Middle-East Journal of Scientific Research 13 (5): 675-679, 2013
ISSN 1990-9233

DOI: 10.5829/idosi.mejsr.2013.13.5.1954

# Using Lean Management Tools at Different Stages of the Innovation Project

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**Abstract:** In this article, the authors consider the possibility of applying lean management tools at the stage of implementation of innovation project life cycle. We have analyzed the relationship between macro- and micro-indicators of lean management, such as the ability to produce the first time through, the overall efficiency of the equipment, compliance with the plan, effective organization of jobs with performance indicators of both the innovative project as a whole and each stage of the implementation, in particular. The use of tools such as MSA (Measurement Systems Analysis), SMED (Single Minute Exchange of Dies) and TPM (Total Productive Maintenance) can effectively influence the innovative project performance indicators such as the period of its implementation, product quality and production cost. Thus, the introduction of the lean production tools at the enterprise will be directed at identifying and reducing both the procurement costs and organizational and managerial expenses. In addition, the main idea of lean production is reduction of operations, sometimes decreasing the value of the products rather than increasing their cost. This will influence the project cost, which is one of the main indicators of the innovation project and will increase project investment prospect.

**Key words:** Innovative project · Project phases · Innovation management · Lean management · Project efficiency

## INTRODUCTION

The main objective of every enterprise is not only maintenance of the achieved position, but the dynamic development as well, that requires constant raising of efficiency, primarily by optimizing costs, improving productivity of existing resources and improvement of product quality.

Lean production is one way of organizing production, including the manufacturing processes optimization, focusing on customer needs, quality improvement and saving the annual turnover of the enterprise by cutting expenditures. The advantage of the lean production methodology is a significant inventory reduction and the organization of a transparent supply chain [1-3]. Also, one of the lean production measures is the product quality improvement provided that there is simultaneous reduction of process costs in order to increase the products competitiveness. Spoilt production is a topical issue for many enterprises. This is associated with the cost of defective products, material losses for maintenance of facilities, tools, transport, storage costs, recycling and labor costs.

Thus, the implementation of the lean production tools at the enterprise will be directed at identifying and reducing both the procurement costs and organizational and managerial expenses. In addition, the main idea of lean production is eliminating the operations, sometimes reducing the value of the products rather than increasing their cost. This will influence the project cost, which is one of the main indicators of the innovation project.

When turning to lean production and its implementation, it is necessary to identify methods to reduce the duration of the auxiliary operations, their cost and impact on the final result that is interconnected with another project indicator - the project implementation and payback period.

One of the cost elements that arise as part of an innovative project is the hidden costs involved in the production process. As part of the lean production methodology, seven types of hidden losses can be identified. The efficiency of any enterprise or project cannot be enhanced without such identification.

**The Main Part:** Overproduction is the main type of hidden losses that affects adversely, i.e. increases the rest

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of the losses. It is associated with the production or performance of a number of functions to forestall what is really required for the next stage or phase [4].

This type of loss is due to shortcomings in the planning system, the large setup times, both during the "Start-up" phase of the innovative project implementation stage and when taking the decision on the development of improving projects that require a change of process flow.

The second kind of hidden losses arising from the implementation of innovative projects is the idle hours caused by delays during one of the innovation project stages, which may arise due to late receipt of the necessary parts, materials and information [5-7]. This type of hidden losses is due to poor planning, delays or poor performance of suppliers' duties, the problems caused by communications or imperfect knowledge management system, resulting in idle hours and, consequently, a loss of time and money.

It is traditionally believed that the next type of loss is excessive movement of operators when searching for necessary parts, tools, or by other employees searching for documentation or information, i.e. it is additional movement of the personnel involved in the implementation of the innovative project, as well as materials and equipment, that do not add value to the process [6, 8]. This type of loss reduces the efficiency of production processes. Despite the fact that most of the processes originally are developed taking into account minimization of unnecessary movements and functions, the losses caused by these movements, remain a major source of hidden costs.

