MANUFACTURING COST POLICY DEPLOYMENT (MCPD): FROM TARGET AND ACTUAL COST TO IDEAL COST

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Abstract. It is obvious that the gap between the need to reduce manufacturing costs and the level that manufacturing companies can achieve is large and often companies do not know how to cope with this situation, especially against the background of increasing competitiveness. Moreover, this gap is widening for many companies even if they use different pathways such as: Total Quality Management (TQM), Total Productive Maintenance (TPM), Industrial Engineering (IE), Just-In-Time (JIT), Lean Manufacturing (LM), Six Sigma and World Class Manufacturing (WCM). However, these approaches do not necessarily guarantee a reduction in unit costs at the level required by the market and the expected profitability, even if they have been successfully implemented. Except for publications on the Manufacturing Cost Policy Deployment (MCPD) system, there have been no published articles or books addressing a methodology for setting targets and means of reducing unit costs, regardless whether sales are up or down. MCPD system establishes competitive cost targets and expected profit targets, breaks down cost improvement targets at the level of products, processes, departments and individuals and aligns systematic (KAIZEN) and systemic (KAIKAKU) improvement activities accordingly. The three phases and the seven steps of the MCPD system and an example of applying the MCPD system are provided below.

Key words: Manufacturing Cost Policy Deployment (MCPD), Manufacturing Cost Improvement (MCI), KAIZEN, KAIKAKU, Cost of Losses and Waste (CLW), Critical Cost of Losses and Waste (CCLW), Lean, Industry 4.0, Cost Reduction.

1. INTRODUCTION

Profitable production is and will remain an eternal challenge to ensure the prosperity and dignity of companies in a global market. The prosperity of a nation through the continuous support of the growth of the manufacturing industry is the foundation of a nation [1–7]. Romania's consistent commitment to innovation

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and productivity is the main challenge for top managers in companies, academia and research.

The aim of this article is to provide a deep understanding of how to adopt a profitable productivity program for manufacturing companies in their effort to achieve a consistent and sustainable competitive supremacy through cost-competitiveness improvement to achieve real structural profit reform based on productivity reform, both in the short term and especially in the medium and long term, in the context of a transformation of the manufacturing flow.

The following issues will be solved in this article [8–11]:

- a methodology for systemic and systematic manufacturing cost improvement (MCI) by setting targets and means of MCI to ensure sustainable competitive supremacy through cost-competitiveness improvement (short presentation of the MCPD system);
- an estimation of the possible scientific decrease in current unit costs in a feasible way based on: (1) the continuous measurement of the main losses and waste and the determination of the main types of cost of losses and waste (CLW) at the level of all manufacturing operations and at the level of all product family costs - PFC, (2) the continuous identification of cost of losses and waste (CLW) behaviour across the entire manufacturing flow;
- the alignment of all effective and efficient improvements (means to achieve MCI) to achieve the critical cost of losses and waste (CCLW) improvement target to meet the annual and multi-annual unit cost reduction target and implicitly target profit at product level, PFC level and at the level of the entire company by increasing productivity (with a continuous focus on moving towards ideal cost or zero CLW).

Therefore, in this paper, the first part briefly describes the MCPD system for a production system that has several operations. After the production system is defined at the level of losses and waste (and then at the level of CLW and CCLW) and is agreed at the level of productivity, three methods of transforming losses and waste into costs are presented in order to continuously support a coherent, stable and scientific cost reduction program. At the end, an example of a successful MCPD implementation is presented.

2. THE MCPD CONCEPT

In the context of transformations in the operations of manufacturing companies, including the introduction of various elements of Industry 4.0 (I-4.0), top managers often make statements such as: “We would like to undertake a reform of the current profit structure so that we can intervene on unnecessary costs for our business. Even if our current improvements of type I-04 seem to have an impact on

cost reduction in some processes, we cannot get clear information about the costs that have been reduced to our products and we cannot properly assess the decision making process for calculating profit and pricing for each product" (the statement of a plant manager at a prestigious multinational company; type of industry: manufacturing and assembly-surgical medical devices; manufacturing regime: repeated lot-machine shop, plastic injection and assembly lines). Another statement is: "Every year, we have repeatedly added employees to and focused on improvements, including the I-04 type, but this is not reflected in the expected business results. I would like to see the financial results of the kaizen and kaikaku projects on the balance sheet level and to know the feasibility of the improvements in their approval phase. Otherwise it is as if we continue to pour water into the sand on a beach" (the statement of a CEO at a prestigious multinational company; type of industry: process – ferrous and non-ferrous metal processing; manufacturing regime: continuous).

