Managing Performance Improvement Initiatives

Case Study at ElARABY Group in Egypt

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***Abstract*—In the current business environment, flexibility and responsiveness to customer requirements and market changes determines to a far extent the company's capability to survival. Companies should focus on selecting/adopting the most suitable improvement initiatives that support their strategic objectives, in order to remain competitive. They usually select performance improvement initiatives to enhance their internal processes and handle such working challenges. Many tools/approaches are available that can be implemented for process improvements. The appropriate selection for the most suitable tool/approach can be appreciated especially before utilizing or investing resources. The current paper introduces a proposed framework to support manufacturing organizations in selecting and determining suitable performance improvements initiative(s). The proposed model is adopted by a home appliance manufacturing firm located in Egypt starting from 2013 to set the firm strategic objectives, and to support operations managers to select the suitable improvement initiatives, significant results related to improving quality rate, increasing throughput, reducing customer returns and manufacturing costs were reported during executives review meeting.**

Keywords*—Balanced Scorecard (BSC; Theory of constrains (TOC; Performance Improvement Initiatives

I. INTRODUCTION

Currently manufacturing companies are facing market volatility. To gain such market competition, organizations should response quickly to customers' needs, reduce lead times, or/and lower their operating costs. The strategic objectives should be determined carefully to support achieving organizations goals. The business strategies refers to competitive approaches toward winning a market niche; being best in quality or lower in price, for example, or offering the most features or newest product/service. Heizer and Render [1] reported that there are three strategic concepts: 1) Differentiation- to provide better product or at least different; 2) Cost leadership- to provide cheaper product; and 3) Better response- to provide product more responsively than competitors. Anyway, strategies differ. And each strategy puts different demands on operations management about how they could achieve organization strategic goals by selecting the appropriate tactics. Tactics are the methods or action plans of supporting and executing the chosen strategy.

The Balanced Scorecard (BSC) approach helps to translate strategies into both objectives and measures, then operational managers have to select tactics/action plans to achieve those objectives. The BSC is the most popular management system in organizations today [2], its popularity comes from the fact that it brings all of the strategic objectives of a business into a single and balanced framework [3]. BSC is one of the most highly touted management tools [4, 5, 6, 7]. The BSC has been developed at Harvard Business School by Kaplan and Norton [8] since the early of 1990. It is a multi-dimensional approach to performance measurement and management that linked specially to organizational strategy [9]. A survey found that 50 percent of Fortune 1000 companies in North America and 40 percent in Europe use a version of the BSC [10]. The basic framework of the BSC consists of four perspectives or four performance measurement; the manager should ensure that the vision and the strategy of the business are in congruence with those performance measurements [11].

As observed by Malmi and Brown [12], BSC is not the only control tool used in an organization. They have pointed out that companies use a package of control tools to manage their operations. Based on each organization strategic objectives, tools could be introduced as a package to manage a specific issue. These tools include:

- Activity based costing
- Value-based management
- Budget control system
- Organizational design and structure

Unfortunately, most of the studies on BSC have focused only on adoption of BSC at the organizational level ignoring to present how to integrate BSC with other control/management tools, for example BSC can't help organizations to identify their strengths and weaknesses or define which processes need to be improved and which processes are suitable, as no mechanism to diagnoses problems was included in BSC, so BSC usually integrated with SWOT analysis. The name SWOT analysis derives from the abbreviation of Strengths, Weaknesses, Opportunities and Threats. Strengths are the advantages that an organization has, Weaknesses are issues that a company can improve and both of them could be determined by performing internal/external audits on organization system/processes. Opportunities are external factors that an organization can take advantages of, while Threats are external future factors disadvantageous for the organization. Both opportunities and threats should be

analyzed with the strengths and weaknesses to see how organization can avoid threats and gain from their available opportunities. Kaplan and Norton [13] suggest that a strategy formulation process starts with a vision, mission and values listing. Secondly, a SWOT-analysis is performed, also Mintzberg, Ahlstrand and Lampel [14] emphasized that a strategy is an engagement between external opportunities and internal strengths, including resources and capabilities, so it is concluded that performing SWOT analysis and initially diagnosing the current manufacturing system are important before constructing BSC.