Let assume additional transportation to be the fourth kind of hidden losses. This transportation is caused by the movement of parts, materials, information or documents without the need, that is they are not transferred from one stage of the innovation project to the next one [1, 9]. This type of hidden losses occurs in a greater or lesser degree during the implementation of the innovation project life cycle and is caused by the fact that in a multistage process, materials, personnel or documentation move from one stage to another, or from one process to another, separated by space or time. All these moves do not add customer value to the manufactured products.

Another type of hidden losses concerns excessive processing, which is caused by two factors [2]. First, use of tools or work materials inappropriate to the technology process that requires additional treatment. Secondly, the occurrence of losses associated with unnecessary treatment. This is caused by manufacturing of products or services with a higher utility value that is claimed by the consumer. Adding functional benefits, which are of no value to the consumer, does not increase the project efficiency. First of all, this is possible due to lack of information on the consumers' requirements and preferences.

Excess inventory is the sixth type of losses in the manufacturing process, i.e. storage of stocks larger than is necessary for the planned work of pull system [8].

Since stocks are always characterized by a certain position and designated purpose and some stocks perform several functions, the same products can simultaneously be, for example, finished goods and the buffer stock. Similarly, the same products may be both raw materials and the reserve stock and some items may be finished products, buffer stock and reserve stock at the same time.

Losses due to excess inventory are related to a number of quality problems such as defects and their rework, problems in production planning, inflated lead times and problems with suppliers. Maintenance of the reserves, freezing the assets and requiring the payment of bank interest, is not a competitive advantage of the projects.

The last kind of hidden losses identified in the lean production methodology, is spoilt production and its rework [8]. Losses due to the spoilage or rework costs occur in the absence of reliable system including embedded error protection methods.

Identification and reduction of the hidden losses, considered above, will give a significant competitive advantage when assessing the innovation project cost and will allow the release of company's additional resources.

One way to identify the hidden losses is mapping the extended value stream, i.e. the identification of all the operations, both adding and not adding the value, required to carry goods through the basic workflows. Such a view of the value stream means that we consider the process as a whole rather than its individual components and making improvement of the whole, rather than optimizing individual parts.

Mapping the extended value stream most often means consideration and planning of all stages of the production process; in this case it concerns all stages of the innovation project, required for manufacturing of a product family.

If we trace the value stream for product family, it may be noted that, as a rule, the value stream crosses the subdivision borders within the enterprise, that is, passes through all the stages of the innovation project life cycle.

As some enterprises are organized based on departments and functional units, it may happen that there would be no person responsible for a specific value stream as a whole. This means that the individual parts of the process will be performed in a manner, which would be considered to be the best from the individual units standpoint, rather than from the value stream perspective. Thus, the mapping of the extended value stream should not be considered for the innovation project stages separately; solution to this problem needs a systematic approach.

The main indicators used in the lean production methodology, are the macro- and micro-indicators [8, 9], which in this study are proposed for the efficiency evaluation of phases and stages of the innovation project life cycle.

Macro-indicators are comprehensive indicators used to monitor the status of the system and manufacturing processes when implementing the lean production tools. We propose to use them when assessing the efficiency at the level of innovation project life cycle stages.

Micro-indicators are designed to monitor the performance of individual actions focused on improving the status of the processes. In the course of this investigation, we propose to apply micro-indicators for evaluating the performance efficiency of the individual stages of the innovation project life cycle.

One of the lean production key macro-indicators is considered to be "the ability to produce the first time through" (FTT) [10], i.e. the percentage of products that completed the production cycle and met the quality requirements first time through. In this case, when implementing the innovative project and applying indicators at the level of project stages, under the "product" we understand not only goods, but also the services provided, as well as the project documentation and the research results. Because of the fact that when forming the innovation project value, we propose to consider each of its stages in the form of process diagrams, where the indicators at the process outputs are assigned in accordance with the customer requirements, this indicator (FTT) can be used from a customers' quality requirements perspective. Development of measures focused on quality improvement will allow improving the quality of the process / process outcome, reducing the deviations from plan indicators and overall costs by reducing the cost of rejected products, rework and warranty service.

