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Operational excellence assessment framework for manufacturing companies

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Abstract

Operational Excellence (OE) is a consequence of an enterprise-wide practises based on correct principles that can be classified under four dimensions; Culture, Continuous Process Improvement, Enterprise Alignment and Results. To achieve OE, organisations have to attain a high maturity level and measurable success in the four dimensions as assessed externally by accredited institutions or consultants. External assessment is costly and can be inaccurate due to the lack of in depth knowledge of the organisation by external assessors, on the contrary, self-assessment of an organisations OE is cost effective and accurate if performed with a complete tool which assesses all four dimensions of OE. A complete OE self-assessment tool is currently unavailable, thus this study focuses on the development of a complete OE self-assessment tool. Using a matrix to critically evaluate and compare existing self-assessment tools in areas such as dimensions assessed, scoring criteria and usability, a complete self-assessment tool is then developed based on the combination of existing assessment tools. The tool is validated through the application, by managers, within a manufacturing company that already implements aspects of lean in order to self-assess its OE. The results of the assessment form the basis on which a roadmap to achieving OE is then developed.

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Keywords: Operational Excellence; Culture; Continuous Process Improvements; Enterprise Alignement; Self-Assesssment; Lean Manufacturing

1. Introduction

The increase in global competition and the need to reduce cost of operations during difficult economic climates have become the main drivers for organizations to introduce continuous improvement and eliminate non-value adding operations. Since the introduction of the Ford Mass Production line in the 1900s by Henry Ford, there has been an evolution from workplace improvements and mass production techniques to Lean manufacturing which has become the 'buzz word' of modern manufacturing (Figure 1) [1]. However, many organizations in recent times have become too reliant on the concepts and tools of Lean Manufacturing, Total Quality Management and Six-Sigma such as Kaizen and Overall Equipment Effectiveness. While these concepts and tools have helped to improve processes and reduce cost, they have under-delivered in terms of cost savings and process efficiency, a problem which has been attributed to the programmatic tool-oriented deployment of these concepts [2].

To successfully implement good improvement tools, it is the underlying principles of these tools that have to be focused on rather than the application of the tools. The concept of Operational Excellence (OE) goes beyond using individual tools and techniques. It incorporates Lean principles with organizational culture and management at a strategic level.

OE has been defined as a consequence of an enterprise-wide practice of ideal behaviors based on the correct principles [2] or simply as a state where each and every employee can see the flow of value to the customer, and fix that flow before it breaks down [3]. Although these definitions may seem broad, it is the correct principles categorized under four dimensions; Cultural Enablers, Continuous Process Improvement, Enterprise

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Alignment and Results (Figure 2) that are fundamental to achieving OE. To achieve OE, not only do organizations have to implement the correct principles, the principles have to also be deeply embedded within the organizations culture. The culture of excellence ensures that everyone within the organization knows the 'why' behind the how and the what, as taught by Dr. Shigeo Shingo, a pioneer of OE. [4].

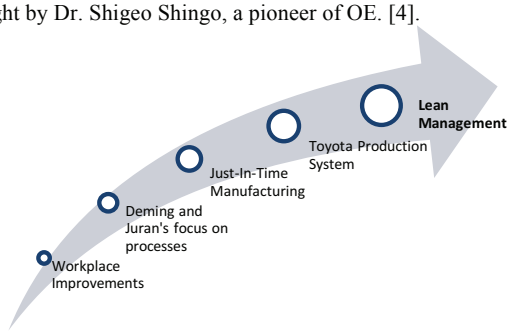

Fig.1. Summary of the evolution from workplace improvements to Lean Management. (Adapted by Naftanaila [1])

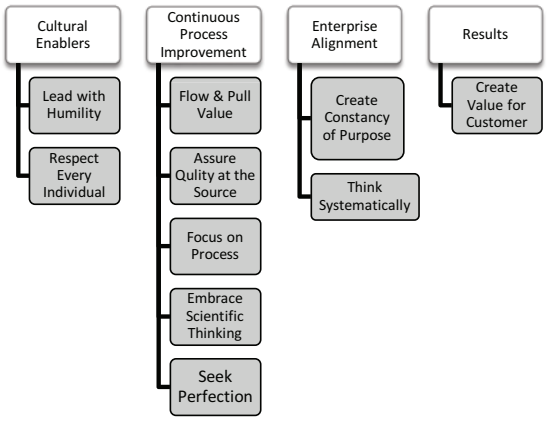

Fig.2. OE dimensions and their underlying principles (Shingo, [4])

The use of assessment tools is one approach that can be adopted by organizations to kick-off their OE journey. Performing assessments serve as a reality check while highlighting the weaknesses and strengths on which organizations can build upon to achieve OE. There are many tools that are currently available for the internal and external assessments of Quality, Lean and Process Improvements for organizations. These tools tend to cover some principles of OE and thus failing to realize how dependent the principles of OE are on each other. In most cases, for example, tools either assess Continuous Improvement or the Results dimensions without taking into account the impact of organizations culture on either.

