NOVA SCHOOL OF BUSINESS & ECONOMICS

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MASTER'S THESIS

LEAN MANAGEMENT

IMPLEMENTATION OF THE 5S METHODOLOGY

A case-study applied to the Luxembourgish construction company CDCL

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Abstract

This paper studies the implementation of the 5S methodology in CDCL, a Luxembourgish construction company, through my direct participation in construction sites as a Lean Assistant Intern. I address the main actions implemented in order to improve the safety, the work conditions, the productivity and the image of construction sites through the implementation of standards: Sort, Set in Order, Shine, Standardize and Sustain. The successful management of change, the implementation of concrete and visible actions and the valorization of every employees contributed to the success of the 5S in CDCL.

Keywords:

5S Methodology

Change Management

Continuous Improvement

Lean Management

Lean Construction

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Introduction

The Taylorism, implemented at the beginning of the 20th Century, has progressively been challenged since the 50's by a new method created by Toyota, the Lean Management. This new methodology's aim is to improve the competitivity in the industry sector through the reduction of waste, a goal of zero defects and the implementation of "Just in Time".

In the last decades, the construction sector became highly competitive, global leaders entered the market, proposing broken prices. With the increasing competition, it became imperative for national companies to find new ways to improve the quality of their work, optimize their cost, improve the time delivery, and assure the safety of employees. It is in this context that the Compagnie de Construction Luxembourgeoise (CDCL), the second biggest Luxembourgish construction company, implemented in 2018 the Lean methodology, as a way to face the increasing competition. The company hired me as an intern in order to deploy the Lean methodology in the company, and particularly the 5S tool in construction sites.

Due to its nature of production, construction sites face unique problems: low safety, low productivity, small construction sites in perpetual evolution, low quality. I will develop in this thesis how the 5S tool can resolve these issues through the implementation of sustain standards. I will first study the origin of Lean Management until its deployment to the construction sector before doing, in a second part, a zoom on the 5S tool.

Part I: Lean Management
From its origins to Lean Construction

1.1. Origins

1.1.1. Taylorism and Fordism

To understand the origins of the Lean Management, it is important to briefly explain the production context of the automobile industry in the 20th century.

The Taylorism is a working method implemented in the industry in the beginning of the 20th century. It consists in a scientific organization of the work in order to have the best productivity possible. There are two main dimensions. The first is a vertical dimension: strict distinction between conception working tasks done by the white collars and execution tasks done by the blue collars. The second dimension is horizontal: the production process is decomposed in easy tasks given to a specialized blue collar. Engineers time scientifically each movement done for each task, study the best tools to realize each movement and define an optimal time.

Figure 1: Taylorism applied in a factory. Retrieved from henryford.fr

In the beginning of the 20th century, Henry Ford develops and applies the principles of the Taylorism in the automobile industry in the USA, it is the creation of the Fordism. The main objective is to increase productivity and production thanks to the division of work (horizontally and vertically) and standardization. Workers are more productive, but the work becomes alienating and disempowering. Very quickly, all the automobile industry, and the industry in general applies these productivity principles.

1.1.2 Toyotism

In 1950, Toyota was a small and local company of automobiles production in Japan. At that time, the global competition was steep, and the company could not invest to face companies such as Ford and General Motors. Automobile companies produced in mass and in assembly line work, allowing them to have large economies of scale. Smaller and local companies, such as Toyota, had to find new ways to cope with the increasing global competition by reducing drastically their cost and by improving their efficiency.

Toyota designed a new form of work organization, called Lean, and implemented it in 1970. The company changed completely the production logic of the first part of the 20th century. The Toyotas' worker is polyvalent, more responsible, and the organization is focused on the increasing differentiated needs of consumers. The objective of the company is to answer to the market with more flexibility, producing just in time, avoid overproduction and improve quality. 20 years after its implementation, Toyota became the global leader of automobiles.

Toyota developed two main pillars; a production system, named "Toyota Production System" and a management system, named "The Toyota Way".

1.1.2.1 Toyota Production System (TPS)

TPS goal is to provide reliable products, durable and in high quality, it is based on two concepts: jidoka and just in time:

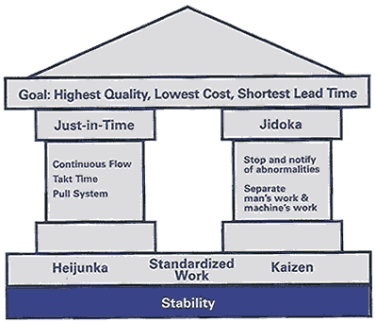


Figure 2: Toyota Production System. Retrieved from lean.org

- Just in Time. "Just-in-time depends on getting exactly the right goods to exactly the right place at the right time" [*Toyota Forklifts*]. In other words, cars are produced on customer demand allowing to reduce wastes.
- Jidoka, or Autonomation in English. The visual environment is built in order to immediately detect abnormalities. Anyone can stop the production process when an abnormality arises allowing to have a zero defects goal.

1.1.2.2 Toyota Way

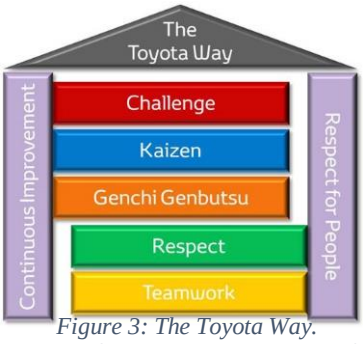


Figure 3: The Toyota Way. Retrieved from blog.operaepartners.fr

Toyota Way is a system of management illustrating the values of the company. It also has two pillars [*Toyota Forklifts*]:

- The continuous improvement: While the TPS' aim is to show the weaknesses of the process, the continuous improvement's aim is to suggest ways to address these weaknesses. It has three values. The firs one is *Challenge*, meaning that Toyota employees must maintain a long-term vision and always challenge the existing situation. The second value is *Kaizen*, there is always room for improvement, everyone in Toyota can take a subject and get the collaboration of other employees to resolve a problem. The last value is *Genchi Genbulsu*, employees must always go to the source and find the origin of the problem in order to resolve it.
- The respect for people: It has two main values, the first one is *respect* in order to create a mutual trust among employees, the second is *teamwork* and favorizes the collective success, it stimulates personal and professional growth.

1.2 Lean Management: Popularization and development

Noticing the success of Toyota, companies in the automobile sector started to implement the strategy and faced the same successful results. In 1990, the term "Lean" appears for the first time [T.Jones, J. P.,1991], the world realized principles of the strategy created by Toyota could be spread among activities and countries. Little by little, the lean strategy was spread among every sector in every continent.

There are five principles of the lean thinking:

- Identify value: The company defines what the customer is willing to pay for in order to offer to the customer what he is expecting and needs, and not what the company can produce.

- Map the value stream: The customer's value is used as a reference point. By mapping the complete life cycle of a product, it allows to define activities that contribute to the customer values, and those which do not bring values. The activity which do not bring values and are unnecessary to the production, are considered as wastes, and are eliminated. Wastes, or mudas in Japanese are grouped in seven categories: Defects, Overproduction, Waiting, Transportation, Inventory, Motion and Over Processing.
- Create flow: Once the waste is eliminated, each step of the process is analyzed in order to ensure that the process runs smoothly and to find new ways to maximize efficiency.
- Establish pull: By establishing customer true needs, the company will follow a 'just in time' strategy and will produce exactly according to the customer needs. The goal is to limit inventory, considered as one of the biggest waste, saving resources, time, space, and cost.
- Seek perfection. The company constantly analyze area of improvements in order to continuously improve the process.

1.3 The Lean Management Tools Box

Besides tools already mentioned, such as Jidoka, Just In time, Kaizen, many other tools are used in the Lean methodology in order to apply lean principles (*refer to Appendix A for a larger list)*:

- Kanban. It is a Japanese word for "Signal Card". Kanban it is a visual production system, used to eliminate waste from inventory. It relies on signal cards which indicate when goods need to be replenished; the idea is to buy material only when needed.
- 5S. Developed in the Part II, it is a tool to improve the organization of a work area and includes five fundamental guidelines: Sort, Set in Order, Shine, Standardize, and Sustain.
- Visual Management. Visual communication technique in order to transmit messages faster and more efficiently. It converts information into visible and understandable format.

- Takt Time. It is the pace at which a product needs to be produced to meet customer demand.
- Poka-yoke. It can be considered as a mistake-proofing tool, it is a dispositive or mechanisms implemented in order to avoid mistakes in the production process.
- PDCA or Deming circle. Acronyms for *Plan - Do - Check - Act*, it is method used in order to improve the organization performance.
- Ishikawa diagrams. The diagram shows the root causes of a problem, *please see Appendix A for an explanation of the diagram.*

1.4 Zoom on Lean construction

The term Lean Construction was first used in 1993 and its goal is defined as: "meet customer demands more effectively and dramatically improve built environment process as well as product." [*Charter and Operating Procedure,* 2012]. Lean construction concerns all activities in the company: the construction sites, warehouse, offices, and also concerns all phases from the design conception to the final product. Lean construction started to be implemented in Europe in the last decade, after the financial crisis in 2008. Global leaders offered broken prices, and it became primordial for companies to improve their productivity in order to maintain their margins.

The construction industry faces unique problems: low safety, low productivity, and small construction sites in perpetual evolution. All this led to a high competitive environment, with construction sites dirty, dangerous and not organized. One new tool has been created in Lean Construction: the Last Planner System, which allows to coordinate all types of construction sites and improve the control over deadlines. It has four main pillars: the participatory and collaborative planning, the research of root causes of problems, and frequent meetings. Each actor participates to the planning, in order to have a concreate and feasible planning, the meetings allow to adapt the planning, and the research causes allow to learn from each other to avoid mistakes in planning in the future.

Part II Zoom on the 5S Methodology

2.1 Definition

The 5S methodology was first implemented by Toyota as part of their TPS and introduced as a way to improve the quality environment in the company. The methodology consists in five fundamental elements, each in Japanese and in English, starting with a 'S': **S**eiri/**S**ort, **S**eiton/**S**et in order, **S**eiso/**S**hine, **S**eiketsu/**S**tandardize, **S**hitsuke/**S**ustain.

