Relevance and Benefit of Commercial Quality Improvement Methodologies at Statistics Canada

Laurie Reedman[1], Andrea Ness[2]

[1] *Statistics Canada, Ottawa, Canada; Laurie.Reedman@Canada.ca*
[2] *Statistics Canada, Ottawa, Canada; Andrea.Ness@Canada.ca*

Abstract
Developing and maintaining credibility is a particular challenge for National Statistical Offices. Without the trust of the public and policy makers, statistical products have little value. To achieve this level of trust, not only does quality need to be assured, but also continuously improved. One way to do this is through certification from a recognized source, such as the ISO or Six Sigma. Most commercial quality improvement methodologies were developed for application in manufacturing; however, many of the principles and practices are a good fit with the core business of producing official statistics. Although the stamp of approval is a demonstration that certain clearly defined quality measures are in place, the effort required to achieve and maintain the certification can be significant, and the effectiveness (impact on actual quality) is not guaranteed.

This paper looks at quality improvement methodologies typically used in industry, and compares them to the principles and practices in use at Statistics Canada. The commercial methodologies considered are Total Quality Management, Lean, Six Sigma, the DMAIC improvement model, agile practices and ISO certification. We look at the underlying assumptions, objectives, constraints, application and expected outcomes, as well as challenges and potential disadvantages and benefits.

Keywords: quality; certification; effectiveness.

1. Introduction

The origin of many quality improvement methodologies lies in the manufacturing industry, where there has always been pressure for quality and speed. To maintain credibility and competitiveness in a marketplace abundant with data from various sources and analysts skilled at data exploitation, there is growing incentive for National Statistical Offices (NSOs) to

improve their efficiency and effectiveness in order to fulfill their mandate and secure their own future. Hence there is interest in quality improvement methodologies that have proven successful in other industries. In this paper we look at several methodologies and compare them with practices and principles in use at Statistics Canada. Section 2 explores Total Quality Management, Lean and Six Sigma methodologies. Section 3 draws a comparison between ISO certification requirements and Statistics Canada's governance instruments and compliance practices. A summary and conclusions are provided in Section 4.

2. Total Quality Management, Lean and Six Sigma

2.1 Total Quality Management

Total Quality Management (TQM) (What is Total Quality Management (TQM)?) can be summarized as a management system for a customer-focused organization that involves all employees in continual improvement. It uses strategy, data, and effective communication to integrate the quality discipline into the culture and activities of the organization. TQM asserts that it is the customer who ultimately determines the level of quality, which is in complete alignment with the principle common among NSOs that quality is fitness for use. Other principles of TQM are strong governance fostering a sense of unity across functional processes; taking a strategic and systematic approach to planning core business activities; continual improvement; fact-based decision-making; and an emphasis on communication.

A fundamental feature of TQM is a focus on process thinking. The methodology describes a process as a series of steps that take inputs from suppliers (internal or external) and transforms them into outputs that are delivered to customers (again, either internal or external). The steps required to carry out the process are defined, and performance measures are continuously monitored in order to detect unexpected variation. In the context of an NSO, the statistical process is described by the Generic Statistical Business Process Model (GSBPM) (Generic Statistical Business Process Model, 2013). Similarly to TQM, inputs are transformed into outputs through well-defined steps, and performance measurement is accomplished through the use of quality and efficiency indicators. At Statistics Canada the GSBPM was adopted as

a reference model in 2014 and performance indicators are monitored at the level of the statistical program as well as at the corporate level. Statistics Canada's quality management strategy is communicated through its Quality Assurance Framework (Statistics Canada Quality Assurance Framework, 2002) and Quality Guidelines (Statistics Canada Quality Guidelines, 2009). The strategy includes a set of guiding principles, which are coherent with the TQM principles.