Manufacturing organizations could not achieve their objectives easily due to existing system constrains. It is important to understand each constrain root of causes before adopting any improvement initiatives/tactics that support achieving organization objectives. Constrain is any element or factor that prevents a system from achieving a higher level of performance with respect to its goal [15] and take one of the following three forms: 1) Physical: resource capacity less than demand; 2) Market: demand less than resource capacity; 3) Policy: rules limiting productive capacity. Understanding constrains root of causes can lead to read just Key Performance Indicators (KPI's) which listed in BSC, and also give directions about specifications of the needed improvement initiatives/tactics to achieve objectives which should be written in BSC. According to Goldratt and Cox [16] one can measure all activities within an organization by using the following operational measurements: 1) Throughput: the rate at which the system generates money through sales; 2) Inventory: all the money that the system has invested in parts to be sold; and 3) Operational expenses: all the money the system spends in order to turn inventory into throughput. In order to achieve the goal (making money), these three measurements need to be improved simultaneously as the following: 1) Throughput needs to be increased; 2) Inventory needs to be decreased; and 3) Operational expenses need also to be decreased. So it is concluded that any constrains restrict the system from achieving above three objectives should be considered as a bottlenecks, and should be ranked using Pareto principle. The selected improvement initiatives should be focused on reducing/eliminating most important system bottlenecks. Relying on this and after determining the real root of causes for each constrain/bottleneck, BSC should be re-adjusted, and the suitable improvement initiatives should be selected. A range of 'on-shelves' improvement initiatives are available such as:

- Lean Manufacturing
- Six-Sigma
- Total Production Maintenance (TPM)
- Total Quality Management (TQM)

The previous improvement initiatives are a sample from the available on shelf initiatives. Organizations that have to implement improvement initiatives still need to know which approaches would be best for their strategic objectives and their stakeholders' value. This is a real concern which has not been adequately addressed in the literature on quality management and operations strategy [22, 23]. Although some surveys have identified trends and widely adopted improvement initiatives, see e.g. [24, 25]. There is a limited body of research and literature addressing rational decision criteria for selecting improvement initiatives, and how to linking the selected improvement initiatives with the organization strategic goals. This gives motivations to develop a model that supporting selection of the appropriate improvement initiatives, based on the understanding of the organizational objectives and the manufacturing system constrains.

II. PROBLEM DESCRIPTION

Manufacturing organizations implement various performance initiatives or techniques to improve their internal processes, A range of 'on-shelves' improvement initiatives are available and can be adopted, these includes Lean manufacturing, Six sigma, total quality management (TQM) tools, total production maintenance (TPM),…, etc. The selected initiatives should support organization in achieving its strategic goals. Usually these 'on-shelves' initiatives are not suitable to be used without adjustment, sequence rearrangement, or even innovation of some special improvement approaches that can be constructed from the current improvement tools. These subjective nature results from the subjective nature of each organization, - each organization has its own different goals - each organization overcome its typical problems resulting from their own specific external or/and internal working constraints. The current research problem can be summarized as the following:

- How can organizations integrate theory of constrains during the BSC developing process in order to accurately set their organization's objectives and define the key performance indicators (KPI's) based on the understanding of their system bottlenecks?
- How can organizations select or even develop an appropriate improvement approach, which can be used in managing their system constrains, reducing/eliminating bottlenecks, and supports them to achieving their strategic goals?