So, in this context, three pertinent questions arise:

- What is the MCPD system? The MCPD system is the systemic and systematic manufacturing cost improvement system, which sets competitive cost targets and expected profit targets and breaks down cost improvement targets at the level of products, processes, departments and individuals and aligns improvement activities accordingly.
- What is the basic purpose of the MCPD system? The basic goal of MCPD system is to ensure a sustainable competitive supremacy through cost-competitiveness improvement to achieve real structural profit reform based on productivity reform.
- Why is MCPD the basis of Industry 4.0? Because the MCPD system sets the ideal costs continuously (unit costs without cost of losses and waste - CLW or zero CLW). In this way, the MCPD system becomes the North Star for manufacturing companies in their endless journey of improvements, including those of type I-4.0, by directing any systematic (kaizen) or systemic (kaikaku) improvement towards achieving the annual and especially multiannual target operational profitability.

The main concern areas of the MCPD system are:

- ✓ increasing the level of productivity by standardizing the cycle time of direct labor and equipment (development of standard operating procedure - SOP; eliminating losses from the design phase of the working method);
- ✓ increasing the productivity level by continuously improving the degree of use of all assets (standardization and continuous improvement of standards on time related losses and physical losses and waste in order to reduce/eliminate them and thus eliminate the related cost of losses and waste).

To meet these main concerns of the MCPD system, for each cost reduction target, the size of cost reduction opportunities, potential risks, possible scenarios

(above or below the capacity of the manufacturing flow – in the bottleneck operation) are scientifically established and then the most effective and efficient systematic (KAIZEN) or systemic (KAIKAKU) improvements, including type I-4.0 projects are selected and implemented.

The MCPD system is a three-phase, seven-step approach (see Fig. 1) [8–11]. The MCPD system uses Deming cycle/wheel PDCA (Plan-Do-Check-Act) for the control and continuous improvement of processes to meet the annual and multiannual MCI targets and means.

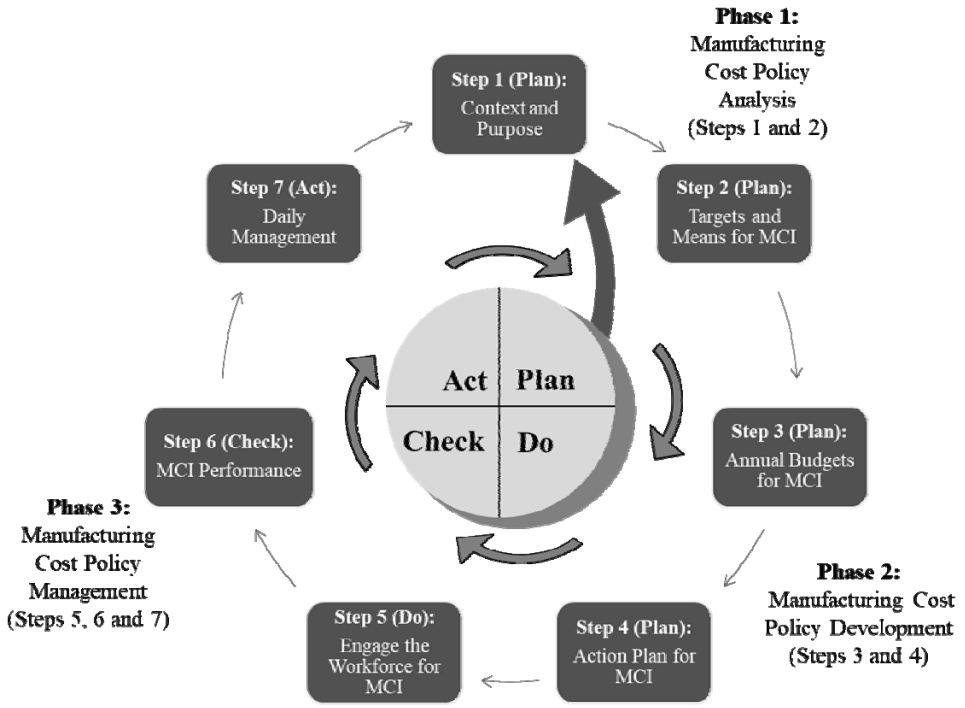

Fig. 1 – The MCPD System.