5S is a tool allowing to build a functional work environment with easy, precise, and effective rules. Its first role is to build a work environment clean and in order, to diminish the work accidents, remove mudas, and improve productivity. It is a highly flexible tool which need to be adapted in function of the specificities of the industry.

2.2 Zoom on each 5S

- Seiri (=Sort). Seiri is about having an effective utilization of a workplace, by keeping only the materials needed at the good place and at the good moment. It improves productivity and safety, by throwing away all the useless, the useful is more accessible, making it easier and safer to find. It also saves space by eliminating from the workplace all the unnecessary.
- Seiton (Set in order). The second element of the 5S can be summarized as the following: "A place for everything and everything in its place". The concept is to have one place for every single item and have a neat and orderly storage of material. The most used tools must be the most accessible. It maximizes effectiveness and safety. The second element of the 5S has various advantages. By maximizing the ease of location, it is time saving in the research of materials. It also improves the structuration and the ergonomics of the working space. By having frequently used materials close to the work area, it allows to reduce inutile movements or motion, this later being one of the seven mudas. Finally, it allows workers to verify easily that they have all the material they need to successfully perform their task.

- Seiso (Shine). The third S consists to clean the working space: eliminate the wastes, the dirt, in order to have a clean working environment. Workers must clean the working area at the end of each task or at the end of the day. Seiso has various advantages, mainly the improvement of safety as a dirty working area can cause work accidents. Seiso allows to improve equipment quality and efficiency, as dirty equipment can lead to equipment failure and waste of time. Workers can notice easier anything out of the ordinary such as oil leaks.
- Seiketsu (Standardize). Seiketsu emphasizes the importance of maintaining a workplace by repeating the three third S Seiri – Seiton – Seiso. In order to maintain habit, rules must be defined, and visual management is a very valuable tool. Standardization allows to have a low maintenance and overhead cost and increase process efficiency [Ahuja, J. S., 2015].
- Shitsuke (sustain). This step is essential in order to perform the methodology on a systematic basis. In order to do so, it is important to continually sensitize and implicate the personnel, encourage initiatives, train everyone in the company. Standard audits are usually developed and implemented during this step in order to encourage self-discipline.

2.3 Advantages of the 5S Methodology

2.3.1 Interconnectivity of Lean tools through 5S

As mentioned previously, Lean methodology has various tools, such as 5S, Kanban, Visual Management, Value Stream Mapping, Poka-yoke etc.… 5S methodology allows to interconnect each tool in order to have a highly efficient working environment. Visual workplace and visual inventory (Kanban) can be done only in an organized environment, where each item has its own place. Parallelly, visual workplace and visual inventory strengthen the implementation of the 5S methodology. 5S allows also to identify easily flaws in the process, strengthening the implementation of the Poka-yoke tool. A lack of 5S, meaning a dirty and disorganized working environment would make other tools ineffective, and it is in that way that 5S can be considered as the foundation of lean methodology.

2.3.2 Benefits of 5S

5S allows to obtain visible results fast for everyone and provide continuous improvements. It has many advantages.

- Productivity. 5S can be considered as the easiest and most effective tool of Lean to improve productivity. An optimized workplace where every material can be found easily faster work without losing time in non-value-added tasks.
- Work conditions. Having a clean and organized working environment improves work conditions, reduce work accidents, and relationally improve moral of workers. It allows them to reduce the waste of time and increase energy, they can focus only on the essential.
- Mudas. As mentioned previously, the reduction of the seven mudas is one of the main principles of lean management. 5S methodology allows to reduce each of them; inventory with the first S, defects with the second S, and motion with the third S. By improving the general process, 5S also reduce overproduction,waiting, transportation and over processing.
- Quality. 5S also allows to identify easily flaws and therefore improve quality of production.

2.4 Illustration

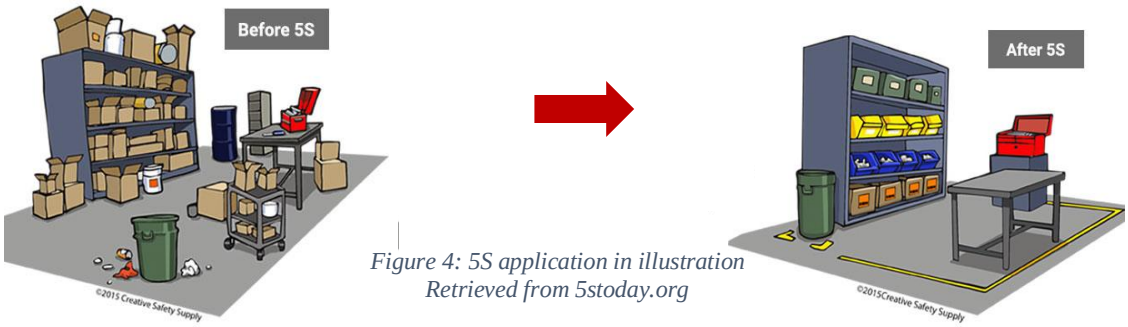


Figure 4: 5S application in illustration
Retrieved from 5stoday.org

The area is full of useless materials (1st S), not organized (2nd S), and dirty (3rd S). The time in searching the material is high, and accidents can happen (stumble, or boxes).

The area is Lean. It is sorted (1st S), with storage units (2nd S), and it clean (3rd S). The area is defined (4th S). The time in searching the material is lower, it is safer, and there is more place to circulate.

Part III The implementation of the 5S in the construction company CDCL

3.1 CDCL

3.1.1 Presentation of the company

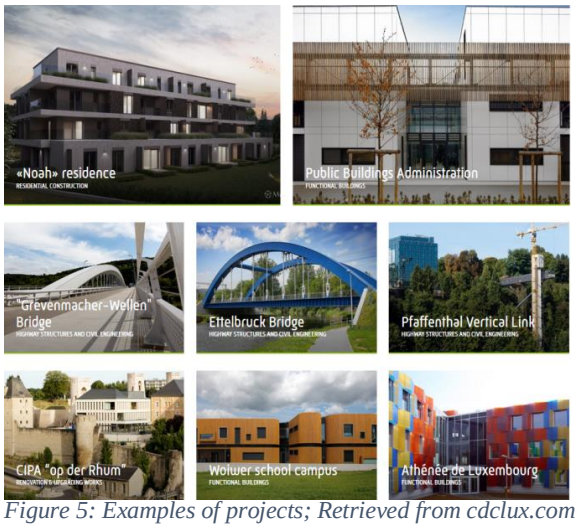


Figure 5: Examples of projects; Retrieved from cdclux.com

CDCL was created in 1979 after the fusion of three Luxembourgish companies. The company is the second Luxembourgish biggest construction company in the country, with an annual turnover between €80M and €100M. CDCL accompanies projects in every phase: from feasibility, to studies, development, construction and after sales service. The company has in mean fifteen new contracts per year, and in numerous domains of constructions, such as structural work, all trades, offices, commercial and residential buildings, engineering structures and roads, renovation, and industrial works. In March 2020, the company had 463 employees, whose 337 were production employees. Besides its permanent employees, CDCL employs 100 temporary workers per year.

3.1.2 Lean department

The economic crisis in 2008 highly impacted the construction sector in Luxembourg. Foreign firms entered the market proposing broken prices. Local companies had to find new ways to cope with the increasing competition in order to maintain their margins. In the same way than Toyota in the 50th, the company CDCL decided to implement the Lean methodology in 2018 as a way to cope with the global competition. It created a new department, the "Operational Excellence", which goal was to implement Lean tools, such as LPS, Kaizens, Takt Time and 5S, *please see Appendix B for the simplified Organigram of CDCL and Lean department*.

3.1.3 Implementation of 5S

The Lean department identified various problematics in construction sites, which directly impact the productivity and increase the probability of working accidents, unfortunately frequent in the construction world.

- The stockage areas: they are not organized, and the access of useful materials is unsafe.
- Finished zones by teams: when a zone is done, workers leave it dirty and leave some materials which could be used somewhere else.
- Working areas: they are not organized and are dirty making the circulation unsafe.
- Sort fields: they are not enough bins, or / and they are not identified making difficult the waste sorting. Moreover, the area is dirty, and the access can be difficult and unsafe.
- Circulation and access: the access to the construction site and the circulation inside can be unsafe and not identified.
- Innovation: there is a lack of storage unit to store properly the materials in the construction sites, moreover innovation is not encouraged to improve the work conditions.

They are all linked to three first 5S: lack of sorting, lack of cleaning, lack of organization. The company realized that 5S could find solutions to each of these problematics, and therefore improve productivity, reduce cost, and decrease the number of accidents. It is in that sense, that the department decided in the beginning of 2019 to implement it some construction sites. In 2020, the implementation of the methodology is still in process.

3.1.4 My mission

It is in this context of continuously improvement, that the company hired me as a Lean Assistant intern. My main mission is to deploy 5S methodology in construction sites. I accompany in total six sites, *refer to Appendix C for a detail of each site*, and I visit in mean two construction sites a week, *please see Appendix D for the frequency of visits for each site*. Moreover, each month I write a monthly report summarizing the advancement state of each

sites. Apart from my direct implication in sites, I participate and develop 5S projects to standardize and sustain the methodology. These 5S missions represented half of my work from January to March. The other half is divided among various Lean, Quality and Security missions, *refer to Appendix E for a detail of my missions.*

3.1.5 Challenges

There are two main challenges to the implementation of the 5S in CDCL. First, unlike industries where workstations are identical and not evolving, construction sites are all different and are in perpetual evolution. 5S must find solutions which can be adapted to every phases of the construction work and be easily transferable to one site to another. Second, 5S works only if workers, who are directly impacted by it, are motivated to its implementation. 5S incites workers, who have decades of experiences, to change radically their habits. An effective change management strategy must be applied so that workers are sensitized to change their habits in order to work in a safe and organized environment in every phases of the construction site.

3.2 5S Methodology applied to CDCL

3.2.1 Principles

The 5S team defined five principles which should be applied to every construction sites.

