The role of Redundancy in Lean Improvement Projects: Lessons from Multiple Case Studies from Hospital

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Abstract
Some Lean improvement projects have been successful while others have not. According to the literature on Lean management principles, a potential explanation for this equivocal state is a paradox that can develop depending on the focus of the project. If the focus is on improving the efficiency of individual resources and not on the interconnections between them, then paradoxically, the worse the efficiency of this resource will become. To overcome this paradox and achieve the expected outcome of Lean projects, the aim for Lean improvement projects should be to achieve “flow efficiency” rather than “resource efficiency”. By conducting a detailed study of eight case studies of Lean improvement projects from two large acute-care hospitals in Singapore, we examine how organizations can systematically focus on flow efficiency by considering the role and value of redundancy in Lean improvement projects. We found that redundancy plays a vital role in enabling the goals of Lean improvement projects to be achieved. Our findings extend the discussions on the “efficiency paradox” and Lean practices in healthcare context by incorporating the nature of the redundancy concept and contextual factors in explaining how Lean practices are being adapted in variant operations settings.

Keywords: Redundancy; Lean; Hospital operations

Purpose
Many hospitals have attempted to improve their service delivery outcomes using Lean improvement projects. These outcomes, however, have been variable, with some such projects being successful while others have not been so (e.g., Papadopoulos, 2008, 2011; Seddon, 2011; Seddon & O'Donovan, 2010; Waring & Bishop, 2010; Young & McClean, 2008). According to
In the literature on Lean management principles, a potential explanation for this equivocal state is a paradox that can develop depending on the focus of the Lean improvement project. If the focus is on maximizing the efficiency of a particular “resource” without due consideration to how this resource integrates with other elements of the system, then paradoxically, the worse the efficiency of this resource will become (Modig & Åhlström, 2012).

To overcome this paradox and achieve the expected outcome of Lean projects, the suggestion in the literature is that the effort should be to optimize the “flow” of the subjects in the system without regard to optimizing the efficiency of any individual resources within the system (Modig & Åhlström, 2012). The aim, therefore, for Lean improvement projects, should be to achieve “flow efficiency” rather than “resource efficiency”. While this view of how Lean projects can be more effective is intuitively appealing, little empirical research exists that examine how organizations fall into the trap of resource efficiency, and how they can systematically focus on flow efficiency.

This work responds to scholarly calls to unpack the nature of the concept of redundancy and its role in Lean outcomes (Cabitza et al., 2005; Valdmanis et al., 2008; Zinn & Flood, 2009). Therefore, we ground the research in the Lean management philosophy and healthcare service literature (LaGanga, 2011; Radnor et al., 2012; Waring & Bishop, 2010) to undertake a detailed research by using multiple case studies of Lean improvement projects in hospital settings.

This paper seeks to offer deeper empirical insights of the efficiency paradox by raising the following research questions: -

*How some Lean improvement projects in organizations have been able to systematically focus on flow efficiency, while others tend to focus on resource efficiency?*

**Methodology**

We address the research question through a detailed exploratory case study methodology that allowed contextual analysis of the case sites to provide an in-depth understanding and more comprehensive examination of the focal phenomena – equivocal Lean outcomes. The exploratory study was conducted in two large full services hospitals involving eight Lean improvement projects (RIEs1) that cut across several departments.

**Overview of Empirical Context**

Hospitals typically design projects to improve their internal operations using Lean improvement methodologies such as the rapid improvement events (RIE) to address problem areas within the organizations and to deliver quick and visible results tactically. The primary selections of improvement projects were identified where Lean type initiatives such as the rapid improvement events had been applied. To maximize learning, this study used purposeful sampling to select a spectrum of eight projects involving multiple disciplinary groups, job functions and departments across the hospitals to represent diverse voices of informants (Eisenhardt, 1989; Stake, 1995). Finally, eight RIEs cases that cut across multiple several hospital departments in the two hospital organizations from various functional groups are studied. The names of the organizations and the

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1 This refers to Rapid Improvement Event (RIE). This research makes use of eight rapid improvement events as the improvement projects that were initiated under the “lean banner”. Therefore, RIE is used as an abbreviation to represent each of the eight improvement projects investigated under this study.
interviewees remain anonymous throughout the process in accordance with the clearance received by the ethics committee.

