Determining the financial value of process improvement – A systematic review

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Abstract
Relying on a systematic literature review, this paper investigates the extent to which the academic community has paid attention to how the financial value of process improvement can be determined for single firms. Searching for articles on Lean, Six Sigma, TQM, and JIT published over almost four decades reveals a marked paucity of work in this area. Furthermore, the works that do exist provide few details in regards to data used or bases for the calculations. Financial value determinations pose serious challenges if complete and accurate impacts are sought, and represent an area in need of more research.

Key words: Process improvement, Lean, financial value determination

Introduction
In this paper we look at how a single firm retroactively can determine the economic value of process improvement (PI). In particular, we assess – via a systematic literature review – how much attention the academic community has devoted to this question. The review confirmed our pre-conceived notion that although there is much talk about process improvement's impact on a firm's financials, there are very few accounts of how firms have determined the value of their PI activities, or how they should do so. We conclude there is a need to determine frameworks and templates for how a single firm can determine the value of its own PI activities.

On Process Improvement
Process improvement (PI): A process is *"any activity or group of activities that takes an input, adds value to it, and provides an output to an internal or external customer"* (Harrington, 1991, p. 9). To improve a process typically refer to activities that increases the value of the output – whether altering the input, changing the transformation process, or even adding metrics that assess the output. A value enhancement can mean one or more of the following: (1) to reduce the mean time to execute the process from input to output, (2) to reduce the variability around the mean process time, or (3) to improve the quality of the outcome of the process.

In the last four decades, the industrial world has faced a plethora of methodologies all aimed at improving the performance of organizations by improving the processes that design, manufacture, and/or deliver goods and services. In our systematic literature search we focus

on four major, well-known improvement approaches: Lean (Womack and Jones, 2003; Liker, 2004; Hopp and Spearman, 2004; deTreville and Antonakis, 2006), Six Sigma (Pande, Neuman, and Cavanagh, 2000; Schroeder et al., 2008), TQM (Dean and Bowen, 1994; Hackman and Wageman, 1995), and JIT (Sakakibara et al., 1993; Sakakibara et al., 1997). Although they have different names and acronyms, they are united by the paradigm that the performance of organizations can be made better by analyzing and improving work and business processes. Thus, process improvement (PI) is the focal point of all these methodologies.

Although we realize there are differences between the methodologies and their aims, our intent here is not to determine links between specific activities associated with each methodology for the purpose of determining which tools and techniques works best for which metrics in what contexts (Shah and Ward, 2007; Staats et al., 2011). Rather, as stated, our purpose is to study how one can determine economic value stemming from an application of an improvement methodology – regardless of which methodology is applied. Thus, we view economic value determinations of improvement activities as independent of any particular form of improvement methodology. We are from now on referring to all four approaches using the generic "PI" acronym.

Systematic Literature Reviews – An Overview

Literature reviews are part of any scholarly treatise, whether a term paper, a thesis, a book, or an academic article. While the general purpose may be the same, i.e., essentially to understand and clarify what type of research has been done to date in a specific field, literature searches come in different forms. The most common type is typically referred to as a traditional or narrative search (Tranfield et al., 2003) or as a subjective review (Fink, 2014). These types are done as part of an article or report. Here, the authors select a set of published work and briefly summarize them with respect to focus, methods, and findings – with the purpose of laying a foundation for the new research presented in the rest of the document. The search processes behind such selections are often not well explained, or even not at all, and the reviews do not claim to be comprehensive. As a result, they have been criticized for bias and lack of evaluation (Tranfield et al. 2003).

The second type of literature reviews – and the one we have adopted for this study – is the systematic literature review (SLR), also referred to as systematic synthesis (Rousseau et al., 2008) or stand-alone systematic review ("stand-alone" since systematic reviews are most often presented as pieces of research on their own and not part of other works; Okoli, 2015). Interestingly, Okoli (2015) ponders the meaning of "systematic," noting that some authors use this word as a way to classify literature reviews, while Okoli categorizes all reviews as being "more or less systematic." Although we agree that reviews can differ in the way they are conducted – a statement that also applies to SLRs – we feel that the latter term is widely used and accepted as referring to a special type of reviews (also Tranfield et al., 2003; Khan et al., 2003; Durach et al., 2017; Rousseau et al., 2008).

