A focus on sustainability as a core value

Building best environmental, social practices into project improvement yields many benefits

By Nadiye O. Erdil

To instill sustainability into our mindset and day-to-day operations, we should go beyond projects solely focusing on sustainability and include one or more sustainability goals in every improvement project.

There is a growing emphasis on the concept of sustainability due to, among other things, increasing public interest, regulatory pressures and corporate social responsibility. Sustainability refers to development efforts and practices that target a balance between the environmental, economic and social needs of the present as well as future generations.

The environmental aspect examines activities and practices related to the use of natural resources, energy consumption, ecological health and pollution. The economic aspect covers strategies that promote economic growth and profits, cost savings and research and development. And the social aspect focuses on the needs of the individual and the communities and includes areas such as standards of living, resources for education and jobs, empowerment and health and safety.

While this triple bottom-line approach captures three focus areas – also known as the three P's: people, planet and profit – the environmental facet of sustainability, followed by the economic, have been the most addressed areas. The manufacturing industry is a perfect illustration of this tendency. The term "green manufacturing" is often used interchangeably with the concept of sustainability when, in fact, green manufacturing refers to methods and strategies that are mindful of environmental impacts. Nonetheless, companies are taking on more and more sustainability projects than ever before and using lean and Six Sigma in these efforts is becoming popular.

Research in this field presents attempts at developing frameworks for seamless integration of lean, Six Sigma and sustainability. These frameworks are mostly developed for managing sustainability projects in which primarily lean and Six Sigma tools are used to attain the project goals.

While this approach generates progress towards sustain-

TABLE 1

Five-step structure

Steps of the DMAIC process together with commonly used lean and Six Sigma tools.

Define	Measure	Analyze	Improve	Control
Develop project charter including problem statement, goals, critical-to-quality requirements, team members and responsibilities, and resources; map the process.	Establish performance metrics; validate measurement system; collect data; determine process baseline.	Analyze data to identify sources of variation and waste; examine the process to identify root causes.	Develop and evaluate solutions; implement selected alternatives.	Verify improvements; develop standards and procedures; develop and implement control plans.
✂ Project charter ✂ Process map ✂ SIPOC ✂ Voice of customer ✂ Stakeholder analysis ✂ Kano analysis ✂ Critical-to-quality tree ✂ House of quality	✂ Key performance indicators ✂ Value stream map ✂ Check sheets ✂ Histogram ✂ Run chart ✂ Process capability ✂ Measurement system analysis	✂ Spaghetti diagrams ✂ Cause and effect diagram ✂ Pareto chart ✂ 5 Whys ✂ Hypothesis testing ✂ ANOVA ✂ Scatter plots ✂ Regression analysis	✂ Prioritization matrix ✂ Risk analysis ✂ Mistake proofing ✂ Visual management ✂ Design of experiments ✂ Failure mode effects analysis ✂ Standardization	✂ Control charts ✂ Dashboards ✂ Audit plans ✂ Performance management

ability, the concept of sustainability and all its aspects needs to be integrated into the mindset and day-to-day operations of organizations for accelerating its adoption, and a different approach is needed. The wide coverage of lean and Six Sigma, their effectiveness record and overlap with sustainability goals establish a foundation for expanding these methodologies to include sustainability concepts in any improvement project. Embedding sustainability goals in smaller scale lean or Six Sigma projects as an alternative to executing large projects with only a sustainability scope can generate a catalyst for system level change. Industrial and systems engineers can be the key drivers in facilitating integration and adoption of sustainability.

Lean generates value by improving process flow and lead-time through identifying and reducing waste from the process. Six Sigma creates value through consistent process output by identifying and reducing variation. Lean Six Sigma is a new generation quality improvement tool that combines the two approaches. Fewer defects and rework, lower levels of inventory, faster production, less space requirement, less transportation, less waiting and increased employee motivation are among its benefits.

To this end, there are significant overlaps between lean and Six Sigma and sustainability in terms of intended goals. Embedding sustainability goals into improvement projects such as productivity improvement, quality improvement, improving logistics, streamlining business operations or reducing costs will lead to transformation that will come as small changes with a focus on improvement in general, but with sustainability as one of its ingredients. Including one or more sustainability goals in every improvement project, not just in projects solely focusing on sustainability, will increase the adoption of sustainability metrics and principles.