The central annual and multi-annual challenge for the management teams is to set targets and means for CLW and CCLW to consistently meet the MCI goal for each PFC and for the company as a whole. To show how to achieve and sustain operational excellence using the MCPD system, we will present the phases and the steps of MCPD.

3. THE MCPD TRANSFORMATION

The development steps of the MCPD system are summarized in Fig. 2.

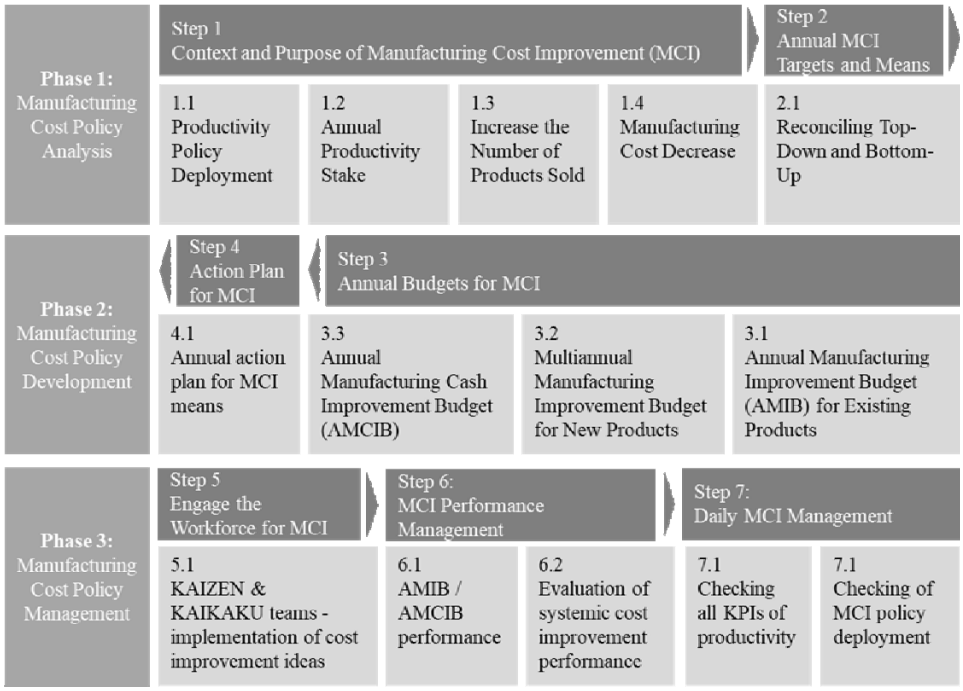

Fig. 2 – Development steps of MCPD system.

3.1. THE FIRST PHASE OF MCPD: MANUFACTURING COST POLICY ANALYSIS

The purpose of the first phase of the MCPD is to define the annual and multiannual expectations for MCI, to identify how CLW will manifest for the next period and to identify the potential root causes of CLW and CCLW respectively (step 1: context and purpose of MCI). At the same time, in this phase, the countermeasures against the main cause of the future CCLW are established, more precisely the choice of the most effective and efficient projects of systematic (kaizen) and systemic (kaikaku) improvement (step 2: annual MCI targets and means). Therefore, in this first phase of the MCPD system the need to reduce the production unit cost of the product is translated in concrete actions at the level of the operations of each PFC by carrying out an effective feedforward control.

3.1.1. STEP 1 – CONTEXT AND PURPOSE OF MCI

Figure 3 shows a model of production system. The model consists of three processing modules and a final assembly and inspection module (considered the bottleneck module). In order to achieve a synchronized production planning and

control, more precisely the connection of the capacity of each module to the current level of takt time, especially of the bottleneck module (in our example module 4), it is necessary to ensure a stability of the real capacity of each module. However, in each module there are different types of losses and waste that have the effect of decreasing productivity. In fact, there is a need to maximize outputs of bottleneck operation (productivity growth through improving effectiveness – reduction/ elimination of losses or not effectively used input) and/or by minimizing inputs (productivity increase through improving efficiency – reduction/elimination of waste or excess amount of input) [12].

