A case study of an integrated manufacturing performance measurement and meeting system

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1. Introduction

In complex value streams, the perceptions about what is needed and what will generate customer value are, in some cases, wrong. In fact, not needed activities do take place and sometimes the needs of the final clients are not taken into account. To avoid these situations, focusing the organization on value streams has been considered to be a key success factor, particularly when applying lean production methodology (e.g. Womack and Jones, 1994; Liker, 2004). Prioritizing the value stream focus is a strategic decision that implies to appropriately adapt day to day practices. The management indicators used are critical elements to appropriately focus the organization on what is important. In particular, a manufacturing performance measurement system (MPMS) can be used to focus the organizations on value stream.

The literature describes several methods for developing a MPMS. What is characteristic about many of these methods is the focus on developing performance metrics and an MPMS based on the firm’s strategy and processes (Bourne et. al., 2000). The appropriateness of an MPMS then depends on the ability to adapt it to the characteristics and objectives of the company. Besides, as stated by Gomes (2004), more important than the design of a MPMS is the implementation and daily measurement process. Meetings are an important part of this implementation. Maskell and Kennedy (2007) explain that in lean companies all routine meetings are held at the location where the work is performed around a board that display the performance. We think that it is important to adopt a formal meeting system that complements the setting up of a MPMS. Meetings can only be fully effective if the appropriate and accurate information is discussed, and gathering information would make no sense if it is not clearly established what will be done with it.

This paper is intended, first, to expose a case of an integrated manufacturing performance measurement and meeting system implemented to focus the organization on value streams and, by doing it, to improve performance, and, second, to analyse the results obtained. The concrete aim of the implementation described is to improve overall equipment effectiveness (OEE) and capacity values. Information is near real-time obtained. An implementation with these characteristics had not been described before.

Since the approach analysed here is new and the authors did not find previous empirical knowledge, it was felt best to gain a deep understanding of what was happening. It was necessary to take a significant amount of time in field research. A case study was conducted since such research is most appropriate in the early stages of research on a topic (Eisenhardt, 1989). According to Piercy and Rich (2009) “The use of single or small numbers of case studies as knowledge building tools is increasing prevalent in the operations management literature”. Single case study approaches cannot offer generalizability in the statistical sense (Yin, 1994). They are however capable of developing and refining generalizable concepts and frames of reference (Pettigrew, 1985). A thorough analysis of a single situation may lead to discovery of non-obvious relationships. The lack of generality in the single-case studies is compensated by an additional level of detail.

The research done consists of an exploratory case study carried out at the Sant Cugat (Spain) plant of Delphi Diesel Systems (DDS Sant Cugat in the rest of the paper), a division of Delphi
Automotive PLC (Delphi in the rest of the paper). DDS Sant Cugat implemented a MPMS integrated with a meeting system to focus the organization on value streams and, by doing it, to improve the performance. The implemented MPMS is near real-time and is based on IT. The effects in terms of performance were analysed. OEE values were particularly relevant in this case. To overcome the weakness of a single-method design, data was gathered through triangulation from multiple sources. Data was collected through an interview with the operations director, informal interviews with APU managers and team leaders and the direct analysis of the plant, all this carried on in March 2012. Interviews provide depth, subtlety, and personal feeling. Documents provide facts, but are subject to the dangers of selective survival. Direct observation gives access to group processes and can reveal the discrepancies between what is said and what is actually done (Pettigrew, 1990).

The outline of the paper is as follows: Section 2 is devoted to the literature review, focusing on MPMS and formal meeting system. After, the characteristics of the company and the MPMS application at DDS Sant Cugat is explained, explaining in detail the overall equipment effectiveness measure and the integration with the formal meeting system. Finally we present the results and conclusions.

2. Literature review

Literature about performance measurement, particularly in companies applying or implementing lean; OEE; meeting systems; and implementation and use of MPMS is presented.

