International Journal of Scientific Engineering and Technology
Volume No.4 Issue No.10, pp: 498-501

ISSN :2277-1581
01 Oct. 2015

Review on the Suitability of Conceptual Performance Measurement Systems for Lean Manufacturing

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Abstract: Lean manufacturing is implemented to improve any organizational performance so that its performance should be measured to assure the organizational goal attainment. But the past studies have not yet suggested any specific performance measurement system for lean manufacturing. Therefore this paper reviews the conceptual performance measurement systems and their suitability to measure the lean performance and hence argues that a new performance measurement framework should be developed.

Keywords: Conceptual Frameworks, Lean Manufacturing, Performance Measurement Systems

I. Introduction

Lean manufacturing has become very popular among today's production philosophies. This concept has been centered to eliminate all types of waste and hence provides many benefits to an organization in improving its performance. Waste elimination, better inventory control, better product quality and better overall financial and operational procedures are some major improvements which can be gained by lean implementation (Abdullah 2003). Therefore lean manufacturing can create a continuing improvement to the efficient and effective management of the organization.

The performance of lean manufacturing cannot be directly measured by using the conceptual performance measurement systems since they do not well address the concepts of lean manufacturing. Literature does not provide sufficient information which addresses performance measurement systems for lean manufacturing (Anand and Kodali 2008). Therefore this paper reviews such conceptual models with limitations which support future researches to develop new frameworks for measuring the performance of lean manufacturing.

II. Performance Management in Lean Environment

Performance management has been defined by several authors (Bitici et al 1997, Conradie and Schutte 2003). The common idea of them was that the performance management is a process by which the organization integrates its performance with its corporate and functional strategies and objectives.

Performance means the fulfillment of the set targets. This achievement of targets can be assessed in different aspects such as financial, operational and human resources. Among them, operational performance is very much important since lean manufacturing is mainly applied in the work floor.

The performance in operational level can be explained by using the product process matrix. As it defines, any manufacturing process can be categorized into jumbled flow, disconnected line flow, connected line flow and continuous flow. Lean manufactuing is mostly applied for the disconnected flow where the manufacturing processes are repititive.

III. Historical Overview of Performance Measurement

Business performance measurement systems have been used for long time starting from the basic management techniques. But those performance measures were further insufficient due to diversification and complexity of the business world. Many academics and practitioners criticized traditional measures which were in financial terms (Dixon et al. 1990, Kaplan and Norton 1996, Neely et al. 1995, Skinner 1971). Encouraging short termism and local optimization, lack of strategic focus and failure on providing information on quality, responsiveness, flexibility, and stakeholders were major weaknesses identified in the financial measures to become outdated. Also Cross and Lynch (1992) explained rare integration and poor alignment of the business processes as other problems in the performance measures used in many organizations.

Therefore further improvements were investigated in the performance measures and non-financial measures were also used to measure the organizational performance.

IV. Performance Measurement Models

Substantive literature provided several conceptual frameworks which measure the organizational performance as a whole instead of considering different functional levels of an organization. These integrated nature of the designs of performance measurement systems create many problems in the business environment (Ghalayini et al. 1997). Therefore this paper suggests to develop a performance measurement system which can separately measure the performance of different hierarchical levels of an organization such as financial, operational and human resources etc. However, these conceptual performance measurement systems have a certain typology related to the performance measurement of an organization.

ISSN :2277-1581
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- The Sink and Tuttle Framework

Sink and Tuttle (1989) introduced the following classical performance measurement framework which is shown in Figure 1.

