# A regulation mechanism based on work activity to improve Lean approach

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**Abstract:** Companies adopting Lean increase their productivity, quality of product and delivery in the short term. But in the medium term, these performance criteria are mitigated by events such as absenteeism, sickness leaves, turnover, etc. To explain this, Occupational Health scientists identify contradictions between the components of Lean and human functioning. One of these contradictions relates to the regulation mechanism of human work activity, specific to human functioning, which would be inhibited in a Lean working environment. In this article, we focus on the integration of this mechanism in the Lean performance approach and, to illustrate our approach, we choose the example of semi-finished stock lying between each workstation: the 'work in progress' inventory. We propose to use a performance indicator that measures the need of 'work in progress' inventory taking into account the regulation mechanism of the work activity. We call this indicator "number of regulating 'work in progress' inventory".

**Keywords:** Work in Progress Inventory, Work Activity, Working Regulation, Lean, Performance, Margin of Maneuver, Occupational Risks.

## 1 Context

Lean[1] is a production and management approach that aims to eliminate production waste in a transformation process in way to only retain the value-added activities [1]. This approach focuses on the reduction of production costs, delivery times and production scrap (Quality). Lean has been theorized in the 80's by researchers from MIT (Massachusetts Institute of Technology), drawing on the Japanese methods, specifically the Toyota Production System (hereinafter abbreviated as "TPS" for Toyota Production System). Lean has been a major attraction in the auto companies and their subcontractors in the 1990's and 2000's [2]. Since the crisis of 2008, all sectors of activity were concerned by this appeal. In 2006, a study estimated that 28% of French employees work in companies that have adopted Lean [3].

[1] In this paper, we will use "Lean" as an abbreviation for the Lean approach.

## 2 Research problem

Today, several studies show a correlation between the use of Lean by companies and a drop of the commonly used performance criteria (Quality, Cost, Delay) because of events such as absenteeism, sick leaves, accidents and turnover [3], [4], [5].

To explain it, several scientists from Occupational Health research area have identified strong contradictions between Lean and human functioning at work [6].

One of these contradictions is about the consideration of the level of autonomy of a worker in his working activity, i.e. of his 'margin of maneuver'. This level of autonomy is the opportunity given by an organization that allows a worker to choose its own way to work according to the production variability considering the constraints of the organization. On the one hand, Lean considers that this regulatory mechanism is not necessary to be taken into account since the production process can be stabilized. On the other hand, Occupational Health scientists believe that this mechanism is a fundamental contribution to the performance of the company due to the autonomy it infers to the worker in order to manage uncertainty and to regulate its process of work [7]. One of the operational consequences of this lack of integration is, for example, the level of 'work in progress inventory', and more precisely how workers regulate their work activity with the help of semi-finished stock of products. This example comes from a cooperative project with an automotive SME, dedicated to the improvement of the deployment of Lean.

On the basis of it, we ask the following question: how to promote the consideration of this regulatory mechanism in the Lean approach of performance adopted by companies?

To provide some answers, we will define the concept of performance and specifically criteria used in Lean. We will describe how the regulation mechanism of work activity plays an important role in performance. In this paper, we will propose to change the approach of performance, underpinned by Lean, by integrating this mechanism. Finally, we will propose an indicator that allows measuring this mechanism using the example of 'work in progress' inventory.

## 3 State of the art

### 3.1 Performance

We propose, in this article, to change the approach of performance underpinned by Lean. But what do we mean by performance? Performance is defined as the quality reflecting the ability of a system to achieve its goals. It characterizes the relationship between the functions to be performed by the system and the compliance of the service actually provided by the resources. Performance is defined from the goals (criteria) chosen by a company (e.g.: economic, legal, social, ecological) and may have a multi-dimensional nature [8]. Thus, we will see in the next section that Lean selects

Quality, Cost and Delay as criteria to evaluate the performance of a production system. To complete the definition of performance, we draw attention to the fact that criteria are measured by indicators.

### 3.2 Lean and its performance approach

We choose to select two components of Lean: technical variability and waste elimination. Technical variability elimination aims to reduce variations observed in a production process, for example by ensuring the quality and consistency of suppliers raw materials or products before they enter the production process (via quality assurance programs for example) or doing preventive maintenance to minimize random breakdowns [9]. This kind of elimination is a prerequisite for implementing another major Lean component: waste elimination. Eliminating waste aims to reduce production process steps considered as non-added value.

Taichi Ohno [9], one of the main Lean theoreticians, identified 7 types of waste involved in a production process:

- Transport, e.g. unnecessary products displacements.
- Inventory.
- Motion, e.g. people or equipment moving more than is required to perform the processing.
- Waiting, e.g. interruptions of production during shift change or maintenance operations.
- Overproduction.
- Over Processing, e.g. under dimensioned tools for scheduled production.
- Defects, e.g. the effort involved in inspecting and fixing defects.