III. UTILIZING BSC AND THEORY OF CONSTRAINS.

This paper introduces a proposed framework to support manufacturing organizations in selecting and determining suitable performance improvements initiative(s). The proposed model was developed by integrating BSC and theory of constrains to accurately determine KPI's. As shown by Figure 1, the proposed model can be considered as a road map that describes a journey of determining internal process improvement initiatives which support achieving the organization strategic goals. After defining the customer objectives, internal process objectives can be determined by using group decision making method, but to accurately determine Key Performance Indicators (KPI's), the authors propose analyzing the current production system considering the three measurements suggested by Goldratt [16], this lead

to define the system bottlenecks. Improvement initiatives and KPI's should be focused to reduce or eliminate those bottlenecks. The following part describes the proposed model.

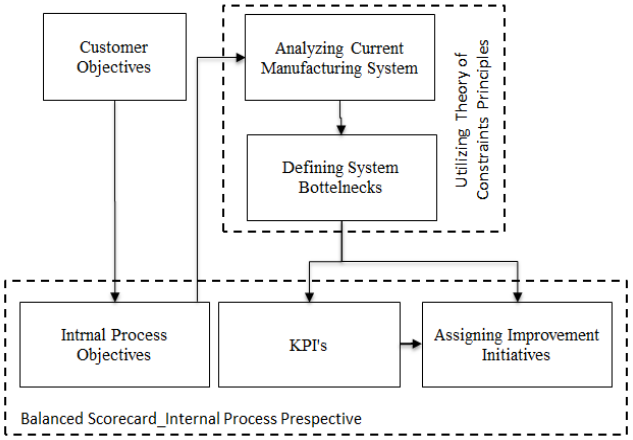


Fig. 1. The Proposed Model

A. BALANCED SCOECARDS (BSC)

BSC is introduced starting from setting the firm financial goals, and based on financial goals the customer goals are also determined. After that the internal process, the organizational learning and the growth goals are defined. Before preparing the BSC, the causal relationship between the previous four perspectives' goals should be illustrated and discussed during constructing the firm strategy map. As BSC is not a diagnosis tool, SWOT analysis also should be performed before preparing the BSC. To perform SWOT analysis it is recommended to diagnose the system by implementing quality management audit to define the strength and weakness points in the system, also benchmarking study, and defining customer value chain analysis are important to determine opportunities and threats. After performing SWOT analysis and considering the budget, the BSC can be developed.

B. ANALYZING CURRENT SYSTEM

As mentioned previously, performing factory diagnosis and quality management audit was needed before preparing SWOT analysis, in order to determine strengths and weakness points. Again it is needed to analyzing current system more deeply after defining the manufacturing objectives. The purpose of this analysis is to provide accurate data about the current system regarding to material, product, and information flow within the system. Value stream map is suggested to be constructed to present all available data related to previous analysis. Also ISO 9001 check list can be used to define nonconformities regarding to quality management system. It is important to consider the type of production system during the analysis step. There are three production systems:

- Discrete flow production system
- Continuous production system
- Batch production system

Historical data analysis should be performed considering type of production system to determine symptoms of problems based on each system needs.

C. THEORY OF CONSTRAINS (TOC)

Objectives listed in the BSC can't be achieved without reducing the effect of bottlenecks, those bottlenecks now can be easily defined after analyzing and diagnosing the current system. In this milestone it is important to understand real root of causes for each bottleneck. The following types of analysis are suggested to be used to understand bottleneck's root causes:

- PARETO ANALYSIS: it is a statistical approach to problem solving that uses a database of problems to identify the number of pre-defined causal factors that have occurred in the system. It is based on Pareto principle, also known as the 80-20 rule, which presumes that 80% of problems are caused by 20% of the causes.
- WHY-WHY ANALYSIS: it is a simple tool for drilling down on the problem statement until the root cause is defined. This method produces a linear set of causal relationships and uses the experiences of the problem owner to determine the root cause and corresponding solutions.

D. TACTICS/IMPROVEMENT APPROACHES

The KPI's and initiatives that will be written in the BSC should be derived from analyzing the system, defining the bottlenecks, and determining bottlenecks real root of causes. By adopting theory of constraints, and deeply understanding the root of causes, the KPI's can be determined more accurately. The hierarchy diagram is suggested to be used to select the appropriate improvement tools; the tree is used to systematically break down an item (KPI's targets) into its lower-level hierarchical components, and by using causal relationship (WHY-WHY analysis), then the improvement initiatives can be selected.

