LEAN MANAGEMENT

IMPLEMENTATION OF THE 5S METHODOLOGY

A case-study applied to the Luxembourghish construction company CDCL

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A Work Project presented as part of the requirements for the Award of a Master’s degree in International Management from the Nova School of Business and Economics.

May 21, 2020
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

This work used infrastructure and resources funded by Fundação para a Ciência e a Tecnologia (UID/ECO/00124/2013, UID/ECO/00124/2019 and Social Sciences DataLab, Project 22209), POR Lisboa (LISBOA-01-0145-FEDER-007722 and Social Sciences DataLab, Project 22209) and POR Norte (Social Sciences DataLab, Project 22209).
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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 competitiveness 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.

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:

- **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

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 first 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 Genbutsu*, 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 favors 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’: Seiri/Sort, Seiton/Set in order, Seiso/Shine, Seiketsu/Standardize, Shitsuke/Sustain.

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. Parallely, 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

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

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](image)

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:

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

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:
<table>
<thead>
<tr>
<th>Project</th>
<th>Description</th>
<th>Benefits Sought</th>
<th>S</th>
<th>Photos</th>
<th>State</th>
<th>My role</th>
<th>Table 2: 5S projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Team Leader Container</td>
<td>Creation of compartments, designed to store each material used by team leaders.</td>
<td>1) <strong>Storage Optimization</strong> <em>(Reduction in time to search for equipment + Reduction of injury)</em> 2) <strong>Standardization</strong></td>
<td>2S</td>
<td>3S</td>
<td>4S</td>
<td>2 prototypes realized. The others are under production in the warehouse. Drawing of the final map through the feedback of the team leaders.</td>
<td></td>
</tr>
<tr>
<td>Dynamic plan</td>
<td>Plan print on an erasable board</td>
<td>1) <strong>Improvement of organization</strong>: Stockage areas, and circulations are marked and can change according to the site phase</td>
<td>1S</td>
<td>2S</td>
<td></td>
<td>Present in every site where the 5S is implemented. I use the plan during each visit in every site, writing missions and drawing zones.</td>
<td></td>
</tr>
<tr>
<td>Closed Plan Hut</td>
<td>Team leaders currently read their plans in an open hut; the project is to invest in closed ones.</td>
<td>1) <strong>Quality improvement through a better plan storage</strong></td>
<td>2S</td>
<td></td>
<td></td>
<td>Reception of 20 huts in February, Distribution in the coming weeks.</td>
<td></td>
</tr>
<tr>
<td>Lattice boxes</td>
<td>Used to store materials frequently used. Project: Compartmentalization of the boxes by team leaders.</td>
<td>1) <strong>Storage optimization</strong> <em>(time saving in the research of material + reduction of injuries)</em> 2S</td>
<td></td>
<td></td>
<td></td>
<td>Presence of compartmentalized lattices boxes in every 5S construction sites. I incite team leaders to create new ones when needed.</td>
<td></td>
</tr>
<tr>
<td>Wood cutting table</td>
<td>Investment in tables more adapted to workers: smaller and with a gauge system.</td>
<td>1) <strong>Improvement of security</strong> 2) <strong>Improvement of productivity</strong></td>
<td>2S</td>
<td>3S</td>
<td></td>
<td>Three prototypes realized by team leaders.</td>
<td>/</td>
</tr>
<tr>
<td>Plans Hut for bricklayer</td>
<td>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.</td>
<td>1) <strong>Storage optimization</strong> 2) <strong>Quality improvement</strong></td>
<td>2S</td>
<td></td>
<td></td>
<td>One realized by a team leader. I accompanied the team leader in the implementation of his idea.</td>
<td>/</td>
</tr>
<tr>
<td>Lattice boxes on chassis</td>
<td>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.</td>
<td>1) <strong>Productivity improvement</strong></td>
<td>2S</td>
<td></td>
<td></td>
<td>Prototypes realized in two construction sites. I verify the benefits of the prototypes used on sites.</td>
<td>/</td>
</tr>
</tbody>
</table>
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 (5th) 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 delimited, and posters identified the stock.

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

CIRCULATION: Circulation is identified and safe.

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

**Since its implementation, 5S enabled you to:**

(1= Totally Disagree; 2= Disagree; 3= Agree; 4= Totally agree)

![Radar Chart](image)

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.