**Research Design & Data Analysis**

Each of the eight improvement projects forms a case as the primary unit of analysis. The eight RIEs were either organized as localized initiatives at the departmental level, involving usually a single department (i.e., RIE 1, 2, 3) or part of a wider program across the hospital organizational level (i.e., RIE 4, 5, 6, 7, and 8). For each improvement project/ RIE , a range of people were interviewed including at least one senior manager, the improvement project lead, team members, staff members who were affected by the change, relevant middle managers and service professionals. The actual number and profiles of informants at each case site varied according to the project scopes and objectives. Data collection occurred from August 2012 to February 2013.

Overall, the study collected a range of material which included semi-structured interviews with informants from different departments who are involved in the studied RIEs; site visits, non-participant observation of project meetings and improvement project events; and analysis of the project implementation reports, organizations’ annual reports and internal management documents, such as review meeting minutes and report. In all, the data includes more than 500 pages of field notes and over 82 hours of audiotapes of meetings and interviews.

Following each site visit, the data was analyzed and a report was written which highlighted the findings under each of the key topics identified in the semi-structured interview protocol. This report was then sent to a senior manager so that the research data was validated by each host site. The analysis of the data involved the examinations of the organizational participants’ understanding of the Lean management approach, their perceptions of the improvement project initiatives and operational efficiency. Table 1 provides an overview of the multiple case studies data sources with details on each of the projects.

**Table 1. Overview of Data Sources and Lean Improvement Projects/ RIEs**

<table>
<thead>
<tr>
<th>Lean improvement projects (e.g., RIEs)</th>
<th>Data Sources</th>
<th>Project Description and Scope</th>
<th>Project Team Composition</th>
<th>Desired Outcomes</th>
<th>Implemented Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Inpatient ward discharge process RIE</td>
<td>3 interviews 3 project meetings 1 RIE participation</td>
<td>To achieve more discharge before noon by increasing the usage of discharge lounge facilities in ward</td>
<td>Include only internal ward personnel</td>
<td>Increase rate of patient discharges by improving utilization of discharge lounge</td>
<td>Localized outcome measures</td>
</tr>
<tr>
<td>(2) Surgical Department RIE</td>
<td>2 interviews 1 RIE participation project site observation</td>
<td>To reduce the number of no shows and cancellations with internal work flow redesign - Target less than 10% no-shows or cancellations</td>
<td>Include only surgical department personnel</td>
<td>To load Surgical theatre improve resource utilization rate of surgical facilities and equipment</td>
<td>Localized outcome measures</td>
</tr>
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<tr>
<td>(3) ECHO (Cardiac Echocardiography Machine) RIE</td>
<td>3 interviews 3 project meetings 2 project site observation 1 RIE participation</td>
<td>To maximize the use of existing Cardiac Echocardiography Machine and peripheral resources</td>
<td>Include only internal personnel from Heart Centre</td>
<td>Improve scheduling of scans to optimize the use of ECHO machines</td>
<td>Localized outcome measures</td>
</tr>
<tr>
<td>(4) Oncology department/ Cancer center RIE</td>
<td>2 interviews 1 project site observation</td>
<td>To coordinate appointment booking and treatment processes of both radiography and chemotherapy</td>
<td>Include internal staff and interfacing department involved in the coordination process</td>
<td>Improve coordination and provide a clear conduit of work flow across interfaces for multiple-tumor cancer patients to undergo same-day chemotherapy and radiotherapy treatments</td>
<td>Cross-department outcome measures</td>
</tr>
<tr>
<td>(5) Housekeeping operations RIE</td>
<td>2 interviews 2 project meetings 1 project site observation</td>
<td>To satisfy greater demand through the management of existing processes</td>
<td>Include personnel from the interfacing departments</td>
<td>Improve information exchange and coordination to reduce wait time in inpatient transfers and admission</td>
<td>Cross-department outcome measures</td>
</tr>
<tr>
<td>(6) Closed Loop dispensary system RIE</td>
<td>3 interviews 1 project site observation</td>
<td>To achieve and coordinate better accuracy of drug replenishments at the wards</td>
<td>Include personnel from the interfacing departments</td>
<td>Enhance coordination for accurate and timely replenishment of drugs</td>
<td>Cross-department outcome measures</td>
</tr>
<tr>
<td>(7) Focused care program for elderly patients RIE</td>
<td>4 interviews 2 project meetings</td>
<td>To direct a better care towards elderly patients that require acute care support</td>
<td>Include personnel from the interfacing departments</td>
<td>Improve coordination and patient flow to the right site of care</td>
<td>Cross-department outcome measures</td>
</tr>
<tr>
<td>(8) Death Registration RIE</td>
<td>3 interviews 1 project meetings 1 RIE participation</td>
<td>To speed up the process and lead time of death registration within the hospital</td>
<td>Include personnel from the interfacing departments</td>
<td>Improve coordination among several departments ensure same-day death registration</td>
<td>Cross-department outcome measures</td>
</tr>
</tbody>
</table>