According to Tangen (2004), the most well-known performance measurement system is probably the balanced scorecard system. The balanced scorecard proposes that a company should use a balanced set of measures that allows top managers to take a quick but comprehensive view of the business. However, according to Ghalayini et al. (1997), the main weakness of this approach is that it is primarily designed to provide senior managers with an overall overview of the performance. Thus, it is not applicable to the factory operations level.

Cecelja (2002), states that there are a number of different methods by which shop-floor data collection can be performed. The simplest, and cheapest, is paper recording and manual storage. This method makes it fairly difficult to use and analyze the data; hence there is a greater probability that the data will not be used to improve the process, making the exercise pointless. The second method is paper recording and input into an MRP system. Although this is cheap to perform, it is labor intensive, resulting in a time lag, low accuracy and is also difficult to analyze. Finally, dedicated shop-floor data collection systems can be implemented that are very flexible, very accurate, and allow the possibility of providing information in real time. According to Jonsson and Lesshammar (1999) no matter what the objective of the system is, a complete MPMS needs to be comprehensive and cover the most critical performance dimensions of the organization.

Within the lean manufacturing context a manufacturing measure is a standard that defines performance criteria for manufacturing processes so that everyone in the organization is working towards the same goal (Khadem et al., 2008). Lean advocates consider that organizations based on continuous flow should limit information needs to local communication between upstream and downstream production units and it is preferable for employees to search for the information they need. For this reason the application of information technology and lean principles have for a long time been seen as mutually exclusive, but both approaches are more and more claimed to be interdependent and complementary (Cottyn et al., 2011).
In complex manufacturing processes the support of IT in the MPMS can trigger, feed or validate the lean decision-making and continuous improvement process by always basing the decisions on the production flow. Sánchez and Pérez (2001) state that lean production implies decentralization of responsibilities to production line workers and a decrease of hierarchic levels within the company. According to the authors, the efficient operation of a lean organization requires the diffusion of information to all levels. In fact, available performance indicators have a critical role on lean practices. Continuous improvement initiatives often begin with information from key performance indicators (Marksberry et al., 2010).

OEE is taken as the critical measure to work with in the case described in this paper. OEE is defined as a measure of total equipment performance, that is, the degree to which the equipment is doing what it is supposed to do (Williamson, 2006). Many companies routinely hit capacity constraints and immediately consider adding overtime for existing workers, hiring workers for new shifts, or buying new production lines to boost their production capacity (Muchiri and Pintelon, 2008). For such companies, the OEE tool can help them to optimize the performance of the existing capacity (Muchiri and Pintelon, 2008).

The OEE measure is a bottom-up approach where an integrated workforce strives to achieve overall equipment effectiveness by eliminating the six big losses (Nakajima, 1988): (1) Breakdown losses (2) Set-up and adjustment losses (3) Idling and minor stoppage losses (4) Reduced speed losses (5) Quality defects and rework losses (6) Start-up losses. However, Scott and Pisa (1998) pointed out that the gains made in OEE, while important and ongoing, are insufficient. It is necessary to focus one’s attention beyond the performance of individual tools towards the performance of the whole factory. To address this need, Braglia et al. (2009) propose an adaptation of the OEE concept to take account of the global performance of a manufacturing line. The importance of OEE is emphasized altogether with the need to combine it with other indicators.

The ultimate objective is a highly efficient integrated system, not brilliant individual tools. Scott and Pisa (1998) coined the term “overall factory effectiveness” (OFE), which is about combining activities and relationships between different machines and processes, and integrating information, decisions and actions across many independent systems and subsystems.

The establishment of a formal meeting system complements the setting up of a MPMS that covers the most critical performance dimensions. The importance of meetings has been emphasized by the literature about manufacturing management and about lean. Fletcher and Taplin (1997) remarks the importance of the operating review meetings is an emphasis on the future, not the past. During these meetings, the focus is kept solely on interdepartmental key performance indicator. They suggest as main point of the meetings procedures to (1) Hold regular meetings, (2) Set an established agenda (3) Review exceptions and commitments, (4) Make performance improvement plans (5) Document meeting action items. According to Maskell and Kennedy (2007), in lean companies performance is reported visually on display boards at the location where the work is performed and all routine meetings are held around this boards. The information of this boards substitute the traditional accountant information.