Given the nature of lean and Six Sigma projects, whether intended or not, almost all produce sustainability improvements as a byproduct. It is the logical next step to systematically embed sustainability goals and metrics into the lean and Six Sigma framework. Such an approach can piggyback on the success and industry embracement of lean and Six Sigma to ensure wider adoption.

Embedding sustainability in lean and Six Sigma: The model

Lean and Six Sigma have been adopted across all industries, not just in manufacturing, as successful methodologies. The five-step DMAIC process (define, measure, analyze, improve, control) provides a structured approach that incorporates a wide range of lean and Six Sigma tools in a goal-oriented manner in management and execution of improvement projects (see Table 1).

This structured approach lays the foundation for systematic integration of sustainability concepts into the framework. Figure 1 shows the steps to take in addition to the traditional DMAIC tasks.

Aligning the sustainability goals of the company and the goals of the improvement project is essential for success; thus, determining the sustainability needs and priorities of the company is a prerequisite. Table 2 (Page 37) shows a list of sustainability indicators commonly used in industry. Any pri-

FIGURE 1

Integrating sustainability into DMAIC

These are steps to take in addition to the usual DMAIC model.

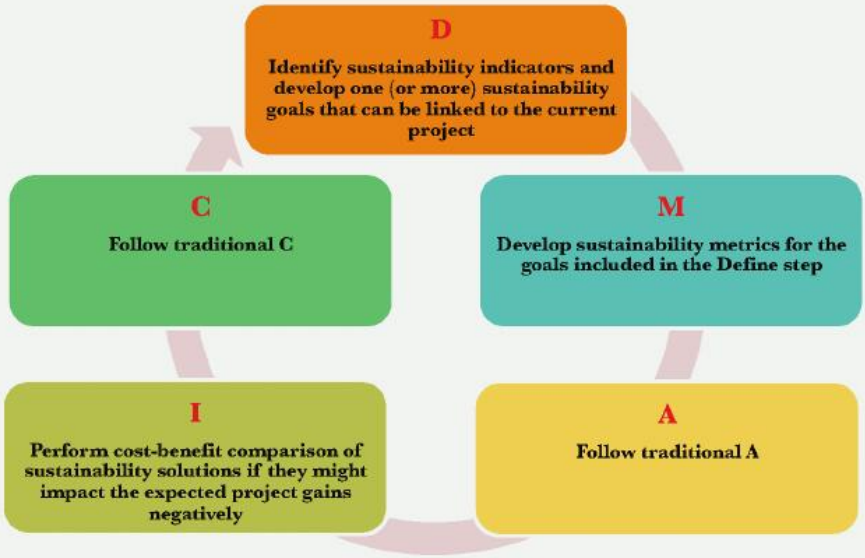
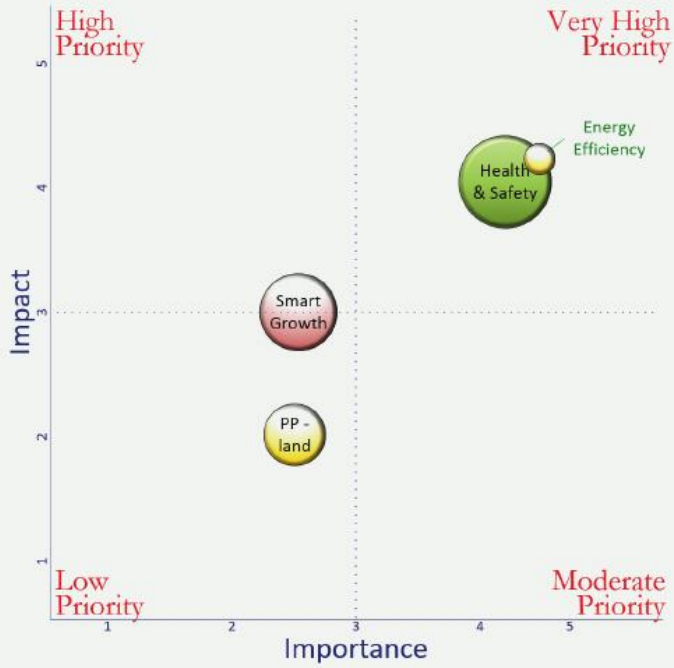


FIGURE 2

Setting priorities

The sustainability indicators priority chart rates efforts based on their importance and impact.



oritization method can be employed. Figure 2 shows a sample priority chart that visually displays an importance-impact-implementation assessment. The X-axis in this chart shows the importance of the indicator, and the y-axis shows impact. The size of the bubbles represents the difficulty in implementation. The larger the bubble the easier the item is to tackle.

