

undergo the certification audit and internal audit as describe in the requirements. Another prominent technique is assessment based on Business Excellence Framework. Self–assessment and external assessment against the Business Excellence Framework (BEF) are applied by the organizations in order to identify improvement opportunities and qualify for quality / Business Excellence award [16]. Both of the audit and assessment can be consider as gap analysis techniques that identify the gap within the organization against the set criteria such as ISO9001 standard and BEF.

On the other hand, most of operation approaches does not have standardized method to diagnose their operation. For example for six sigma and lean improvement approaches, decision making techniques were utilised to select the improvement project. Selection of Six Sigma projects are one of the most frequently discussed in Six Sigma literatures and various approaches proposed [17] [18].

TABLE II: COMMON OPERATION IMPROVEMENT DIAGNOSIS TECHNIQUE

Improvement Approaches	ISO9001 Quality Management System	Business Excellence Framework	Six Sigma	Lean
Diagnosis Technique	Quality Audit/ Gap analysis	Assessment/ Gap analysis	Project Selection	Project/ Kaizen selection

Based on the common diagnosis techniques in table II, study on the trend in literature was conducted in three databases which are Science Direct, Emerald and Google Scholar. The procedure to conduct the search as followed: 1) Boolean search of exact phrase i.e. “Quality Audit”, “Business Excellence Assessment”, “Six Sigma Project Selection” and “Lean Project Selection”; 2) Filter by year; 3) Filter by relevant. The result of literature trend is tabled in table III.

TABLE III: STATISTICS ON HIT OF FOUR COMMON DIAGNOSIS TECHNIQUES

Year range	2010-2014	2000-2015	2000-2004	2005-2009	2010-2014
Database	<i>Science Direct</i>	<i>Emerald</i>	<i>Google Scholar</i>	<i>Google Scholar</i>	<i>Google Scholar</i>
Business Excellence Assessment	0	5	21	13	11
Quality Management Audit	23	20	89	39	30
Lean Project Selection	0	0	0	2	4
Six Sigma Project Selection	15	22	20	87	352

At first, the phrase of “Quality Audit” hit more than 16,000 results due to it is related with quality of accounting audit. Hence the search was change to “Quality Management Audit” and “Quality Management System Audit”. From the search, number of hit for all the diagnosis technique was higher on google scholar. This is due to the google scholar database include the books in comparison with other database. The highest hit for year 2000 to 2015 was on six sigma project selection and follow by quality audit in google scholar, while both in Emerald and Science Direct indicate vice versa. At the same time, there were also high hits (33 hit in google scholar) in quality audit before year 2000. This search hits indicated that the quality audit and six sigma project selections were the most prominent operational diagnosis technique discussed to identify the opportunities for improvement. There were also numbers of hit for BE Assessment in compare to Lean project selection. The Lean project selection only been discussed after year 2010 in which include 2 books and 2 article on concept. Based on result of search, the current trend on literature as followed: 1) decision making on six sigma project selection; 2) issues and modalities of quality audit; 3) issues and modalities of BE Assessment and 4) concept on lean project selection.

The selection of Improvement initiative is another diagnosis technique which is significantly discussed in literatures. The selection of improvement initiative may have to evaluate the organization performance and hence leading towards identifying the improvement opportunity for operation.

IV. PRIOR FRAMEWORKS ON OPERATIONS DIAGNOSIS TO IDENTIFY OPERATIONAL IMPROVEMENT OPPORTUNITIES

The framework for operation improvement diagnosis provides the modalities to conduct effective operation diagnosis. There are many frameworks related to decision making especially on six sigma project selections. However most of the framework covers only the concepts of the improvement approaches and decision making tools instead of diagnosis process. Thus, four prior frameworks that can assist the operational diagnosis to identify operational improvement opportunities as shown in

table IV was discussed due to: 1) Generic framework include the improvement approaches and diagnosis techniques; 2) Details of requirements, steps and/or procedures; 3) Academic, best practice and standard framework.

