Daily Meetings 4.0 -
A case study to contribute to digitalization in the context of the paper industry

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Abstract: The fourth industrial revolution is changing the paradigm not only of industry, but also of society. This work focuses on the paper industry and how daily production meetings can be affected in this revolution. In this line of research, a case study was carried out with the aim of contributing to the digitalization of a daily meeting, on shop floor paper production unit. A diagnosis of the meeting was performed, which allowed the potential of digitalization to be identified, as well as the limitations of the meeting and the aspects to be improved. The causes of the limitations found were then identified using the 5 whys methodology. Based on the analyses carried out, improvement solutions were proposed regarding its content, means of information, participants and the respective daily board. One of the main concerns was the choice of information to have in the digital board, with greater emphasis on the choice of ideal KPI for the daily meeting considered as a case study. A new agenda is proposed for the daily meeting with the aim of the meeting to be held with the digital board and be permanently updated, which enables a more agile and effective daily meeting. Finally, a methodology was developed, so that other daily meetings in the company can be digitalized, on shop floor. The daily case study meeting was thus improved, verifying the requirements necessary to be subsequently digitalized.

Keywords: Lean Thinking, Daily Meetings, i4.0, Visual Management Boards, KPI, Digitalization.

1. Introduction

One of today's challenges in companies is the monitoring of technological evolution. There is a need to take advantage of technological developments, given the constant increase in efficiency and effectiveness of processes.
This case study follows this need and involves continuous improvement methodologies, which, being based on permanent communication between people, also requires an adaptation in the way of communicating. The study object, a daily meeting (DM), in the context of the paper industry, is one of the bases of communication in a logic of continuous improvement. The digital board, in this context, will allow the updating of information in the board would be automatic, and the use of alarmistic, which promotes a more effective and efficient meeting.
The following main goals should be taking in account to respond to previous company's needs:
- Ensure that DM is efficient and in line with Lean thinking;
- Improve the daily board through visual management tools, so that it is possible to turn the DM monitoring board into a digital one;
- Selection of KPI that are relevant for the DM of the case study;
- Development of an approach with a sequence of activities that allows the digitalization of support boards for other DM of the company, in shop floor.

This document is structured as follows:
Section 2 provides a brief review of the main concepts and methods related to the objectives of this work. In section 3, the case study is introduced with a small contextualization in the company. Section 4 provides the diagnosis to DM and identification of the main limitations. A root cause analysis is made in section 5. Section 6 proposes improvement solutions to make DM more efficient and effective. A methodology with a sequence of activities to apply digitalization in other DM in the company is develop in section 7. Finally, Section 8 presents relevant conclusions to be considered, with work limitations and suggested future work.

2. Literature Review

According to Meissner et al. [1], the digitalization of procedures and tasks must always involve a transformation of procedures in which the value flow and efficiency of resource use are valued. Thus, it is essential to use Lean logic and continuous improvement before digitalization [2]. Lean organizes operations to maximize the flow of value to customers, and in turn to minimize waste [3][4].
Lean thinking can be defined by five fundamental principles, created by Womack and Jones [5]: specify value; identify value flow; define continuous flow; implement pull production; search for perfection. Lean thinking is inherent in Lean concepts and tools. Thus, a summary of Lean concepts and tools relevant to this work is presented, with a common goal: to identify and eliminate waste.
The **PDCA cycle**, or Deming cycle, is a fundamental tool in Lean thinking. It is an iterative methodology aimed at achieving process improvements. The methodology is processed as follows: **P**lan - identification of the problem and determination of its

root causes; **D**o - development and implementation of containment actions, in order to solve the identified problem; **C**heck - analysis of results, in which they are compared with the objectives; **A**ct - improvement of containment actions, and standardization of the successful process [2][6].

Continuous improvement is a strategy that aims to achieve small improvements [6]. It is based on the PDCA cycle [7]. Root cause analysis is a problem-solving methodology, which requires methods such as the 5 whys, and the fishbone diagram, also known as the Ishikawa diagram or cause and effect diagram [6]. The corrective actions intend to permanently eliminate the problem, avoiding the implementation of quick solutions. Finally, standardization oversees identifying the best practices of a process [2][8].

Daily Meetings

According to Hertle et al. [9], the Darmstadt model is a management system, which can be considered as a type of PDCA cycle and is specifically adapted and directed to the shop floor. The objectives of this model considered as relevant for this work are the following: to analyze deviations; to define actions of short duration; to increase communication by stimulating discussion.

Another Lean management system was identified: the Lean Daily Management System (LDMS) [7]. The system is directed to the daily work of leaders, that is not directed to the shop floor. However, three of the five elements, that compose it, are relevant for this work: daily meetings of work groups; Primary Visual Display (PVD); and Kaizen actions form, known as Kaizen Action Sheet (KAS) [10]. Although this system is not scientifically valid, it meets the daily practices of many companies, including the case study. For the same reason, the system was exposed in this work.

Based on the Darmstadt model, LDMS and the rest of the literature found, some objectives that a DM intends to achieve are presented. In order to make the objectives more perceptible, they were divided into two categories: operational and cultural.