2.2 Lean

Lean focuses on maximizing process velocity by providing tools for analyzing process flow and delay times at each activity in the process (Lean-manufacturing-junction.com, 2014). It differentiates "value-added" from "non-value-added" work and provides tools for eliminating the root causes of non-value-added activities, which it succinctly calls "waste". It defines eight different types of waste: wasted human talent; defects; inventory; overproduction; waiting time; motion; transportation; and processing waste. Other tenets of Lean are promotion of concurrent development; delaying irreversible decisions for as long as possible; keeping close contact with users and clients; having strong governance with a clear focus.

In 2009 Statistics Canada's senior management committee commissioned a task force to assess the feasibility of achieving 5% efficiency on Statistics Canada's operating budget through an improved business architecture. Their recommendations include a set of principles, noted below, that are reminiscent of Lean and TQM principles: make corporately optimal decisions rather than locally optimal decisions; data processes are to be metadata driven; optimize use of corporate services; maximize re-use; minimize tool kits; staff are to be proficient in corporate business applications and tools; improve statistical information management; eliminate rework; focus on the core business; separate development from ongoing operations; increase electronic data collection; and remove structural obstacles to efficient operation. These principles are formalized in a Corporate Business Architecture.

2.3 Six Sigma

Six Sigma methodology recognizes that variation hinders the ability to reliably deliver high quality services (What is Six Sigma?). Its goals are achieved through a prescriptive approach to informed decision making. The term "Six Sigma" is a quality control reference. In quality control, one measures variability of a process in terms of its standard deviation, represented by the Greek letter sigma. Six Sigma refers to process variation on the magnitude of plus or minus six times the standard deviation. A process that is "in control" will produce products that are no more than plus or minus six sigma away from the average 99.99966% of the time. In other words, there will be no more than 3.4 defects per one million opportunities.

At Statistics Canada we monitor corrections made to disseminated statistical products, where a product is defined as the combination of a short text giving highlights, hyperlinks to detailed metadata, and hyperlinks to aggregate data tables. In 2015 there were 1162 disseminated products, 0.6% of which were corrected after they were disseminated because they were found to have errors in accuracy. Using Six Sigma definitions, this represents four sigma performance. To achieve six sigma performance, while producing approximately 1100 products per year, Statistics Canada would have to make no errors for accuracy in over 900 years.

As stated above, Six Sigma means that no more than 3.4 defects are observed in one million opportunities. An assumption implicit in this assertion is that the process produces enough volume to observe one million units of observation in a reasonable timeframe. If there is less volume then the error rate is more volatile. Another assumption of Six Sigma is that units falling within +/-6 sigma are of acceptable quality. In some processes one would want to intervene as soon as any unit exceeds the +/-3 sigma limits, even though we would expect on average 0.5% of units to fall outside these limits. Six Sigma terminology does not allow for different levels of tolerance to variation.

2.4 Implementation

Originally, Lean was a method for optimizing automotive manufacturing (Lean-manufacturing-junction.com, 2014). Six Sigma evolved as a quality initiative to eliminate defects by reducing variation in processes in the semiconductor industry (What is Six Sigma?). Together the two methodologies enable a reduction in the cost of complexity. A standard improvement model is used to implement Lean Six Sigma. One such model is called Define Measure Analyze Improve Control (DMAIC), where each phase is linked logically to the previous and next phases (The Define Measure Analyze Improve Control (DMAIC) Process). The DMAIC model bears close resemblance to the project approach to quality improvement encouraged and promoted by Juran (Juran and Godfrey, 1951). At Statistics Canada we use quality control methodology and many of the practices inspired by Juran in repeated operations such as data collection and coding. While we do not employ the DMAIC jargon the principles of quality improvement promoted and supported by the Quality Assurance Resource Centre are quite similar.

As described by McSweeney and Moore (2015), the experience of implementing Lean Six Sigma at the Central Statistics Office in Ireland was challenging. While the quality improvement recommendations that arose were valid and appropriate, there was some resistance among staff and uneven follow-through on implementing changes. Learning from their first attempt at Lean Six Sigma, they embarked on a new strategic program, this time with stronger governance, a clearer goal of good problem solving rather than Lean Six Sigma certification itself, and an emphasis on engagement and communication.

