Assessing the Value of Process Improvement Suggestions

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Abstract. Firms struggle to estimate the expected benefits of improvement suggestions. As a result, pointless or even damaging suggestions are sometimes implemented at the expense of potentially valuable improvement suggestions. This paper reviews, discusses, and advises on the use of available value assessment methods. Thereby, the paper contributes to the production improvement literature and practices with an overview and classification of common value assessment methods.

Keywords: Continuous improvement; Manufacturing cost deployment; Kaizen

1 Introduction

The ability to continuously identify and implement improvement suggestions is a hallmark of successful organizations. In the lean literature and practice, the term *kaizen*—meaning change for the better in Japanese—is established as the reference method [1, 2]. It involves regular improvement workshops (known as quality circles [3], kaizen blitz, or kaizen bursts), the continual encouragement of improvement suggestions from all employees (sometimes referred to as a continuous improvement culture [4]), and large-scale improvement projects (known as *kaikaku* [1]). While kaizen, by definition, should improve performance, it is often unclear if and how much it does. How the potential gain from a kaizen activity should be measured has been an enduring challenge.

Evaluating production improvement suggestions is a frequent task in manufacturing, but it is usually less rigorous than it should be. Often, managers select improvement projects by taking a leap of faith. In other cases, middle managers battle for the attention and investments of senior management by writing up speculative business cases for their proposed improvement projects. As a result, firms spend a great deal of money on useless improvements, fixing issues that are non-critical or have low or no effect on factory performance. The literature has suggested some structured methods to overcome this challenge, but few are well-known and generally accepted.

It is arguable that a priori value assessment is of less importance because any kaizen is good by definition, and companies should take all the opportunities they can. However, this viewpoint is misguided for four reasons. First, companies operate under financial and resource constraints, which creates alternative costs for each investment. Hence, companies should not choose *any* project but the improvements that matter the most for the firm's strategic objectives (e.g., revenue growth; cost reduction; or meeting strategic goals related to sustainability, social responsibility, or other issues). Second, not all intended improvements are effective; sometimes, instead of making things better, changes make things worse (known as *kaiaku*) [5, p. 142]. Besides wasting resources before and after such changes, such results are detrimental to the further motivation of a continuous improvement culture. Third, companies can use quantified improvement data to prescribe the value of new improvement suggestions [6]. Finally, convincing skeptical senior managers to invest money and resources in an improvement project often requires some kind of estimate of its cash flow—even if it is purely based on speculation. Even if one agrees or not with the ubiquitous tendency to measure everything, metrics are part of modern management.

There are plausible reasons why companies do not use rigorous value assessment methods. On the one hand, it is very difficult to correctly assess the cost reduction or revenue growth potential of improvement suggestions. It is also often difficult to assess the cost of implementing the suggestion. On the other hand, for small improvements, a rigorous process may slow down the improvement pace or discourage suggestions from employees. For these reasons, it is not clear when and what form of value assessment methods should be used to support the selection of suggestions for implementation. The challenge is to professionalize the selection method while simultaneously sustaining or growing the improvement culture.

If value assessment is crucial to improvement activities, why does the literature not offer a standard method for it? We assume this is because it is very complicated to take into account all the different requirements and contextual variables needed. Nevertheless, engineers, management researchers, and economists have come up with a range of methods that are used to assess the value of improvements at different stages of pre-implementation. In this paper, we review common value assessment methods from the literature and practice. Additionally, we advise managers on when and how to assess the value of process improvement suggestions.

2 Existing value assessment methods

Not surprisingly, companies that use objective prioritization methods report a higher success rate for improvement projects compared to those companies that exclusively use subjective methods [7]. The lack of structured project selection methods leads to lost opportunities, sub-optimization, and inefficient resource allocation. In our review of the literature—and drawing on our insights from working with many manufacturing companies—we found only a few established objective value assessment methods for improvement projects. We discuss these methods in terms of their reliance on different types of qualitative and quantitative data: arbitrary methods (Level 0), qualitative methods (Level 1), operational methods (Level 2), and financial methods (Level 3). Figure 1 illustrates these levels and the typical forms of decision support measurements they involve. These methods are cumulative; financial metrics (in dollars) are derived from operational metrics (changes in time use, quality, etc.) based on some qualitative judgments (e.g., what metrics are recorded), which are influenced by individual judgments.