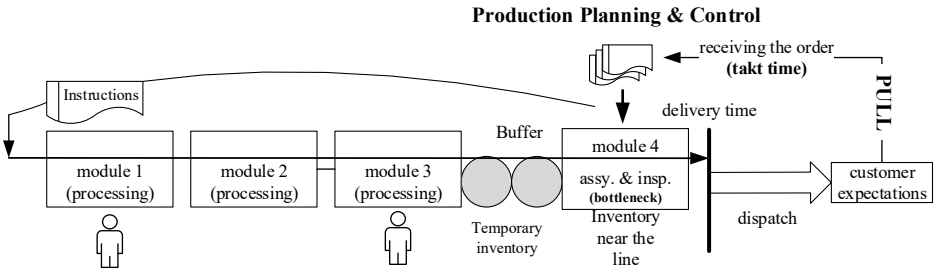

Fig. 3 – Synchronous production planning and control according to the continuous matching of the capacity of the bottleneck operation with takt time.

By transforming the losses and waste into costs, the cost of losses and waste (CLW) is obtained. Some of these have effects on the occurrence of other losses and waste and other costs of losses and waste in the same module and/or modules of the production system in Fig. 3. The costs of losses and wastes affecting other CLWs are considered to be critical costs of losses and waste (CCLW).

Three methods of conversion of losses and waste into costs can be used [12]:

(1) the unique rate method: allocation of all transformation costs of a manufacturing flow on bottleneck module for determining for each module both value-added costs, as well as non-value-added costs or cost of losses and waste (CLW) for each product. Material costs are allocated on each module through BOM (bill of materials).

(2) the modules rates method: allocation of transformation costs of a manufacturing flow on each module of manufacturing flow for determining for each module both value-added costs, as well as non-value-added costs or cost of losses and waste (CLW) for each product. Material costs are allocated on each module through BOM (bill of materials).

(3) the causality method: allocation of transformation costs of a manufacturing flow on each module of manufacturing flow for determining for each module both value-added costs, and non-value-added costs or cost of losses and waste CLW for each product. Establishing the causal relationships

between the cost of losses and waste throughout the entire manufacturing flow (or the CCLW) for both bottleneck profit modules and bottleneck capacity modules in order to direct improvements. In determining the types of costs associated with each loss and waste, the probable sales scenarios (increasing or decreasing) are taken into account Material costs are allocated on each module through BOM (bill of materials).

As shown in Fig. 4 in summary, different costs of losses and waste may be present in each module of a production system [8–11,13,14].

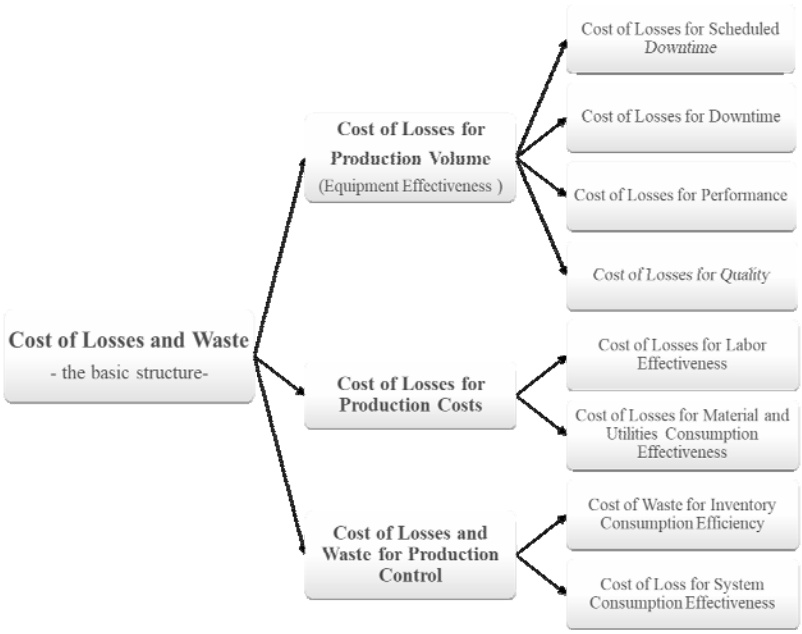

Fig. 4 – The basic structure of Cost of Losses and Waste (CLW).