Operational objectives are to compare the current state with the ideal [7][11]; to update the last minute news elements [11]; to focus each person on critical KPI [10]; to report deviations, analyze causes, and implement corrective actions [6]; to identify problems in real time [7][11]; to problem solving [12]; to distribute tasks to workers [6]; to expose problems at an early stage [12]; to ensure that operators are ready for the day [12]; to exchange information directly [13]; to exchange feedback among the team [13]; to collect ideas for improvement and implement them [11].

Cultural objectives are to transform a work group into a work team [10]; to transmit an accurate image of the current state to all elements [10]; to instill a sense of responsibility and ownership under the area of work, process and its functions [13][11][10]; to provide the basic needs of satisfaction: survival, power, fun, freedom and a sense of belonging [10]; to improving management [6]; to establishing leadership levels within each team [6]; to transmitting Lean thinking to workers [6]; to motivating their minds and hearts [6]; to encouraging continuous learning [12]; to fostering a constructive relationship between operators and shift supervisors [11]; and to strengthening trust among team members [11].

Part of the diagnosis of the case study required a survey of the objectives of visual management, more specifically of the company's daily chart. After some research, it was found in the literature the following **objectives of visual management** [14]: facilitate the visualization and understanding of the current situation to workers; share the direction and intentions of the company; connect and interconnect the activities of the company, in order to reach the customer the right value, in time, safely and fulfilling the cost requirements; expose critical results so that their meaning is clear; transmit transparency.

Key Performance Indicators

KPI must be chosen correctly, i.e., they must help to understand if the business is on the right track. They are only relevant and useful if they are properly organized in critical business areas [15]. Some authors suggest that the selection of the right KPI should be initiated with the definition of a strategic performance management approach, [15] [16][17]. Next, the KPI are selected according to specific requirements explained in detail below. Finally, the target for each KPI is defined.

Regarding the strategic performance management approach, Kaplan and Norton [17] created the **Balanced ScoreCard** (BSC) concept that allows the identification, management and measurement of strategic objectives. The approach was created with four original perspectives - customer; financial; internal process; learning and growth - and later David Parmenter [16] suggested two additional perspectives - employee satisfaction; environment and community [16]. However, there are several authors who added different perspectives to the four originals, such as ethics, politics and philanthropy [18].

One of the requirements for the selection of KPI, adopted in this work, is the **S.M.A.R.T. logic.** It was created to ensure the effectiveness of strategic and operational objectives. Later, it was adapted for KPI. Each KPI must be validated by the five characteristics that represent "S.M.A.R.T." [19][20]: **S**pecific: must specify the target area for improvement, be clear about the state they want to achieve; **M**easurable: must be quantifiable, in order to measure their progress towards the objective; **A**ssignable: specify the human position and activities to maintain their credibility, and ensure their measurement; **R**ealistic: must be determined according to the available resources, so that it is

achievable; and **T**ime-related: define a time scale, i.e. clarify a target date to achieve the objective. A KPI must meet the five criteria [19].

Some authors recommend selecting the KPI through categories [15] [16]. However, several ways of organizing the KPI by categories were found. According to Tokola et al. [21], planning, quality, productivity and workers are the appropriate categories to organize the KPI. On the other hand, Lindberg et al. [22] advocate planning, energy, raw materials, maintenance, inventory and equipment as categories. Smith [23] designates the categories as: sales, services, parts and workshop. Marr, in two of his publications, divides the KPI into two categories: workers, finance, customers, sales, processes and social [24], and planning, productivity, quality, workers, maintenance, suppliers, customers and environment [15].

Digitalization

The combination of digitalization and lean manufacturing has great potential to combat the problems that companies currently face: the increased complexity of processes, the level of customer demand for flexibility in their orders, as well as increased efficiency, and productivity [25][26][27][28]. Digitalization is an approach that responds to the above-mentioned needs, such as increasing the dynamism and complexity of digital technologies [25][29]. It is considered a technological trend that allows an improvement in quality, flexibility and productivity [30]. The literature says that before implementing digitalization, companies must have implemented Lean thinking [1]. One of the first steps to take is to improve their daily meetings, according to this thought. As for digitalizing support boards for daily meetings, no publications were found on this subject.

3. Contextualization of the case study in the company

This work is applied in a paper production company. The DM belongs to one of the company's paper production units. This unit is divided into four main areas: paper machine 4 (PM4), coil area, mandrel preparation and paper disintegration. PM4 is composed of subareas, such as: additives, pulp preparation and the machine itself, also called PM4. The reel area contains two winders, a rewinder and a wrapper. In addition to fulfilling its function, the mandrel preparation areas are also used as a warehouse. The PM4 process works 24 hours a day, 365 days a year, with three daily shifts and 5 teams in total. According to the hierarchical level of the company, the DM is located at the base of the pyramid. Each team has 13 operators, a coil area coordinator and the shift supervisor.