There are obvious differences in the project characteristics across the spectrum of eight improvement projects. Throughout our analysis, attention was given to identify the dominant
contextual features that are indicative of the variant contexts of the Lean improvement projects. The findings based on the above analyses are provided in the next section.

**Findings**

This section begins with an overview on the case sites experience. Findings from the case analyses are presented to address the overarching research question. Our analysis first considers the role of redundancy conceived in the Lean improvement projects and examine for the dominant contextual features that are salient in the variant Lean improvement projects.

In the single department projects, there was either little or no attempt to engage in collaboration with the other departments in the hospitals. The primary focus is to optimize the use of existing resources in the department. There was **lack of a flow view and an understanding on interconnected resources and elements** across departmental boundaries **that may require bridging and integration**. There is almost no or little regard of the external parties that may be connected to the ward processes. This is succinctly reflected in the following verbatim.

“*Let’s first start by mapping the internal work flow within our department. We’ll map processes from the point where patients are admitted to our ward to the point where they exit our ward. This will form the scope this project and our focus of our next 3 days discussions.*”  
*(Project lead at the Inpatient ward discharge process improvement project RIE)*

Unlike the single department projects where the focus was mainly on tracking utilization rates of specific resources within the department, inter-departmental projects are distinct in their primary focus on enhancing patient flow. These projects make use of the patient journey map as the basis in the value stream mapping. The term used in this exercise is quoted as “*We map the value streams from the patients’ perspective*”. As a result of this clear vision, the different departments were able to work harmoniously towards a common goal.

These inter-department projects predominantly take a flow based view. In these projects, the multiple disciplinary departments recognized their inherent interdependency and acknowledged that patients’ experience is not the work of a single department but require the collaborative work from various interconnected departments along the patient’s journey. A common desire of these inter-department projects is to enhance patient flows efficiency. Therefore, the Lean practices are adapted to enable the coordination of work through the integration of interconnected elements within the healthcare service delivery system.

It was generally acknowledged that those staff who had attended the inter-departmental Lean events had a better understanding of the end to end process of the patient flow journey than those who are involved in the single department RIE and the nature of the redundancy concept was not seen in a negative light. In fact, redundancy is recognised as having an enabling role in facilitating the flow of internal operations/ processes. The organiser of the death registration RIE highlighted this conception in the following quote.

“*The understanding of process has changed since our staff attended the Lean event. They were able to see how the work linked together across the hospital. And they now recognise a common vision in enabling patient flow. On hindsight, our objective was not to eliminate all forms of waste but rather to expedite the necessary work to be carried so that the 24 hour time line can be met.*”  
*(Senior Manager in charge of the Death Registration RIE)*
On the whole, we found themes relating to the ideas of coordination, redundancy enabling interfaces integration, collaborative work, patients’ well-being and safety, timely communication, frequent interaction and Interdependency are the resounding ideas deemed to support the desired flow efficient operations. In contrast to the single department Lean project that borne a primary interest in the elimination of redundancy; there is little or no emphasis on the elimination of resource redundancy in work areas. In fact, there is recognition that redundancy may facilitate flow efficiency across the hospital system. The focus is placed on how to achieve the required support from the interconnected elements that are part of the service delivery chain. This is evident of a patient centred view, which is a strong motivating force that brings the distinct groups that are separated by the departmental boundaries to work collaboratively throughout the inter-departmental improvement projects.