More important than the design of a MPMS is the implementation and daily measurement process (Gomes, 2004). The literature in this field is emerging. Most of the research focus was on designing performance measurement systems, with few studies illustrating the issues in their implementation and use (Nudurupati et al., 2011). The use of performance measures and meetings have been reported to be important. For example, there is a belief at Toyota that reports and meetings that occur away from the actual site of the work being discussed will lead to incorrect assumptions and conclusions (Koenigsaeker, 2009).
Different aspects of the implementation and use of performance measurement systems have been dealt with by the literature. Bartoli and Hermel (2004) study the cause of the sometimes disappointing results of the IT implementations. They conclude that the introduction and the development of IT must be conceived and controlled as a true process of change with its global effects. Wei et al. (2008) propose a comprehensive framework for measuring the performance of an enterprise resource planning. They state that an information system implementation project supposes a big investment and clear and measurable benefit objectives have to be established and controlled. Gomes and Yasin (2011) present an approach to performance measurement and management for small and medium organizations (SMOs) with global business aspirations. The approach presented offers practicing managers a systematic and practical approach to performance measurement, management and improvement. Bhasin (2008) proposes a refinement of the Balanced Scorecard to assess lean implementation. He proposes as a topic for future research the ways to develop dynamic rather than static measurement systems, which takes organisational changes into account.

Finally, Bourne et al. (2005) analyses through a multiple case study the success factors in implementing an indicator system. In high-performing units the main drive for performance came from continual interaction with the performance data. In these units managers had their own data collection systems and indicators of performance. The information provided by the system was confirming the previous information they already have. In the literature reviewed papers exploring how to integrate performance measurement and a formal meeting system were not found.

3. Characteristics of the case

Delphi is one of the world's largest automotive part manufacturers and has approximately 146,600 employees (Delphi, 2012). Delphi is a former General Motors company that became independent in 1999 and has been implementing the lean manufacturing concepts since the early 1990’s. Delphi is considered an example of lean transformation of a big traditional company (Woolson and Husar, 1997). Delphi has been recognized with the Shingo Prize for operational excellence, also called “the Nobel Prize of manufacturing” by Business Week (2000), in twenty-seven plants. The Shingo prize recognizes organizations in the USA, Mexico and Canada for the successful implementation of world-class practices (Shingo, 2012). The policies and tools which are based on lean manufacturing are applied in all Delphi units and form the Delphi Manufacturing System (DMS). The DMS is widely acknowledged. For example it is described by Liker, (1997) together with Daimler-Chrysler Operation System and Ford Production System. Some case studies of Delphi are found in (Mabry and Morrison, 1996; Salaiz, 2003; Nelson, 2004).

DDS Sant Cugat manufactures Diesel fuel injection pumps of two product groups, dfp1 and dfp3, for some of the main automotive customers (Delphi, 2012). The plant has been operating for fifty-five years and employs around one thousand people. DDS performs the machining and assembly of the pumps. The assembling process is made in two lines for the dfp1 product group (assembly line 1 and assembly line 2 in figure (1)) and one line for dfp3 product group (assembly line 3 in figure (1)). The machining process of the different components is basically composed by a soft stage machining process, a heat treatment process and a hard stage process. The plant is characterized by its big dimension; process variety and process complexity (see Figure 1 showing the process flow diagram. Dark blue corresponds to dfp3, light blue to dfp1).
DDS Sant Cugat has been applying the lean manufacturing principles for years. In 2002, DDS Sant Cugat was selected as model plant for the implementation of the DMS within the Diesel Division. The DMS was adapted to the needs of the division and published in Delphi’s “Lean Toolbox”. The DMS was later implemented in other plants of the group. The current top and intermediate managers of the plant participated in this process. According to Jaume Roquet, operations director of the plant when this study was developed, the experience acquired by the current managers as lean leaders during the initial implementation of DMS is a key aspect of the more recent transformations. For DMS the focus of the organization to the production flow is a critical aim. According to DMS documentation, DMS is “a Manufacturing System with an implementation process that recognizes the interdependencies of its elements and drives to flow manufacturing”. The application of the DMS at DDS Sant Cugat makes information and material flow through the different operations as follow. The demand is frozen, leveled by type, quantity and frequency over a monthly period of time. The tool used to level production mix in the shop floor is a Heijunka box in each of the main assembly lines. This enables the production to meet customer demand while avoiding batching. The machining processes produce the material needed to the assembly lines by following a pull system. Two tuggers move the material every forty-five minutes. The different operations in the value stream are balanced and the cyclical work is decoupled from non-cyclical work to guarantee that the production flows in a constant pace.