4. Diagnosis of Daily Meeting

This section follows the line of thought that was considered throughout the diagnosis made to DM in the company. This aims to contribute to understand the dynamics of the meeting, its limitations, in order to identify the root causes, and consequently propose solutions for improvement. In order to collect the necessary information, several visits were made to the company for one month. The diagnosis was carried out using data obtained from the observation of ten meetings and interviews with some company members. Then, analyses considered relevant were applied to the DM. The focus was on its content, means of information and participant's performance. The dynamics of the daily board supporting DM were also studied.

4.1. Daily Meeting Content

Currently, the DM includes the following content: safety moment; situation on accidents and other safety issues; analysis of indicators and deviations; review of instructions for the shift; review and update of the execution of opportunity works and team tasks; update of the improvement plan. The first analysis was to determine whether the current DM content meets the objectives of a DM (operational and cultural) found in the literature. By comparing these objectives with the agenda of the meeting, it is possible to conclude that the cultural category is practically not fulfilled. From the analysis carried out (**Table 4.1**), it can be concluded that the operational objectives are generally present in the meeting agenda, except for one that refers to identifying problems in real time.

Table 4.1 Compliance with the operational objectives of a daily meeting in relation to the content of the DM, green and red symbols mean "complied with" and "not complied with", respectively.

Operational Objectives	Complies / Doesn't comply	Content of the corresponding agenda
Identify problems in real time [7][11]	✗	-
Compare the current state with the ideal one [7][11]	✓	Analyze indicators and deviations
Manage tasks [6]	✓	Review and update team tasks
Update the last minute news elements [11]	✓	Review instructions for the shift
Troubleshoot [12]	✓	Review instructions for the shift
Exposing problems at an early stage [12]	✓	Review and update opportunity works
Exchange information directly [13]	✓	All of them
Collect improvement ideas and implement them [11]	✓	Update improvement plan

To complement this analysis, employees of the company were interviewed in order to analyze if their opinions meet the objectives of a DM. It can be concluded that the elements focused mainly on the operational category, since only one, out of four respondents, mentioned cultural objectives.

Therefore, the existence of a strategy for this meeting to meet the cultural objectives was not clear. The agreement between the objectives mentioned by the various elements of the company and the topics of the meeting is also analyzed. It appears that there is no topic in simultaneous agreement by all stakeholders. This means that the stakeholders, both those who deal with the DM and those from a higher hierarchical level, are not fully aware of the topics established for that meeting.

The last analysis of the content of the meeting was to analyze the frequency with which a topic is mentioned in the meetings. It was noted that there is a great variability of approach to topics in each meeting in the five teams. Of the seven topics on the agenda, only four have a frequency above 50%.

4.2. Involvement of operators in the DM

A frequency of operator's involvement was made based on the ten meetings observed. In order to assess performance, the following aspects were considered: concentration, participation and discussion of ideas. From the analysis carried out, and assuming the effectiveness of the method used, the following elations can be observed: the concentration of operators in meetings is relatively low, as is the discussion of ideas. Their participation corresponds to a higher frequency because in the end of each DM each operator talks about their subarea. Regarding the number of participants, it was noted that in no meeting did all the operators in the DM take place. Such events arise since the production unit cannot be in operation without the control of any operator.

4.3. Information Resources

In order to deepen the means of information used, all their types in the DM were analyzed. Thus, an analysis of the agreement between the means of information and the content of the meeting was made, and a proportion of the use of these means in the ten meetings observed. It was found that the vast amount of information available makes it difficult to select the most relevant means for DM.

In order to make a comparison with the proposals for improvement in a final phase of the work, the current state of the meeting is illustrated in relation to its content, and the operational objectives (**Table 4.2**).

Table 4.2 Current state regarding meeting content and operational objectives

Content of Meeting	Current status
Safety Moment	✓
Accidents and other safety issues	✓
Analysis of indicators and deviations	✗
Shift instructions	✓
Opportunity works	✓
Team tasks	✗
Improvement plan	✗

Operational Objectives	Current status
Identify real time problems [20][22]	✗
Compare the current state with the ideal one [20][22]	✗
Manage tasks [17]	✓
Update last-minute news elements [22]	✓
Troubleshooting [48]	✓
Exposing problems at an early stage [48]	✓
Exchange information directly [16]	✓
Collect improvement ideas and implement them [22]	✗

It is noted that the current status of the DM does not partially meet the meeting agenda, nor does it fully comply the objectives of a DM.

4.4. Dynamics of the Daily Board

This section begins by analyzing the areas of the board, the opinions of the company's staff, the frequency of use of the board and finally establishes a concordance between the content of the DM and the areas of the board. The current daily board (**Figure 4.1**) is divided into the following areas: 5S+Safety (1); meeting standard (2); indicators map (3); improvements (4); accident free days indicators (5); PM4 design (6); production opportunity work (7); maintenance opportunity work (8); maintenance planning (9).

Figure 4.1 Current daily board

In order to understand if the current board meets the objectives of visual management, the elements of the company questioned earlier are address again in relation to the objective of the daily board. It was found that the answers of the elements of higher hierarchical level are much more complete than the ones of lower level. It is noted that only the opinion of the Lean Coordinator included one of the objectives of the visual management boards found in the literature. The remaining elements were directed more towards the areas of the board and less towards its objectives. On the other hand, operators did not know how to answer the question, so there is a big need for training in this area.