Reviewing past stand-alone reviews reveals several differences in structure and rigor. Based on readings of past review studies, two aspects that most clearly stand out are (1) how past research studies are selected for review and (2) whether the review is undertaken with a specific set of research questions in mind, or whether it mines the selected literature with the purpose of identifying themes or trends. Examples of the selection processes in the first area include pre-specifying a set of journals – often highly rated academic journals as a prior for

quality – and then manually screening them for articles that fit the search profile, and conducting searches of selected databases using carefully crafted search terms – possibly augmented with other searches, such as scanning retrieved articles' reference list, searching on Google Scholar, etc. (Okali, 2015).

These variations point to the need of a strict definition of a systematic review. Okoli (2015, p. 880), echoing Fink (2014), verbalize the requirements this way: *"A rigorous standalone literature review must be systematic in following a methodological approach, explicit in explaining the procedures by which it was conducted, comprehensive in its scope of including all relevant material, and, hence, reproducible by others who would follow the same approach in reviewing the topic."*

The most operational way of defining a review is by outlining a process and detailing the individual steps. Khan et al. (2003) lay out a detailed 5-step approach, Tranfield et al. (2003) suggest a 10-step process, Rousseau et al. (2008) a 4-step process, Denyer and Tranfield (2009) a 5-step process, Fink (2014) a 7-step process, Okoli (2015) an 8-step process, and Durach et al. (2017) a 6-step process. With those processes as a starting point, we formulated and followed a 6-step review process tailored to the peculiarities of our search. Comments on each step are found in subsequent sections.

The Detailed Review Process

Step 1 – Identify purpose and frame the research questions

The general purpose of this study is to develop an understanding of how one can determine the economic value of process improvement activities. In regards to the financial benefits of process improvement (PI), there are two broad questions we are pursuing here:

> Q1: How does one measure the post-implementation financial impact of PI projects for a single firm?
>
> Q2: What can we learn, via field studies, about the process of, and complexity and obstacles to, financial benefit determination in practice?

Step 2 – Select literature sources

For this study, we identified relevant articles using an electronic database search. The primary database was Proquest's ABI INFORM Complete. In cases where articles were not available in ABI INFORM, they were retrieved via links to other databases with which our university library has licenses. Thus, while the majority of articles were found in ABI INFORM, some were picked up from databases – with the two most frequently accessed being EBSCO and ScienceDirect. An important criterion for the searches was that we needed retrievals of full-length articles to be able to inspect the returned works. Cases where searches returned only abstracts were due to the university library's lack of licenses for full-text options.

Step 3 – Screen the literature (inclusion and exclusion)

The third step is where the raw number of entries in a database is reduced in accordance to the research questions posed and specified requirements that focus the search. This is a step calling for both inclusion and exclusion (Khan et al., 2003; Tranfield et al., 2003; Okoli, 2015). *Inclusion* refers to a primary selection of references based on applied search strings and imposed filters, while *exclusion* refers to a subsequent process of pruning the initial set of retrieved materials from the database using other criteria.

Step 3a: Inclusion

The two research questions posed earlier are generic and apply to a variety of contexts. We narrowed the search to manufacturing firms and their related supply chains. We also narrowed the search to documents in English, with publication dates in the period Jan 1, 1980 to May 1, 2017.

Although some sources on SLR, e.g., Tranfield et al. (2003) and Rousseau et al. (2008), propose identifying unpublished documents (the "grey" literature), we confined ourselves to works that have not just been published but also peer-reviewed and appeared in scholarly journals. This was done for two reasons. First, we hypothesize that academic work would be more honest, unbiased, detailed, and specific regarding the financial benefit determination linked to process improvement than works by practitioners. Second, we wanted to find out if the topic of economic benefit determination in PI contexts was one that had attracted scholars in the academic community. In all, we conducted searches with and without the following filters: Articles, Scholarly Journals, Peer Reviewed.