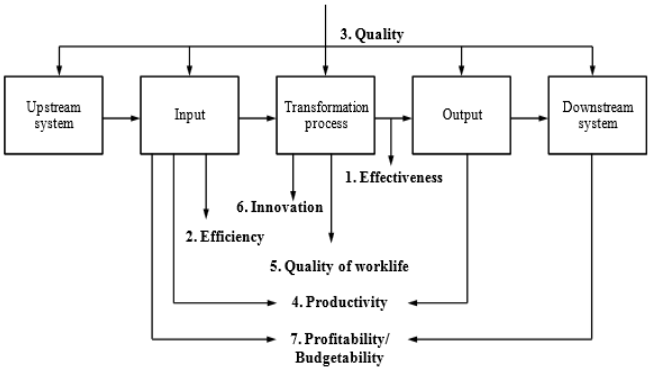

Figure 1: The Sink and Tuttle Framework

Source:http://www.diva-portal.org/smash/get/diva2:328905/FULLTEXT01.pdf

The Sink and Tuttle framework explains that the performance of an organization is interrelated with effectiveness, efficiency, quality, productivity, quality of work life, innovation and profitability. These seven criteria describe the functionality of any organization in a simple way.

But, today the complexity of the business processes cannot be explained by using this performance measurement framework hence it should be further improved with flexibility and time of the processes which are considered in lean manufacturing. Also it does not have any link with stakeholders who are the key players in lean manufacturing to explain their impact on the organizational performance. Therefore this study argues that the Sink and Tuttle framework does not sufficiently measure the performance of lean manufacturing.

- Balance Scorecard

Kaplan and Norton (1996) developed the balance scorecard which is a commonly used framework for performance measurement (Anad and Kodali 2008). It comprehends an organization in four perspectives.

1. Financial/ Regulatory (to satisfy constituents, what financial and regulatory objectives must be accomplished?)
2. Customer (to achieve the vision, what customer needs must be served?)
3. Internal (to satisfy the customers and stakeholders, in which business processes must be excelled?)
4. Learning and Growth (to achieve the goals, how to learn, communicate and grow?)

This framework consists with financial and non-financial measures and supports to review the organizational plans strategically.

But reviewing literature, this study identifies several weaknesses in this performance measurement framework hence argues that the balance scorecard cannot be applied to measure the performance of lean manufacturing. Those weaknesses are;

1. Balance scorecard views an organization in strategic level but not in operational level. But Lean manufacturing is widely used in operational level.
2. Balance scorecard fails to explain the stakeholders who are considered in lean manufacturing.
3. As Ghalayini et al. (1997) identified, balance scorecard is a monitoring and controlling tool rather than an improvement tool. But lean manufacturing is a concept that widely considers continuous improvement of the manufacturing processes.
4. Balance scorecard does not possess dynamic measures (Bhasin 2008, Maltz et al. 2003, Susilawati et al. 2013). But the concept of lean manufacturing has the flexibility to act on the changing environment.

The balance scorecard fails in these situations to measure the performance of lean manufacturing.

- The Strategic Measurement Analysis and Reporting Technique (SMART) System- The Performance Pyramid

Figure 2 shows the performance pyramid which was proposed by Cross and Lynch (1989).

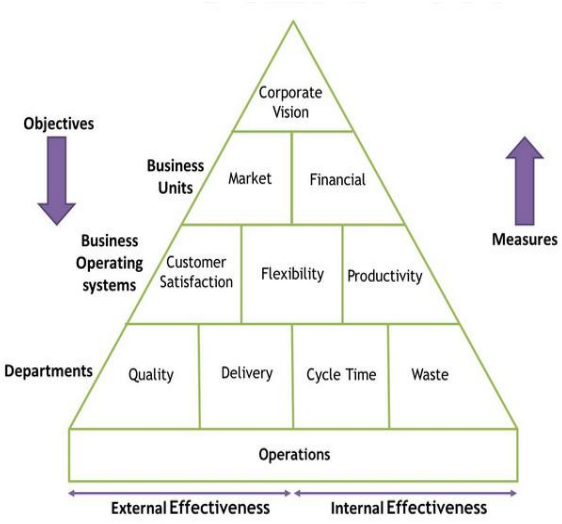

Figure 2: The Performance Pyramid (SMART System)

Source: http://knowledgegrab.com/glossary/performance-pyramid-2/

This system explains the link between different hierarchical levels of an organization. It integrates corporate vision with the

ISSN :2277-1581
01 Oct. 2015

operational level hence clearly shows the goal achievement through different levels.