The first two frameworks shown in table IV was developed by Thawesaengskulthai [11] in 2007 (Publish paper in 2010[19]) and Mohammad [10] in 2012 as their PhD research. The main objective of their framework is to select the improvement initiative. In the process of selecting appropriate improvement initiative, the organization performance needs to be evaluated either by audit, assessment or gap analysis. Hence, during the process of selecting improvement initiative, the operational improvement opportunities need to be identified.

TABLE IV: FOUR PRIOR FRAMEWORK ON OPERATION DIAGNOSIS TO IDENTIFY OPERATIONAL IMPROVEMENT OPPORTUNITIES

#	Framework	Improvement Approaches	Main Criteria of selection	Diagnosis Techniques
1	Thawesaengskulthai's framework 2010 [19]	Part of selection of initiative TQM, BPR, ISO9001, BEF	Pay-Off, fashion setting, Strategic Fit, Organization Fit	Gap Analysis (organization's weaknesses)
2	Mohammad's framework 2012 [10]	Selection of improvement initiative based on TQM and BE concept	Feasibility, Organization fit and Value / Benefit	Provides examples of tools and techniques for gap analysis / diagnosis which include organizational assessment based on BEF, benchmarking, SWOT analysis and business performance review
3.	ISO audit framework 2011 [20]	Quality/ Environment Management System	Standard such ISO9001, ISO14001, ISO13485 etc.	Quality Audit
4.	Karapetrovic and Willborn 2001 [21]	Business Excellence and quality management system	BEF and ISO9001	Advance Concept of integrating audit and assessment

The main steps in operational diagnosis should include initiation, diagnosis process and implement the improvement [15]. As shown in Figure 4, the initiation process has been defined as motivation to trigger the improvement, the gap analysis and selection process is the diagnosis process and deploys initiative as the implementation stage. The framework also provides the selection criteria to select the improvement initiatives. At the same time, the selection criteria on fashion setting, pay-off (or results), strategic fit and organization fit can be adopted as operational improvement opportunities selection process. However, the framework only suitable to select limited initiative such as TQM, ISO9001, BPR, Lean and BE model instead of operational improvement. As an alternative, initiatives such as ISO9001 and BE Model can be consider as improvement approaches and best practice that already have the criteria and baseline for operational practice and improvement. In operational improvement, the selected improvement initiative such as ISO9001, BE Model, BPR, TQM should become the criteria for selection of operational improvement opportunities that needed by organization by comparing their current practice against the criteria.

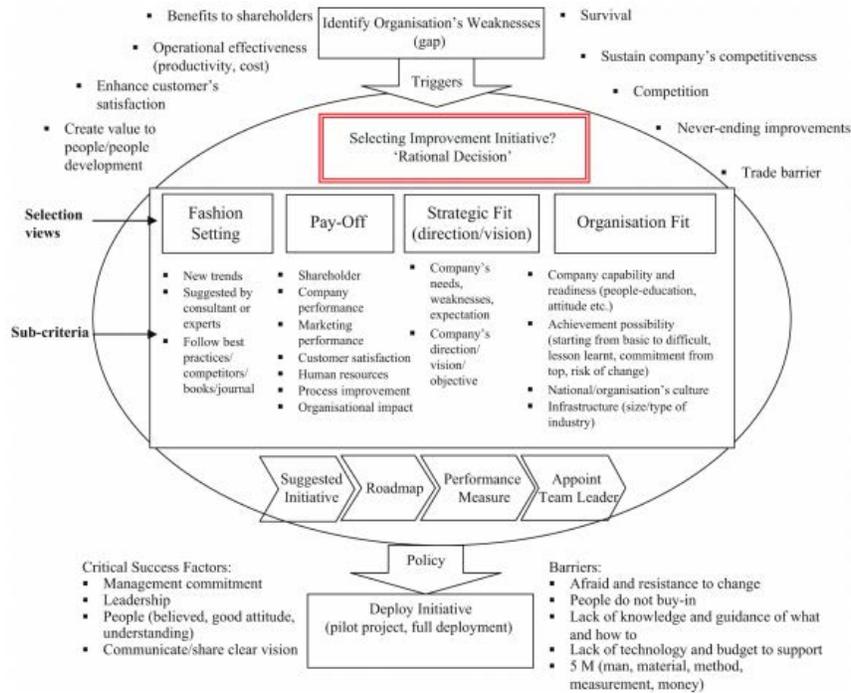


Fig 4: Thawesaengkulthai's framework [19]