The first activity in integration efforts is to select sustainability indicators that can be linked to the project goal(s). This is where the visual mapping of sustainability assessment in Figure 2 will steer the efforts. The sustainability indicator selected will depend on the nature of the improvement project; however, as a rule of thumb, the improvement teams should focus on larger bubbles first and simultaneously consider the items in higher priority regions.

After the sustainability indicator(s) is selected, sustainability goals and metrics have to be added to the project. In some cases, sustainability goals will already be in alignment with the project goals. In other words, the lean and Six Sigma project goal can be a sustainability goal even if it is not labeled as such. In other cases, additional goals will be added to the project to cover a sustainability aspect.

Avedis Donabedian's (1966) triad of quality indicators – structure, process and outcomes – was originally developed to examine health services and evaluate quality of healthcare and provides a comprehensive approach in developing goals and metrics with the focus on the whole instead of the end result.

- Structure measures evaluate the adequacy of the environment and include items such as facilities, equipment, procedures, human resources and leadership.
- Process measures assess the quality of activities, i.e., whether they are performed satisfactorily, such as the level of compliance to existing policies, accuracy of diagnosis, etc.
- Outcome measures evaluate the results such as patient experience, complication rates and mortality rate.

This approach is highly comprehensive and useful in developing sustainability goals and metrics, and later for identifying areas of improvement. Furthermore, this approach can help overcome the issues in implementation of sustainability, including the almost sole focus on environmental and economic aspects overlooking social sustainability.

TABLE 2

Setting priorities

Common sustainability indicators used by companies.

Environmental	*Social*	*Economic*
Energy efficiency/consumption	Health and safety	Consumption patterns
Efficient use of natural resources	Standard of living	Distribution of wealth
Pollution prevention - emissions to air	Education and skills	Research and development
Pollution prevention - emissions to water	Employment (retention, loss of talent)	(New processes and
Pollution prevention - emissions to land	Community	products, technology)
Waste management	Diversity and equity	Revenue generation
Efficient use of materials	Identity	Smart growth

TABLE 3

Goals, outcomes mapping examples

From "Reducing Welding Defects in Turnaround Projects: A Lean Six Sigma Case Study," Nicole Anderson and Jamison Kovach.

Lean Six Sigma project goal: Reduce unexpected downtime in turnaround projects
Measurable goals: Reduce the average weld repair rate

Sustainability indicator	**Structure (resources)**	**Process (Delivery)**	**Outcomes (results)**
• Health and safety (social) • Education and skills (social) • Pollution prevention – emission to air (environmental) • Energy efficiency (environmental)	• Company policies on hazardous materials • Energy use monitoring system	• Documentation of health effects of welding material (gases and fumes) • Percentage of welders that are ranked by American Welding Society classifications • Energy conservation practices	• Percentage of substitute material used to minimize the hazards of welding material • Percentage of welders trained to improve skill levels • Amount of energy usage

As an example, Table 3 shows sustainability goals and outcomes mapping applied to a lean Six Sigma case study by Nicole Anderson and Jamison Kovach to demonstrate the integration of sustainability indicators into improvement projects and the use of structure-process-outcomes measures approach to develop sustainability goals and metrics.

Once the goals and metrics are identified, they must be made visible and recognizable to the team members throughout the project lifecycle so the improvement efforts encompass the attention required for attaining sustainability goals as well. Therefore, the goals and metrics should be integrated into the lean and Six Sigma tools.

Take a value stream map (VSM), for example, a commonly used tool in lean and Six Sigma projects. The sustainability indicators can be added to the VSM in three ways: 1) as a kaizen event, 2) in the timeline and 3) as part of the data box. Figure 3 shows a sample VSM with the possible locations for integration of sustainability goals and metrics. In this VSM, the kazien event focuses on energy use, while the water use is monitored throughout the process in the timeline and the number of trained employees are captured for each process step in the data box.

In the case of traditional process maps, the sustainability goals and metrics can be added by color-coding the process blocks. With attention to the structure and purpose of a particular tool, any can be tailored to capture sustainability elements in the project.