Therefore, the first activity of the MCPD system (see Fig. 2: 1.1 – Productivity Policy Deployment) is to define the implementation of the production company's policy, respectively:

• *productivity policy* or direction of action proposed by an organization (through targets and means); and

• *productivity deployment* or positioning of all resources (“combat troops”) in action (“military action”) to carry out effective and efficient actions and activities to achieve targets through means.

The next activity (see Fig. 2: 1.2 – Annual Productivity Stake) is to understand as accurately as possible the current and potential level of the next

period of CLW and CCLW for each module. Therefore, after answering the question: What does the company want? (volume of products and MCI), the management seeks to answer scientifically the question: How much profit can be obtained from MCI based on increased productivity (without investments; by reducing/eliminating losses and waste with the help of KAIZEN – systematic improvements and KAIKAKU – systemic improvements). The continuous awareness by top managers of the possible level of annual and multiannual profit obtained by increasing productivity (reducing/eliminating CLW) is essential in the logic of the MCPD system. In this way, top managers will be able to unlock all the resources needed to meet the annual productivity stake with a direct impact on increasing profitability based on MCI. The result of raising awareness of the annual productivity stake is defining the number of products needed to be produced and sold (see Fig. 2: 1.3 – Increase the Number of Products Sold; based on increasing efficiency or in other words based on reducing/eliminating losses) and defining the required level to reduce unit costs (see Fig. 2: 1.4 – Manufacturing Cost Decrease; based on efficiency gain or in other words based on waste reduction/elimination).

3.1.2. STEP 2 – ANNUAL MCI TARGETS AND MEANS

The second step of the MCPD system is the most sensitive challenge. In order to set annual targets and means, a continuous and consistent reconciliation between the top-down approach (the need for profitability through productivity) and the bottom-up approach (opportunities to increase productivity) is needed to set the annual and multi-annual MCI target for each product family, for each way CCLW manifests itself and for the whole company.

In fact, the following is continuously determined at the level of each module:

- ✓ the level of losses and waste (measurement of non-productivity);
- ✓ the sources that generate losses and waste at the level of the entire manufacturing flow (losses and waste behaviors over time);
- ✓ the CLW level by continuously converting losses and waste into manufacturing costs;
- ✓ the level of critical costs of losses and waste (CCLW) (cost of losses and waste behaviors over time);
- ✓ the current assumptions for CCLW improvement (analysis of the feasibility of improvements);
- ✓ the annual MCI targets;
- ✓ the annual MCI means targets.

In fact, as shown in Fig. 5, for each module, for each product family and for the total company, the annual target level of CLW met by KAIZEN and KAIKAKU is set.

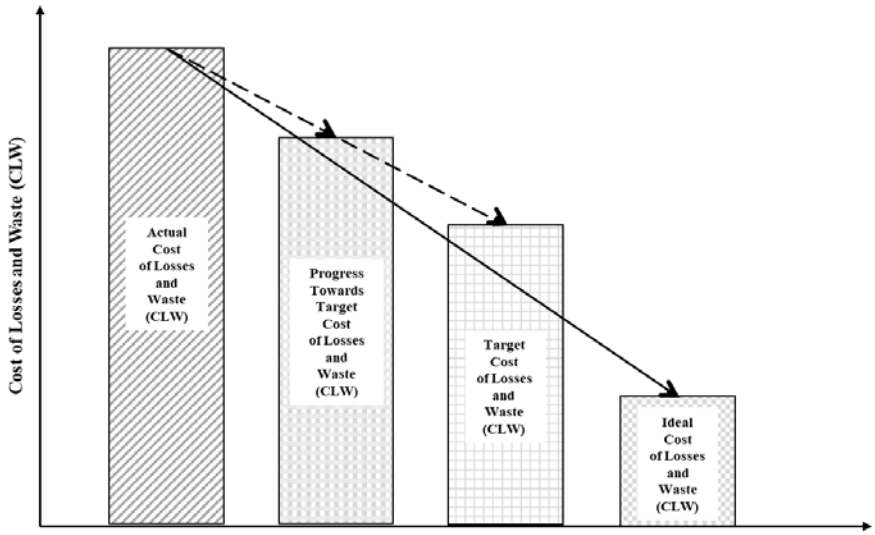

Fig. 5 – From target and actual cost to ideal cost.