Thawesaengkulthai's framework [19] focusing on the triggers for adoption, selection views and criteria, processes involved after selecting the initiatives, critical success factors and barriers. Selection only focuses on six initiatives: TQM, Six Sigma, ISO 9001, Lean, Business Process Reengineering, and BEM. Some of limitations of Thawesaengkulthai's framework have been refined by Mohammad [10], such as provide clearer step-by step procedures to select improvement, include create, review and/or understand organizational profile as one of the steps for selection of improvement initiatives and use BEM as an overarching framework for managing and aligning multiple organizational improvement initiatives [10][27]. As shown in figure 5, Mohammad's framework [19] uses the acronym 'GUIDE' which represents the five key steps to select improvement initiatives: (1) Goal setting, (2) Understanding relevant improvement initiatives, (3) Identifying decision criteria, (4) Deciding on the appropriate initiative, and (5) Evaluating the decision. The proposed multilayer guidance model focuses on the holistic processes to be used in selecting improvement initiatives whereby its contents are explicitly aligned to the BEM. Diagnosis and identify improvement opportunities are part of step 1 'Goal setting'. Step 1 also provides examples of tools and techniques for gap analysis / diagnosis which include organizational assessment based on BEF, benchmarking, SWOT analysis and business performance review. Additional diagnostic tools and techniques can be added in GUIDE model which includes audit based on ISO9001, and brainstorming.

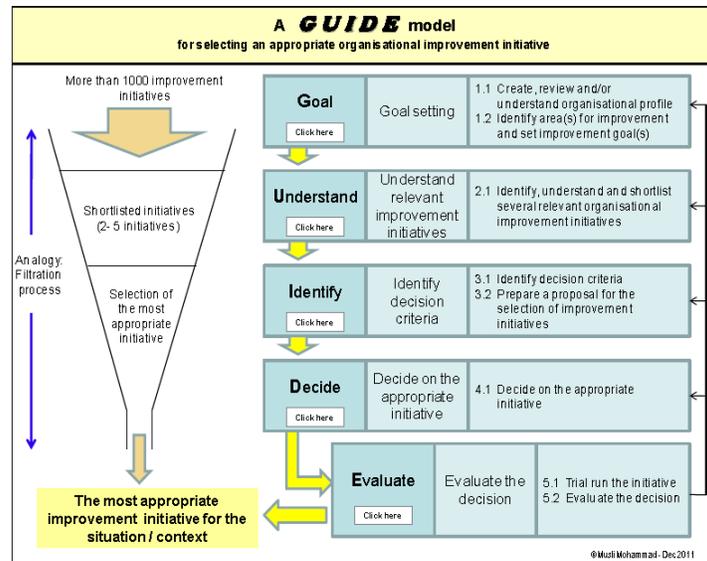


Figure 5: GUIDE model for selecting organizational improvement initiatives [19]