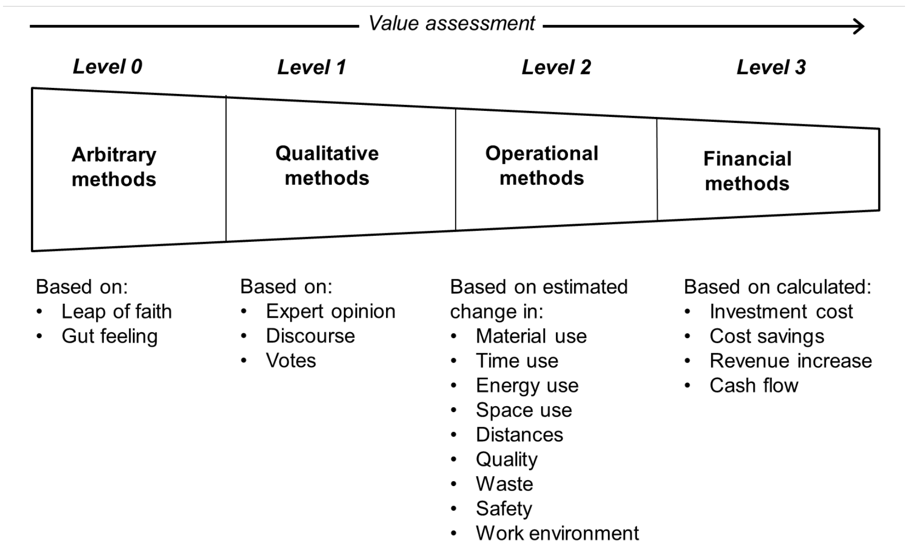

Fig. 1. Levels of value assessment.

We briefly discuss a few common qualitative methods that are used at Levels 0 and 1 before reviewing in more detail objective assessment methods at Levels 2 and 3. At Level 2, companies use operational metrics. For example, suggestion X is expected to reduce material losses by 5% or suggestion Y is expected to decrease energy usage by 3%. While quantitative metrics like these can be convincing, they are incomplete. The financial metrics of Level 3 ultimately provide answers to the question: What will be the return on this investment?

2.1 Arbitrary methods (Level 0)

At Level 0, projects are started purely based on a gut feeling or leap of faith. This complete lack of an objective assessment methods may be justified if the cost of applying the methods would be higher than the expected benefits. Sometimes, the simple rule of thumb is applied to inform the decision to implement or not. For example, 'if an improvement suggestion X makes the workplace more compliant with a certification Y, then it should be implemented.' While this type of value assessment is quick and simple, it risks being incorrect or ineffective.

2.2 Qualitative methods (Level 1)

At Level 1, an elaborate qualitative assessment is conducted that informs the expected effectiveness of suggested improvement ideas. An example is to ask experts if the suggestion has been successful elsewhere in the past. Another example is to ask a larger group of stakeholders their opinion and discuss the advantages and disadvantages or to organize some sort of voting system. Often, suggestions are sorted qualitatively into a prioritization matrix comparing difficulty versus benefit (i.e., a pain/gain matrix).

2.3 Operational methods (Level 2)

We identified four prominent operational methods:

1. Manufacturing cost deployment (MCD): focus on process losses,
2. Material flow cost accounting (MFCA): focus on material flow losses,
3. Kaizen costing: focus on product cost drivers, and
4. Value stream mapping (VSM): focus on system flow improvement.

The first operational method, MCD, assigns costs to the root causes of losses in a manufacturing process and sorts the losses according to the potential effects of improvement [8]. Systematically selecting projects that eliminate the root problem—rather than the symptoms—can contribute to a sustained reduction of production costs. This method is based on a series of spreadsheet matrixes labeled A to E: The A Matrix identifies and quantifies losses in a manufacturing system, the B Matrix clarifies cause-and-effect relationships, the C Matrix connects losses and manufacturing costs, the D Matrix connects causal losses and improvement techniques, and, the E Matrix identifies benefit values and establishes the cost-reduction program. MCD follows a seven-step roadmap [9] from identifying and categorizing losses to selecting improvement projects based on a total cost–benefit analysis. Although the seven steps are straightforward, MCD is an advanced improvement technique, which requires input from both the accounting and production departments. Since it is based on loss calculations, this method is most useful in a technology-intensive environment. MCD is an integrated part of the world class manufacturing program developed by Prof. Hajime Yamashina at Kyoto University and championed by leading automobile companies such as Fiat Chrysler and IVECO.