Although we chose to begin searching for full texts, our main searches were for reasons of quantity and efficiency restricted to the title and/or the abstract of the documents. This is because applying search strings to the full text of a document produced in our case such a large number of returns that it would be prohibitive for human reviewers to screen all documents by reading the full text versions (see the Exclusion step). Thus, while we in this study use the full text option for a few initial searches, the documents chosen for manual screening are found via a search of title and/or abstract only. Another argument for restricting the core searches to title and/or abstract is that we are looking for works on process improvement and its financial benefits. It is reasonable to assume that if that type of benefits play an important part in an article, this emphasis will be reflected in the article's title or abstract.

We partitioned the search strings into two parts – one characterizing the manufacturing context and the applied process improvement methodology (i.e., either Lean, Six Sigma, TQM, or JIT), and the other the financially-related search terms (for brevity, we refer to those as the "financial terms"). The database searches were then conducted – for each of the four PI approaches – with and without the financial terms. To illustrate, the two halves of the search string for Lean were as follows (when used, they are connected with the Boolean operator "AND"):

- PI and manufacturing context: ti,ab("lean manufacturing" OR "lean production" or "lean thinking" OR "lean six sigma" OR "lean tools" OR "lean methods" OR "lean methodology" OR "lean practices") AND ti,ab("manufacturing" OR "firm" OR "production")
- Financial terms: ti,ab("cost" OR "costs" OR "cost benefit" OR "cost benefits" OR "financial performance" OR "financial benefit" OR "financial benefits" OR "economic justification" OR "economic benefit" OR "economic benefits" OR "economic value" OR "revenue" OR "revenues") NOT ti,ab,su("costing")

Step 3b – Exclusion

It was discovered during the search that some returns from the databases did not provide a complete, full-length article but only an abstract. Since this prevented a detailed screening, those returns were eliminated. Further screening showed that several of the retrieved articles'

titles and/or abstracts mentioned multiple PI methodologies (e.g., both Lean and Six Sigma, both TQM and JIT, etc.). Such returns were consolidated so that duplicated articles were eliminated for the continued review process.

The pruned set of returned articles from each of the four main searches (i.e., Lean, Six Sigma, TQM, and JIT were then read in detail by two reviewers for additional classification and coding. To remain in the final sets, each article had to pass three tests: (1) Does it present and/or discuss financial costs/benefits of process improvement in one or more actual companies?; (2) Is the article about PI in a manufacturing environment (incl. product development and supply chain)?; and (3) Is it a scholarly article? A final check was done to exclude articles that were either fully conceptual without any empirical data, or whose main purpose was to introduce analytic models that could assist with PI analyses and decisions. Thus, model-based articles were excluded even if they used actual company data if the purpose was merely to illustrate model calculations.

Step 4 – Appraise quality of remaining studies

This is an exclusion step where work considered inferior from a methods perspective are removed from the pool of papers to be reviewed in detail (Okoli, 2015; Khan et al., 2003; Fink, 2014). This type of screening must be fitted to the type of studies reviewed.

In this study we did not directly screen for quality of method, but for type of method used in the studies. A quality-based evaluation of the studies was later done as part of Step 5.

Results from Search and Screen (Steps 3 and 4)

Results from Step 3a

The initial search results for the four process improvement methodologies tell a revealing story about the lack of serious attention paid by academics to financial benefits of PI. First, full-text searches on the four methodologies without any restrictions returned a total of 131,569 documents from the time span lasting from January 1, 1980 through May 1, 2017. Restricting these searches to include financial terms anywhere in the document brings this number down to 101,143. This means that about 77% of all documents during this time period contain references to, or discussions of, financial impact. Narrowing the search further by requesting articles that are peer-reviewed and scholarly lowers the number of returns to 26,271 articles. This means that scholarly articles on PI that also *mention* some form of financial benefits represent 20.0% of all documents published on the four methodologies.

As stated earlier, we adopted the view that any article serious about PI's financial performance picture would also include financial terms in the title and/or the abstract. This criterion sharply reduces the number of articles from 26,271 down to 677 if the terms are found in the title and/or the abstract. This latter finding – which represent the starting point for our qualitative screening (see next section) – shows that scholarly articles that have found the financial impact of PI methodologies important enough to mention it in their titles or abstracts represent a meager 2.58% of all scholarly articles written about Lean, Six Sigma, TQM, and JIT in the last four decades. As will be seen in next section, this fraction is in reality even smaller due to misclassifications or not meeting our criteria that the articles discuss actual PI results from manufacturing companies.