Action plan which consists of the selected improvement tools shall be developed. The sequence of implementing improvement tools should be determined based on the historical data analysis and by involving process owners.

IV. CASE STUDY

The proposed model was adopted by a home appliance firm located in Egypt to support determining objectives, and finding suitable improvement initiatives/programs which help to achieving firm strategic goal. Before adopting the proposed model the firm tries adopting many improvement initiatives such as manufacturing lean principles, six sigma approach. Already good results were achieved by adopting those "on-shelve" approaches, but actually the gap between the desired strategic goals which should be achieved and the current situation obtained after adopting such initiatives were founded, this is because chosen improvement programs can't treat special firm problems/bottlenecks. Each organization has unique constrains and problems, so the improvement

programs should be developed and adjusted after diagnosing of the manufacturing system and understanding constrains. The firm decided to start implementing the proposed model with the manufacturing system which produces family of products (Washing machines). We coded it here as "W100". The firm aims to find a focused improvement initiative that support achieving its strategic goal in relatively short time and with optimal usage of resources.

The objective listed in the BSC is to increase market share of products W100 by 6.5% in the following six months, which means increasing sales plan and production plan by the same percentage.

By considering the theory of constrains, and preparing check lists to diagnose the system to find out the real root of causes that restrict the system to achieve the strategic objectives, and after performing factory diagnosis; "the lack of assembly lines volume flexibility" was discovered as the main problem that restricts the manufacturing system from achieving its goal. Three bottlenecks are considered as root of causes for the lack of volume flexibility, they are:

- Machines factor: relatively long breakdowns.
- Unbalanced assembly work-stations.
- Relatively long lead time, due to long set-up times and bad quality products that need to be repaired.

For each bottleneck, the hierarchy diagram is used where it can be logically present the real root of causes - which determined by using WHY-WHY analysis - and by linked bottlenecks with the associated strategic objectives. Also historical data analysis can be used to prioritize the importance and the impact of those causes. Figure 2 presents the impact percentage of the previous three bottlenecks based on historical data. 40% of lack of volume flexibility is due to long lead time, 30% is due to machines breakdowns, and 25% is due to unbalanced assembly work-stations. The improvement team collects historical data about the previous three months lack of volume flexibility, and after classifying this data the percentages of lack of volume flexibility causes are prioritized as shown in Figure 2.

Subsequent to performing factory diagnosis that highlights the main improvement constraints. The BSC was developed to accurately set rational targets and to reduce those bottlenecks then improving volume flexibility, the revised targets are:

- Improving mean time between failure (MTBF) by 35%, and reducing mean time to repair (MTTR) by 10%
- Improving assembly line smoothing by 50%
- Reducing Set-up time by 25%
- Reducing nonconforming products quantity by 65%

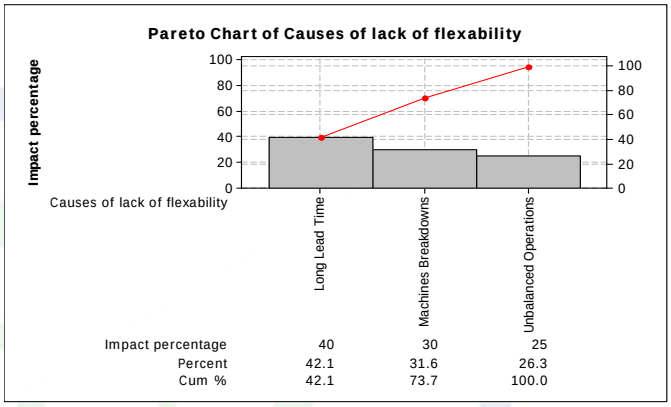


Fig. 2. Pareto Chart of Causes of Lack of Flexibility

After analyzing real root of causes, the improvement tools can be decided and the road map of improvement approach/tactic can be presented as shown in Table I. The circles presented in Table I code strategic objectives, manufacturing objectives, problems discovered by factory diagnosis, bottlenecks, KPI's, and improvement initiatives. Figure 3 presents the relationship between these circles. As shown each relation (arrow) holds a specified percentage. These percentages illustrate the causal relationship strength based on historical data analysis. The improvement team utilizes both historical data of previous three months related to the causes of each bottleneck and after classifying these causes; percentages that present the strength of each cause can be calculated.