Analyze, improve and control

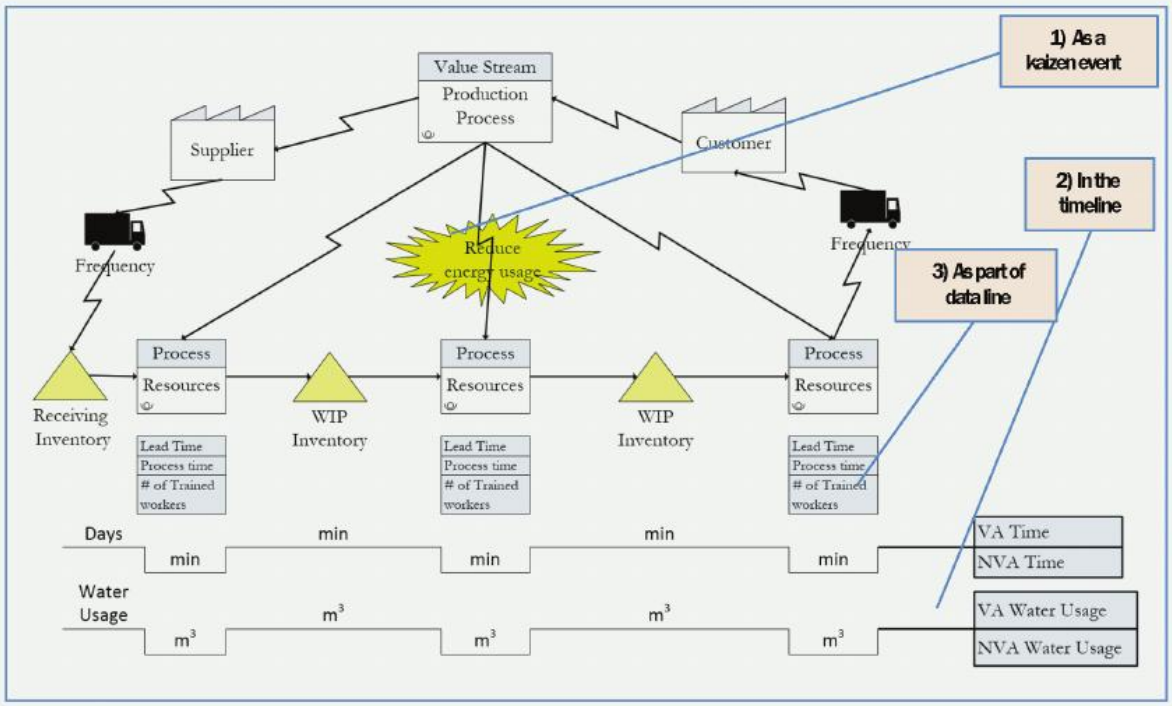
The analyze phase is conducted in the usual manner to identify the sources of variation and waste, and to examine the process to identify root causes for original project goals as well as sustainability goals. The structure-process-outcomes metrics are used to identify areas with opportunities for sustainability improvements.

As with any recommended solution, a cost analysis should be done prior to implementation. In the case of sustainability solutions, one can argue that sustainability efforts will al-

FIGURE 3

Value stream map

Possible locations for the integration of sustainability goals in a lean and Six Sigma process.



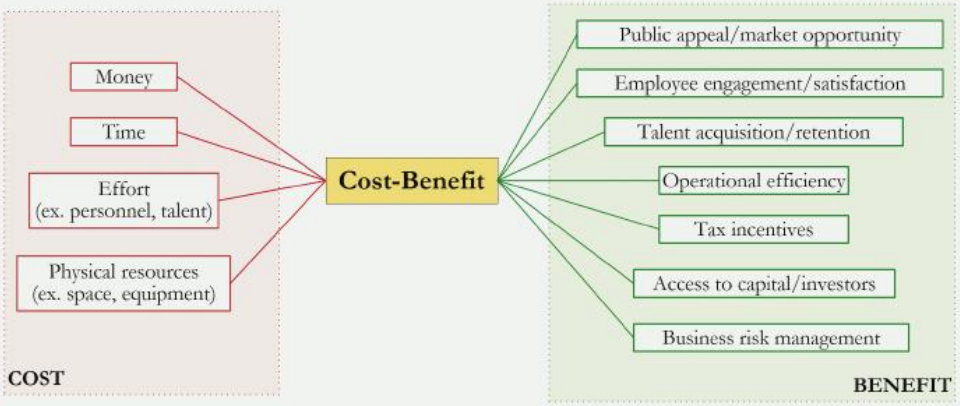
most always negatively impact the project outcomes. However, sustainability solutions assessments should not be based on financial numbers alone. As noted before, sustainability is more than economic development; therefore, both financial and nonfinancial outcomes of sustainability initiatives must be considered.