Results from Step 3b

The 677 articles – spread out over Lean, Six Sigma, TQM, and JIT – were manually screened to see if the search had returned articles valid for our purpose. Of the 677 returns, 45 were duplicates (i.e., the article was also found in one of the other three searches). Further, an inspection of the remaining returns showed that in 99 cases the databases did not contain full-length versions – preventing further screening. A detailed reading of the remaining articles showed that 319 did not discuss financial outcomes of process improvements, the context in 50 of them were not manufacturing, and 46 were not deemed to be scholarly works. With some articles failing more than one these three tests, a total of 339 articles were excluded – leaving 194 articles. Finally, 104 of these were classified as conceptual or model-based, leaving 90 articles in the final set – amounting to 13.3% of all 677 articles.

Results from Step 4

Based on Step 3's inclusion/exclusion process, we divided the final set of 90 articles into 27 micro studies and 63 macro studies. The first cluster encompassed case studies of firms undertaking improvement projects (micro studies). The second cluster consisted of studies of firm populations where the financial outcomes are linked to the firms' degree of adoption of PI practices (macro studies). These two types of studies are methodologically different, with micro studies being single-firm field studies using primary data – but often undertaken without addressing any articulated research question – and the macro studies representing research using primary and/or secondary data with the aim to unravel any statistical links between PI activities and financial outcomes.

Based on our stated research questions, we will here only discuss micro studies – leaving an analysis of macro studies for the future.

Analysis and Synthesis of Retrieved Micro Studies (Step 5)

We began by classifying the 27 micro studies as either *prospective* vs. *retrospective* in regards to financial impact assessment. As it turned out, all studies reviewed were post-implementation studies (in other words, none of the studies described an analysis that projected future economic impact preceding the implementation). In the continued detailed reading, screening, and coding of the 27 micro studies, we considered the following questions to characterize the studies:

- Are single or multiple projects analyzed?
- What types of financial impact are claimed?
- Is the article clear with respect to definitions of variables and determination of financial impact?
- Is the cost to achieve any claimed benefits mentioned in the article?
- Was Accounting or Finance involved in the financial benefit determination or validation?
- Does the article discuss any issues or complexities involved with financial benefit determinations?

We observe the following from the close reading of the 27 articles, while addressing the above questions:

a) There is an almost even split between articles analyzing single vs. multiple projects. Studies discussing multiple projects were all longitudinal in nature.

b) Process improvement's emphasis on reducing cost is dominant (23 of 27 articles discussed cost reduction), and this was the sole focus of all single project studies.
c) The set of outcome measures gets somewhat broader in studies looking at multiple projects. Here, impact on profit, cash flow, and cost avoidance are claimed – in addition to cost reduction. Cost avoidance was a listed benefit for one firm that decided to build its own machinery rather than procuring it from machine builders (see Amin et al., 2013), while freed cash flows were claimed via inventory reductions in three firms (see Billesbach, 1994; Kaplinsky, 1994; and Mistry, 2005).
d) As part of the review process, we assessed whether resources affected by the process improvement were clearly identified, whether the articles listed the sources of the data, whether cost or benefit determinations were presented in adequate detail, whether gross benefits were determined and presented, and, finally, if the article presented financial impact while also including the cost of undertaking the process improvement activities so net benefit could be determined.

   In two-thirds of the articles the determination of individual costs or benefits were either not presented, or presented in such a fuzzy way that makes replicability difficult or even impossible. In addition, determination of gross benefits was absent in over half of the studies. Finally, while one-third of the studies mentioned various costs of undertaking improvement projects and/or implementing the solution, only four of those presented any quantification of such costs.
e) We also looked for two other aspects in regards to financial impact determinations. The first was whether the article mentioned and/or discussed the involvement of Accounting or Finance staff, and the second was whether the article stated any problems, difficulties, or concerns in regards to the financial impact determination process. Only one of the articles made any comments regarding the impact determination (Kaplinsky, 1994), and only two alluded to any involvement of Accounting or Finance staff (Mistry, 2005; Rodin and Beruvides, 2012).
f) A final part of our screening process was a subjective quality grading of each article in regards to its perceived value in providing insights into the financial impact determination process, or serve as templates or models for such a process. A 5-point scale was used, with 5 = very valuable, 4 = valuable, 3 = moderately valuable, 2 = minimal value, and 1 = no value. Our scoring here is clearly highly personal, but it forced us to sharpen our opinion of each article's contribution by using quantification. Only three articles were in our view "very valuable" in that they provided detailed insights into the financial determination process