Agile practices describe how to apply Lean principles in a particular domain (Beck et al, 2001), and are most often used in software and system development. The "agile manifesto" describes four important values. It says, "We are uncovering better ways of developing software by doing it and helping others do it. Through this work we have come to value:

- Individuals and interactions over processes and tools
- Working software over comprehensive documentation

- Customer collaboration over contract negotiation
- Responding to change over following a plan.

That is, while there is value in the items on the right, we value the items on the left more". (Beck et al, 2001). Key principles of Agile are active user involvement; develop small, incremental releases and iterate; focus on frequent delivery of products; complete each feature before moving on to the next; integrate testing throughout the project lifecycle; collaboration with stakeholders is essential. For software development at Statistics Canada, and particularly in the SAS Technology Centre, a lightweight methodology is used that focuses on the implementation of complex algorithms. In some ways our approach does include elements of agile methodology, for example delivering multiple versions, rapid delivery and continuous enhancements. Overall however we strive to use a common sense approach that carries minimal overhead.

3. ISO Certification

We focus on ISO 9001: Quality Management System, sub-family 20252: Market, Opinion and Social Research, as it is the ISO family most closely aligned with the core business of a national statistical office.

3.1 Research process management system requirements

The Standard looks first at the organization's management framework. It looks for a governance structure that assigns responsibility for the management of processes and projects to senior level officials. It has specific requirements for the maintenance and archival of documentation (metadata) and data. It further stipulates security and confidentiality measures to be in place for the protection of metadata and data. The Standard includes competence and training requirements for staff as well as certain requirements specifically for sub-contracted workers.

At Statistics Canada the Policy Suite is a collection of governance instruments that describe our management practices. Principles and practices in the governance instruments are largely

coherent with the Standard's requirements, with some noticeable differences. For example, subcontractors or consultants employed by Statistics Canada are required to sign the Oath/Affirmation of Secrecy and abide by the Directive on the Use of Deemed Employees, rendering the application of quality management of subcontractors identical to that of Statistics Canada employees. In other instances, for example regarding confidentiality protection of respondents and security of data and metadata, Statistics Canada's practices exceed the Standard's requirements. Certification would be of little benefit and could potentially be harmful if it was interpreted as a relaxation of practices regarding confidentiality and data security.

3.2 Managing the Executive Elements of Research

This section of the Standard looks at how the organization manages client requests. In the Statistics Canada context this is interpreted as how we manage ad hoc survey requests. The Standard looks for client involvement in specifying needs, and a process to determine the availability of the necessary resources and expertise to carry out the project. All methodological aspects of the project are to be fully researched, documented and shared with the client, including the sample design, collection method, processing steps, schedule of activities and deliverables, and questionnaire design. The handling of documentation, analysis and reports is subject to constraints in terms of publication, retention, storage and disposal and security protection.

At Statistics Canada the Departmental Project Management Framework is a set of standard project management processes, templates and tools used throughout a project's lifecycle to initiate, plan, execute, control and close out the project. This framework corresponds well to the project management requirements of the Standard. Statistics Canada's Directive on Documenting Statistical Metadata is coherent with the Standard's documentation requirements. An area of Statistics Canada that could benefit from a stronger protocol however is the standardization of documentation of "briefings" (meetings) with clients (stakeholders), particularly at the stage of specifying needs and objectives.

3.3 Data Collection

This section of the Standard looks at fieldwork and those performing it, various data collection modes, and the handling of data from respondents and from other sources. The Standard has very detailed requirements for the recruitment, training and management of fieldworkers, as well as requirements for how they identify themselves to respondents and how they protect the confidentiality of collected data. The Standard also describes validation techniques for both the performance of fieldworkers and the data they collect. At Statistics Canada all collection activities are centralized under the Collection and Regional Services Branch, which includes a centre of expertise in collection planning, development and research. Essentially all of the requirements of the Standard regarding data collection are met or exceeded by our practices. One minor exception is that in the case of self-completed surveys, Statistics Canada does not provide an estimated survey length when participants are invited to complete the survey. An area where Statistics Canada exceeds the requirements of the Standard is data collection from secondary sources. We have numerous governance instruments on the use of administrative data, including the Policy on the Use of Administrative Data Obtained under the Statistics Act and the Directive on Obtaining Administrative Data under the Statistics Act.