The second method, MFCA, is an environmental management accounting tool originally proposed in Germany and further refined in Japan, the application procedure for which was standardized as ISO 14051 in 2011 [10]. This six-step method systematically reveals losses and material usage wastes in a manufacturing process and evaluates them in terms of material, energy, system, and waste management costs, thereby supporting improvement projects targeting these losses and wastes. Hence, it focuses only on the physical material flow (and losses) throughout the manufacturing processes. As in the case of MCD, this method needs both operational and accounting data. MFCA has been used to support process improvement in many firms [e.g., 11].

The third method, kaizen costing [12-14], applies to products in the manufacturing phase (as an extension of target costing in the product development phase). When using kaizen costing, firms define a competitive cost for a product and then break the costs of producing it into seven categories: supply chain (including materials); manufacturing; waste; disposal; legal; recruitment; and marketing, sales, and distribution costs. In kaizen costing, cost reduction targets are set regularly (e.g., every month), and teams work to reduce any of the products' seven cost categories. Kaizen costing is a method for involving all employees in the continuous pursuit of cost reduction.

The fourth method is the well-established VSM. The goal of VSM is to visualize the flow of a product from the supplier to the customer through the different processing steps of the plant [15]. VSM draws a map of all the processes and transport for a specific product family. Thereby, it creates transparency about the value adding and non-value adding activities, and the user can derive improvement suggestions, which are visualized as kaizen bursts in the visual map. These improvement suggestions mainly intend to eliminate the non-value adding time and thereby decrease the lead time. However, there is no intention in VSM to combine these suggestions with a cost dimension.

For all these operational methods, the analysis is mainly performed in the operational layer and reveals operators' non-value adding actions, losses of material usage and machine time, and their physical amounts. Improvement suggestions are derived from the potential elimination or reduction of those non-value adding elements. Only by estimating the potential economic effects of eliminating or reducing wastes can these elements be translated into costs with the help of accounting data. Although MCD, MFCA, and kaizen costing calculate cost reduction estimates in monetary terms, these methods are only able to estimate improvements to the *current* production system (kaizen) and not to innovations that are radically new to the system (kaikaku).

2.4 Financial methods (Level 3)

Ultimately, to support an improvement idea, managers want to know how much cash must be invested and how much cash will be received and when. In the field of project finance [16], several approaches are commonly used to evaluate the economic potential of a project. A set of these methods is static, which means that they do not account for the change in values over time. These methods are simple and do not have complex formulas. However, they lack precision in calculating the return. For instance, the break-even point (or payback period) looks at how long it will take for the investment in the improvement to amortize (as a rule of thumb, a payback period longer than 3 years is a hard sell). The return on investment (ROI) can be used to define the invested resources in relation to the expected outcome. It is calculated by dividing the net profit (expected revenue minus expected costs) by the expected costs in order to get a return rate. An alternative to ROI is the internal rate of return (IRR), which is more complicated to calculate but take the time value of money into account.

The second set of methods is dynamic, which means they take into account the potential change in value over time. An example is the net present value (NPV), which compares the monetary inflow with the monetary outflow over time. There are alternatives to this model (e.g., the internal rate of return), all of which are based on the same underlying logic. If there are many projects being proposed, a profitability index calculating the NPV per dollar investment can be used to prioritize and select among them.

In addition, and often based on the method above, numerous sophisticated mathematical optimization models for project prioritization have been suggested in the literature. However, these advanced models find limited use in practice because they are context specific, managers do not understand them, or the model assumptions do not hold.

3 Decision support model

Improvement suggestions can be very different in scope and impact. They can range from taping the floor to mark the place of a fire extinguisher to changing the layout of a value stream. We posit that the optimal method to evaluate improvement suggestions depends on the type of suggestion. To cluster the improvement suggestions, we differentiate them into two dimensions: impact and scope (see Figure 2).