The DMS also highlights the importance of having an organization based on the production flow. According to DMS documentation, “We cannot separate Manufacturing, PC&L, ME, Purchasing, PE, HR, Sales, Business line... and so on because all functions must support manufacturing that is our core. All activity is connected and this focus will maximize the performance as an enterprise”. The plant is divided into five autonomous production units (APUs) that are managed by an APU manager leading a team of 10-20 indirect employees and 100-250 direct workers. The APUs have decision and financial autonomy while strictly following the standards of Delphi and the plant. The aim of this organizational solution is to focus the teams on the production flow, enhance entrepreneurship, team work, flexibility and problem-solving reactivity while preserving the technical knowledge and specialization of the functions.
4. The new integrated manufacturing performance measurement and meeting system

In 2009, DDS Sant Cugat faced a new and demanding challenge. Due to the high demand the strategy adopted consists in taking as much advantage as possible of the capacity of the plant. To serve these objectives an integrated manufacturing performance and meeting system has been developed that gives great importance to the overall equipment effectiveness measure. The goal of the system is to strengthen the focalization of the activity on the value streams. According to the interviewee, Jaume Roquet, Operations Director “the performance measurement system and the meetings, for us constitute one system. It makes the teams focused on the aspects that will make a difference in the performance of the business.” The application was highly successful and allowed the plant to cope with the increasing customer demand through an increased focus of the organization on the volume performance dimension. This section describes first the new MPMS explaining the OEE measure in detail. After, the integration with the meeting system is described.

4.1 The new near real time manufacturing performance measurement system

The performance management boards were changed by an IT supported near real-time manufacturing performance measurement system (MPMS) that was developed to fulfill the following needs:

1. To simplify and integrate the performance measurement system in a single system and adapt the refreshment frequency to the frequency of the manufacturing process.

2. To develop indicators that motivate continuous improvement of the decentralized teams not only showing the result but also helping to detect the root causes of the deviations and help to focus the efforts of the teams.

3. To link the targets of the indicators with internal or external customer needs.

Table 1 shows details about the new MPMS. It covers the most critical performance dimensions: security, quality, volume and cost. Every performance dimension has at least one result indicator (that defines what to achieve) and one process indicator (that defines how to achieve it), as suggested by De Haas et al. (2000). In the following table the refreshment frequency of the different indicators is also described.

<table>
<thead>
<tr>
<th>Result indicator</th>
<th>Process indicator</th>
<th>Refreshment frequency</th>
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<tbody>
<tr>
<td>Security</td>
<td>Number lost work day cases</td>
<td>The root cause analysis process has been done and is visible on the system (or not) Number and description of all kind of injuries/risks detected</td>
</tr>
<tr>
<td>Quality</td>
<td>Number of external customer complaints (parts per million)</td>
<td>The root cause analysis process of the external customer complaints has been done and is visible on the system (or not) Number and description of internal customer complaints (parts) First time quality rate and Pareto chart of causes</td>
</tr>
<tr>
<td>Volume</td>
<td>Premium freights (€)</td>
<td>Overall equipment effectiveness (OEE) and Pareto chart of causes in every machine</td>
</tr>
<tr>
<td></td>
<td>Number of stoppage hours to internal customer</td>
<td></td>
</tr>
</tbody>
</table>

http://mc.manuscriptcentral.com/jmtm
The OEE measure is explained in detail in the rest of this section. In DDS Sant Cugats’ MPMS the OEE measure is critical due to the characteristics of the plant. The plant performs a high volume manufacturing process. Capacity utilization is of a high priority and stoppages or disruptions are expensive in terms of lost capacity. Dal et al. (2000) suggest that OEE measurement is best suited in those cases. Effectively the plant is characterized by:

1) **Dimension**: 500 different machines that perform 150 different operations.

