTR stage that encourages resilience in processes to support solutions or create the flexibility to change if an existing solution no longer works. This can be characterized as “SSM - Stage 8 – Follow-up Stage” to ensure a solution continues to be effective or change it if it no longer works.

Limitations

The greatest limitation of this research is that it is a single case, which may not generalize to other contexts. Conducted in an Action-research manner suggests that the subjective observations can be biased by researcher and expert panel preferences rather than actual events. Nurse and actor behavior may be affected simply because they are being observed – (i.e. the Hawthorne Effect; Deming, 1986). Another weakness was that the implementation relies on the seminal Weick, Sutcliffe, and Obstfeld (2008) findings as guides, which are admittedly insufficient for a full implementation model.

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