Ohno specifies that waste elimination aims to reduce delivery time, cost and quality defaults. Thus, Lean uses Quality, Cost and Delay criteria to evaluate the performance of a production process. In this paper, we will focus on a specific indicator aimed to measure one of the seven types of waste above mentioned. This indicator measures the number of ‘work in progress’ inventory. ‘Work in progress’ inventory is composed of semi-finished products located between two workstations. This indicator is used by Lean to assess Cost and Delay criteria of performance.

Indeed, getting too much ‘work in progress’ inventory in a production site generates several problems such as:

- Trapped capital (Cost criterion)
- Financial risk of being obliged to sell obsolescent products (Cost criterion)
- Decreased flexibility in changeovers (Cost and Delay criteria).

Lean focuses on the production process and believes it can be stabilized. As we explain below, this approach can be challenged by another one that focuses on human functioning at work and which believes that the process cannot be stabilized.

### 3.3 Work activity regulation

We now introduce this approach. This approach is centered on mankind at work and focuses on work activity.

Work activity refers to the activity actually performed by workers and differs from the area of assigned tasks (e.g.: procedures). Work activity depends on goals and means that are assigned to the worker, as well as its personal characteristics.

According to available means (e.g.: tools, support from another worker) and goals which are assigned (e.g.: cycle time, quality criterion), a worker will make compromises to achieve the stated objectives. The compromise is done between given means ("External Means") and the worker internal state ("Personal Resources"). This process is called “Work Regulation”. As a result of this process, the worker will choose a way to do his work (“Modus Operandi”). Variously, this compromise would be made to the detriment of the worker internal state (e.g.: working faster in despite of fatigue) or of the results of the work (e.g.: not achieving the appropriate quality) [10].

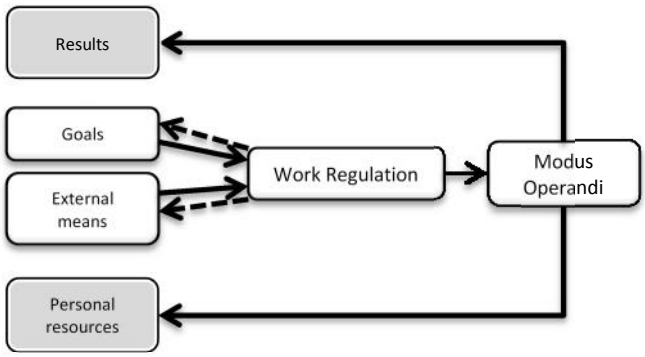



**Fig. 1.** The work regulation mechanism [10].

Thus, the worker is led to build up ‘margin of maneuver’ in its working environment that allows him to regulate his work activity against variability in a way to preserve his health (internal state) and to reach the objectives (see Fig.1). In a production environment, ‘margin of maneuver’ can take the form of time (e.g.: moving ahead on a chain transfer) or space (e.g.: building up a buffer stock). In this human-centered approach, performance is rather seen as the ability of an organization to let worker building up the pertinent ‘margin of maneuver’ to face variability, rather than the ability to stabilize a process.

On this topic, the Occupational Health scientists’ community, particularly through French institutions such as ARACT[2] and INRS[3], agrees that technical stability, one of

[2] ANACT : Agence Nationale pour l’Amélioration des Conditions de Travail (National Agency for Working Conditions Improvement).

the Lean components, has never been observed in a production process. However, it has been observed that, in Lean, work activity 'margin of maneuver' have been removed assuming that technical process is stabilized. Applied to 'work in process' inventory, Lean considers them as wasteful whereas the Occupational Health scientists' community considers them as 'margin of maneuver'. In short, we refer to the illustration done by Bourgeois which sets work activity regulation as a leverage for performance in the production process [11].

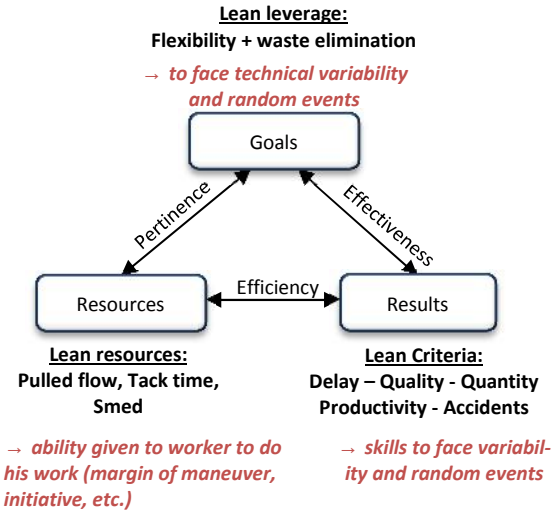



**Fig. 2.** Regulation mechanism of work activity as a performance leverage [11].

[3] INRS : Institut National de Recherche sur la Sécurité (National Institute Of Health and Safety Resarch)