2) **Variety of manufacturing processes**: drilling, electrochemical machining, heat treatment and surface hardening, turning, grinding, cleaning, assembly, test processes and painting processes.

3) **Variety of failure modes**: Every machine has between 100 and 300 different causes that can stop production flow.

The result is that the production flow can be stopped by a very wide variety of causes. As suggested by Jonsson and Lesshammar (1999), such complexity makes it necessary to have a more detailed data collection for OEE measurement than a classification into the six big losses proposed by Nakajima (1988). The OEE is measured in 100% of the machines in the plant. The data is collected and introduced in a software system by two workers (see figure 2 for an example of collected information), following standardized routes, with a frequency of two hours (see figure 3). In order to know accurately the capacity losses, every possible failure mode is codified in every machine. The responsibilities of the workers that collect the data are also ensuring the quality of the data by teaching the workers how to use the codes in case of mistakes.
Figure 2: Example of the OEE information collection. Source: Delphi Diesel Systems S.L. translated to English.
The information collected is then introduced in an IT system. This computer system allows everybody to have access to the information at any moment in any aggregation level. In the following picture there is an example of how the information is displayed. The system always shows the Pareto chart of the losses from last day and the last four weeks classified within the six big losses proposed by Nakajima (1988) (see figure 4). Any loss can be selected in order to have more detailed information about the exact reason of stoppage. For example in figure 4 the breakdown loss is selected (accounts of 6,3% of losses in the last four weeks and 11,3% in the previous day) and the Pareto of the exact causes are displayed.
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a)-j) indicate: a) Idling and minor stoppage losses  b) Breakdown losses  c) Start-up losses  d) Set-up losses  e) Errors in the measure  f) Quality defects  g) Adjustment losses  h)&i) Rework losses  j) Reduced speed losses

Figure 4- Example of the OEE measure. Source: Delphi Diesel Systems S.L. translated to English.

For OEE target setting, DDS Sant Cugat uses the concept of Operation Rate (OR) which is defined in internal manuals as the “minimum level of OEE to meet customer demand”. OEE performance lower than OR in one machine means a risk of stopping the complete flow of a product. The calculation of the operation rates is made based on the coming month’s demand, machines opening hours and machines cycle times with an OR-calculation standard tool (see Figure 5). The OR concept is used for target setting in the MPMS and gives the OEE measure a complete flow and customer orientation. The comparison of the OEE levels with the OR makes it possible for the decentralized teams to quickly identify bottlenecks and focus on the production flow and external customer needs.
4.2 The integration of the MPMS and the formal meeting system

Meetings can only be effective if the appropriate and accurate information is discussed. Gathering information would make no sense if it is not clearly established what will be done with it. The MPMS supports these meetings by showing the information that must be checked (result indicators) and allowing the possibility of going into detail (process indicators). The meeting system applied in DDS Sant Cugat differentiate between daily meetings called “Daily stand-up meetings”, weekly and monthly meetings called “operating review meetings” and quarterly meetings called “top5 focus meetings”.

Daily stand-up meetings

The objective of this meeting is to define the abnormalities of the day before and the risks for the current day based on the information provided by the result indicators compared to the planned performance in terms of security, quality, volume and cost. In case of abnormalities, the associated process indicator is checked in order to quickly understand and react to the problems. For example, OEE measure is only checked in case that the volume was lower than the customer needs. This meeting is performed every morning in the shop floor by the APU staff (APU manager, quality manager and manufacturing engineering manager). After the meeting the DDS Sant Cugat directors do a plant tour through the five APUs in order to quickly review the major abnormalities and risks. The manufacturing teams that work in shifts also perform the daily stand-up meetings but with a lower scope.
Figure 6 - The manufacturing performance system that supports the daily stand-up meetings. Source: Delphi Diesel Systems S.L.