**Have you noticed improvements in:**

(1= Totally Disagree; 2= Disagree; 3= Agree; 4= Totally agree)

![Bar Chart](image)
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, one 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](image)

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 parallely 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.
BIBLIOGRAPHY


APPENDIXES

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Appendix A: Lean tool box

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

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

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Type</th>
<th>N° of Teams</th>
<th>Photos</th>
<th>Frequency of visits</th>
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<tr>
<td>Hotel Melia</td>
<td>Hotel</td>
<td>Structural Work in finishing state,</td>
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<td>Stugalux Differdange</td>
<td>Residence</td>
<td>Structural Work</td>
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<tr>
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<td>Structural Work</td>
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<tr>
<td>Mathendahl</td>
<td>School</td>
<td>Structural Work</td>
<td>3</td>
<td></td>
<td>Once per week</td>
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<tr>
<td>Luxite 2</td>
<td>Parking and office desks</td>
<td>Structural Work</td>
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<td></td>
<td>Once every two weeks</td>
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<tr>
<td>Port de Mertert</td>
<td>Port</td>
<td>Roads and Networks</td>
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<td></td>
<td>Once every two weeks</td>
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</table>
Appendix D: Frequency of visits for each construction site

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<tr>
<th>Week Number</th>
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<th>Noah</th>
<th>Luxite</th>
<th>Stugalux</th>
<th>Mathendahl</th>
<th>Port de Mertert</th>
<th>N° of visits</th>
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<td>3</td>
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</tbody>
</table>

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

Cumulative number of audits per week in construction sites from January to May

COVID-19: Temporary shut down of CDCI activities due to the country confinement
COVID-19: Resumption of 55 visits through video

Cumulative number of audits per week

Week Number

Cumulative number of audits per week
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
Un rangement est en cours dans la zone par Roberto.

- 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°1 – Zone de travail

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

Zone de stockage n°3

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.
Les zones quittées par l’équipe de Diris sont propres et rangées.

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

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.

L’équipe a réalisé immédiatement.

Étapes:
1. Bois non placé directement dans la benne
2. Bois placé directement dans une benne à proximité
3. Étape 1
4. Étape 2
5. Étape 3
6. Étape 4
7. Étape 5
L'équipe de Denis a travaillé sur la cabane d'outils ouverte du sous-sol afin d'adapter aux besoins de la maisonnette:
- Ajout 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

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

Exemple de rangement scie

Idée d'innovation vue au chantier:
Ajouter une plaque métallique afin d'y ranger les aliments.

Un travail sur les zones extérieures est prévu lors des prochaines réunions afin d'améliorer l'image du chantier.
Appendix G : Gazette de l’innovation – 1st Edition

GAZETTE DU SS

ANNEE 2020 // NUMERO 1

NOUVEAU : SORTIE D’UNE GAZETTE SUR LES INNOVATIONS ET AVANCEES SS

ESTRIE : PUBLICACION DE UNA GAZETA SOBRE AS NOVIDADES E DESENVOLVIMENTOS DO SS

5S

PLACEMENT

Gazette de l’innovation

LES REALISATIONS 2020 / REALIZAÇÕES DE 2020

- Gitterboxes compartimentées
- Plaque métallique sur gitterboxes compartimentées
- Gitterboxes sur châssis avec système de pince
- Cabanes à plans maçonnier
- Cabanes à plans formulées
- Compartmentage container chef d’équipe 5S

LES REALISATIONS 2019 / REALIZAÇÕES DE 2019

- Tablet à découpe bois
- Tri des déchets sur zone de travail
- Container principal
- Rangements Scie

Tablet à découpe bois
- Mesas de corte de madeira
- Separação de resíduos na área de trabalho
- Container principal
- Armação das serras

Gitterboxes compartimentées / Caixa-palete compartimentadas

Félicitations aux équipes d’Aragon, Guia 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
- Moindre accessibilité / Réduction de la prévalence

Parabès aux équipes d’Aragon, Guia et de Machado, pour leur participation au groupe de propriétaires de caixas-palete compartimentadas.

Bénéficios :
- Ganhar tempo na pesquisa de material
- Reduzir o risco de lesões nas mãos
- Menos acesso / Reduzir o perigo

Plaque métallique sur gitterboxes compartimentées

Félicitations à l’équipe d’Aragon, sur le chantier Neuh.