The aim of this research therefore is to develop an assessment framework based on OE principles for the assessment of manufacturing companies who are struggling with the implementation of lean initiatives. From the assessment results, a roadmap to OE for the organization can then be developed.

2. Review of Existing Assessment Frameworks

Table 1 presents a list of existing assessment tools in the areas of Quality, Lean, Culture and Operational Excellence and the dimensions of OE they assess. From the list, it can be deduced that majority of the existing assessment tools are focused on the process improvement and results dimension of OE with only the Shingo assessment tool, solely used by the Shingo Institute in Utah and is therefore not made available to organizations for internal assessments, covering all 4 dimensions.

To develop an OE assessment framework, a review of the existing tools; Shingo Assessment [5], European Foundation for Quality Management (EFQM) [6], Malcom Baldrige National Quality Award (MBQA) [7], Kobayashi 20 Keys of workplace improvement [8], Lean Enterprise Self-Assessment (LESAT) [9], Rapid Plant Assessment (RPA) [10] and Good-to-Great assessment [11] tools were evaluated under 4 requirements as detailed in Table 2.

Table 1. Assessment tools and OE dimensions they assess

	Culture	Process Improvement	Enterprise Alignment	Results
Shingo	■	■	■	■
EFQM	■		■	■
MBQA	■			■
RPA	■	■	■	
Kobayashi		■		
LESAT		■		■

Table 2. Requirements for OE assessment framework to be developed

Requirement	Purpose
Assessment Style	Assessment style of the assessment tool is critical to the assessment framework to be developed as it allows personnel within the organisation to readily assess their organisations performance; at a significant lower cost compared to external assessments. In addition, it allows for the easy monitoring of the cultural aspect of an organisation as internal assessors are usually personnel with in-depth knowledge of the organisation.
Scoring	OE maturity levels defines how well the principles of OE are embedded within an organisations culture. OE maturity levels are categorised from Level 1 (20%), Level 2 (40%), level 3 (60%), level 4 (80%) and level 5(100%) depending on the total score from assessments, by existing OE tools. The scoring system adopted for the assessment framework to be developed has to be in line with the maturity levels to allow organisations to easily identify where they belong.
Accuracy of Results	Organizational culture is the main pillar of OE as it reveals the extent to which the principles of OE are embedded within the organization. To accurately assess this, assessment tools have to probe the culture of an organization in depth. This process can only be done over a long period of observation and interaction with organization personnel. Rapid assessment tools are therefore not best suited for the assessment of culture within an organization.
Areas Assessed	To assess OE, all 4 dimensions; Culture, Process Improvement, Enterprise Alignment and Customer Results have to be covered by the assessment tool.

The assessment tools shortlisted were then evaluated under the four categories; Assessors, Scoring, Assessment Tool and Areas Assessed.

- *Assessors*: Shingo, EFQM and MBQA tools were designed primarily to be used by assessors from their respective institutes and therefore cannot be used as accurate self-assessment tools. The scoring matrix is based assessor's experience and interpretation of the performance of the organization and might therefore result in differences in score. The LESAT, Good to Great, RPA and Kobayashi tools on the other hand were designed as self-assessment tools and thus presents a structure scoring system and easy to understand and interpret contents [5]-[10].
- *Scoring*: The assessment tools identified adopt quantitative scoring methods by ranking areas on a scale from 1 to 5 depending on the organizations performance or scoring from 1% to 100%. This method can result in organizations targeting specific areas to increase their score rather than focusing on how to improve overall. In addition, scores from assessment can be inaccurate, for example, when using the EFQM assessment method, data from questionnaire and interviews conducted are matched against statements to determine the score rather than considering each individual statement and the details involved. This can lead to inconsistent and inaccurate scoring when using the EFQM framework, an issue which has been blamed on the scoring criteria being too general [8]-[10]. To address the inaccuracy of qualitative scoring methods, Li and Yang presented a method based on multi-criteria decision making methods (MCDM), a complex but accurate scoring method, when assessing organizations [12]. The MCDM framework split each of the attributes being assessed in the EFQM framework into several levels with each level having a weighted score based on the impact of the level.
- *Accuracy*: While the EFQM, Shingo and Kobayashi require in depth investigation before scoring organizations, the Rapid Plant Assessment for instance, is a quick assessment method. Performing quick assessments mean organizations are able to easily and frequently assess their performance although the assessment might not represent an accurate reality of the organization. Quick assessment tools really heavily on visual information and evidence rather than in depth investigation into areas of an organization. It is therefore relatively easy to perform well when using a quick assessment tool [11].
- *Areas Assessed*: In Table 1 the OE dimensions assessed by the tools shortlisted are highlighted. Additionally, how these assessment tools assess each dimension of OE is presented in table 3. It also highlights the weight of each dimension on the final result, highlighting the extent to which each assessment tool values each dimension. The RPA and Kobayashi tools are heavily influenced by "Process Improvement" with little emphasis on "Results", while the EFQM and MBQA tools, on the contrary, are influenced by "Results". The Shingo tool, is the only tool with most balanced assessment in terms of weighted score across the four dimensions of OE [13], [14].