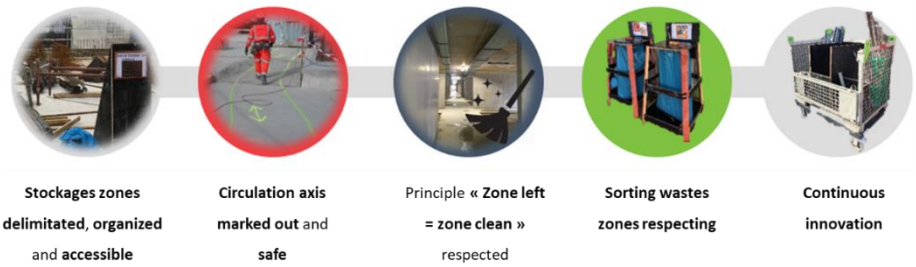


Figure 6: The five principles of 5S in construction sites, done by the author of the thesis

3.2.2 Steps applied to the implementation of 5S in construction sites

The 5S team, follows the same steps to every construction site in order to apply the principles, implement and sustain the 5S methodology:

First Step - Presentation to the Team: When the 5S team has a new construction site where it implements the 5S, the first step is to meet the supervisor team and the workers. During the meeting, a presentation of 5S is done through a PPT presentation, where definition, benefits, goals, and examples of outputs in other construction sites are presented.

Second Step - Identification of main problematics applied to the site: After the presentation, a visit of the construction site is done, main problematics are identified.

Third Step - Determination of priorities: From the problematics observed, the 5S team defines the priorities, in accordance with the supervisor team. The idea of defining priorities is to not force workers to change radically their habits from one day to another, but rather change habits step by steps, starting with the main problematics of the construction site.

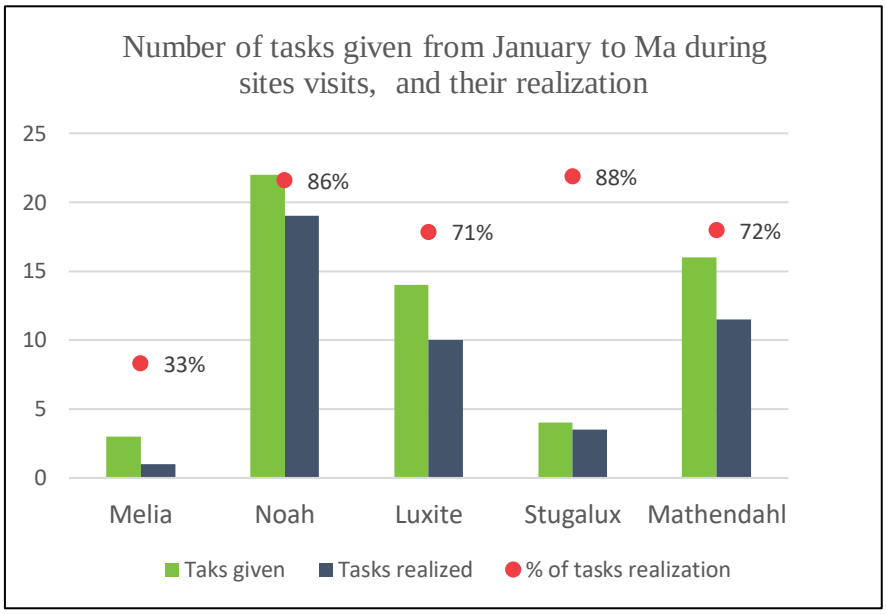
Fourth Step - Weekly audit on sites: The 5S team visits the constructions site once a week. It is the main point of the process. It allows to identify the areas of improvement and define with the teams on site the rules and tasks to apply. It allows also to accompany the teams and implement a continuous improvement plan. The audit uses the following standard:

Problematics	Items audited	Example of questions
The stockage areas	Definition of areas Evacuation of useless materials Storage of material Accessibility of material Identification	Do they exist? Are they respected? Presence of useless materials on site? Material grouped by type or task? Is the accessibility easy and safe? Is the zone visually identified?
Finished zones by teams	Free of material Cleanliness of the zone	Is the zone empty? Is the zone clean?
Working areas	Organization and cleanliness Identification and safety of circulation	Is the area clean and organized? Is the circulation free of material and identifiable?
Sort fields	Respect of waste sorting Cleanliness of bins and accessibility Visual Identification	Is the waste in the appropriate bin? Is the accessibility free of material and clean? Is the zone visually identifiable?
Circulation and access	Identification and safety of circulation Access to the construction site safe	Is the circulation free of material and identifiable?
Innovation	Implementation of new ideas Utilization of 5S storage units	Did the teams create new storage units?

Table 1: Standard of Audit

Each visit is subject to a written report, *please see appendix F for an example of report*, which consist of a grading for each items audited, the action plan for the following week, the respect of tasks from the previous week and a summary of each problematics with photos.

The action plan consists of tasks to do before the following visit, generally for the team leaders. I give in mean between two and three tasks per visit. Then I verify the application of the tasks the following visit. The graph besides show the number of tasks I gave from January to March and their percentage of realization.



Graph 1: Number of Tasks and their realization

Fifth Step - Reduction of visits: Once main problematics have been resolved, and that workers become more autonomous in the application of the 5S principles, visits are reduced.

3.2.3 Realizations

3.2.1 Project within the scope of the four first S

Weekly audits allow to observe common problematics in construction sites, and therefore develop action plans. Below a list of actions developed by the 5S team:

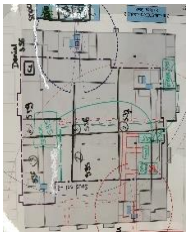
Project	Description	Benefits Sought	S	Photos	State	My role
Team Leader Container	Creation of compartments, designed to store each material used by team leaders.	1)**Storage Optimization (**Reduction in time to search for equipment + Reduction of injury) 2) **Standardization**	2S 3S 4S		2 prototypes realized. The others are under production in the warehouse.	Drawing of the final map through the feedback of the team leaders.
Dynamic plan	Plan print on an erasable board	1**) Improvement of organization**: Stockage areas, and circulations are marked and can change according to the site phase	1S 2S		Present in every site where the 5S is implemented	I use the plan during each visit in every site, writing missions and drawing zones.
Closed Plan Hut	Team leaders currently read their plans in an open hut; the project is to invest in closed ones.	1)**Quality improvement through a better plan storage**	2S		Reception of 20 huts in February, Distribution in the coming weeks	/
Lattice boxes	Used to store materials frequently used. Project: Compartmentalization of the boxes by team leaders.	1) **Storage optimization** (time saving in the research of material + reduction of injuries)	2S		Presence of compartmentalized lattices boxes in every 5S construction sites.	I incite team leaders to create new ones when needed
Wood cutting table	Investment in tables more adapted to workers: smaller and with a gauge system.	**1) Improvement of security** **2) Improvement of productivity**	2S 3S		Three prototypes realized by team leaders.	/
Plans Hut for bricklayer	Bricklayer currently do not have huts. The project is to build some with the open plans hut which will be soon replaced and create compartments.	**1) Storage optimization** **2) Quality improvement**	2S		One realized by a team leader	I accompanied the team leader in the implementation of his idea
Lattice boxes on chassis	The project is to invest in chassis so that the lattice boxes can be moved with the working area without the need of a crane.	**1) Productivity improvement**	2S		Prototypes realized in two construction sites	I verify the benefits of the prototypes used on sites

Table 2: 5S projects

3.3.2 Project within the scope of the fifth S

Additionally, to the projects listed above to implement in construction sites, other actions are implementing by the 5S Team in order to improve the sustainability (5^{th}) of the 5S methodology. As explained in Part II, Shitsuke is essential in order to sustain 5S methodology in a company, and is implemented by sensitize and implicate the personnel, encourage initiatives, train everyone in the company. Below a list of Shitsuke actions done by the 5S team:

- Creation of a quarter gazette of innovation. I wanted to encourage more initiatives, implicate employees, valorize them, and spread the good ideas. Therefore, I created a gazette which lists and congratulates every 5S innovation in the past quarter, it is written in French and Portuguese, *please see Appendix G*. I wrote the first one in March 2020, and it was distributed with the pay slips of April to 300 employees.
- Annual celebration. The first ceremony was realized in March 2020 in order to invite all the personnel who participated in the implementation of the 5S in the year 2019. This celebration's goal is to implicate employees and valorize them.
- Creation of a 5S label. A label is added on the hard hat of workers who participate in 5S, in order to create a visual community, valorize and implicate employees
- Implementation of audits and reports (cf. Part III 3.3). The regular audits encourage self-discipline and train employees. I participated in the improvement of the written report in order to have one more in adequation with our visits.

3.4 Results

3.4.1 Results in photos

STOCKAGE AREAS: In 5S sites, stockage areas are defined, the useless materials are evacuated, the material grouped by type or task, the accessibility is better and safer, the zone is delimitated, and posters identified the stock.

Figure 7: Example of a 5S stockage area

Figure 8: Before and after 5S in a stockage area

The photo alongside shows that the gathering of material facilitates the circulation: the risk of stumbling is lower.

FINISHED ZONES: 5S finished zones are clean and free of materials

Figure 9: Before and After 5S in a finished zone

CIRCULATION: Circulation is identified and safe.