Discussion

Two broad issues emerge from our review: Why is the process of determining the financial implications of PI so rarely discussed in the scholarly literature, and does it matter? We discuss each issue in turn.

The rarity of financial benefit determinations in the literature

The scarcity of scholarly works undertaking financial analyses of project improvements could be attributed to various forms of bias affecting the search process (i.e., we may have missed important articles in our search). However, that may not be the whole story. One additional reason can be that companies may be unable to retrieve relevant data, simply

because they have not been tracked in sufficient detail. Although post-audits (Anbaria et al., 2008; Neal and Holmes, 1990) typically are connected with capital investments, and most PI projects do not fall under that banner, a parallel can be drawn between post-audits and retrospective PI analyses. First, research shows that post-audit usage is inconsistent among firms (Linder, 2005; Clarke et al., 2015). Second, while there are many reasons for that, the most common appears to be problems linking costs and benefits to individual projects, difficulty in getting data for post-audits, lack of qualified personnel to undertake such audits, and the reluctance of managers to cooperate (Linder, 2005; also see Wageman and Hackman, 1995). That said, we venture to guess that another important reason is that the authors of most of the studies we looked at were more interested in documenting the improvement process itself, and the mechanics of undertaking it, than in the financial outcomes.

Does it matter if the economic value of process improvement is undetermined?

The scarcity of descriptions of economic value determinations in the literature, coupled with our discussions with various managers on this topic, have led us to believe that formal determinations are, in fact, quite rare in practice. In most of the articles we reviewed we also note that the financial value determination is almost perfunctory and not the main focus on the articles (again, only two articles focused exclusively on economic impact: Browning and Heath, 2009, and Rodin and Beruvides, 2012). This raises a relevant question: Does it matter that we do not know more about how to determine PI's economic value for the single firm?

Although we want to believe in the wisdom of the crowd, we suspect that many managers struggle with the notion of PI's economic value and want to understand how to systematically think about, and act in line with, a value determination process. Further, in the short run it is fully acceptable for an organization to view a PI project as R&D, and to spend money to learn about how to plan and execute such projects without demanding a short-term payback. However, one would expect that an organization that repeatedly engages in PI wants to verify whether such projects are economically viable for the organization. For example, individual firms can perform poorly with respect to economic outcomes from PI activities. One reason may be that they overspent on implementation (consultants, training, new equipment, etc.; Browning and Heath, 2009) and on maintaining the system (e.g., PI staff; Rodin and Beruvides, 2012). Of special interest is the case of an organization that adopts an organization-wide improvement system. Tied to such meso-systems (Schroeder et al., 2008) are commonly a central staff of PI experts. One question to answer in that context is how large should a staff office be for maximum economic value, and how should that number change over time given that employee learning takes place?

Conclusions

We began this study after having observed that works dealing with process improvement activities – whether based on Lean, Six Sigma, TQM, or JIT – mention both non-financial and financial benefits, but although the former (operational benefits) get vast coverage, it is difficult to find in-depth discussions of financial performance and the process of determining impact. A strong impetus for our study was, thus, to be able to make solid and supported claims that this perceived omission in the literature was in fact real.

There is a clear need for more research specifically dedicated to the financial value determination. In this context Browning and Heath (2009) is the only paper focused on theory building through its model of how Lean contributes to cost. Undertaking retrospective

economic evaluations is difficult and hindered by factors such as temporal influences, uncertainty about causality, and data gaps. However, the development of templates for how such evaluations can and should be done is a worthy goal that can help any company involved with process improvement to better judge the economics of its improvement activities.

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