The effectiveness of the board and its use was then assessed by the same observation method. The results show that although the rates of use by area are reduced, some time is spent on the indicators map, and this time refers only to the updating of the values and not to their supposed analysis. Opportunity work in production and in maintenance are often used by teams.

The last analysis consisted of associating the content of the DM with the areas of the board. It was found that the following areas of the board are not associated with the content of the agenda: 5S+Security, PM4 design, and maintenance planning. The following agenda items are not associated with any area of the board: security moment, instructions for the shift, and team tasks.

Therefore, the main limitations of the DM detected during the diagnosis are as follows: the meetings are inconsistent; the DM board is not appropriate to the agenda; the DM board is not used in its entirety; there is a lack of involvement by operators.
This section included all diagnoses of DM including analysis about the meeting and the board, DM limitations setting. Next section takes care of root cause analysis.

5. Root Cause Analysis

In this subsection, the root causes of the limitations detected were analyzed in order to identify the most appropriate actions to be taken. For the root cause analysis, the 5 whys method was chosen [6], since the problems are qualitative and easy to apply. It is also important to note that the root causes determined in this subsection were discussed and finally confirmed in a meeting with the company.
The first problem identified **"the meetings are inconsistent"** was analyzed. It was asked "why" several times until there is no more answer to the question. The root causes found were: there is no standardization in the information sources; the information presented don't allow for an expeditious analysis; lack of adequate algorithm and automation of KPI calculation; lack of training of shift supervisors; KPI do not meet the needs of the production unit; summary status of non-automated improvements; duration of the DM too long; and no priority is given to the DM.
It was done the same procedure for the other limitations. Therefore, the second problem **"the board is not suited to the agenda"** founded the root cause: purely informative areas.
The third problem **"the board is not used in its entirety"** founded the following root causes: duplicate work for the shift supervisor; opportunity works are not intended for daily updating; and lack of automation in the way KPI are exposed.
The final problem **"lack of operators involvement"** founded the root cause: lack of operators training.
For a better organization and structuring of the root causes, these were organised by categories, using as reference the sections of the DM diagnosis: information resources; KPI; DM participants; DM organization; and daily board.
Information Resources: There is no standardization in the information sources; and the information presented don't allow an expeditious analysis.
KPI: KPI do not meet production unit needs; lack of adequate algorithm and calculation automation; and lack of automation in the way KPI are exposed.
DM Participants: Lack of training of shift supervisors and operators.
DM Organization: Non-automated summary status of improvement plan; DM duration too long; and no priority is given to DM.
Daily Board: Purely informative board areas; updating the board is duplicate work for the shift supervisors; and board areas are not intended for daily update.

6. Proposed Solutions

The present section consists of the study and determination of solutions to be proposed regarding the root causes found. It is divided into four parts: rationale of the proposed DM, selection of KPI, dynamics of the DM, and methodology development.

6.1. Rationale for the proposed Daily Meeting

The restructuring of DMs agenda eliminates many of the root causes related to its participants and its organization. The participants defined in the current DM, such as the shift supervisor and the operators, meet the information found in the literature. However, there was a need to introduce gradual or intensive training, depending on the priorities of their superiors, for shift supervisors and operators of all teams.
The content of the proposed DM is intended to make the DM more effective, having been taken into account the needs of the production unit (**Figure 6.1**), and the meetings attended by the company and all the analyses carried out in the previous section. The proposed content includes some topics of the current content, such as the safety moment, analysis of KPI and deviations, shift tasks and a summary status of improvements. However, they are only similar in some points and their approach is different, as will be explained in dynamics of the DM. The remaining topics have been added in order to ensure the improvement of the limitations found. The attendance register was created because DM was not given priority. The KAS system was proposed to be addressed in the DM, so that the suggestion of improvements can be potentiated, only when there is a need to do so.

Current Content	Proposed Content

• Safety moment
• Accidents and other safety issues
• Analyse KPI and variances
• Review instructions for the shift
• Review and update execution of opportunity works and team tasks
• Update improvement plan
	• Attendance register
	• Safety moment
	• Analyse KPI and variances
	• Work plan
	  • Maintenance planning
	  • Shift tasks
	• Action Plan
	  • Summary status of improvements
	  • KAS System

Figure 6.1 Current DM content compared to the proposed content

Regarding the DM schedule, one of the root causes detected was that the duration sometimes becomes too long, e.g., when it was sometimes 30 minutes long. Therefore, a maximum duration of 10 minutes is suggested, with the aim of making the meeting as brief as possible for the process to continue to be a priority.
As an additional suggestion, prior preparation by the shift supervisor regarding DM is recommended. This

recommendation serves as a reduction in the duration of the DM, since prior preparation avoids hesitation on the part of the shift supervisor, and a consequent saving of time.
An analysis was performed to see if the proposed content of the DM meets all the operational objectives found in the literature review (**Table 6.1**). This proves that all operational objectives are met by the proposed DM.