**The nature and role of the redundancy concept**
A key concept that continually features in the analysis is the concept to “redundancy”. We found that besides being perceived as waste in some instances, redundancy is also recognized as having a vital role in enabling the goals of Lean improvement project in variant contexts. Our findings suggest that this conception of redundancy as having a supporting role in facilitating the achievement of Lean improvement outcomes can be more closely defined as ‘built-in spare capacity’ or ‘allowable redundancy’. When the approach to operations improvement is predominantly localised with little regard to the interconnected elements as displayed by the single department projects, the predominant interest lies in maximizing individual resource efficiency and eliminating redundancy within the internal department. Paradoxically, this results in a worsened state of efficiency around the particular resources that has been suggested by the notion of *efficiency paradox*.

In contrast, Lean projects that involved more than a single department tend to perceive their work activities as being intricately dependent on the collaborative support of their fellow colleagues outside their own departments. They perceive redundancy as having a facilitating role that drives the flow of patients within the service delivery chain of the hospital. Their predominant focus is on flow efficiency. The expected outcomes of these projects have been successfully achieved. Besides the prior descriptive findings based on the case analysis, our analytical approach allowed us to identify four prominent contextual features that characterizes the projects.

**Contextual Features**
The contextual features are generated from coding the responses on questions relating to the service contexts and the key operational challenges. Attention was given to pick up contextual details that characterize the different project case sites. The four service attributes generated from our analyses include service variety, Interdependency, capital resource intensity and uniqueness of services provided under the scope of the improvement projects. Table 2 provides the descriptions of these contextual factors.

<table>
<thead>
<tr>
<th>Contextual factors (Service attributes)</th>
<th>Descriptions</th>
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</thead>
<tbody>
<tr>
<td>1. Service variety</td>
<td>The number of distinct services provided/ offered under the scope of the improvement project.</td>
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</table>
On the whole, of the projects where the focus was on resource efficiency, these case studies show that key contributing factors include: - the level of interdepartmental involvement in the individual projects. Projects that are mostly organized within a single department involving only the internal staff of the specific department tend to be organized by individual departments that offer more unique services; such as Cardiac Echocardiographic imaging. The work activities under the scope of these single department projects also tend to require lesser interactions with other departments in the service delivery process. Further, the services offered within the specific department tend to incur higher capital resource costs.

On the other hand, the inter-departmental projects where the dominant focus was on flow efficiency, the distinguishing features that enabled this orientation to be achieved included a greater incorporation of inter-disciplinary views as multiple departments are involved in the delivery of a variety of services. These inter-departmental projects are organized across multiple departments and may be parts of the hospital-wide program. Often, these inter-departmental projects require a higher level of interactions across distinct departmental boundaries. Table 3 highlights the different nature of redundancy cognitions and the contextual influences in the multiple Lean projects case studies.

**Table 3. Contextual attributes of the respective Lean improvement projects**

<table>
<thead>
<tr>
<th>Lean improvement projects (RIEs)</th>
<th>Nature and role of Redundancy</th>
<th>Contextual Factors</th>
<th>Desired dominant outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Service variety</td>
<td>Interdependency</td>
</tr>
<tr>
<td>(1) Inpatient ward discharge RIE process</td>
<td>Redundancy is conceived as waste</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>(2) Surgical Department Operations RIE</td>
<td>Redundancy is conceived as waste</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>(3) ECHO (Cardiac Echocardiography Machine) RIE</td>
<td>Redundancy is conceived as waste</td>
<td>Low</td>
<td>Low</td>
</tr>
</tbody>
</table>
Both the within-case and cross-case analyses of the projects showed that there were interplays between resource efficiency and flow efficiency. It is evident that there is a mix of Lean improvement projects at the organizational level that are designed with distinct interest of efficiency within the hospital. This is also displayed by the attitude of practitioners who are involved in the inter-department project. Often, informants would raise issues relating to the need of having to meet a certain level of resource efficiency and the pressure to coordinate a better patient’s flow of across the hospital. This suggests that a singular focus on flow efficiency across the hospital service delivery system may not be possible without some level of resource efficiency focus.