The overall equipment efficiency (OEE) is another macro-indicator of lean production [9], which shows the product release capabilities, the efficiency and the quality level of products manufactured at the given equipment that is more applicable for the implementation stage of the innovation project. This indicator shows the throughput capacity associated with a decrease in production cycle time, thereby reducing the probability of a manufacturing variance from the production targets, rejected products and rework costs, that leads to lowering total outlay.

The third macro-indicator of lean production is the time from delivery to delivery (DTD) [9, 10], i.e. the total time from the delivery of raw materials or supplies to the delivery of finished products to the consumer.

The improvement of this indicator will allow increasing the ability of timely deliveries that will have a positive impact on customer satisfaction, as well as reduce the number of operations with the materials and supplies. The latter will reduce the probability of material damage and the cost of operations with materials and finished products and thus will lower total outlay.

The last indicator of lean production used to the extent of the innovation project stages, is the production in line with a plan (BTS), i.e. compliance of the production plan and product delivery to target indicators, which is measured as the ratio of actual product output to the standard volume of production.

For the enterprise, the main advantage of improving this indicator is the improvement in DTD indicator owing to their interchangeability. Besides, lower transaction costs of materials and finished goods lead to lower total outlay.

It is proposed to apply the above considered macro-indicators of lean production for evaluating the performance efficiency of the innovation project life cycle stages that enables the evaluation of the level of costs at the implementation of each stage, including the hidden costs that will affect the final cost of the innovative project. Besides, the improvement of these indicators will affect the innovation project implementation period by reducing the duration of stages and increasing the efficiency. In other words, there is a direct relationship between the macro-indicators of lean production, used for evaluating the performance of the innovation project stages and the indicators of the project competitiveness in the whole.

As already noted, apart from the macro-indicators, in lean production methodology there are also micro-indicators, proposed for evaluation of the performance efficiency at the level of innovation project life-cycle phases.

**The Micro-Indicators Include:**

- Labor capacity, which indicates the amount of produced goods (services) per hour of labor time;
- Production area, i.e. the total space used for the production of goods; the figure includes all the space occupied by the equipment, as well as the storage space for material in process;
- The distance that products pass during the manufacturing process, which characterizes the total distance traveled by the parts, semi-finished articles or finished products throughout the manufacturing process;
- Changeover time, i.e. a time when the manufacturing process is not functioning because of the change;
- The volume of work in progress, i.e. the production amount or volume, which is in production;
- Lead time, i.e. the time from the first operation process to the final operation;
- Idle hours, i.e. part of the above described OEE indicator.

Table 1: Choice pattern of the lean production tools to minimize hidden losses

| | | |
|---|---|---|
| 1 Mapping the extended value stream<br>CURRENT STATUS | 2 Mapping the extended value stream<br>FUTURE STATUS | 3 Identification of hidden losses<br>(defective products) |
| 4 Determination of the loss causes | 5 Ranking the losses by reason<br>Reducing Poka-Yoke variability | 6 Application of lean production tools MSA and SPC<br>Ranking the losses by performance results |