But the performance pyramid does not describe any indicator or mechanism to identify the performance measures which explain improvements in the business processes. Therefore this system does not possess accurate measures for the performance of lean manufacturing.

- The Performance Measurement Matrix

The performance matrix was proposed by Keegan et al. (1989). It explains cost and non-cost perspectives versus internal and external perspectives of business performance as depicted by Figure 3.

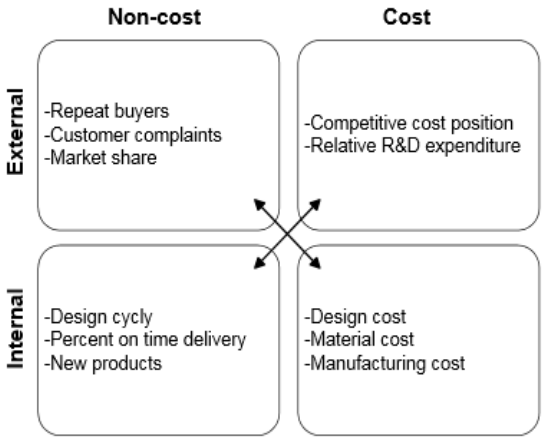

Figure 3: The Performance Measurement Matrix

Source: http://www.diva-portal.org/smash/get/diva2:7852/FULLTEXT01.pdf

The performance matrix comprehends an organization as holistic. Therefore less information is provided on the performance of each hierarchical level. Since this framework does not directly suggest performance measures at the operational level related to employee involvement, inventory and use of resources, this study argues that the performance matrix is not adequate to measure the performance of lean manufacturing.

- The Performance Measurement Questionnaire

The performance measurement questionnaire developed by Dixon (1990) assesses the current level of the organizational performance and the area which is needed to be improved in quality, labour and machine efficiencies. Therefore this framework can measure the performance of lean manufacturing at the operational level to an extent.

But literature found some weaknesses of the performance measurement questionnaire. Insufficient involvement of the management during auditing (Bourne and Neely 2003) and less attention on continuous improvement (Ghalayini and Noble 1996) are such weaknesses reviewed when compared to the major concerns in lean manufacturing. Therefore this study argues that the performance measurement questionnaire does not sufficiently measure the performance of lean manufacturing.

- The Performance Prism

Neely et al. (2001) introduced the performance prism that has perspectives on stakeholder satisfaction, strategies, processes, capabilities and stakeholder contributions as explained in Figure 4. Therefore this framework suggests comprehensive and dynamic measures for organizational performance.

Figure 4: The Performance Prism

Source: http://www.diva-portal.org/smash/get/diva2:328905/FULLTEXT01.pdf

Though the performance prism suggests important performance measures, their implementations are not much clear. Some measures among them are not effective in practice. Also this framework provides less information about the logic among the measures. Therefore no clear evidence could be found to measure the lean performance in the reviewed literature.

- Theory of Constraints

Goldratt (1990) defined the theory of constraints to identify the things that create higher performance of any system than the required level so that the information overflow can be avoided (Jackson 2000). This framework suggested five steps as follows;

1. Identify the system constraint.
2. Describe how to exploit the system's constraint.
3. Subordinate everything else to the above decision.
4. Elevate the system's constraint.
5. When a constraint is broken go back to step 1.

The relevant constraints defined by the above steps can be easily used to visually map an organization which is one of the procedures followed in lean manufacturing. Therefore the theory of constraints can partially measure the performance of lean manufacturing but not in sufficient. Since these measures assess the financial perspectives such as net profit, return on investment and cash flow, the performance of lean manufacturing in operational level cannot be adequately measured.

V. Conclusions

Assessing the performance of lean manufacturing can be done by using a suitable performance measurement framework which is not yet found in the reviewed literature. The conceptual performance measurement frameworks have weaknesses and insufficient evidence to explain the concept of lean manufacturing. Therefore this paper emphasizes the requirement of further researching in performance measurement of lean manufacturing hence to develop a new framework by considering the suitability of each conceptual system.

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