# 4 An approach for integrating Lean performance and human work activity

## 4.1 Introducing a multi-level regulation mechanism

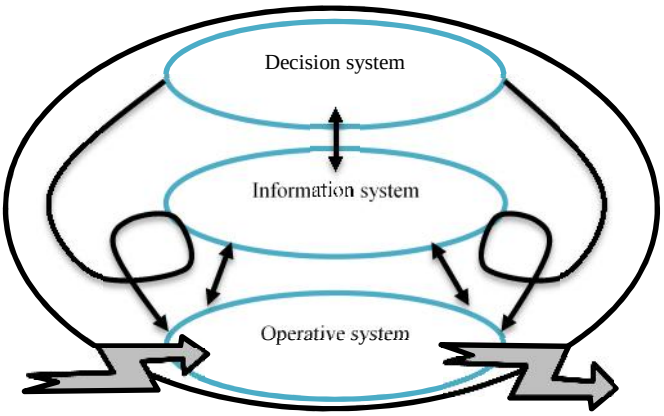



**Fig. 3.** Canonical model [12]

We consider the canonical model of Le Moigne [12] (Fig. 3) that breaks up an organizational system into three sub-systems: a decision system that regulates an operative system through an information system that supports information flows. This model is generally a recursive model that allows modelling the system at different levels of granularity [13]. This model helps us to highlight the information feedback between operating and decision systems.

Thus, we have seen in Figure 1 that the regulatory mechanism of work activity is an adequate leverage for performance and that Lean does not integrate this mechanism into its components, considering it as a waste to eliminate. So, how to promote the integration of this mechanism as a performance leverage in Lean and, accurately, how to promote the integration of 'margin of maneuver'?

On the basis of the previous elements, we propose a new Lean approach of performance. In this approach, we believe that the regulation mechanism of work activity is a leverage.

Our aim is to define a global approach that allows the control of a whole system, i.e. on the operational, tactical and strategic levels, integrating this regulatory mechanism. This mechanism is located at a very detailed system level where human activity is performed.

We propose to characterize the information flows and the decision activities in order to take into account the regulatory mechanism for each worker. Especially, the decision-making system will receive bottom-up feedback information about indicators related to 'margin of maneuver'measured in the production environment (operating

system). Our method consists here in defining new kind of indicators that represent ‘margin of maneuver’ reducing the impact of the process variability on the performance.

### 4.2 A ‘margin of maneuver’ indicator: the number of regulating ‘work in progress’ inventory

Referring to Figure 3, which indicator is able to inform the decision-making system about a ‘margin of maneuver’ state or a ‘margin of maneuver’ need status? We propose to use an indicator related to ‘work in progress’ inventory which integrates the pertinent number of ‘margin of maneuver’ to do the job. As located at an operational level and involved in the regulation of work, we propose to name it "number of regulating ‘work in progress’ inventory".

We oppose this definition with the one used in Lean: "number of ‘work in progress’ inventory". Indeed, Lean focuses on the number of products between workstations and tries to reduce it, regardless of whether these products could be necessary to the performance of work because of the existing variability.

How to measure the "number of regulating ‘work in progress’ inventory"? We could calculate the standard deviation from the upstream and downstream work in progress inventory consumption and use it as a reference value.

To do so, it is important to base the calculation on observations and interviews with several workers involved by the production environment, repeating measurements taking into account variations observed in production (e.g.: beginning of the day, unplannified orders, seasonality).

This indicator would be a "steering" type indicator. It would help to check how ‘work in progress’ inventory requirements vary during a production cycle, compare this value with the means given to workers in the production situation and adjust these means in way to come close to the reference value previously calculated.

## 5 Conclusion

Thus, we propose to change the Lean approach of performance to integrate the regulation mechanism of work activity. We use Le Moigne model to feed the decision-making system with bottom-up feedback information though indicators related to ‘margin of maneuver’measured in the production environment. As an example, we propose to use an indicator that measures the needed ‘work in progress’ number in order to adapt the means of production necessary to help workers to do their work properly.

Aside from the question of changing the lean approach of performance, we are aware of the importance of defining a generic method to implement the proposed approach into companies, and especially SME’s. This method should change the “waste elimination” mental picture. It will help stakeholders to sort out useful opera-

tions for the regulation of work activity from non-added value operations. By this way, decision stakeholders will be able to get the appropriate 'margin of maneuver' indicators and thus base their performance analysis on more global and long-term Quality, Cost and Delay criteria.

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