Figure 10 : Circulation axis in a 5 site

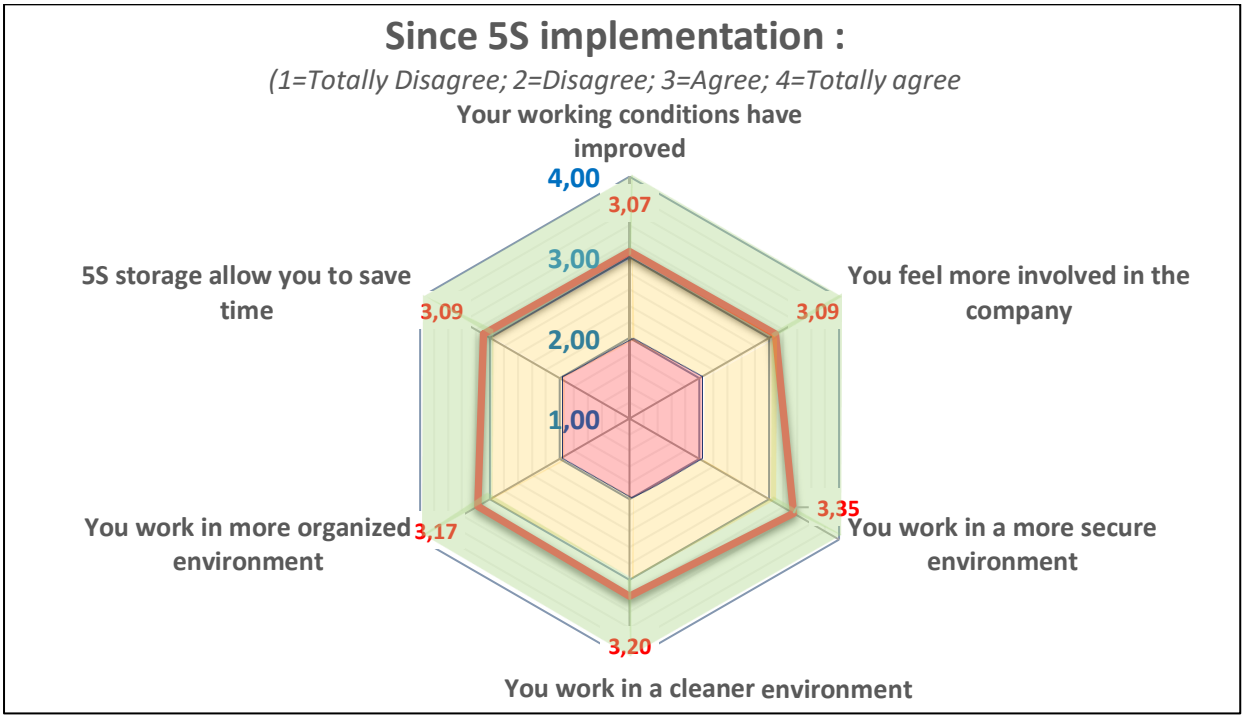
SORTING FIELDS: The sorting is respected, the accessibility is easy and safe, and the zone is visually identified.

Figure 11: Sorting field in a 5S site

3.4.2 Survey Analysis

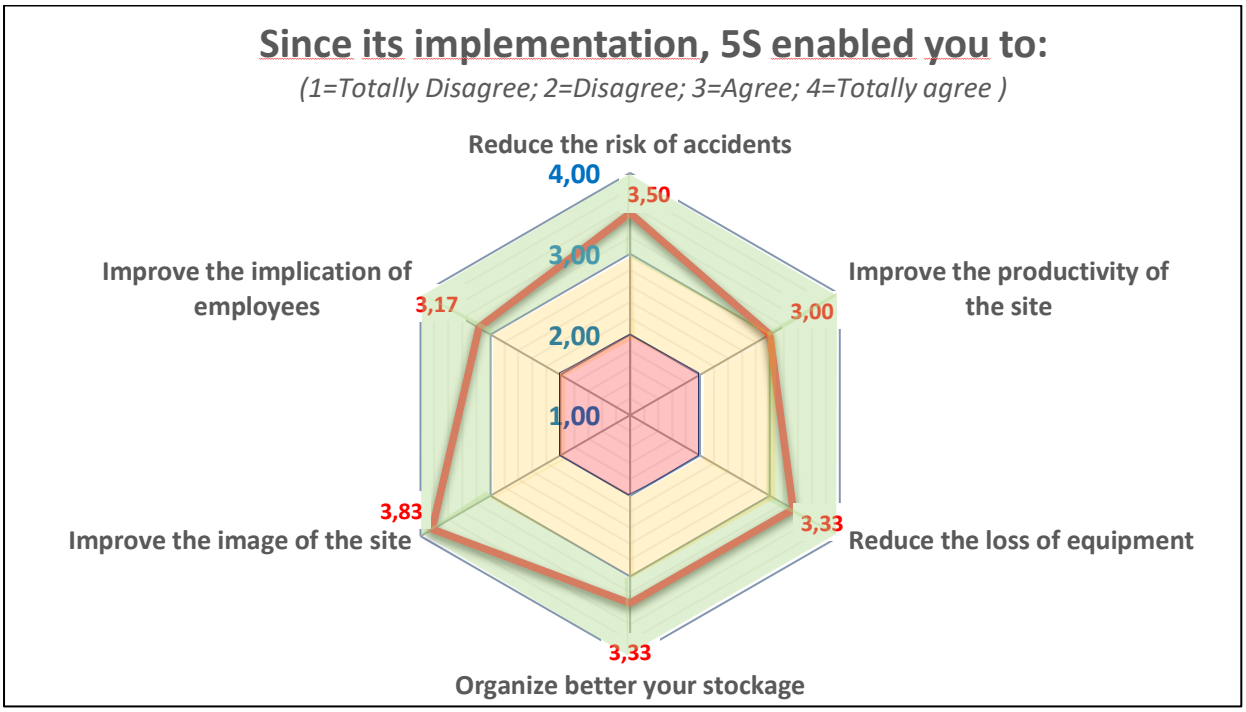
Although visual results can be noticed, the methodology has been implemented only a year ago, and there is a lack of qualitative data to quantify the results. It is in that sense that I realized a survey in order to measure the working conditions and the advantages of 5S perceived by the personnel directly impacted by its implementation. There are 29 participants: 6 in supervisory teams and 23 team leaders and workers. I adapted questions according to the role of participants, to have questions more focused on working conditions for workers, and questions more focus on productivity for managers. *In appendixes H, one can find the list of all participants' answers, as well as the mean, standard deviation, and coefficient of variation for each question.* For each question, participants could answer either Totally Agree (=4), Agree (=3), Disagree (=2) or Totally Disagree (=1).

The graph below shows the mean answers from workers and team leaders. They are satisfied with all the criteria asked, they agree that work conditions have improved, they are more involved in the company, 5S storage allow them to save time, they work in a more organized environment, and mostly the work environment is safer and cleaner.



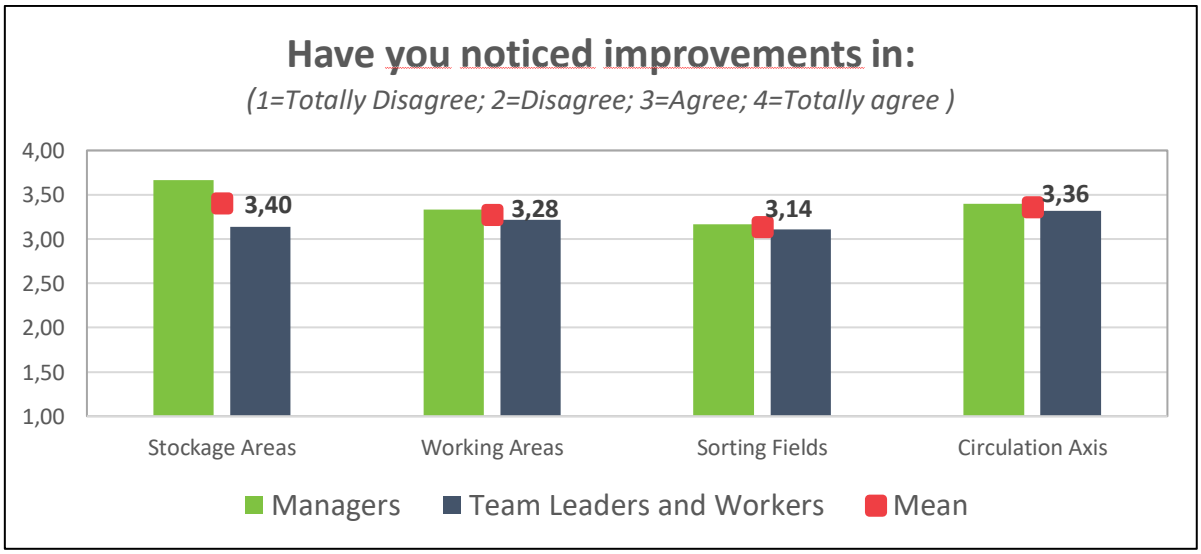
Graph 2: Radar Chart, Answers to the survey done by the author of the thesis

The graph besides shows the answers from the supervisory team. They agree that 5S improve the productivity of the site, it reduces the loss of equipment, it improves the implication of employees, it help to better organize stockage, and mostly it reduces the risk of accidents and improve the image of the site.



Graph 3: Radar Chart, Answers to the survey done by the author of the thesis

The last part of the survey was common to workers and supervisory team. They all agree that there is an improvement in management of work areas, sorting areas, and mostly in stockage areas and circulation axis.



Graph 4: Bar Chart, Answers to the survey done by the author of the thesis

The general mean for any questions is 3.2/4 (3.4 for responsible and 3.2 for workers). The coefficient of variation is 0.07, meaning that there is a very low variation among answers. Therefore, on can say that the perception of 5S is positive and very homogeneous. Moreover, the mean answers for every question is between 3.0 and 3.8 with a coefficient of variation between 0 and 0.16. We can conclude that employees directly impacted by the implementation of 5S, managers as workers, are satisfied with it and noticed improvements in a wide area of subject, particularly subjects concerning the image of the site, the safety and the stock management. Written feedbacks from participants also illustrate the positive opinion of participants, as showed by the below verbatims traduced in English:

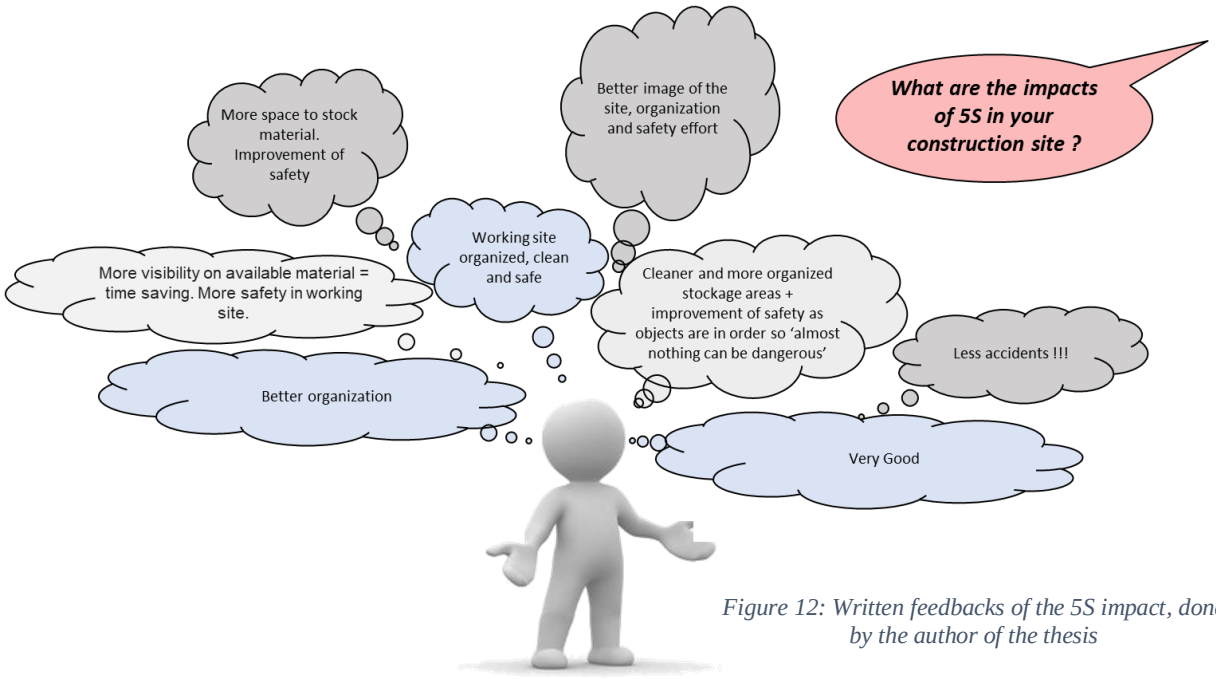


Figure 12: Written feedbacks of the 5S impact, done by the author of the thesis

The direct impact of the three first S are confirmed: better organization, better safety and better cleanliness perceived. However, Shitsuke actions are relatively new or not yet diffused (for example, the first Gazette was distributed after the gazette), we can therefore expect soon an improvement of area directly impacted by these actions, such as the involvement of employees.

Notations and feedbacks are very promising for generalizing the methodology to all construction sites of CDCL.

3.4.3 Benefits of 5S

As stated below, one year after the 5S implementation in CDCL, visible results can already be observed and employees in construction sites noticed real changes. There is a clear visual distinction between sites where the 5S is applied and where it is not. The 5S site is clean, organized, and safe. The benefits resulting are summarized as follow:

- **Better work conditions**:
  - Safer environment of work: The improvement of the tidying in the stockage areas, the working areas, and the circulation axis allow to circulate easily and without any disruptive elements. Therefore, it reduces the risk of accidents caused by tripping.
  - Improvement of the Moral: the storage units created to improve the accessibility of materials and the new rules of cleanliness improve the working environment conditions, and relationally improve moral of workers.
  - Valorization of workers: Through the implementation of Shitsuke actions, workers feel more implicated and valorized in the company.
- **Improvement of productivity and cost reduction:**
  - Reduction of materials lost and improvement of its quality: By creating storage units so that there is "A place for everything and everything in its place" allow to identify easily what is missing, and incite to always putting back all the material at the end of the day. Parallelly, it allows to keep the material in good state.
  - More working time in added-value activities: The storage units allow to reduce the time in searching the material, giving workers more time to work and to focus on essential.
  - Reduction of accidents: direct impact on productivity
- **Improvement of the construction site image:** Construction sites are clean and tidy. Customers have a better image of the company, and parallelly the image of the quality and professionalism of CDCL grows.

3.4.4 Limitations of the results

Although the survey is a first step to measure the advantages perceived by the personnel, there is still a lack of quantitative data to quantify the 5S benefits. The next step of the 5S team will be to implement relevant KPI in order to measure improvements. For example, a KPI implemented in order to measure the improvement of productivity, through an analysis of the number of accidents before and after the implementation of 5S, would be relevant. Some other analysis could be done, in the long term, in order to measure the quality and number of lost materials on site. A larger analysis could also be performed, in the coming years, of the total production time of 5S sites in comparison to sites where 5S was not implemented.

3.4.5 Factors of success

The implementation of 5S in CDCL has proven to be effective. In my opinion, its success can be explained by four main reasons. First, a successful change management approach. The 5S is not implemented from one day to another to every construction site, but rather steps by steps. Workers are accompanied by the 5S Team in its implementation with a weekly visit and new tasks to be done. It allows both employees in the construction site and members of the 5S team to learn and improve the methodology. Then, the 5S team implements concrete and visible actions. In a few weeks, workers can realize the benefits of the methodology with the improvement of safety and cleanliness, which encourage workers to continue the efforts. The success can also be explained by the valorization of employees, through the implementation of annual ceremony, the newspaper, and the attention from the 5S team to every worker implicated in the 5S. Finally, without the support and commitment of the top-management, the 5S implementation would not be as effective as it is. In their communication and action, they bring their support to the 5S team and show to all workers that 5S is essential in the future of the company.

Conclusion

As part of my internship, I participated in the deployment of 5S on different construction sites of the Luxembourgish company CDCL. This internship allowed me to familiarize with various Lean Management tools, mainly the 5S tool. This tool has been implemented in 2019 and already shows concrete improvements in numerous sites by improving the organization through the implementation of new standards: sort, set in order, shine, standardize, and sustain. These improvements contribute to improving the safety of the site and of the personnel, improving the working conditions, and give a positive image of the company to customers and stakeholders (residents, subcontractors, etc...).

If Lean and 5S have proven to be effective in the industry, the management of change is a real challenge in the construction sites. Indeed, it challenges operational practices with employees who are not always ready to change the habits they have for decades. Change management is the most important challenge of the approach because without the support of all it is difficult to deploy such a methodology. The 5S team manages this issue with regular visits, by advancing step by step, and by implemented concrete actions so that everyone can realize the benefits of the approach.

The team also valorize the approach through communication and valorization of employees, with the implementation this year of an annual ceremony and the diffusion of a company newspaper oriented towards 5S innovation, in order to sustain the approach.

The 5S is in its operational deployment and has proven to bring real positive outputs. The following steps will be the implementation of other complementary Lean tools, such as Kanban to improve inventory management system and the standardization of visual management on all sites, which became in May my main mission.

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APPENDIXES

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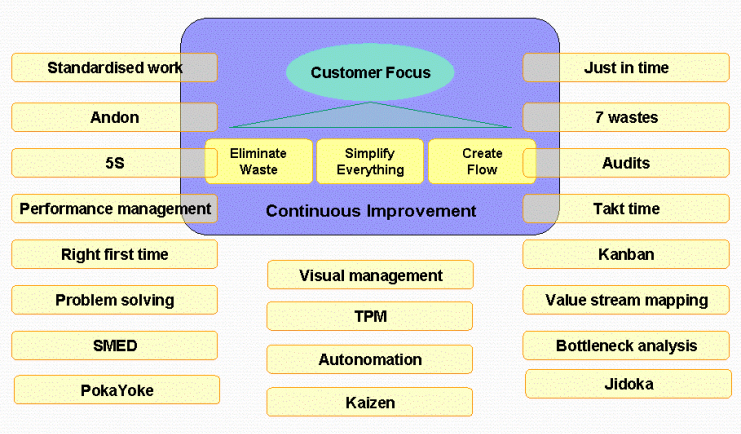
Appendix A: Lean tool box

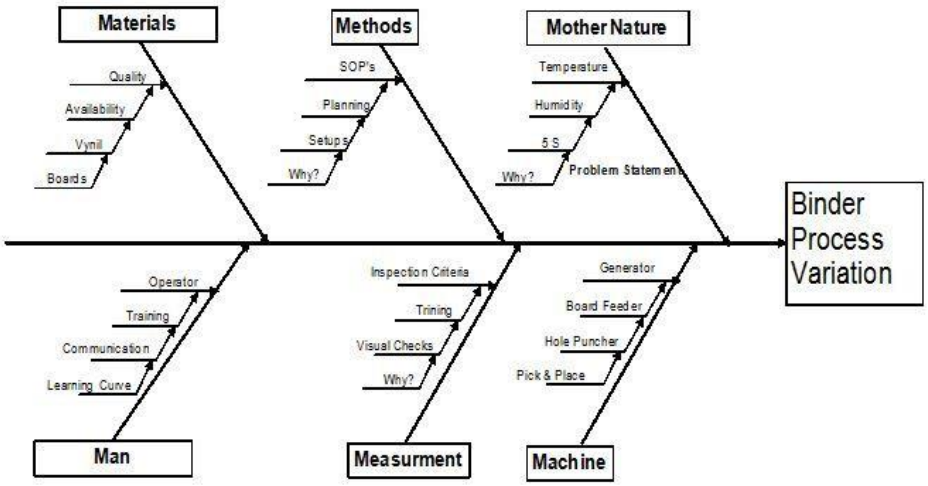
Lean Management is implemented through various tools, the most common are listed below:



Retrieved from leanmanufacturingtools.com

Zoom on Ishikawa diagrams

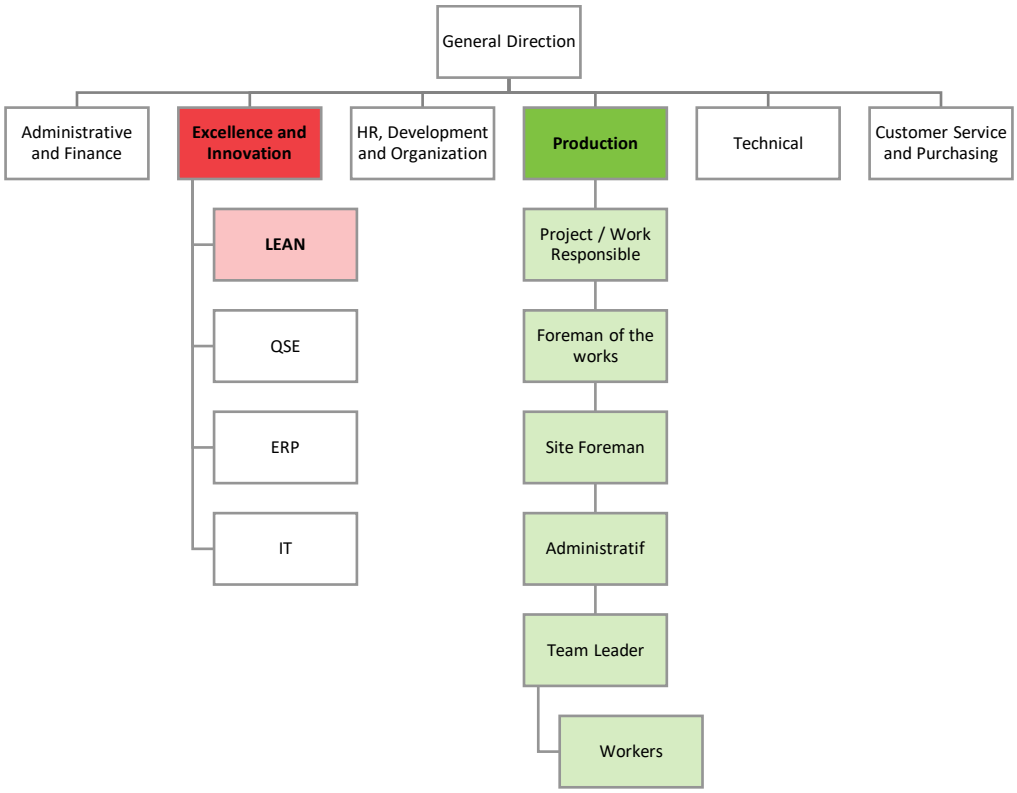
Developed in 1962, the Ishikawa diagram, also called 5M, or fishbone diagram visually shows causes leading to an effect. It can be used in order to find the causes of a problem or identify and manage risks during the implementation of a project. The inventor of the model recommends looking at events in five different aspects, the five "M". Lately, a sixth M has been added "Mother Nature", which represent the environment.



Appendix B: Simplified Organigram

Below a simplified organigram, showing:

- My position as an intern in the Lean department
- The hierarchy of the production Department, department with who I interact highly in construction sites with the implementation of 5S.

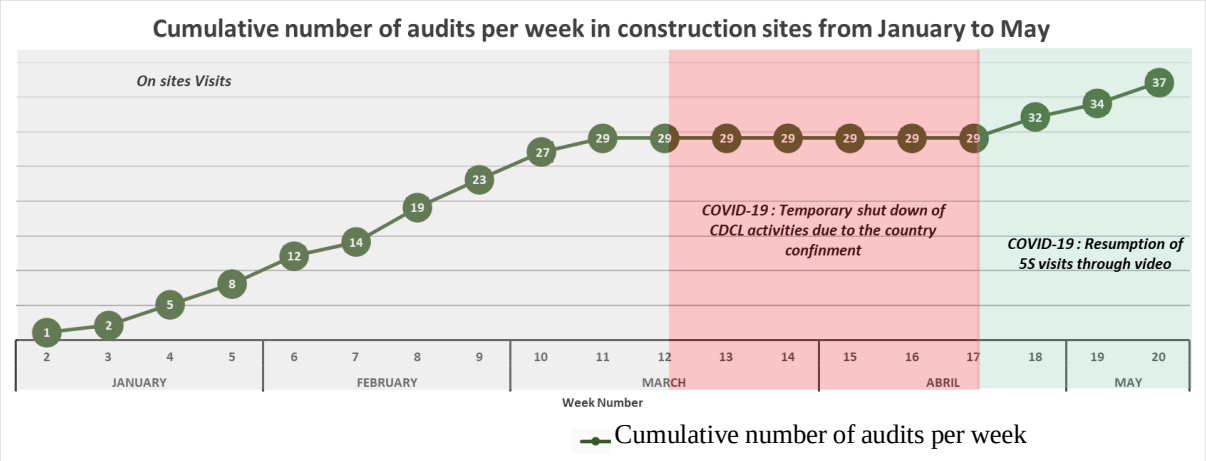


Appendix C: List of Construction Sites I participated in

Name	Type	Type	N° of Teams	Photos	Frequency of visits
Hotel Melia	Hotel	Structural Work in finishing state, beginning of all trades	1		Once per week
Stugalux Differdange	Residence	Structural Work	1		Once per month
Noah	Residence	Structural Work	1		Once per week
Mathendahl	School	Structural Work	3		Once per week
Luxite 2	Parking and office desks	Structural Work	2		Once every two weeks
Port de Mertert	Port	Roads and Networks	1		Once every two weeks

Appendix D: Frequency of visits for each construction site

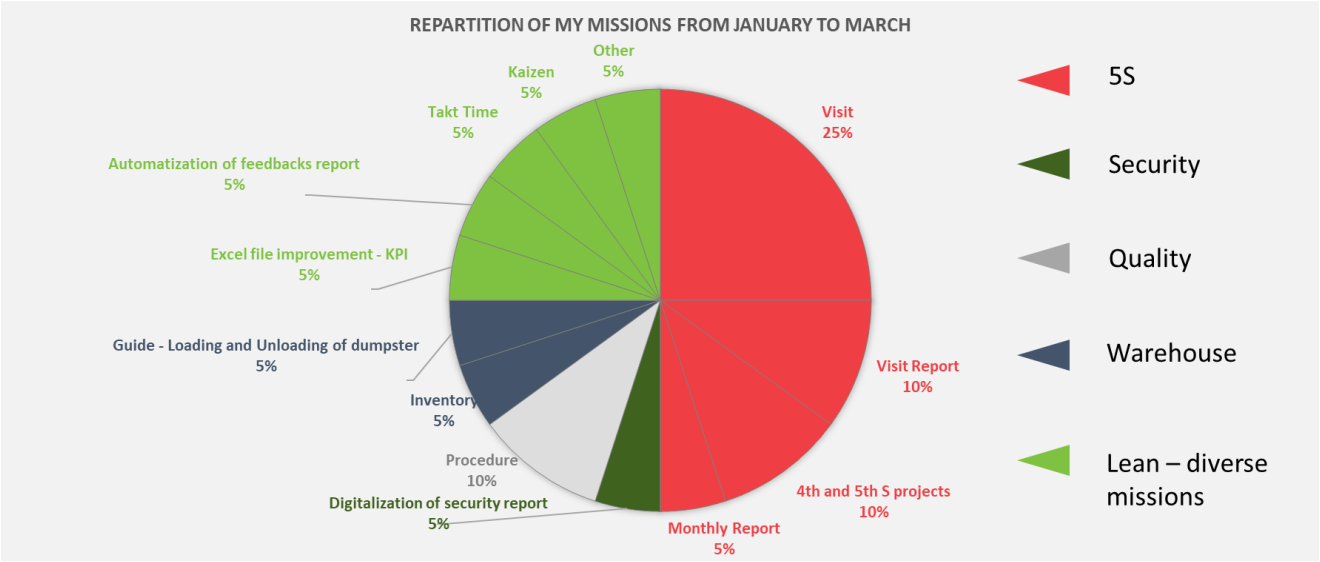
VISITS PER CONSTRUCTION SITES							
Week Number	Melia	Noah	Luxite	Stugalux	Mathendahl	Port de Mertert	N° of visits
2	1						1
3					1		1
4		1	1	1			3
5	1	1			1		3
6	1	1	1			1	4
7		1			1		2
8	1	1	1		1	1	5
9	1	1		1	1		4
10		1	1		1	1	4
11		1			1		2
12							0
13							0
14							0
15							0
16							0
17							0
18		1	1		1		3
19		1			1		2
20		1	1		1		3
Number of visits	**5**	**11**	**6**	**2**	**10**	**3**	**37**
Frequency of visits	**Every 2 weeks**	**Every week**	**Every 2 weeks**	**Every 4 weeks**	**Every 1,3 weeks**	**Every 2 weeks**	**2 per weeks**



Appendix E: My Missions

5S missions represented half of my time from January to March, and are divided between the visits on sites, the writing of the report, the sustainability and sustainability projects, and the monthly reports. Apart from my 5S missions, I have other various projects:

- Security: The security manager audits everyday sites and use an Excel file in order to write her audit after her visit. My mission is to digitalize the audit through a software in order to have it on tablet computer so that the auditor can fill the audit directly during the visit.
- Warehouses missions: I accompany the warehouse in diverse missions. For example, I did the inventory of editable tools and will implement the Kanban tool. I also write a guide to explain to drivers how to load and unload dumpsters.
- Quality: I write internal procedures for various departments.
- Diverse Lean Missions: I automatized the feedback report, filled by supervisory teams at the end of their projects, using Python in order to have a clean and accessible database, I improve Excel files to represent better KPI, I accompany a site in the implementation of the Takt Time tool and I participate in the follow-up of Kaizen.



Appendix F: Audit Report; An Example

CDCL

CR Visite 5S 193036 Ecole et maison relais Mathendahl

Date de la visite:	13/03/2020	N° de la visite:	11	Thème :	Tour 5S	Rédacteurs:	Mélanie Schmitt + Inès Lacour

CHANTIER

N° Chantier :	193036	Nom du Chantier :	Ecole et maison relais Mathendahl
Encadrement du chantier:	Resp. projet : Guillaume Dupuis	Chef d'équipe :	Roberto Sapuppo (839), Daniel Dias (260), Dinis Da Silva Loureiro (262)
	Conducteur Tx : Cédric Rengshausen (+ Loic Desset)		

VISITE PRECEDENTE

Date:	06/03/2020	Thème de la visite:	Tour 5S	Résolution:
Points précédents:	Equipe de Roberto: Organisation et rangement de la zone de stockage principale (zone 1).			✗
	Equipe de Daniel: Finaliser l'organisation de la zone 3 : ajout d'affichage + rangement du matériel de coffrage et du bois dans la zone 4 (rampe).			!
	Equipe de Dinis: Amélioration de la cabane à plans afin de l'adapter aux besoins de son équipe maçonnerie.			✓

VISITE DU 13/3/2020

Remarques 5S chef d'équipe:

	DS	RS	DD
ZONE DE STOCKAGE (cf. PIC)	Maçonnerie	Zone 1	Zone 2 + 3
a. Zones existantes et identifiées sur le PIC	→	→	→
b. Evacuation du matériel inutile	→	→	→
c. Matériel regroupé par type ou par tâche	→	→	→
d. Circulation sécurisée + matériel accessible	→	→	→
e. Identification visuelle (ex: affichage)			
ZONES QUITTEES			
a. Libérées de tout matériel	→	↓	→
b. Principe zone quittée=zone propre respecté	→	↓	→
c. Passation des zones aux ST vides et propres			→
ZONES DE TRAVAIL			
a. Poste propre et organisé	→	→	→
b. Circulation identifiée et libre de tout matériel	→	→	→
INNOVATION			
a. Mise en place d'idées novatrices	→		
b. Utilisation de rangements 5S	→		→