Lower operating costs and increased profitability, employee engagement and satisfaction, public appeal and market opportunity, talent acquisition and retention, better management of business risks, access to capital and investors and tax incentives are the most commonly listed benefits of sustainability to businesses. A comprehensive cost-benefit comparison of sustainability solutions would include items such as the ones shown in Figure 4.

FIGURE 4

Cost-benefit elements

A comparison of the economic impact of sustainability solutions.



Finally, the control phase focuses on maintaining the gains of improvement and involves developing and executing control plans. Any control phase tool can be used to monitor the sustainability activities completed in the previous phases.

Future outlook

One of the reasons environmental sustainability is the most commonly addressed component among the three pillars is that it naturally aligns with improvement activities, especially in goods-producing industries such as manufacturing, construction and agriculture. For example, reducing rework would lead to less use of materials and energy as rework consumes more resources than necessary. Emphasizing sustainability gains in projects with such scope will not require more organizational resources and will help raise employee

Study: Why sustainability makes economic sense

If saving the planet and its resources weren't motivation enough, many experts say sustainable practices are also good for the world's economic bottom line.

A study published in *Science* written by an international group of scientists urged world leaders to boost efforts and policies to address climate change. In their view, a commitment to more sustainable practices will save money in by mitigating the damage to people, infrastructure and systems.

"Acting on climate change has a good return on investment when one considers the damages avoided by acting," said lead author Ove Hoegh-Guldberg from the University of Queensland in Australia.

As an example, rising sea levels can create more damage during storms, inflicting greater harm on communities and their economies. Developing countries are particularly vulnerable to such environmental impacts because they lack the ability to overcome such events.

"The developing African countries are amongst those to be affected most in terms of impacts on economic growth in the absence of strong climate change mitigation," said Francois Engelbrecht from the University of the Witwatersrand, Johannesburg.

Professor Rachel Warren from the Tyndall Centre at the University of East Anglia in the UK assessed projections of risk for forests, biodiversity, food, crops and other critical systems, and found significant benefits for limiting global warming.

"The scientific community has quantified these risks in order to inform policymakers about the benefits of avoiding them," she said.

Hoegh-Guldberg reiterated the importance of the coming year (2020) in terms of climate action.

"Current emission reduction commitments are inadequate and risk throwing many nations into chaos and harm, with a particular vulnerability of poor peoples," he said. "Tackling climate change is a tall order. However, there is no alternative from the perspective of human well-being and too much at stake not to act urgently on this issue."

awareness of sustainability.

Other environmental sustainability indicators, such as waste management and pollution prevention, might require more resources than the improvement project needs alone. Mapping social sustainability indicators in these types of industries is more challenging, as their inclusion will enlarge the scope of the project and require more organizational resources.

In service industries, the situation is almost the opposite; integrating social sustainability indicators is less challenging than integrating environmental sustainability indicators. This is because of the nature of service industries, which are more labor-intensive and where larger populations are impacted by the services provided, such as healthcare and education. Nevertheless, some goals and metrics will naturally align with the project goals and will not require additional resources, but others may not be as straightforward to link.

As you might have noticed, while embedding environmental and social sustainability indicators into lean and Six Sigma efforts have been addressed explicitly, economic sustainability indicators have yet to be discussed. This is not because the model fails to function in this area, but rather is due to the dimension of sustainability in question. Economic sustainability refers to practices that support long-term economic growth without compromising other dimensions of sustainability. Many social and environmental sustainability efforts have economic sustainability as an outcome, directly or indirectly. Recycling, energy conservation, hiring, purchasing, and community contributions such as providing job opportunities and supporting educational institutions are some examples.

Aside from linking sustainability indicators to improvement projects and its impacts on project scope and resource requirements, support and commitment from top management, team building and motivation issues are important factors to address in embedding sustainability into organizational culture, and in the success of implementing the model described above. Furthermore, the effective implementation of the proposed model requires lean and Six Sigma practitioners trained in sustainability. This is where higher education comes into play.

If sustainability has to be a way of life to be a way of business as Anand Mahindra, the chairman of Mahindra group, once said, then the future generation has to be educated to have sustainability literacy. The industrial and systems engineering curriculum should prepare students to understand and address sustainability challenges. When ISEs enter the field, this knowledge allows them to be the change agents and use models such as the one described above to take sustainability to the next level and make it a core value in all we do. ❖

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