Figure 7 - Example of a meeting area where the daily stand-meetings are done. There are 22 in all the plant (one per setter and operators team). Source: Photo done on a visit to Delphi Diesel Systems S.L.
Operating review meetings and TOP5 focus meeting

The operating review meetings have the objectives of planning, result indicators performance review and continuous improvement. These meetings are performed on a weekly basis by the APU staff. On a monthly basis the team presents their performance results and the action plan to the plant directors.

The TOP 5 focus meeting is performed every quarter with the purpose of selecting the most important improvement projects. The APU staff define their performance dimension focus called “business problem” between security, quality, volume and cost (in order of importance). The definition of the “business problem” is based on result indicators with targets linked to internal and external customer needs. It is decided which the five most important projects are, that the team will focus on. These are called the “TOP5 priority projects” and they are focused on the performance dimension that will have more impact on APU's internal and external performance. In figure 9, there is an example of the TOP5 priority projects from the fourth quarter of 2011 (Q4 2011) listed in order of importance.

<table>
<thead>
<tr>
<th>QVC</th>
<th>Title (including target)</th>
<th>owner</th>
<th>achieved</th>
<th>saving (k€)</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>OEE IMAS DFP1 (56% → 61%)</td>
<td>M</td>
<td>55%</td>
<td>V</td>
<td>Repeat</td>
</tr>
<tr>
<td>2</td>
<td>OEE IMAS AI DFP1 (60% → 68%)</td>
<td>M</td>
<td>67%</td>
<td>V</td>
<td>100%</td>
</tr>
<tr>
<td>3</td>
<td>OEE HD DFP3 hard stage (70% → 80%)</td>
<td>P</td>
<td>80% (no FM)</td>
<td>V</td>
<td>100%</td>
</tr>
<tr>
<td>4</td>
<td>ROF Heat Treatment founds</td>
<td>P</td>
<td>100%</td>
<td>V</td>
<td>100%</td>
</tr>
<tr>
<td>5</td>
<td>Q - C Material reduction in j ail by 15% (124k€/current)</td>
<td>P</td>
<td>99k €/25k €</td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>

Figure 8- Example of APU TOP 5 focus meeting conclusions from the fourth quarter of 2011 (Q4 2011). Source: Delphi Diesel Systems S.L.
Figure 9: The manufacturing performance measurement system that supports the operating review meeting. Source: Delphi Diesel Systems S.L.
4.3 Results

The solution presented in this paper resulted in being highly successful in DDS Sant Cugat. The OEE levels increased between 5% and 10% from January 2009 to January 2012. The following table shows how the current OEE values are very close to the design OEE. The design OEE is the OEE that the machine can perform based on the manufacturing process. Higher values than design OEE can only be achieved through a redesign of the machine.

<table>
<thead>
<tr>
<th>Manufacturing process</th>
<th>Number of machines</th>
<th>OEE average January 2012</th>
<th>Design OEE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drilling</td>
<td>10</td>
<td>65%</td>
<td>65%</td>
</tr>
<tr>
<td>Drilling</td>
<td>2</td>
<td>68%</td>
<td>70%</td>
</tr>
<tr>
<td>Heat treatment and surface hardening</td>
<td>1</td>
<td>97%</td>
<td>95%</td>
</tr>
<tr>
<td>Electrochemical machining</td>
<td>4</td>
<td>75%</td>
<td>80%</td>
</tr>
<tr>
<td>Grinding</td>
<td>7</td>
<td>85%</td>
<td>85%</td>
</tr>
<tr>
<td>Cleaning</td>
<td>3</td>
<td>95%</td>
<td>95%</td>
</tr>
<tr>
<td>Assembly</td>
<td>20</td>
<td>95%</td>
<td>95%</td>
</tr>
<tr>
<td>Test</td>
<td>10</td>
<td>80%</td>
<td>80%</td>
</tr>
<tr>
<td>Painting</td>
<td>1</td>
<td>90%</td>
<td>90%</td>
</tr>
</tbody>
</table>

Table 2-OEE results vs design OEE values. Source: Delphi Diesel Systems S.L.