Table 2: Lean production tools at the innovation project implementation stage

| Innovation project stages | Macro-indicators | Innovation project phase | Micro-indicators |
|---|---|---|---|
| | - The ability to produce the first time through (FTT)<br>- Overall equipment efficiency (OEE)<br>- Time from delivery to delivery (DTD)<br>- Better technologies of sustainability (BTS) | Innovation project phase<br>Innovation project phase<br>Innovation project phase | - Labor capacity<br>- Production area<br>- The distance that products pass during the manufacturing process<br>- Changeover time<br>- The volume of work in progress (WIP)<br>- Lead time (MCT)<br>- Idle hours (element of OEE) |

| Hidden losses | Loss types | Loss characteristics | Loss causes | Tools to address loss |
|---|---|---|---|---|
| | Defective products | - Inspection costs<br>- Follow-up costs<br>- Rework costs<br>- Expenses for claims | - Poor quality of process control<br>- Poor quality of incoming inspection<br>- Poor quality of workplace<br>- The lack of an integrated system | - Prevention of errors<br>- Reducing variability<br>- Poka-Yoke<br>- Statistical methods of SPC and MSA |
| | Idle hours | Idle hours of equipment due to waiting of materials or equipment failure | - Unstable workload<br>- Improper maintenance<br>- Unsteady supply<br>- Poor quality materials | - Improving the industrial management<br>- Separation of the value adding time from the time not involved in the value chain<br>- Pull systems and frequent supplies, LT |
| | Excess inventory | - Extra space for storage<br>- Large reserves between the processing operations | - The lack of local optimization<br>- Unreliable processes<br>- Unreliable suppliers<br>- Uneven production plan<br>- Unsteady supply | - Balanced production plan<br>- Pull production<br>- TPM<br>- Elimination of "bottlenecks", LT |
| | Irrelevant movement | - Unnecessary movements in the workplace<br>- Excessive movement<br>- Disorder at the workplace<br>- The movement that does not add value | - Discordant workflows<br>- Improper equipment location<br>- Lack of integrated system | - Workplace optimization<br>- Sequential arrangement of the equipment and convenient location of the materials |
| | Excessive processing | - Irrational expenses<br>- Idle run of machine | Actual requirements of the customer are not specified | - The improvement of technology |
| | Loss of working time | - Irrational use of running time between production operations<br>- Waiting for tools | Inefficient industrial management | - Work time study<br>- Mapping the extended value stream |

The main distinguishing feature of the lean production micro-indicators is the need to reduce them in order to improve the enterprise performance, in contrast to the macro-indicators, which should be increased using lean production tools.

These indicators, as noted, may be applicable for any of the innovation project stage and the considered products include services, information, or provided project documentation.

Thus, the application of lean production indicators as part of an innovative project will allow identifying both the procurement costs, organizational and managerial expenses and hidden costs, as well as identifying their causes in order to develop measures to minimize them.

As noted, mapping the extended value stream allows identifying the hidden costs at the innovation project life cycle phases.

The algorithm for selecting lean production tools is presented in Table 1.

Choice of the lean production tools to minimize other types of hidden losses can be done in accordance with the presented pattern of choice. These hidden loses can be caused due to excess inventory, movements, idle hours, processing and loss of working time.

To reduce these types of hidden losses, various lean production tools can be applied, which include JIT system ("Just in time"), aimed at ensuring the timely supply of raw materials that leads to reduction of excess inventory. Other tools that can be applied include: work time study, 5S to adjust the workplace, SMED for rapid changeover of the equipment, Poka-Yoke method to prevent errors caused by human factors.

Thus, the choice pattern for use of lean production tools to reduce the hidden losses at the implementation phase of the innovative project life cycle is presented in Table 2.

Application of lean production tools is traditionally implemented as part of the production process, but, in our view, this methodology can be applied at all stages of the innovation project life cycle. In particular, the 5S methodology (workplace adjustment) is applicable at the pre-design stage of the innovation project to harmonize the search of relevant information and research. FMEA technique, focused on risk analysis and identification of the causes of nonconformance, will be practically relevant at the stage of the innovative project extension when monitoring the project implementation.

## CONCLUSION

Thus, lean production methodology allows us to identify the hidden losses at each stage of the innovation project life cycle and minimize them through the use of relevant tools that causes decrease in innovative project cost as a whole and helps to increase its investment potential.

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