A BARE-BONES APPROACH TO LEAN SIGMA FOR LOW-RESOURCE ENVIRONMENTS

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ABSTRACT

This research proposes a bare-bones version of lean sigma appropriate for use in extremely resource-limited environments. In these environments, such as those found typically in developing nations, the time and money needed to build a 'traditional' lean sigma infrastructure are unavailable. A survey of existing research and the authors' professional experience are used to summarize the resources needed to run a traditional lean sigma program. This motivates the need for a bare-bones approach to lean sigma, the essential elements of which are then proposed.

Keywords: lean, Six Sigma, quality, limited resources, developing countries

INTRODUCTION

This paper will analyze the appropriateness and applicability of lean sigma methods in environments where resources are extremely limited, and therefore where the time and money required to create a 'traditional' lean sigma infrastructure are unavailable. These environments could include governmental entities, or non-profit organizations operating within developing countries, as well as smaller, underfunded, organizations in countries such as the United States. For example, in the United States, small healthcare providers operating in inner cities often have limited resources and find the prospect of a traditional lean sigma program daunting. The knowledge, tools, data, and support needed to run a traditional lean sigma program will be considered, and then contrasted with the essential, or 'bare-bones' elements required to achieve successful lean sigma implementation. A lean sigma model appropriate for use in these 'low-resource environments' will be proposed.

ORIGINS AND IMPACT OF LEAN SIGMA

Lean Management

Toyota's manufacturing methods, tweaked and perfected over the course of several decades, beginning in the 1950's, became known as the Toyota production system (TPS). The TPS is based upon unrelenting waste reduction, production triggered by customer demand, simplifying process flows, and continuous improvement, [2]. The TPS subsequently formed the basis for 'lean production', although Toyota itself never used the word 'lean' to describe the TPS. In fact, the phrase 'lean production' is credited to an American, John Krafcik, an MIT research assistant working with the international motor vehicle program in the late 1980s [9].

Lean production methods are not only applicable to manufacturing, but to service processes as well. Processes related to loan application reviews, insurance claims, and the treatment of medical patients can all be improved with lean approaches [4]. Because of its relevance to the service sector, lean production is now more commonly referred to as 'lean management' (and often just shortened to 'lean').

Lean seeks to efficiently manage a business by eliminating waste and non-value-added activities. Some important lean concepts, such as mistake proofing (known as *poka-yoke* in Japanese) have been used in many industries for years, but often without formally being part of lean programs. For example, the notion of methodically tracking instruments during surgical procedures incorporates mistake-proofing concepts [3].

Six Sigma

In contrast to the Japanese origins of lean, Six Sigma originated in the 1980s in the United States at Motorola Corporation, and its principles were subsequently adopted by many other American companies, including GE and Allied Signal. Motorola noticed that when it manufactured complex products containing a large number of components (mobile phones, for example), it resulted in a correspondingly high probability of defective final products [4]. To address this problem of high product failure rates, Motorola developed a methodology that focused on reducing process variation so that the incidence of defects and other mistakes were minimized.

Lean Sigma

Six Sigma, and to a lesser extent lean, use project-based approaches to improve process performance and, in both cases, their original applications were in manufacturing. However, lean practitioners have traditionally organized one to five-day improvement projects, often called Kaizen events, where a team of employees focuses their attention on solving a pre-defined problem with the help of an experienced Kaizen facilitator. In contrast, Six Sigma practitioners employ a much longer project structure that follows a prescribed sequence of steps referred to as 'DMAIC'; define, measure, analyze, improve, and control [10]. The first four phases of the Six Sigma process typically require three to six months, and the control phase, where actual cost savings are tracked, often lasts for six to 12 months. The Six Sigma project structure is heavily focused on quantifying cost savings of the improvement project and calculating its accrued financial benefit.

With different historical origins, but similar goals, Six Sigma and lean management can each be effective on their own. However, many companies now combine lean with Six Sigma in an effort to simultaneously reduce waste using lean methods, and reduce process variation using Six Sigma. The resulting combination of these two improvement approaches is typically referred to as "lean sigma".

Lean sigma methodologies have become very popular, particularly within major corporations in the United States and other industrialized nations. The service sector has jumped into lean sigma as well, including healthcare and government agencies. However, critics of lean sigma have said that it is too complex, requiring too many layers of management, too much project tracking and follow-up, too many levels of training and certification, too much paperwork, and too much data collection. Although monetary savings have been achieved by the numerous companies successfully using lean sigma, many smaller or less wealthy organizations have been reluctant to start a lean sigma program because of the perceived infrastructure and upfront cost.

Therefore, it seems natural to ask if it is possible to see results from lean sigma in cases where infrastructure is lacking, or in situations where organizations need to deploy lean sigma with minimal investment, minimal resources, and minimal staffing. For example, what are the barebones requirements for lean sigma to be deployed in low to low-middle income countries? How could government ministries (a Ministry of Health, for example) in developing nations benefit from lean sigma, despite having small budgets and a poor infrastructure?

For example, in developing nations, most organizations cannot afford to hire expensive trainers, consultants, or outside lean sigma experts. They must use more homegrown or organic methods for lean sigma implementation (i.e., self-taught approaches). Contrary to the United States, where resources tend to be plentiful, developing nations often have limited access to items such as computers, plain paper and office supplies, copy machines and printers, classroom space, and comfortable areas to meet and plan.