The pole star of the MCPD system is the ideal level of CLW or zero CLW (beyond which improving CLW is no longer feasible).

3.2. THE SECOND PHASE OF MCPD: MANUFACTURING COST POLICY DEVELOPMENT

This second phase of the MCPD system aims at coordinating the MCI's means (KAIZEN and KAIKAKU projects) to achieve the annual MCI targets.

3.2.1. STEP 3 – ANNUAL BUDGETS FOR MCI

In the logic of the MCPD system, beyond the conventional logic of the budgetary approach of external profit (obtained on the basis of sales), in order to achieve the annual objective of MCI, annual improvement budgets are elaborated following the following 6 steps (following the PDCA cycle):

1) *planning items to set annual MCI targets (PLAN)*: more precisely setting the annual CLW and CCLW targets;
2) *action items to set annual MCI means (PLAN)*: activities to set the annual MCI means and annual losses and waste targets;
3) *annual manufacturing improvement budgets (PLAN)*: the activities to set (1) an annual manufacturing improvement budget for existing and new products (AMIB); and (2) annual manufacturing cash improvement budget (AMCIB);

4) *action items for annual action plan*: *kaizen* and *kaikaku for MCI (PLAN/DO)*: annual actions (*kaikaku*) and activities (*kaizen*) for MCI (identifying and implementing solutions to meet MCI targets – mostly engineering solutions);
5) *monitoring and evaluation of manufacturing improvement budgets (CHECK)*: monitoring and evaluating the effectiveness and efficiency of manufacturing improvement budgets by (1) comparing improvement budget targets with current production budgets (for existing and for future products); and (2) comparing cash improvement budget targets with actual manufacturing cash budgets;
6) *new cost standards, replication and new MCI targets geared to the ideal cost (ACT)*: setting the new cost standards; expanding solutions successfully implemented horizontally in other similar processes and/or equipment, and continually setting new MCI targets that are continuously directed to the ideal CLW.

3.2.2. STEP 4 – ACTION PLAN FOR MCI

The fourth step of the MCPD system concerns the development of an annual action plan for MCI means at company level. The annual MCI action plan aims to fully involve all people in the company's departments and beyond the company's departments to achieve annual MCI targets.

The main activities of this step are:

- ✓ centralization of all annual kaizen and kaikaku projects to meet the annual MCI targets;
- ✓ establishing the link between CCLW targets and kaizen and kaikaku project targets;
- ✓ determining the share of kaizen or kaikaku improvement projects in reducing CCLW (for example, 50% of CCLW in a module);
- ✓ determining the share of each kaizen or kaikaku improvement project in achieving the annual MCI objective;
- ✓ setting the annual priorities of the kaizen and kaikaku strategic projects;
- ✓ establishing the necessary teams to participate in the annual kaizen and kaikaku projects to achieve the annual MCI target;
- ✓ establishing methods of improvement and steps to address improvement;
- ✓ establishing deadlines for identifying solutions for improvement and for implementing and validating solutions approved by senior managers;
- ✓ establishing the tasks of each person within the kaizen or kaikaku project to achieve the MCI goal in time;
- ✓ timely allocation of all resources necessary to reach the annual MCI targets.

3.3. THE THIRD PHASE OF MCPD: MANUFACTURING COST POLICY MANAGEMENT

The goal of manufacturing cost policy management, the third phase of the MCPD system, is to reduce or eliminate incorrect and incomplete improvement project implementation.

3.3.1. STEP 5 – ENGAGE THE WORKFORCE FOR MCI

This step aims at the full involvement of participants in the kaizen and kaikaku projects for meeting the annual MCI targets based on the annual action plan developed in the previous step, based on the structured kaizen and kaikaku meetings (MCI means). Interdepartmental organization and lifelong learning are crucial to continuously identify and implement profitable improvement projects amid a pro-cost and pro-productivity culture, such as the MCPD culture.

The kaizen and kaikaku projects focus on the CCLW approach. It seeks to fully and continuously understand all the links between losses and waste, manufacturing costs and modules/processes/equipment and the definition and continuous awareness of the zero CLW state or the ideal cost.