Autonomie
Maintien de la tâche
Tâche en cours
Début de tâche
Tâche non commencée

Bien
Moyen
A revoir
Non commencé/ concerné

Remarque 5S chantier

IMAGE DU CHANTIER DE L'EXTERIEUR			
a. Barrières HERAS propres + bâches CDCL			
b. Aperçu du chantier			→
ZONES DE TRI			
a. Zones identifiées sur le PIC			→
b. Respect du tri dans les bennes			→
c. Nombre de bennes en quantité suffisante			→
d. Propreté autour des bennes et accessibilité			→
e. Identification visuelle (ex: affichage)			→
AXES DE CIRCULATION SUR CHANTIER			
a. Libres de tout matériel			→
b. Identifiés et/ou balisé			
c. Accès chantier sécurisé			→

Comparaison avec le passage précédent	
↑	En progrès
→	Equivalent
↓	En déclin

PROCHAINE VISITE		PAR QUI ?
POINTS A SUIVRE:	Organisation et rangement de la zone de stockage principale (zone 1).	Equipe Roberto
	Continuer à ranger la zone 3 : zone bois + créer une zone sous-traitant	Equipe Daniel
	Organiser la zone 5: regrouper le matériel par type afin d'améliorer son accès	Equipe Daniel
	Maintenir le principe de "zone quittée = zone propre"	Equipe Dinis

Pic Dynamique

CDCL

CR Visite 5S 193036 Ecole et maison relais Mathendahl

ZONE DE STOCKAGE

Zone de stockage n°1

Un rangement est en cours dans la zone par Roberto.
Bonnes pratiques:
- Regrouper le matériel par type
- Laisser des axes de circulation entre le matériel afin d'y accéder facilement et en toute sécurité

Zone de stockage n°3 – Zone de travail

Un rangement de la zone est en cours par l'équipe de Daniel.
De l'affichage va être ajouté afin d'identifier la zone Bois.

Zone de stockage maçonnerie au 5S

La zone de stockage est organisée et propre.

Zone de stockage n°5

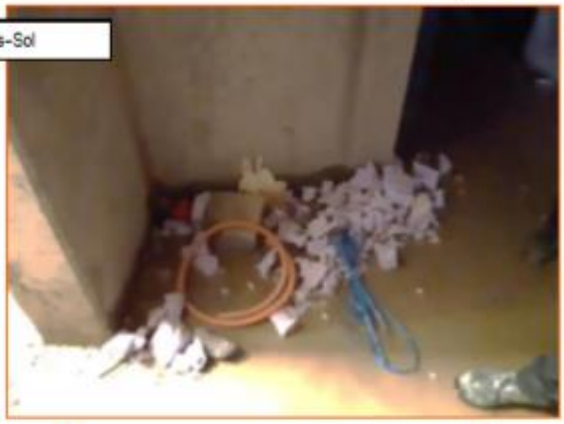
La zone sera rangée par l'équipe de Daniel afin d'accéder facilement au matériel stocké.

CDCL

CR Visite 5S 193036 Ecole et maison relais Mathendahl

ZONES QUITTEES

Sous-Sol



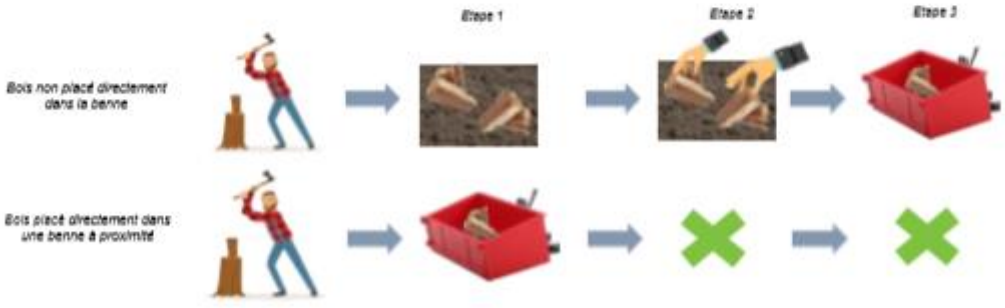
Les zones quittées par l'équipe de Dinis sont propres et rangées.

Attention à bien respecter le principe de "zone quittée = zone propre" par l'équipe de Roberto.

ZONE DE TRAVAIL

La benne n'est pas à proximité de la table de découpe. Placer le bois directement dans la benne après découpe permet un gain de temps

Action réalisée immédiatement.



CDCL

CR Visite 5S 193036 Ecole et maison relais Mathendahl

RANGEMENTS 5S

L'équipe de Dinis a travaillé sur la cabane à plans ouverte du sous-sol afin de l'adapter aux besoins de la maçonnerie:
- Ajouts de rangements afin de ranger le matériel utilisé quotidiennement par l'équipe
- Ajout de roues pour que la cabane puisse se déplacer facilement
- Réduction de la taille (profondeur) afin qu'elle puisse passer les portes
- Ajout d'une lumière

Exemple de rangement scie

Idée innovation venue du chantier:
Ajouter une plaque métallique afin d'y ranger les aimants.

Idée innovation: Un rangement peut être crée par l'équipe de Roberto afin de ranger la scie à proximité de la table de découpe et à hauteur de main.

IMAGE DU CHANTIER DE L'EXTERIEUR

Un travail sur les zones extérieures est prévue lors des prochaines séances afin d'améliorer l'image du chantier.

Appendix G : Gazette de l'innovation – 1st Edition

ANNEE 2020 // NUMERO 1

GAZETTE DU 5S

NOUVEAU : SORTIE D'UNE GAZETTE SUR LES INNOVATIONS ET AVANCÉES 5S
ESTREIA : PUBLICAÇÃO DE UMA GAZETA SOBRE AS NOVIDADES E DESENVOLVIMENTOS DO 5S

L'équipe 5S tient à remercier toutes les personnes impliquées dans le succès du 5S depuis sa mise en place en 2019.

N'hésitez pas à nous contacter si vous avez une idée d'innovation, nous serons là pour vous accompagner !

A équipe 5S agradece a todas as pessoas envolvidas no sucesso do 5S des a sua criação em 2019.

Não hesite em entrar em contato conosco se você tiver uma idéia inovadora, estaremos lá para apoiá-lo!

5S CDCL 1

LES REALISATIONS 2020 / REALISAÇÕES DE 2020

- Gitterboxes compartimentées
- Plaque métallique sur gitterboxes compartimentées
- Gitterboxes sur châssis avec système de pince
- Cabanes à plans maçonnerie
- Cabanes à plans fermées
- Compartimentage container chef d'équipe 5S
- Caixa-palete compartimentadas
- Placas de metal sobre as caixas-palete compartimentadas
- Caixas-palete sobre chassi com sistema de grampo
- Cabines para planos em alvenaria
- Cabines para planos fechadas
- Contentor compartimentado para os chefes de equipa 5S

LES REALISATIONS 2019 / REALISAÇÕES DE 2019

- Tables à découpe Bois
- Tri des déchets sur zone de travail
- Container principal
- Rangements Scie
- Mesas de corte de madeira
- Separação de resíduos na área de trabalho
- Contentor principal
- Arrumação das serras

5S CDCL 2

Gitterboxes compartimentées / Caixa-palete compartimentadas

Félicitations aux équipes d'Agostinho, Giuseppe et de Machado, qui ont rejoint le groupe des propriétaires de gitterboxes compartimentées.

Avantages :
- Gain de temps dans la recherche de matériel
- Réduction du risque de blessures aux mains
- Meilleure accessibilité / Réduction de la pénibilité

Parabéns às equipes Agostinho, Giuseppe e Machado por se juntarem ao grupo de proprietários das caixas-palete compartimentadas.

Benefícios :
- Ganhar tempo na procura de material
- Reduzir o risco de lesões nas mãos
- Melhorar os acessos / Reduzir a penúria

5S CDCL 3

Plaque métallique sur une gitterboxe compartimentée
Placas de metal sobre as caixas-palete compartimentadas

Félicitations à l'équipe d'Agostinho, sur le chantier Noah.

Avantages :
- Meilleure stockage -> maintien de la qualité, meilleure longévité des aimants
- Meilleure accessibilité -> gain de temps

Parabéns à equipa do Agostinho no estaleiro Noah.

Benefícios:
- Melhor armazenamento -> manutenção de qualidade, melhor longevidade dos ímãs
- Melhor acessibilidade -> economia de tempo.

Gitterboxes sur châssis | Système sans soudure| Test en cours
Caixas-palete sobre chassi | Sistema sem soldagem | Em teste

Félicitations à Marco Paulo, du dépôt, qui a crée un système de pince avec du matériel récupéré.
2 gitterboxes sur châssis sont en test sur chantier.

Avantages:
- Gain de temps Grue -> Le châssis permet de déplacer la gitterboxe manuellement
- Le système de pince permet l'interchangeabilité des gitterboxes.

Parabéns ao Marco Paulo, do depósito, que criou um sistema de grampos com material reciclado.
2 caixas-palete sobre chassi são em testes nos estaleiros.

Benefícios:
- Economia de tempo com o guindaste -> O chassi permite mover a caixa-palete manualmente
- O sistema de grampo permite a troca entre as caixas-palete.

5S CDCL 4

ANNEE 2020 // NUMERO 1

GAZETTE DU 5S

LES INNOVATIONS 5S
AS INOVAÇÕES 5S

Cabane à plans maçonnerie / Cabines para planos em alvenaria

Félicitations à l'équipe de Dinis, sur le chantier Mathendahl.

Travail effectué :

1. Ajout de rangements afin de ranger le matériel utilisé quotidiennement par l'équipe
2. Ajout de roues pour que la cabane puisse se déplacer manuellement
3. Réduction de sa profondeur afin qu'elle puisse passer les portes
4. Ajout d'une lumière

Parabéns à equipe Dinis no estaleiro Mathendahl.