3.4 Data Management and Processing

This section of the Standard pertains to all data handling activities that take place after data collection but prior to estimation. In particular, it looks at coding practices, data analysis, electronic data tables, and data security. The requirements are quite technical and detailed. Through the use of corporately supported software systems to perform editing, imputation, coding, record-linkage, weighting, estimation, disclosure control and tabulation, Statistics Canada meets or exceeds all of the Standard's requirements. In addition, the Directive and Guidelines for the Validation of Statistical Outputs is an additional step to assure the quality of data tables prior to dissemination.

3.5 Report on Research Projects

This section of the Standard looks at quantitative research, qualitative research and observational research, and has strict requirements for full disclosure to clients of all documentation describing the methodology, data sources, analysis methods, etc. In fact, the Standard stipulates that the documentation should be sufficient to allow the client to replicate the project at a later date. Statistics Canada does not do observational research. Qualitative testing is used primarily in the design of questionnaires, and full documentation is shared with stakeholders. The Directive on the Documentation of Statistical Metadata and the Policy on Informing Users of Data Quality and Methodology together prescribe a thorough list of metadata elements that are documented and made available to data users. However Statistics Canada does not share its sampling frames. Therefore in the strictest interpretation of the Standard's requirements, we are not compliant, choosing rather to protect the confidentiality of our population units and survey respondents.

4. Summary and Conclusions

The principles of Total Quality Management, Lean and Six Sigma are coherent with the core business of producing official statistics. We have found it beneficial at Statistics Canada to adapt these and other quality management strategies into our own set of principles and practices, enforced by our suite of governance instruments. While these governance instruments ensure that our practices are generally consistent with the requirements for Lean Six Sigma and ISO 20252, the gains of pursuing formal certification are not obvious. In our experience the key ingredients to successful quality improvement initiatives have been a clear governance structure, strong leadership, and well communicated common goals.

5. References

Beck K., Beedle M., van Bennekum A., Cockburn A., Cunningham W., Fowler M., Grenning J., Highsmith J., Hunt A., Jeffries R., Kern J., Marick B., Martin R.C., Schwaber K., Sutherland J. and Thomas D. (2001) Manifesto for Agile Software Development, http://www.agilemanifesto.org/iso/en/

ISO (2012), International Standard, ISO, Switzerland.

Juran J. and Godfrey A. B. (1951), Juran's Quality Handbook, McGraw-Hill, N.Y.

Lean-manufacturing-junction.com (2014), http://www.lean-manufacturing-junction.com/lean-manufacturing-principles.html

McSweeney, K. and Moore, K. (2015), Innovating to do more with less – the story of Lean Six Sigma in the Central Statistics Office, Ireland, Statistical Journal of the IAOS, vol. 31, no. 4, pp. 587-592.

Statistics Canada Quality Assurance Framework (2002), http://www.statcan.gc.ca/pub/12-586-x/12-586-x2002001-eng.pdf

Statistics Canada Quality Guidelines (2009), http://www.statcan.gc.ca/pub/12-539-x/2009001/introduction-eng.htm

The Define Measure Analyze Improve Control (DMAIC) Process, ASQ, http://asq.org/learn-about-quality/six-sigma/overview/dmaic.html

The Generic Statistical Business Process Model V.5 (December 2013), UNECE, http://www1.unece.org/stat/platform/display/metis/The+Generic+Statistical+Business+Process+Model

What is Six Sigma?, ASQ, http://asq.org/learn-about-quality/six-sigma/overview/overview.html

What is Total Quality Management (TQM)?, ASQ, http://asq.org/learn-about/total-quality-management/overview.html