The basic activities of this fifth step of MCPD are: (1) departmental and interdepartmental organization for achieving the MCI targets, (2) establishing sources for determining training needs related to the fulfillment of the MCI targets, (3) developing an initial and updated annual training plan for operators, supervisors and managers to achieve the MCI targets, and finally, (4) running the activities and actions of the annual MCI means to meet annual MCI targets.

3.3.2. STEP 6 – MCI PERFORMANCE MANAGEMENT

The annual MCI performance management refers to the effectiveness and efficiency of annual MCI means (kaizen and kaikaku projects), to check the achievement of the annual MCI targets.

So, the annual MCI performance management refers to: (1) performance evaluation of AMIB/AMCIB, (2) the assessment of the degree of employee involvement to achieve MCI targets, and (3) systemic cost improvement performance management.

3.3.3. STEP 7 – DAILY MCI MANAGEMENT

The daily MCI management refers to the daily control of modules, processes, equipment, people, and inventory or, in other words, shop floor management for MCI. This daily control implies: (1) checking the achievement

level of productivity policy deployment, to check routine tasks (to achieve the annual external profit expected from sales/production) and (2) verifying the degree of achievement of MCI policy deployment to check the tasks for improving and innovating in the workplace (to achieve annual MCI targets). For the continuous monitoring of MCPD system the following are used: (1) MCI Status Board; (2) MCI Department Status Board and (3) MCI Module/Process Status Board.

So, to achieve the manufacturing target profit by continually decreasing the CLW using MCPD, irrespective of sales progress, there is a need for [15–18]:

- strengthening the external manufacturing profit through maximizing outputs, if sales volume has an increasing trend – the predominant need for productivity growth by improving effectiveness (reducing losses - not effectively used input);
- strengthening the internal manufacturing profit through minimizing inputs, if the volume of sales has a decreasing trend – the predominant need for productivity increase through improving efficiency (waste reduction - excess amount of input).

4. EXAMPLE OF APPLYING THE MCPD SYSTEM

To exemplify the achievement of multiannual manufacturing target profit on the basis of external and also internal profit, the figure below shows an example of meeting MCI targets at DD-Plant after 3 years for ”AAP” Product-Family Costs (PFC).

Figure 6 shows the phases and results of the implementation of the MCPD system as follows:

- in the initial phase, before using MCPD, basic information on price, profit and cost was known;
- in the second phase, before improvement using MCPD, based on unit CLW measurements (after 3 months of process-level measurements) the percentage of CLW in the unit manufacturing cost structure of about 40% was determined (CLW was measured and localized at the level of each process of ”AAP” PFC; 2 major types of losses and waste were measured: time-related and physical). In this way, the money stake for potential product improvements and for total planned sales (15,230,000 units) was established before planning and implementing any improvement project. In this way, the CLW sizing has opened up the appetite of top managers to develop and strengthen the culture of continuous improvement as the stake of increasing operating profit is determined;
- in the third phase, after the first 3 years since joining MCPD, kaizen and kaikaku feasible projects were planned and implemented to achieve both multiannual manufacturing target profit and ROI target, based on productivity growth. The multiannual manufacturing target profit was

accomplished through the contribution of the external manufacturing target profit of $24,205,000 (based on sales) and internal manufacturing target profit of $14,100,000 (based on meeting MCI targets).