The third framework discussed here, made reference to framework by ISO [20]. Framework by ISO was selected for discussion based current international standard available for quality audit. The ISO 19011:2011 assumed special importance and significant due to the standard was accepted worldwide as the guideline for quality auditing and the framework shown in figure 6. The ISO framework was developed based improvement of previous version in 2002 and ISO10011-1,2,3 in 1991. The contents of ISO10011 were mainly based on ASQC guideline developed in 1986 which can be considered as the first framework in quality auditing. Gardner [22] complimented that the ISO framework allowed the auditor to implement audit program with the auditing framework. The framework considered by Gardner as audit program, audit interview concepts, lateral-view of auditing concept, and the audit criteria or requirement have provided a new perspective and a greater awareness of organizational requirements. However, in order to further improve the framework, Gardner [22] suggests that the organizational self-assessments and organizational tool kits should be used as tools for effective audit. Even, the ISO framework was develop to suit any type of audit, the guideline were biased toward compliance audit [23]. The ISO framework was found to be over emphasis on ethical, professional conduct which unable to utilize the improvement type of audit. It was found that the ISO framework does not discussed the tools and techniques such as process approached audit as per Hutchin suggestions. The dynamics auditing as suggested by Barthelmy and Zairi [24] and tools suggested by Gardner [22] were not been presented by ISO framework. However, the ISO framework can provides Mohammad's framework the guideline on establishing and implementing the operational diagnosis process. Meanwhile, Mohammad's framework can provides the ISO framework with relevant tools and decision making techniques in identifying the operational improvement opportunities.

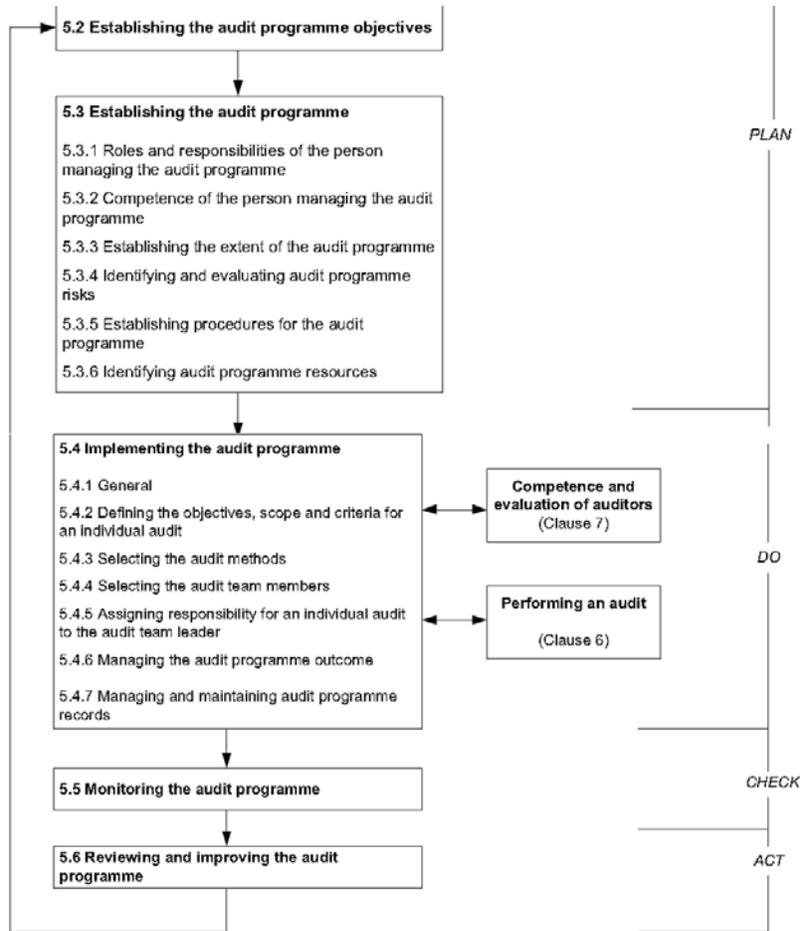


Fig. 6: ISO standard framework [20]

Finally, the framework by Karapetrovic and Willborn presented the advanced concept on integrating the quality audit and assessment technique. The framework is shown in figure 7. This framework is generic for quality audits and assessment. It clearly defined where operational diagnosis either audit or assessment can be integrated. The Karapetrovic & Willborn framework provide the initiation of diagnosis process with multiple criteria such ISO9001requirement and BEM. However the framework is still in conceptual framework and need further development. The framework does not provide clear step in diagnosis and decision making techniques to select operation improvement opportunities. In compare with Thawe and Musli framework, there was no real case study to validate both the ISO standard framework and Karapetrovic&Willborn framework.