Table 3. Categorization of components of existing assessment tools against Shingo Dimension and Principles (in brackets the weight of each category)

OE Dimensions	Shingo Assessment Areas	EFQM Assessment Areas	MBQA Assessment Areas	Rapid Plant Assessment (RPA) Areas	Kobayashi 20 Keys Assessment Areas
Culture	(25%) Lead with Humility Respect Every Individual	(22.5%) Leaders People Partnership and Resources	(25%) Leadership Human Resource Management	(20%) Safety Environment, Cleanliness and Order Team Work and Motivation	(20%) Improvement Team Activities Empowering Workers Cross Training Conserving Energy and Materials
Continuous Improvement	(35%) Flow & Pull Value Assure Quality at Source Focus on Process Embrace Scientific Thinking Seek Perfection	(10%) Products and Services	(14%) Quality Assurance of Products and Services	(42.5%) Scheduling System Use of Space and Product Line Flow Inventory Condition and Maintenance Commitment to Quality	(70%) Cleaning and Organising Inventory Quick Changeover Manufacturing Value Analysis Zero Monitor Manufacturing Coupled Manufacturing Maintenance Time Control and Commitment Quality Assurance System Eliminating Waste Production Scheduling Efficiency Control Site Technology
Enterprise Alignment	(20%) Create Constancy of Purpose Think Systematically	(17.5%) Policy and Strategy Partnership and Resources	(13%) Information and Analysis Strategic Quality Planning	(30%) Visual Management Management of Complexity and Variability Supply Chain Integration	(10%) Management by Objectives Developing Your Suppliers
Results	(20%) Results Create Value for Customer	(50%) Customer, People, Society & Key Performance Results	(48%) Quality and Customer Results	(7.5%) Customer Satisfaction	(0%) N/A

Based on the review conducted, the existing assessment tools have been found to be one dimensional, in that, they fail to cover all dimensions or guiding principles that lead to OE unlike the Shingo Assessment tool which covers all the dimensions of OE. The cost of conducting the Shingo Assessment, however, limits the accessibility and frequency at which organizations can assess their performance on their way to OE.

3. Assessment Framework Development

To assess OE of an organisation, an assessment framework has been developed by linking existing assessment tools that satisfy the following criteria that were set based on the requirements identified as necessary for an OE assessment framework:

1. Be a self-assessment tool addressing the cost associated with external assessments and thus also allowing for internal personnel familiar with the organisations ethos and culture to be the assessors.
2. Have a quantitative scoring system, making it easier to relate the assessment tool to other assessment tools. Furthermore, quantitative scoring system is allowing for a relatively easy monitoring of progress overtime and is less likely to misinterpretations.
3. Assess areas that are in line with the principles of OE

The Kobayashi tool has been chosen as the ideal tool for assessing principles under the Continuous Process Improvement dimension and together with the EFQM assessment tool, which is designed to assess all principles under Cultural Enablers, Enterprise Alignment and Results, an OE assessment framework based on existing assessment framework has been developed.

The framework developed is based on the Shingo Framework principles and how it is related to its company's current principles. The idea thus is to be able to tailor the framework to the needs of any implementing company. The starting point thus is collecting information in order to identify and establish how the OE principles are aligned with the implementing company's core purpose and principles. To develop the framework, the data collected were summarized and analyzed. The development consists of three Stages; understanding the Shingo Framework Principles, understanding the implementing company's principles (using the EFQM assessment for the overall principles and Kobayashi 20 keys for specific key improvements) and alignment of Shingo and company's principles.

4. Assessment Framework Validation

The assessment framework developed was applied at a UK based lean implementing manufacturer of construction products for the global market. This was to validate the applicability of the assessment framework. The internal assessors within the case company were already familiar with the use of existing assessment tools and this simplified the assessment process.