Table 6.1 Verification of compliance with the operational objectives, according to the proposed content of the DM; the green and red symbols mean "complied with" and "not complied with", respectively.

Operational Objectives	Complies / Doesn't comply
Identify problems in real time [7][11]	✓
Compare the current state with the ideal one [7][11]	✓
Manage tasks [6]	✓
Update the last minute news elements [11]	✓
Troubleshoot [12]	✓
Exposing problems at an early stage [12]	✓
Exchange information directly [13]	✓
Collect improvement ideas and implement them [11]	✓

6.2. Digital Board

In this work, the concept of digital board will be defined as a daily board with all the relevant areas for the success of DM, in a digital format. In order to ensure a good perception of the functioning of the digital board, the information included in the board will have three levels of priority and visualization:
- **Level 1**: the information belonging to this level represents the first layer of information in the board, i.e. it corresponds to information displayed without any user participation. This type of information is made up of two aspects: i) the primary display of digital board (PDDB), which contains all the information discussed during the DM; and ii) alarmist, which, although not permanently on the board, consists of warnings and information that appear in the PDDB automatically, without the need for user participation for such. This is top priority information, in the sense that its approach in DM is mandatory.
- **Level 2**: information corresponding to the second layer of the digital board. It consists of two aspects: i) expansion of a PDDB area, after a selection by the user; ii) it consists of obtaining detailed information about the PDDB area (by selecting one of the graphs or areas displayed in i)).
- **Level 3**: information of low priority, but which must exist as a complement, for situations of consultation, or infrequent use of specific documents, or even of direct search for information that is not easily found through various expansions from the PDDB.

The digital board is defined by the set of these three levels. Its use during the DM is attributed to the shift supervisor, although operators also have the capacity to do so. With this there is a time saving, and unnecessary confusion is avoided due to the high number of operators compared to the only shift supervisor present in the DM. The suggested PDDB was based on the proposed content, which included all agenda items. In the top right corner of the PDDB there is a menu button that allows access to all information with priority level 3.

6.3. Key Performance Indicators Selection

This subsection addresses one of the most important issues in a DM, and one of the main objectives of this work, the selection of KPI. This selection will eliminate the root causes of the "KPI" category. According to the information found in the literature, the selection of successful KPI is carried out in three steps: strategic performance management approach; KPI selection; and target value definition. However, this case study does not intend to create an entirely new approach, but rather to adapt the existing one [15]. This approach is divided into two parts:
1. Adaptation of the company's current KPI, with the analysis of the suitability of the KPI in relation to its objective; and with the verification of the S.M.A.R.T. logic, in which, unlike an objective, a KPI must comply with the five characteristics, as described in the literature [19].
2. Addition of KPI, in order to comply with both the perspectives of the strategic performance management approach and the KPI organization categories, as found in the literature.

6.3.1. Adaptation of the company's current KPI

For this work, the strategic performance management approach adopted as a reference was the BSC, reviewed in the literature. The case study is located, according to the hierarchical level, at level 0, i.e., the DM is affected by the mission and strategy only indirectly, since it is a meeting at the shop floor level. Therefore, the objectives chosen by the company, as well as its KPI, were collected for review. This is followed by the analyses and respective adaptations, in which they were carried out for each of the company's current KPI (**Table 6.2**).

Table 6.2 Adaptation of the company's current KPI

Operational Objective	Current company KPI	S.M.A.R.T.?	Fit for purpose?	Adapted KPI
Be proactive in the fight against accidents, giving clear guidelines that safety comes first and supporting its teams in the implementation of their annual programmes.	Number of accidents	✓	✓	Number of incidents (NI)
Meet and enforce quality specifications of manufactured products ensuring that no defective products are shipped to customers.	Number of complaints paper	✗	✓	Weighted customer satisfaction índex (WCSI) Performance rate (PR)
Contribute to implement in the area of its responsibility the application of the 4th S within the scope of the 5S+Security programme.	Number of areas with at least level 4S in the area for which it is coordinator (4S)	✓	✓	-
Contribute to the implementation of Lean System in the area of your responsibility.	Level (N1 to N3) committed to sustainable implementation in your team and area of responsibility (LS)	✓	✓	-
Be vigilant with regard to the results of quality measurements of the products manufactured, alerting the various persons responsible for the daily deviations, giving recommendations regarding the actions to be taken in the event of deviations.	Average downtime	✓	✓	Cost of paper waste (CPW)
	Number of breaks	✓	✓	
Be proactive in proposing improvement actions, documented and detailed, accepted for implementation; implement a defined development plan, committed to management	-	✗	✗	Improvement status índex (EISI)

6.3.2. Addition of Key Performance Indicators

After reviewing the company's current KPI, and making the necessary adaptations, the literature states that it is necessary to consider the perspectives of the BSC, the strategic performance management approach adopted in this work. Although it is a matter of KPI directed to the bottom of the pyramid, and the BSC is directed to the organizational top management, it is essential that these encompass all the perspectives of the BSC. According to the literature, there are several authors proposing several additional perspectives, in addition to the four original ones. therefore, two additional perspectives were chosen that best fit the case study: worker satisfaction, and environment and community [16]. In addition, KPI can be organized into several categories for more careful and complete selection. These categories are not universal for most of the authors. Therefore, a set of categories was adopted that best fits the case study [21], according to the literature and opinions of the company's employees: planning, quality, productivity, costs and workers. Thus, the adopted KPI associated with the selected categories, as well as the six perspectives of the BSC (***Table 6.3***), are followed. It was found that only the two perspectives of the BSC corresponding to employee satisfaction, and environment and community were not met. Thus, two additional KPI will be proposed to ensure compliance with the two mentioned perspectives.