Trabalho realizado:

1. Acréscimo dum espaço de armazenamento para armazenar os equipamentos utilizados diariamente por equipa
2. Acréscimo das rodas para que a cabine possa ser movida manualmente
3. Redução da profundidade para poder passar pelas portas
4. Acréscimo duma lâmpada.

Cabanes à plans fermés / Cabines para planos fechadas

Réception de 20 cabanes à plan fermées. Elles seront distribuées aux chefs d'équipe ayant des cabanes ouvertes.

Avantages:

- Protection des plans lors d'intempéries
- Présence de lumière
- Réduction du bruit donc meilleure concentration
- Lieux de recharge des machines HILTI pendant la journée

Receção de 20 cabines para planos fechadas. Essas cabines serão distribuídas aos chefes de equipa que tenham cabines abertas.

Benefícios:

- Proteção dos planos durante o mau tempo
- Presença de luz
- Redução de ruído, logo, melhor concentração
- Locais de carregamento das máquinas HILTI durante o dia

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LES INNOVATIONS 5S
AS INOVAÇÕES 5S

Container Chef d'équipe 5S / Contentor do chefe de equipa 5S

Remerciements au dépôt et à toutes les personnes ayant contribuées à l'aboutissement de ce deuxième container Chef d'équipe.

Les containers seront compartimentés dans les semaines à venir et distribués en priorité aux CE ayant des containers galvanisés gris ou bleu.

Agradecimento ao depósito e a todas as pessoas que contribuíram para a conclusão deste segundo contentor destinado aos chefs de equipa.

Estes contentores serão compartimentados nas próximas semanas e serão distribuídos prioritariamente aos CEs com contentores galvanizados em cinza ou azul.

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EVENEMENTS 5S 2020
EVENTOS 5S 2020

Réalisation d'un barbecue début Mars afin de féliciter toutes les équipes ayant contribuées à la mise en place du 5S en 2019

Grelhada no início de março para parabenizar todas as equipes que contribuíram para a implementação do 5S em 2019

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EVENEMENTS 5S 2020
EVENTOS 5S 2020

Merci à tous ceux qui étaient présents

***

Obrigado à todos que estiveram presentes

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LES INNOVATIONS 5S 2019
AS INOVAÇÕES 5S 2019

Dans le cadre de la sortie de la première gazette 5S, nous souhaitons également féliciter toutes les innovations réalisées au cours de l'année 2019. / ***Juntamente com lançamento do primeiro 5S Gazeta, aproveitamos também para parabenizar todas as inovações feitas durante o ano de 2019.***

Tables de découpe / *Mesas de Corte*

Toute innovation est bienvenue afin de collaborer ensemble à la création d'une table de découpe adaptée aux équipes. N'hésitez pas à nous contacter afin qu'on vous accompagne dans cette démarche, à l'adresse suivante : i.lacour@cdclux.com

Félicitations aux équipes de Rosa sur le chantier Baumeister, Fernando sur le chantier Batiself , Antonio sur le chantier Batiself.

Travail effectué :
- Création d'un système de gabarit
- Réduction de la hauteur des tables
- Agrandissement de la table

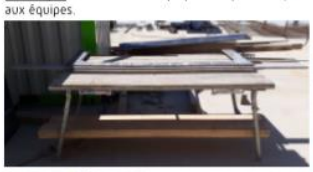
Avantages : Tables de découpe plus adaptées aux équipes.

Qualquer inovação é bem-vinda para colaborar na criação de uma mesa de corte adaptada às equipes. Não hesite em contactar-nos para que possamos ajudá-lo nesse processo, o nosso email é: i.lacour@cdclux.com

Parabéns às equipes de Rosa no estaleiro Baumeister, Fernando no estaleiro Batiself, Antonio no estaleiro Batiself.

Trabalho realizado:
- Criação de um sistema de gabaritos
- Redução da altura da mesa
- Ampliação da mesa

Benefícios: Mesas de corte mais adequadas para equipas.



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LES INNOVATIONS 5S 2019
AS INOVAÇÕES 5S 2019

Tri des déchets sur zones de travail
Separação de resíduos na área de trabalho

Félicitations aux équipes ayant créées des poubelles permettant un tri facile des déchets sur les zones de travail.

Parabéns às equipes que criaram latas de lixo para facilitar a separação de resíduos nas áreas de trabalho.




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LES INNOVATIONS 5S 2019
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Container Principal / Contentor Principal

L'équipe 5S se tient à votre disposition pour vous aider à compartimenter votre container principal. N'hésitez pas à nous contacter afin qu'on vous accompagne dans cette démarche, à l'adresse suivante : i.lacour@cdclux.com

A equipe 5S está à sua disposição para ajudá-lo a compartimentar o seu contentor principal. Não hesite em contatar-nos para que possamos ajudá-lo nesse processo, através do email: i.lacour@cdclux.com



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LES INNOVATIONS 5S
AS INOVAÇÕES 5S

Rangements Scie / Arrumação das Serras


Présence de plus en plus fréquente de rangements scie sur chantiers.

Félicitations à toutes les équipes !

Avantages:
- Protection contre la pluie
- Meilleure longévité de la scie
- Accès facile et rapide à la scie à proximité de la table de découpe et à portée de main

Notamos que está a ser cada vez mais frequente a arrumação das serras nos estaleiros de obras.

Parabéns a todas as equipes!

Benefícios:
- Proteção contra a chuva
- Maior durabilidade das serras
- Acesso fácil e rápido às serras. Mais próximas da mesa de corte e de fácil

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QUELQUES CHIFFRES
ALGUNS NÚMEROS

REALISATIONS / *REALIZAÇÕES*

	ANNEE / *ANO* 2019	1° TRIMESTRE 2020
EQUIPES FORMÉES AU 5S EQUIPAS FORMADAS AO 5S	19	+ 4 Équipes / Equipas
Dont GO DAS QUAIS, GO	19	+ 3
Dont VRD DAS QUAIS, VRD	0	+ 1
GITTERBOXES COMPARTIMENTÉES CAIXAS-PALETE COMPARTIMENTADAS	≃ 10	+ 4 Gitterboxes Caixas-palete
CONTAINERS CHEF D'EQUIPE 5S CONTENTOR CHEFE DE EQUIPA 5S	1	+ 1 Container Contentor

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GAZETTE DU 5S

QUELQUES PHOTOS SOUVENIRS
ALGUMAS FOTOS A LEMBRAR





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GAZETTE DU 5S

QUELQUES PHOTOS SOUVENIRS
ALGUMAS FOTOS A LEMBRAR







Appendix H: Survey, question and answers

Totally Agree (=4), Agree (=3), Disagree (=2) or Totally Disagree (=1)

Data		Since its implementation of 5S,						Since its establisment, has 5S enabled you to:						Have you noticed improvements in the management of :				
Working Site	Category	Your working conditions have improved	You feel more involved in the company	You work in a more secure environment	You work in a cleaner environment	You work in more organized environment	5S storage allow you to save time	Reduce the risk of accidents	Improve the productivity of the site	Reduce the loss of equipment	Organize better your stockage	Improve the image of the site	Improve the implication of employees	Stockage areas	Work areas	Sorting areas	Circulation axis	Mean
Luxite	Foreman of the works							3	3	4	4	4	4	4	3	3	3	3,5
Noah	Foreman of the works							3	3	3	3	3	3	3	3	3		3,0
Noah	Foreman of the works							4	3	3	3	4	3	4	3	3	3	3,3
Stugalux	Foreman of the works							4	3	3	3	4	3	4	4	4	4	3,6
Melia	Site Foreman							4	3	3	4	4	3	4	3	3	3	3,4
Mathendahl	Project Responsible							3	3	4	3	4	3	3	4	3	4	3,4
Bascharage	Team Leader	3	3	4	4	3	3							3	3	3	3	3,2
Bam Olm	Team Leader	4	3	2	1	2	4							4	4	3	4	3,1
Luxite	Worker	3	3	3	3	3	3							3	3	3	3	3,0
Luxite	Worker		4	4	3	1	4							3	3	4	3	3,2
Luxite	Worker		3	3		3									3	3		3,0
Luxite	Worker	3	3	3	3	3	3							1	3	2,5	4	2,9
Luxite	Worker	3	3	3	3	3	3							4	4	4	4	3,4
Luxite	Worker	3		3	3	3	1							3	3	3	3	2,8
Noah	Worker	3	3	4	4	3	3							3	3	3	3	3,2
Noah	Worker	2	2	3	3	3	2							3	3	3	4	2,8
Noah	Worker	3	3	3	3	3	3							3	2	3	4	3,0
Noah	Worker	3	4	3	3	4	3							3	3	3	3	3,2
Noah	Worker	3	4	4	4	4	3							3	3	3	3	3,4
Noah	Worker	3	3	3	3	3	3							3	3	3	3	3,0
Noah	Worker	3	3	3	3	4	3							3	3	3	3	3,1
Noah	Worker	4	3	4	4	4	4							4	4	4	4	3,9
Noah	Worker	3	3	4	3	3	3							3	3	3	3	3,1
Noah	Worker	3	3	4	4	4	4							4	4	4	3	3,7
Stugalux / Mathendahl	Worker	3	3	4	4	4	3							4	4	3	3	3,5
Stugalux / Mathendahl	Worker	4	3	3	3	3	3							3	4	3	3	3,2
Stugalux / Mathendahl	Worker	2,5	3	3	3	3	3							3	3	3	3	3,0
Mathendahl	Worker	3	3	3	2,5	3	3							2	3	2	3	2,8
Stugalux	Team Leader	3	3	4	4	4	4							4	3	3	4	3,6
Mean		**3,07**	**3,09**	**3,35**	**3,20**	**3,17**	**3,09**	**3,50**	**3,00**	**3,33**	**3,33**	**3,83**	**3,17**	**3,25**	**3,24**	**3,12**	**3,33**	**3,21**
Standard Deviation		0,3	0,2	0,5	0,5	0,5	0,4	0,5	0,0	0,4	0,4	0,3	0,3	0,5	0,4	0,3	0,4	0,2
Coefficient of variation		0,09	0,08	0,15	0,16	0,16	0,13	0,14	0,00	0,13	0,13	0,07	0,09	0,16	0,13	0,10	0,13	0,07