As indicated in the previous section, the understanding of the implementing company's principles is conducted through the EFQM assessment. The EFQM questionnaire was used that consists of 44 equally weighted questions categorized under Leadership, People, Strategy, Partnerships & Resources, People Results, Customer Results, Society Results and Business Results [6].

The Questionnaire was completed by six Managers/Leaders from the following departments; Manufacturing, Engineering, Supply Chain, Marketing and Procurement departments. The manager assessing the organization scored based on observation, interaction with associates and experience.

The assessors established the level for each key by discussing the current state of the organization against the Kobayashi's standard and agreeing on an accurate score the best fits the organizations current state. The results from the assessment conducted using the Kobayashi and EFQM assessment tools were used to establish the current maturity level of the case company as summarized in Table 4.

Table 4. Assessment results using the EFQM and Kobayashi Assessment Tool

Dimension	Assessment Result
Process Improvement	2.5
Cultural Enablers	2.6
Enterprise Alignment	2.4
Results	2.3

Once the current state and desired end state had been established, the next phase is to conduct a gap analysis, identifying the necessary projects in each dimension to close the gap between current and desired end state. A roadmap can help for prioritizing projects and initiatives.

5. Development of roadmap

A roadmap is a way of representing an organizations strategy towards achieving its goals. Roadmaps vary in content although mostly include details such as timescale and the sequence of short and long term plans outlined to help an

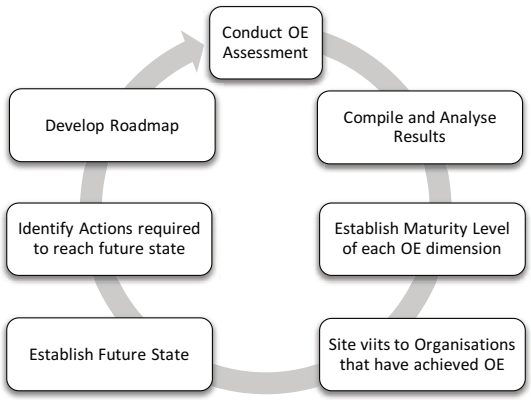

Fig.3 Roadmap Development Process

organization from one point to another. The roadmap to be developed consisted of three phases; Current State, which is based on the assessment of the organizations; Future State, which is based on Level 5 Shingo Maturity Level and Gap

Closure, which is based on data collected from previous winners of the Shingo Prize.

The current state as describes was assessed with EFQM and Kobayashi 20 keys, and the desired end state had been established based on the company's pursue of OE. The gap analysis helped identifying the necessary projects in each dimension to close the gap between current and desired end state.

To identify the projects, the data collected from interviews and case studies with Shingo Prize were analyzed. The analysis involved the identification of improvement projects in each dimension completed by the previous winners of Shingo Prize.

Cultural Enablers: To achieve an OE culture, all employees must be respected, to achieve this it is important to develop the employees and empower them by explaining the 'why' behind every decision. This can be done by first establishing the knowledge of employees before further developing them in their area of work, in addition all employees must be trained in the principles of OE.

Once the Improvement projects were identified, the next stage was to prioritize. This involved the division of the projects under short term, medium and long term. To prioritize the project, four factors were considered:

- *Current lean implement company's project list*: Before prioritizing the proposed improvement projects, the current projects list in the validation company had to be considered. This was to ensure that the proposed projects do no impede the progress of current projects.
- *Resources Available*: Some of the projects proposed require more resources in terms of personnel and time. An example is the provision of 6-sigma training for all associates, in order to do this, the organization must allocate time within all departments and ensure enough 6-sigma experts are qualified to train others within the organization.
- *Ease of Implementation*: Some of the projects proposed are easier to implement than others as they require little resources and are independent of other projects. An example is the presentation and communication of the organizations model which details the vision and mission statement of the organization. On the other hand, the introduction of employee recognition scheme involves financial commitments by the organization and as such might take some to come into fruition.
- *Information acquired from Case Study Phase*: From the data collected, a trend in projects prioritized by previous achieves of OE maturity level 5 was established.
- Cultural Improvement projects were first to be implemented, organizations begun by training leaders, managers and associates in operational excellence culture by enrolling them on cultural excellence programs. The introduction and communication of the organizational goal was also conducted as one of the first steps.