Table 6.3 Association of KPI adapted to the categories and perspectives of the BSC

		Adapted KPI							Complies / doesn't comply
		NI	WCSI	PR	4S	LS	CPW	EISI	
Balanced Scorecard perspectives	Financial	-	-	-	-	-	●	-	✓
	Costumer	-	●	-	-	-	-	-	✓
	Internal Processes	-	-	●	-	-	-	-	✓
	Learning and growth	●	-	-	●	●	-	●	✓
	Employee Satisfaction	-	-	-	-	-	-	-	×
	Environment and Community	-	-	-	-	-	-	-	×
Categories	Planning	-	-	●	-	-	-	-	✓
	Quality	-	●	-	-	-	-	-	✓
	Productivity	-	-	●	-	-	-	-	✓
	Costs	-	-	-	-	-	●	-	✓
	Employees	●	-	-	●	-	-	-	✓

The KPI proposed for **employee satisfaction** is the level of employee satisfaction, which in a simple way indicates whether workers are satisfied and fulfil their wishes and needs at work. This KPI is recommended by some authors, with examples of successful applicability in companies [24][16].

The proposed additional KPI, to enforce the **environment and community** perspective, was selected based on the reality perceived during the internship at the company and conversations with its employees. Therefore, the adoption of chemical consumption as a KPI related to this perspective is proposed. Thus, the list of proposed KPI fulfils the six BSC perspectives, as well as the previously

successfully verified categories. To conclude the selection of KPI, the mode of exposure of each KPI (**Figure 6.2**) is presented. It should be noted that the improvement KPI is the only one that does not belong to the area of the KPI in the board. It belongs to the status of improvements (level 2) and not to the analysis of KPI.

6.4. Dynamics of the Daily Meeting

This subsection begins by presenting the dynamics of DM with its proposed content and the information at priority levels 1 and 2. As well this type of information is accessed in the digital board. It also presents priority level 3 information and its access modes from the board. The aim will be to eliminate the root causes belonging to the categories "information resources" and "DM organization".

6.4.1. Level 1 and 2 Priority Information

Attendance register: solution found for the root causes "DM duration too long" and "DM is not given priority". For the second root cause it is proposed two DM instead one per shift. This topic is addressed through a biometric reader, illustrated in the lower right corner of the PDDB. The reader recognizes the participants' fingerprints and registers their presence. The purpose of this topic is to facilitate the shift supervisor's task of transmitting RD information to the absent participants.

Safety moment matches the topic of DM's current agenda in the company but differs in its approach. The slides would be read by operators before DM. During the meeting this topic is addressed through a digital and online learning platform (level 2), in which participants answer questions regarding the slides read by them using the platform.

Analysis of KPI and variances: KPI shall be updated automatically by the digital switchboard, with the frequency of each specific update and last updated log. The PDDB area containing the KPI can be expanded (level 2). In addition, it is possible to open any exposed KPI so that detailed information can appear for proper analysis. The expanded KPI window contains an options icon in the upper right corner that offers various options, such as adding problem solving, in which the recorded action is saved in the PDDB area of shift tasks, or querying histories, changing target value, and adding notes.

Work plan: This topic includes two subtopics: maintenance planning, which belongs to the company's current DM, and shift tasks. While shift tasks are included in the PDDB, maintenance planning comes in the form of a weekly alarm, since it is the frequency of updating and need for consultation. Shift tasks would be addressed through an online job management platform and would be exposed in the PDDB. The states of the tasks are illustrated at the top of the area. The tasks are represented by a card with the name and time of update. The tasks assigned to each subarea are differentiated by colors, in which tasks in the coil area are grey and in PM4 are black. There is a top priority line, in which shift tasks with an immediate execution requirement must be recorded through the card, above the top priority line. In addition, each card can be expanded with all task details (level 2).

Action plan: Currently, the improvement plan is divided into two parts: discussion of ideas, and execution of the improvement. Both the discussion of ideas and the execution of improvements are not part of the scope of DM. Therefore, the suggested solution to adapt this topic consists of the action plan divided into two parts: summarized improvement status; and KAS system [10]. The first part aims to inform the participants of the DM, in a summarized way, about the improvement actions that are being executed in their daily work area. The progress report would only be of an informative nature for DM participants. It should be noted that the area of the PDDB "current status of improvements" is the only one that is not responsible for updating the shift supervisor. This area of the PDDB should be expanded for improvement actions to be visualized. This is level 2 information, in which the list of ongoing improvements appears and the state in which each one is currently located. The second part of the action plan, KAS system [10], appears in the PDDB only as an indication of the subtopic. Therefore, the entire procedure of the KAS system belongs to level 2 information.