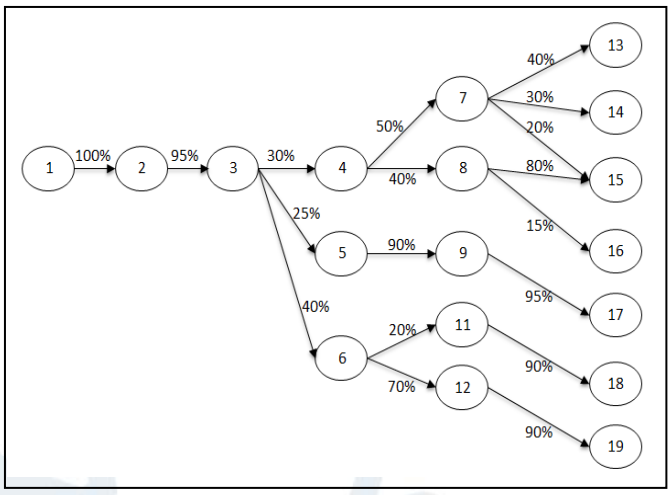
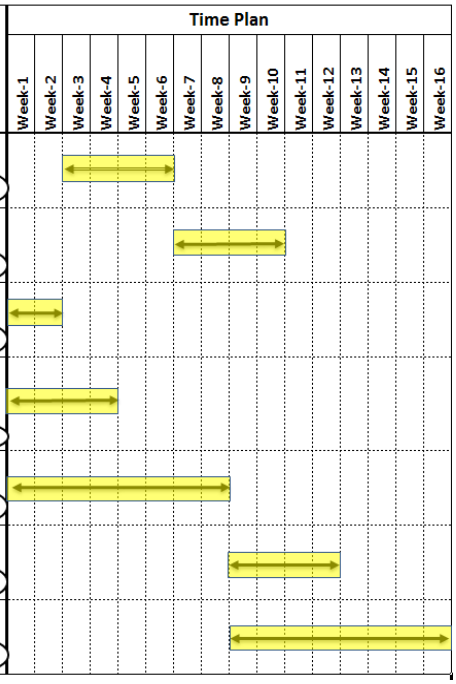


Fig. 3. Causal Relationship Strength between Objectives, Diagnoses, KPIs, and Improvement Initiatives

TABLE I. DEVELOPING OF TACTIC/SUGGESTED IMPROVEMENT APPROACH

Strategic Objective (From Strategy Map)	Manufacturing Objective (From BSC)	Problem discovered during factory diagnosis	Bottlenecks	KPI's	Improvement Initiatives/Tactics	Time Plan
Increasing market share of product-W100 by 6.5%, (1)	Increasing production plan by 6.5%, (2)	Lack of assembly lines volume flexibility (3)	Machine factor, due to relatively long breakdowns. (4)	Improving mean time between failure by 35% (7)	Applying Conditional Based Maintenance (13)	
				Reducing mean time to Repair by 10% (8)	Applying Autonomous maintenance (14)	
			Unbalanced operations cycle time. (5)	Improving assembly line smoothing index by 50% (9)	Standardize repairing methods and preparing SOP (15)	
			Relatively long lead time, due to long set-up times and non-conforming products that need to be repaired. (6)	Reducing Set-up time by 25% (11)	Applying 5S's and visual management principles on spare parts inventory (16)	
				Reducing repaired quantity by 65% (12)	Rearranging Activities between operations (17)	
					Utilizing Single Minute Exchange Device Approach (18)	
					Utilizing DMAIC road map to reduce non-conformities (19)	