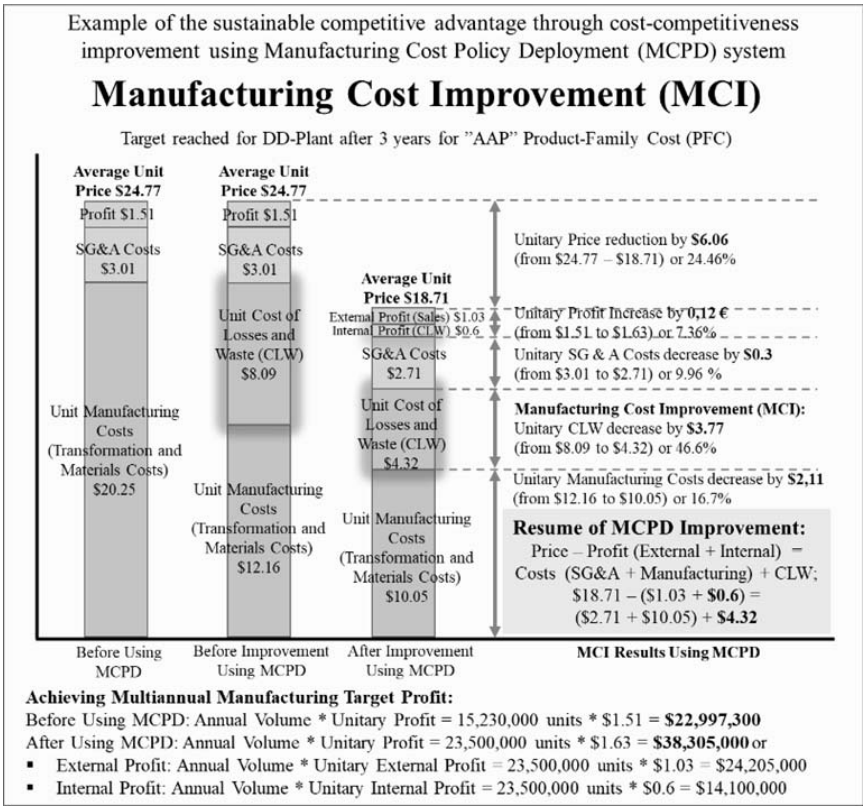

Fig. 6 – Example of applying the MCPD system.

In conclusion, the continuous knowledge and awareness of the CLW at the level of each module/process and each PFC, in fact operating profit to be obtained through kaizen and/or kaikaku, facilitates real managerial commitment, reduces resistance to change, increases the involvement of all departments, and beyond, reduces or eliminates the reactive behavioural style of managers, and improvement projects, especially kaizen, are performed completely and correctly to achieve MCI targets. In other words, if you have on Fig. 6 possible offers of operating profit, $22,997,300 and $38,305,000, then your decision is simple, is not it? Yes.

What is to be done is to move to a true culture of productivity for profit by measuring and continuously addressing non-productivity processes, namely CLW and by developing profitable kaizen and kaikaku projects continuously linked to market needs.

5. CONCLUSION

Companies that do not control their costs do not stay in the market. Are everyone in the company aware enough of the importance of costs in these times? How can you double your profits? Can you sell and produce twice as much? Could your company grow to double the current size in the same market? Well.... you don't have to! By reducing unit costs by just a small amount, you can double your profits without the need for a single new customer and without creating a single additional product. You won't have to hire more people, enter new markets or get a new production space - just focus on being more effective and efficient with what you already have. In any company there are numerous opportunities to reduce costs without affecting customer satisfaction. Improving costs is much more than controlling and cutting costs. True manufacturing cost management means: (1) deep and continuous understanding of manufacturing costs, (2) good manufacturing cost design, (3) identifying opportunities for cost improvement, and last but not least, (4) the choice of the best ways to improve costs.

So, the MCPD system does not mean a new costing method but it means the alignment between the need for cost reduction and the effective and efficient opportunities to improve the cost of losses and waste (CLW) in the company's operations (continuously aiming at zero CLW or ideal costs). The MCPD system (or system building for cost-competitiveness improvement) completes the production management function, is compatible with any production system and improves overall business results by improving cost competitiveness (focusing on the costs associated with non-productivity or costs associated with losses and waste).

Through the deployment of kaizen and kaikaku projects in a structured way and constantly directed to the ideal cost, the manufacturing flow transformation is achieved through productivity. The continuous measurement of non-productivity (losses and waste) and its transformation into costs (CLW and CCLW) provide an exact definition and localization of the manufacturing company’s problems. By analyzing and continuously reducing CLW and CCLW on the basis of ongoing kaizen and kaikaku projects for MCI, month after month and year after year, both external manufacturing profit through maximizing outputs and internal manufacturing profit through minimizing inputs, regardless of the sales trend, are enhanced. So, it is time to fully understand that external manufacturing profit based on sales volume is no longer enough to be truly competitive and profitable in a global market of the future. It is the time to reach the internal manufacturing target profit required for healthy competitiveness or the operating profit gained from reducing and/or eliminating CLW scientifically, systematically and systemically and to achieve business objectives.

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