Figure 6.2 Exposure mode of selected KPI

Considering the proposed content for DM, the PDDB is followed (**Figure 6.3**).

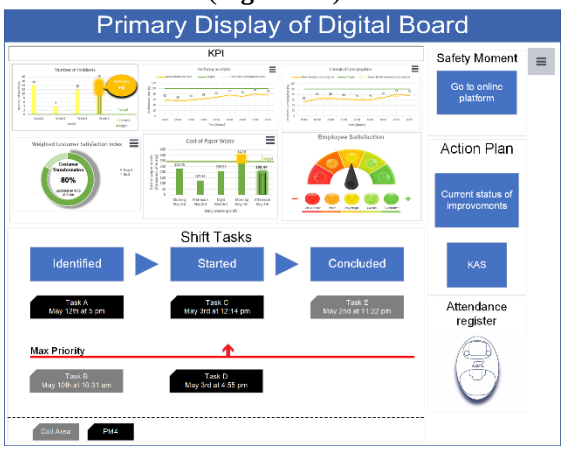

Figure 6.3 Primary Display of Digital Board

6.4.2. Level 3 Priority Information

This type of information is the most diversified, being considered the most versatile. The only way to access this information is through the menu button, located in the top right corner of the PDDB. By selecting on the menu button, the shift supervisor displays several sections in order to improve the organization of all existing documents. In addition to the sections, there is a search field in which the shift supervisor just types the name of the document you want to consult, or even keywords. The sections are organized as follows: formative documents; maintenance; specific histories; and agendas / calendars.

7. Methodology Development

A methodology was created that generalizes the path to be followed for other DM in the company to be digitalized in the context of the shop floor.

1. **Contextualization of the DM**: with the definition of the process and characterization of the production unit. The subareas of the unit are defined, and the boundaries of the process are also delineated.
2. **Identification of the needs to adapt the current agenda to daily digital meeting agenda (DDMA)**: at this stage the current situation of the meeting is measured, in which the current agenda of the meeting is collected with the opening hours, participants and content. All the data collected is checked and the quality of the data analysed. The current agenda is compared with the DDMA and the adaptations to be made to adopt the DDMA are determined, considering the defined process.
3. **KPI selection and preparation**: KPI selection should be implemented in two steps: adapting the current DM KPIs; and adding KPIs. Adaptation is established through its operational objectives assigned by top management. Each KPI is analyzed through S.M.A.R.T. logic and suitability for its purpose. Finally, KPIs are added in order to fulfil the six perspectives of the BSC, and the five categories of KPI organization, as in ***Table 6.3***. Each KPI should be defined based on the structure found in the literature and the respective source of information.
4. **Preparation of the digital board**: based on the digital board, it is adapted according to the DM process. It must contain the content of the DM adapted in 2. and the three levels of priority, in relation to the information used. At this stage, the network of connections between the digital board and the integrated systems of the company is established.
5. **Implementation / Validation**: the proposed solutions are implemented, through a meeting simulation. Thus, the dynamics of the meeting and the connection of the meeting with the digital board are validated.
8. **Review**: The entire methodology and respective results are reviewed so that they can be adapted later, ensuring continuous improvement.

One of the great advantages of this methodology is that it already includes Lean thinking, thus avoiding an additional concern for the company to verify if DM is Lean.

8. Conclusions and Future Work

This work arose from a challenge requested by the company of the case study which consisted in taking the first steps so that the DM could be digitalized in a future work. According to literature, before implementing digitalization, it is necessary to fulfil some requirements, so that digitalization does not become a failure for companies. These requirements were transformed into objectives of this work, mentioned in the first section. And all these objectives were fulfilled with distinction. The proposed DM meets the objectives found in the literature, as well as ensuring an effective transmission of information, with updated data, and a dynamic and interactive approach to topics. The proposed digital board has the advantage of being fed by the company's integrated systems, with a permanent update, warnings and key notifications to maximize DM efficiency. It will create a healthy competitiveness between the production unit teams. The teams would have the possibility of consulting the current and complete performance of other teams, in previous DM, and in turn, a healthy competition between teams would emerge. Apart from competitiveness, the digital board would create a broad base, in which the exchange of knowledge and experience between teams is stimulated and valued, so that the production unit surpasses itself.

As **future works**, it is suggested to validate the proposed solutions in the case study, as well as to implement the methodology developed in the company. Finally, it would be interesting to start a study of the cultural impact in the company, after these implementations. It's aim would be to realize if there is resistance to change on the part of employees, and if there is any cultural change regarding their Lean thinking.

9. References

[1] Meissner, A., Müller, M., Hermann, A., and Metternich, J., 2018, "Digitalization as a Catalyst for Lean Production: A Learning Factory Approach for Digital Shop Floor Management," Procedia Manuf., **23**(2017), pp. 81–86.