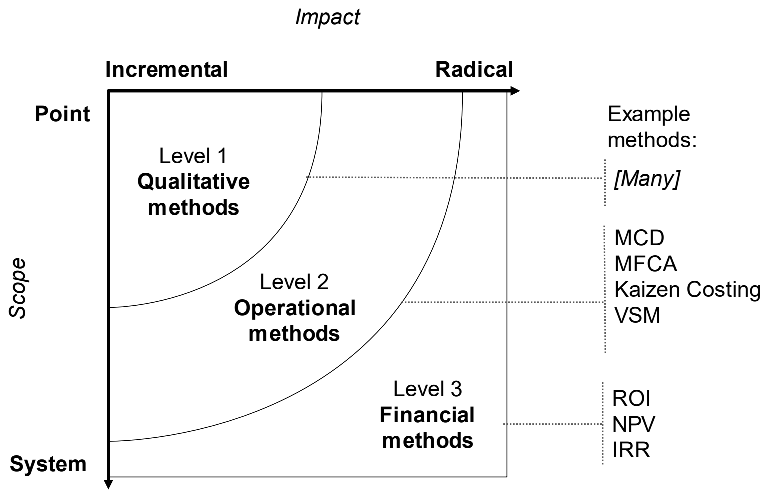

Fig. 2. A decision support model for when to prioritize different value assessment methods.

The impact dimension (along the horizontal axis) captures the magnitude of the change. A suggested change can range from incremental (kaizen) to radical (kaikaku). An incremental change would introduce small improvements to an existing system, for instance, changing the location of boxes of screws at an assembly station. A radical suggestion would fundamentally change the process, for example, by automating the screwing process or eliminating the need for screws through a change in the product design.

The scope dimension (along the vertical axis) captures the focus of the improvement. This can range from a point improvement to a system improvement. Point improvements have limited influence beyond the single process or activity improved. System improvements refer to holistic change at the system level, including several processes. For example, consider the redesign of a product where its previously separate parts can be produced in one piece with additive manufacturing. This suggestion would involve many processes in the value stream.

For incremental point improvements on the shop floor, qualitative methods are sufficient. Using a qualitative method helps to motivate and encourage employees to come up with many small improvements. However, if the suggestion becomes more radical or system oriented, operational methods are needed to justify and assure worthwhile investments. Finally, if the suggestions are both radical and system oriented, financial methods need to be used to calculate the hard financial returns of the suggestion.

When using this decision support model, practitioners should consider a range of contextual variables that may affect the choice of using a particular value assessment method. In particular, they should pay attention to existing value assessment practices, managers' affinity for quantitative metrics, data availability, the organization's experience in continuous improvement, resource accessibility (cash, time, and people), and number and quality of improvement suggestions raised. For example, if an organization has no culture for improvement suggestions, using qualitative assessment methods (Level 1) can encourage the kaizen culture to develop. More advanced firms would typically move toward quantitative methods (Levels 2 and 3).

Some mature, lean firms try to assist project selection by moving from traditional accounting to lean accounting. Traditional accounting practices have been criticized for not being able to capture the value of improvement projects besides simple cost-cutting point improvements (e.g., automation of a manual process). As a response, the lean accounting literature has suggested ways to allocate costs to product streams rather than functional cost centers [17]. In the general accounting literature, similar concepts such as activity-based costing (ABC) are well-known but still not widely adopted (a recent survey found that only 18.7% of Irish firms have moved from traditional accounting to ABC [18]). The accurate allocation of overhead to product streams remains one of the main difficulties with ABC. If properly implemented, lean accounting (or ABC) can be used to directly identify improvement potential. ABC can demonstrate how profitable different product streams are to the firm, and the company can use this information to prioritize the improvement of the streams with the highest return. It has been shown that companies that use ABC have a higher improvement rate than companies with traditional accounting systems [19].

4 Conclusion

This paper presented a review and discussion of common value assessment methods used in manufacturing improvement activities. We derived four levels of assessment methods (see fig. 1): no method, qualitative methods, operational methods, and financial methods. Managers can use these assessment methods to assist and increase the effectiveness of decisions related to improvement suggestions. We suggested a simple framework to help practitioners select among the different methods based on two characteristics of the improvement suggestion: its impact and its scope (see Fig 2).

Managers must be aware of the limitations of the available methods. For example, all quantitative models have problems cost setting soft issues related to human factors and the work environment. Issues related to risk and safety, for example, would usually not be picked up by cost–benefit assessments alone. It is also important to remember that even the most advanced quantitative methods represent simplifications of real-world systems. Moreover, all methods can be manipulated by users who have particular agendas or incentives. It is perhaps pertinent to close with the following quote from W. Edward Deming: "No one knows the cost of a defective product – don't tell me you do. You know the cost of replacing it, but not the cost of a dissatisfied customer" [quoted in 20].

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