6. Validation of Roadmap

The validation of the roadmap developed, that is schematically presented in Fig.4, was performed by organizing a workshop where managers, supervisors and operators at the validating company were invited to assess and provide feedback on the roadmap. Feedback presented were in the following areas:

- Flexibility of Roadmap: A concern of the organization was how well the roadmap can be adapted to incorporate current projects within the organization and the consequence of not following strictly, the sequence of improvement activities listed in each dimension. To address this, the organization were informed that it is the principle that were relevant and the projects identified were to instill the principle. The roadmap is therefore dynamic in terms of the sequence

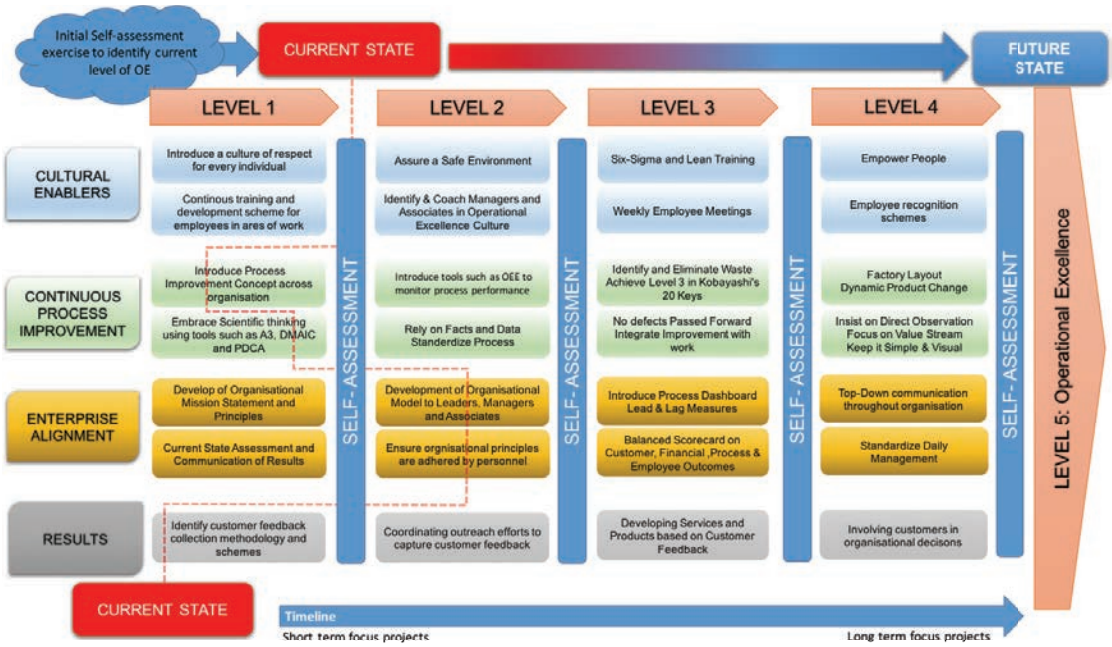

Fig. 4. Roadmap to OE maturity level 5

of projects. Current projects within the organization could also categorized under the dimension where they fit within the roadmap and thus also helping the organization to prioritize the current project depending on where they fit placed on the roadmap.

- Timeline of the Roadmap: The company requested the addition of a timeline highlighting the length of time it will take to reach each maturity level. This could not be included based on the fact that cultural change is unpredictable and thus varies in timeline. To address this issue, a timeline highlighting short term and long term targets for the company was incorporated and although it did not set a target time for each maturity level, it highlighted the projects that needed to be completed in the short and long term.

7. Conclusions

From the study conducted the following conclusions can be drawn:

- Based on the review conducted, the existing assessment tools are generally either biased towards process improvement or towards results. Assessment tools developed by Institutes that award prizes such as the MBQA and EFQM are results driven with little focus on culture and process efficiency, this is because, the assessors from their respective institutions spend little time assessing the culture.
- Existing assessment tools such as the EFQM assessment tool and Kobayashi's 20 Keys to Workplace Assessment tool can be used to assess together to assess all 4 dimensions of the Shingo Framework Before developing a roadmap, organizations have to first establish their current state, this allows them to identify their strengths and weaknesses going forward, in the case of the validating company, it was discovered that the organization organizations strength was striving for improvement but a weakness was the communication system in the organization.

The roadmap presented in Fig.4 is tailored to the needs of the validating company, however the activities on the roadmap, can be used as a guideline for other organizations.

The framework and roadmap developed can indicate the way forward for a company's journey towards OE. However, such a framework cannot be used for investigating what the likely effect would be if such improvements were implemented. So while the framework would have identified which lean practices to improve and possibly how to improve them, little is known about how the proposed improvements will behave in reality. Operational and cultural changes in that case can be assessed using a number of different simulation tools [15]-[18]. The proposed framework thus needs to be coupled with such in order for a company to get the most out of it.

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