[2] Buer, S. V., Fragapane, G. I., and Strandhagen, J. O., 2018, "The Data-Driven Process Improvement Cycle: Using Digitalization for Continuous Improvement," IFAC-PapersOnLine, **51**(11), pp. 1035–1040.

[3] Ballé, M., Jones, D., and Orzen, M., 2015, "True Lean Leadership at All Levels," Ind. Manag., **57**(1), pp. 26–30.

[4] Ballé, M., 2019, "Lean Is a Product-Driven Strategy" [Online]. Available: https://www.lean.org/LeanPost/Posting.cfm?LeanPostId=1024. [Accessed: 01-Jun-2019].

[5] Womack, J. P., and Jones, D. T., 1996, *Lean Thinking*, Simon & Schuster.

[6] Imai, M., 2012, *Gemba Kaizen: A Commonsense Approach to a Continuous Improvement Strategy*.

[7] Work, S., and Hamel, M. R., *Kaizen Event Fieldbook for Effective Events*.

[8] Vilarinho, S., Lopes, I., and Sousa, S., 2017, "Design Procedure to Develop Dashboards Aimed at Improving the Performance of Productive Equipment and Processes," Procedia Manuf., **11**(June), pp. 1634–1641.

[9] Hertle, C., Tisch, M., Metternich, J., and Abele, E., 2017, *The Darmstadt Shop Floor Management Model*, ZWF.

[10] Lareau, W., 2001, *Transforming Office Competitive Advantage*.

[11] McLoughlin, C., and Miura, T., 2017, *True Kaizen*.

[12] J. Miller, M. Wroblewski, J. V., 2014, *Creating a Kaizen Culture: Align the Organization, Achieve Breakthrough Results, and Sustain the Gains*.

[13] Poksinska, B., Swartling, D., and Drotz, E., 2013, "The Daily Work of Lean Leaders - Lessons from Manufacturing and Healthcare," Total Qual. Manag. Bus. Excell., **24**(7–8), pp. 886–898.

[14] Galsworth, D. G., 2017, *Visual Workplace - Visual Thinking*, CRC Press.

[15] Marr, B., 2015, *Key Performance Indicators for Dummies*, John Wiley & Sons, Ltd.

[16] Parmenter, D., 2010, *Key Performance Indicator Developing, Implementing, and Using Winning KPIs. Second Edition*.

[17] Kaplan, R. S., and Norton, D. P., 1996, *The Balanced Scorecard: Translating Strategy into Action*, Harvard Business Review Press.

[18] Hansen, E. G., and Schaltegger, S., 2016, "The Sustainability Balanced Scorecard: A Systematic Review of Architectures," J. Bus. Ethics, **133**(2), pp. 193–221.

[19] Cormier, R., and Elliott, M., 2017, "SMART Marine Goals, Targets and Management – Is SDG 14 Operational or Aspirational, Is 'Life Below Water' Sinking or Swimming?," Mar. Pollut. Bull., **123**(1–2), pp. 28–33.

[20] Doran, G. T., 1981, "'There's a S.M.A.R.T. Way to Write Management's Goals and Objectives,'" Manage. Rev.

[21] Tokola, H., Gröger, C., Järvenpää, E., and Niemi, E., 2016, "Designing Manufacturing Dashboards on the Basis of a Key Performance Indicator Survey," Procedia CIRP, **57**, pp. 619–624.

[22] Lindberg, C. F., Tan, S., Yan, J., and Starfelt, F., 2015, "Key Performance Indicators Improve Industrial Performance," Energy Procedia, **75**, pp. 1785–1790.

[23] Smith, J., 2014, *The KPI Book*, Insight Training & Development Limited.

[24] Marr, B., 2012, *Key Performance Indicators: The 75 Measures Every Manager Needs to Know*, Pearson.

[25] Hoellthaler, G., Braunreuther, S., and Reinhart, G., 2018, "Digital Lean Production-An Approach to Identify Potentials for the Migration to a Digitalized Production System in SMEs from a Lean Perspective," Procedia CIRP, **67**, pp. 522–527.

[26] Prinz, C., Kreggenfeld, N., and Kuhlenkötter, B., 2018, "Lean Meets Industrie 4.0 - A Practical Approach to Interlink the Method World and Cyber-Physical World," Procedia Manuf., **23**(2017), pp. 21–26.

[27] Tarvin, P., 2016, *Leadership & Management of Machining: How to Integrate Technology, Robust Processes, and People to Win!*, Hanser Publichers, Munich.

[28] Bortolotti, T., Romano, P., and Nicoletti, B., 2010, "Lean First, Then Automate: An Integrated Model for Process Improvement in Pure Service-Providing Companies," IFIP Adv. Inf. Commun. Technol., **338 AICT**, pp. 579–586.

[29] McKinsey&Company, 2015, *Industry 4.0 - How to Navigate Digitization of the Manufcaturing Sector*.

[30] Jäger, J., Schöllhammer, O., Lickefett, M., and Bauernhansl, T., 2016, "Advanced Complexity Management Strategic Recommendations of Handling the 'Industrie 4.0' Complexity for Small and Medium Enterprises," Procedia CIRP, **57**, pp. 116–121.