The notion of bare-bones lean sigma could be seen as analogous to the concept of "designing for the other 90%", a phrase first coined by Cindy Smith [13]. The author argued that product designers spend most of their time designing products for wealthiest ten percent of the world's buyers. However, the majority of the world's population cannot afford $400 fashion eyeglasses. Rather, they need $5 functional eyeglasses that are still durable and fit-for-use. This idea has caught on and many products are being designed that are fit-for-use, are very low price, yet improve quality of life for their owners; for example, human-powered water pumps for crop irrigation, rolling water transportation containers, and solar stills for water purification. Many examples of these products can be seen at the Cooper-Hewitt National Design Museum site (http://www.designother90.org/). These designs all take a bare-bones approach to product design that minimizes the cost of the items, and often take advantage of local materials.

REVIEW OF PREVIOUS WORK

Various researchers have voiced sentiments echoing the thesis presented in this paper. Several authors point out that Six Sigma is essentially a reductionist approach, suited to solving well-defined hard problems in a structured environment. They make the case for injecting systems thinking into Six Sigma to make it applicable to unstructured complex environments [6] [7]. Parris describes how process improvement methodology can benefit the work of INGOs (international non-government organizations), yet also states how the classic methodology may have to be modified [12].

Recognizing the potential benefits but also acknowledging the low-resource environment in Africa, researchers have proposed kaizen (in other words, lean principles) as a workable solution. Ohno, et.al cite reasons why kaizen is well suited for the environment today in Africa. These include complementarity with western top-down approaches, low cost, and contextual similarity to conditions that existed in Japan at the time kaizen was developed [11]. The Japanese International Cooperation Agency (JICA) has set up an Ethiopian Kaizen Institute to help small and medium-sized companies apply kaizen in Ethiopia and The Kaizen Institute has established a branch in Africa (http://afr.kaizen.com/home.html).

Other researchers, based on a pilot study of experiences in service and manufacturing sectors in East Africa, concluded that the most useful tools are the original seven tools for quality improvement proposed by Ishikawa. These tools consist of the Pareto diagram, the scatter diagram, histograms, run charts, check sheets, fishbone diagrams, and control charts. These are intuitive, low-cost techniques, and from a training standpoint do not require considerable budgets [5]. These seven tools then, along with management optimism and commitment, would seem to form the back-bone for lean sigma in low-resource environments.

In fact, Ishikawa felt that the use of sophisticated statistical methods had been overemphasized in postwar Japan and would actually intimidate workers, whereas simpler methods, such as the original seven tools, would have been sufficient to solve most problems [8]. Therefore, using only the traditional seven tools of quality improvement to identify and solve problems would appear to be sufficient in most low-resource situations. Aside from the use of the seven tools, what are the bare essentials of a successful lean sigma program in a low-resource situation? *Knowledge* seems essential, as well as *leadership* and vision to sustain the gains. *Knowledge* would include awareness of useful quantitative tools, methodologies, statistics, and worker motivation and industrial psychology. Beyond these items, the need for the more elaborate characteristics of a traditional lean sigma program could be debated.

In the United States, the primary reason for using lean sigma is to reduce waste and process variation, and thereby reduce costs. Reducing cost increases profits, and this, in theory, keeps people employed, pleases shareholders, and may ultimately allow the firm to stay in business. In developing nations, with scarce resources and poor infrastructure, the driving force is often not increased profits, but desperation to improve the quality of life.

Items and resources important for a successful lean sigma program often include; computers and software for data analysis and data storage, software for creating reports, project tracking software, timing devices, items or prizes to award to staff, follow-up auditing support during the *control* phase, access to pertinent work locations and associated travel funds (ability to travel with the project team to where the work is performed), notebooks and writing instruments, clip boards, and cameras and video recording or camera equipment.

PROPOSED METHODOLOGY

Our proposed methodology is informed by the following principles.

1. *Project selection.* Management is best placed to determine on which problem should be the focus of the lean sigma project. This reasoning is based on the following:
    a. Several studies (eg. [1] [5]) have shown that management commitment is critical for improvement projects to succeed.
    b. In low-resource environments, especially in small firms, management is more likely to have continuity and insight into the business.
    c. This will also permit multiple stakeholders that may have a common interest, but different value systems to arrive at a consensus as to what might constitute a worthwhile goal.

2. *Undertake short-to-medium term process improvement activities.* The experience in the community has been that if quality initiatives fail it is generally due to poor project execution. Therefore, the natural domain of a bare-bones lean sigma approach would be short term projects more in the spirit of Kaizen events. Focusing on small, easy to accomplish projects would ensure a higher success rate.

3. *Analysis tools.* As described earlier, field evidence validates the usefulness of the basic analysis tools in low-resource situations. These are easily mastered tools that are both quantitative and qualitative in nature. The only additional tool that might be suggested is simulation. Laptop computers are ubiquitous and simple visual simulation of process flows can help pinpoint waste and inefficiencies.

4. *Control.* In lieu of prescriptive steps to ensure continued acceptance of a new, improved process, allow for the process to adapt and grow or perhaps wither away. This approach envisions the process improvement initiatives as providing 'mutations', the more successful of which will naturally take root.

CONCLUSION

An argument has been made that in low-resource environments, such as in developing nations in Africa, the traditional approach to lean sigma, with its associated complex infrastructure, training, and organizational requirements, is inappropriate. It was suggested that a better approach in these situations is to use a bare-bones approach, by focusing on the basic quality improvement analysis tools, and attacking short to medium-length projects first, using a Kaizen event methodology. The authors future research in this area will include designing a visual model that codifies different approaches for lean sigma program infrastructure. It is envisioned that this would include specifying under which economic resource level each lean sigma approach is most suitable.

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