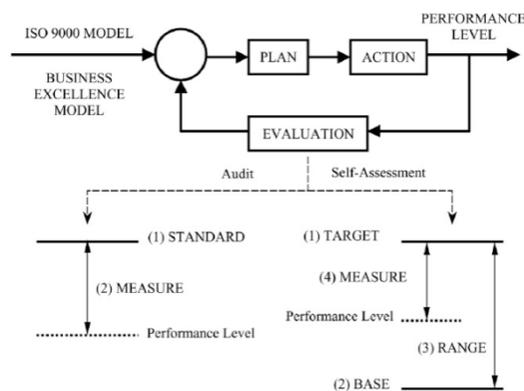


Fig. 7: Karapetrovic & Willborn framework [21]

As per discussion above, the summary of the strength and limitation of each framework is shown in table 5. The main strength of each framework can be used to develop the effective operation diagnosis framework focused on baseline organization performance improvement. This strength could be utilized to compliment the limitations in other framework especially on ISO and Karapetrovic & Willborn frameworks. However, all the prior frameworks were not focus on operation process.

TABLE V: PRIOR FRAMEWORKS STRENGTH AND LIMITATION

#	Framework	Strengths	Limitations
1	Thawesaengskulthai 2008 [25]	<ul style="list-style-type: none"> ▪ Clear factors on motivation and selection criteria for selection of improvement initiatives ▪ Provide decision making matrix 	<ul style="list-style-type: none"> ▪ Focus on selection of approach that normally the set as audit/ assessment criteria ▪ Does not focus on operation process ▪ No clear step by step approach
2	Mohammad 2012 [10]	<ul style="list-style-type: none"> ▪ Focus on the holistic processes to be used in selecting improvement initiatives whereby its contents are explicitly aligned to the Business Excellence Models (BEMs), such as Baldrige Excellence Framework and European Foundation for Quality Management (EFQM) Excellence Model. ▪ Provide decision making matrix 	<ul style="list-style-type: none"> ▪ Focus on TQM and BE concepts ▪ Even ‘operations / processes’ is part of the BE framework, detail on specific operation issues not explicitly covered.
3.	ISO audit framework 2011 [20]	<ul style="list-style-type: none"> ▪ Most widely use. ▪ Include the PDCA and quality assurance of the diagnosis process 	<ul style="list-style-type: none"> ▪ Does not provide decision making technique ▪ Does not focus on operation process ▪ Does not provide the motivation factors, organizational maturity factors
4.	Karapetrovic and Willborn 2001 [21]	<ul style="list-style-type: none"> ▪ Provide the light for integrated diagnosis technique. 	<ul style="list-style-type: none"> ▪ Does not provide decision making technique ▪ Does not focus on operation process ▪ Does not provide the motivation factors, organizational maturity factors

V. CONCLUSION AND FUTURE FOCUS

Operational diagnosis utilised to identify operation improvement became a matter of discussion especially after introduction of improvement approaches such ISO9001, BEF, Six Sigma and Lean. It is a known fact that each of the improvement approach needs to have the diagnosis technique before the approaches can implement. The diagnosis technique can be in name of audit, gap analysis, and project selection. It will lead to decision making on selection of improvement opportunities. Even with more than a million organizations certified to ISO9001, and hundreds of thousands of organization embarking award based business excellence, the operation team required a simple framework for them to diagnose their performance and offering a perspective into the enhancement of their operation. Although the availability of prior frameworks which allows them to select improvement initiative, room for modification or alteration for betterment is evident as such this would grant organisations with a better scope and platform thus providing focus on operation issues and enable them to plan for their improvement.

Though researchers have been moving in varied directions to attain benefit of operational improvement, the future focus should develop the specific operation diagnosis mechanism with simple decision making techniques and tools. It should utilised all the current best practice in operational improvement approaches such as BEF, ISO9001, Lean, Six Sigma and provide the guideline on selection of appropriate techniques and tools. The generic framework will enable organization to diagnose their operation performance and identify their high impact operational improvement.

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