The result indicators also show radical improvements. The use of an integrated near real-time performance measurement and formal meeting system made it possible for the APU teams to focus on the volume performance dimension and the aspects that would have a critical impact in the volume increase. From the first quarter of 2009 to the fourth quarter of 2012 there was an increase of volume of 120%, with no capital expenditure in new equipment, through bringing OEE values close to the design OEEs and several cycle time improvements. It must be noted that the new MPMS and the formal meeting system described in this paper had an important contribution to this achievement but they are not the only factors that had influence in this achievement.

Figure 10-Volume evolution vs. target volume from 2009 to 2011. Source: Delphi Diesel Systems S.L.
Regarding the objective to focus the organization on value stream, the interviewed persons agree on that more attention to whole value streams have been appreciated.

5. Conclusions

This paper analyses the results obtained by implementing an integrated MPMS and formal meeting system, designed and used as a single system. The paper is based on a case study carried out at DDS Sant Cugat (Spain). In 2009, DDS Sant Cugat faced a new and demanding challenge. Due to the high demand the strategy of Delphi consists in taking as much advantage as possible of the capacity of the plant. To serve these objectives the performance management boards were changed by an integrated near real time MPMS and formal meeting system that gives great importance to the OEE measure. The application was highly successful and allowed the plant to cope with the increasing customer demand.

The objective of the new system consists in focusing the organization on the value streams and, by doing it, to improve performance, particularly the OEE. In relation to the objective to focus the organization on value streams, the only evidence available is the opinion of the interviewed persons. It is not a strong limitation for the analysis as the final objective of the system was to improve the performance. Performance improving has been intense and clearly coincident with the implementation of the new system.

From the analysed results, we deduce that an integrated near real time MPMS and formal meeting system can give place to an increased focus of the organization on value streams and an outstanding performance improvement. As the analysed factory does not seem to have exceptional characteristics, it is reasonable to think that good results could be obtained in other cases with similar characteristics. The analysed MPMS is near real-time and is IT based. We cannot discard that these factors are significant for the successful implementation, as they provide clear advantages for the system to be functional. However, the priority given to OEE is probably not such a relevant factor as the final aim of the described system consists of focusing the attention on certain parameters. We have no reason to believe that it would be non-effective when prioritizing other metrics different from the OEE measure.

This research provides an exploratory contribution in the fields of performance measurement systems. The focus of the previous literature in this area was mostly on designing, with few studies illustrating the issues of implementation and use (Nudurupati et al., 2011). The present work tries to address this shortcoming. The presented case confirms previous works stating the importance of how the use of performance measures and the meetings are organized (Koenigsaecker, 2009) and the need of involvement of the whole organization (Bartoli and Hermel, 2004; Bourne et al., 2005). The joint planning of the performance measures and the meeting systems that has been presented resulted to be clearly successful. Due to the exploratory nature of the research, general conclusions cannot be obtained. However, the fact that the characteristics of the described plant are not unusual leads us to think that the experience is replicable, as future research must verify.

For the management community, this paper provides a new way of designing and using manufacturing performance measurement systems that may be used in other real practical cases. The described system can give place to major performance improvements with minimum investment. It shows a detailed example of how to collect data and measure OEE by using information more detailed than other procedures previously described by the literature, such as the classification into the six big losses proposed by Nakajima (1988).

This research has one main limitation; this study is applied in a single manufacturing plant and provides in consequence tentative and provisional insights. Considering the limited amount of research on the subject this kind of exploratory research is considered to be appropriate. Given the initial and limited character of a single case study, further research is
needed in this area to verify the findings. In besides, there is a need to dig deeper into the some non-obvious relationships of the presented system with contextual variables.

6. References


Acknowledgments

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