**Contextual Factors and Propositions**

Our analysis of the contextual factors reveals that they can influence the focus of Lean efforts and conceptions of redundancy to differing degree to shape the resultant outcomes in specific manners. Therefore, this paper suggests the following propositions.

For the first contextual factor, i.e. service variety; we posit that service variety exert its influence in a specific manner.

**Proposition 1:** Lean projects in service areas that offer a greater variety of services are more likely to focus on flow efficiency that leads to successful lean outcomes.

The second contextual factor identified is interdependency. Departments that are highly dependent on other external departments tend to adopt a flow based view. This is because they
require the collaborative support from other functional units and it is in their interest to call on a collective interest among the other departments so that their work activities can be carried out effectively. Examples of these inter-department projects that involved high need for dependent departments to collaborate are the closed loop dispensary RIE, death registration RIE, focused care for elderly patients RIE, housekeeping operations RIE and the cancer center RIE. Hence, we propose that:

**Proposition 2:** Lean projects in service areas that involve more interdependent disciplinary/functional groups are more likely to focus on flow efficiency that leads to successful lean outcomes.

For the third contextual factor, i.e., capital resource intensity; departments that are comparatively higher in capital resource intensity have a higher interest in maximizing resource use. Therefore they tend to adopt a resource focused view. These departments are surgical department ECHO (i.e., Cardiac Echocardiography) lab. On the other hand, departments that are lower in capital resource intensity tend to bear a lower interest in maximizing resource usage and are more likely to focus on the flow of patients across departmental interfaces. Therefore,

**Proposition 3:** Lean projects in service areas that operate under higher capital resource intensity are more likely to focus on resources efficiency that leads to unsuccessful lean outcomes due to efficiency paradox.

For the last contextual factor; i.e., uniqueness of services; highly unique services such as those offered at the surgical departments tend to be more resource focused. In contrast, less unique general services are more intricately dependent and connected with other disciplines and departments. They manifest a sense of urgency to have high support in integration coordination to carry out their normal routine operations and work activity in a seamless manner. Therefore,

**Proposition 4:** Lean projects in service areas that provide more unique type of services are more likely to focus on resources efficiency that leads to unsuccessful lean outcomes due to efficiency paradox.

Conclusions
The primary contribution of this paper is in unpacking the nature of the redundancy concept and revealing its role on the equivocal Lean outcomes. The findings from a spectrum of eight case studies involving Lean improvement projects in two large hospitals indicate that the concept of redundancy can be generally dichotomized based on resources and/or flow. The study also highlights the importance to understand how contextual factors may drive the adaptation of Lean practices and equivocal outcomes in specific contexts by developing a set of propositions relating to the contextual influences on the equivocal Lean outcome. Even though scholars have argued that Lean has to be adapted in consideration of the contextual difference (e.g., Ahlstrom, 2004; Allway & Corbett, 2002; Holweg, 2007; Holweg, et al., 2004), yet there are relatively few studies that provide explicit discussions on how can operations managers adapt Lean to achieve successful outcomes in more certain and predictable ways. This paper extends this contention by offering a set of propositions involving the salient contextual factors that are expected to guide practitioners in successfully adapting Lean practices to achieve the desired outcomes in more certain and predictable ways.

Finally, these findings also advances studies that discussed the influence of context on quality improvement success in health care (Kaplan et al., 2010; Øvretveit, 2011) by incorporating contextual saliency pertaining to the service and operations management domains besides those that are mostly concentrated in organizational structure and data/information systems (such as
leadership from top management, organizational culture, data infrastructure and information systems).

References


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