This analysis highlights the suitable tools that can be used to reduce the effect of manufacturing system bottlenecks. These selected tools can be considered as the proposed improvement initiatives. According to Table I they can be presented as follow:

- First bottleneck; relatively long breakdowns due to machine failures:
  1. Applying conditional based maintenance on critical machines
  2. Applying autonomous maintenance
  3. Standardize repairing methods and preparing working instructions to illustrate them.
- Second bottleneck; unbalanced assembly work-stations:
  1. Rebalance the assembly line and standardize assembly methods.
- Third bottleneck; relatively long lead time :
  1. Utilizing single minute exchange device approach (SMED) to reduce start-up losses
  2. Utilizing six-sigma approach to reduce non-conformities resulted during assembly

The impact of the previous tools on achieving the required goals has been investigated. As example, the selected tools to improve the mean time between failures (MTBF) are:

- Conditional based maintenance, in which the maintenance labor have to monitor machines, using check lists, to discover any abnormal condition, and then take corrective actions to restore the normal conditions again.
- Standardizing repair methods, all maintenance labor should follow the same right methods to restore, repair, and maintain machines. These can be done by preparing approved working instructions, and implementing training sessions to improve operators' skills.
- Autonomous maintenance, in which machines' operators themselves should be capable to perform routine maintenance work, and monitor the machines' parameters

After evaluating the impact of the selected tools that were chosen to reduce bottlenecks and achieving updated KPI's, one needs to develop an implementation plan for these improvement initiatives. Sequentially, a Gantt chart was prepared; Table I presents the time frame of applying previous tools/approach. It was estimated to take 16 weeks to finalizing this improvement program. The adopted improvement program consists of "on-shelves" improvement tools, such as Lean manufacturing tools, six sigma tools, and TPM tools. These tools were introduced and adopted based on understanding of manufacturing system bottlenecks. The result of this focused improvement program is illustrated in Figure 4, as shown production rate was increased by 6.22%.

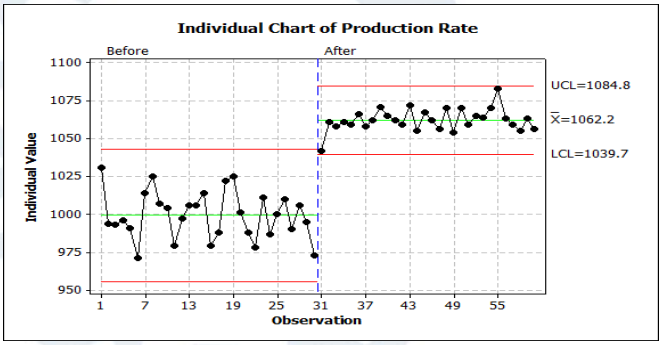


Fig. 4. Individual Chart of Production Rate

CONCLUSIONS

The proposed model was developed to select and construct improvement initiatives/programs, it supports achieving manufacturing organization strategic goals. The proposed model is developed based on integration between BSC and theory of constraints. Goals, objectives, and measures are translated down and across the organization through a process of discussions. Hierarchy diagram, WHY-WHY analysis and Pareto analysis are used to find the suitable improvement tools, and then an improvement action plan is developed. This action plan presents the sequence of applying the selected improvement tools and the scheduled time needed for the implementation.

The proposed model was adopted in an Egyptian manufacturing firm from 2013, with family of products coded as W100. The selected improvement initiative consists of improvement tools already founded in many improvement approaches. These tools were selected based on understanding the manufacturing system bottlenecks. The appreciated results can summarized as following:

- Increasing production rate by 6.22%
- Achieving manufacturing goals in relatively short time (16 weeks), due to determining the focused improvement program.

A future extension to the previous work is to integrate theory of constraints not only to find internal process improvement initiatives but also to find Customer, Learning and growth improvement initiatives.

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