Atouts :
- Moins de stockage -> maintien de la qualité, meilleure longévité des éléments
- Moindre accessibilité -> gain de temps

Parabès à equipe de Agustinho no estaiado Neuh.

Bénéficios :
- Menos armazenamento -> manutenção de qualidade, melhor longevidade dos itens
- Melhor acessibilidade -> economia de tempo

Gitterboxes sur châssis | Système sans soudure | Test en cours

Caixas-palete sobre chassi | Sistema sem soldagem | Em teste

Gitterboxes sur châssis sont en test sur chantiers.

Parabès aux Marco Paula, du dépôt, qui a créé un système de pièce avec du matériel récupéré.

2 gitterboxes sur châssis sont em testes nos estaiados.

Avantages :
- Gain de temps Grue -> Le châssis permet de déplacer la gitterbox manuellement
- Le système de pièce permet l’échangeabilité des gitterboxes

Parabès ao Marco Paula, do depósito, que criou um sistema de gramos com material reciclado.

2 caixas-palete sobre chassis são em testes nos estaiados.

Avantages :
- Economia de tempo com a guindaste -> O chassi permite manejo de caixa-palete manualmente
- O sistema de gramos permite troca entre as caixas-palete.
Cabane à plans maçonnées / Cabines para planos em alvenaria

Félicitations à l’équipe de Disto, sur le chantier Mathendahl.

Tâches effectuées :
1. Ajout de rangements afin de ranger le matériel utilisé quotidiennement par l’équipe.
2. Ajout de rayons pour que la cabane puisse se déplacer facilement.
3. Réduction de la profondeur afin qu’elle puisse passer les portes.
4. Ajout d’une lampe.

Félicitations à l’équipe Disto sur le chantier Mathendahl.

Travaux réalisés :
1. Agencement de 36 espaces de rangement pour abriter les équipements utilisés habituellement par l’équipe.
2. Ajout de 36 rayons pour que la cabine puisse se déplacer facilement.
3. Réduction de la profondeur pour les portes et les portes.
4. Ajout de 36 lampes.

Cabanes à plans fermés / Cabines para planos fechados

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

Aristcrat:
- Protection des plans lors d’intempéries
- Prévention de l’humidité
- Réduction du bruit, meilleure concentration
- Lieu de stockage des machines MILIT pendant la journée

Résultats:
- Protection des plans à l’étouffée de temps
- Présence de la lumière
- Réduction de la réduite, meilleur concentration
- Lieu de rangement des machines MILIT pendant la journée

Remerciements au dépli et à toutes les personnes ayant contribué à l’abouchissement de ce deuxième containerChef d’équipe.

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

Agrémentement au dépli et à toutes les personnes qui contribueront à cette deuxième container dédiée aux chefs d’équipe.

Ces containers seraient compartimentées dans les saranas à venir et seront distribuées prioritairement aux CE avec containers galvanisées en gris ou bleu.

Merçi à tous ceux qui étaient présents

Obrigado a todos que estiverem presentes
Tables de découpe / Mesas de Corte

Toute innovation est bonne vivre afin de collaborer ensemble à la création d’une table de découpe adaptée aux équipes. N’hésitez pas à nous contacter afin qu’un deux accompagnes dans cette démarche, à l’adresse suivante : info@cooelec.com.

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

Travail effectué :
- Création d’un système de guidage
- Réduction de la hauteur des tables
- Agrementissement de la table

Avantages : Tables de découpe plus adaptées aux équipes.

Quelques innovations à bien-vivre pour collaborer sur la création d’une table de découpe adaptée aux équipes.

N’hésitez pas à nous contacter afin qu’un deux accompagnes dans cette démarche, à l’adresse suivante : info@cooelec.com.

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

Travail effectué :
- Création d’un système de guidage
- Réduction de la hauteur des tables
- Agrementissement de la table

Avantages : Tables de découpe plus adaptées aux équipes.

Container Principal / Contenedor Principal

L’équipe SS se tient à votre disposition pour vous aider à compartimenter votre conteneur principal. N’hésitez pas à nous contacter afin qu’un vous accompagne dans cette démarche, à l’adresse suivante : info@cooelec.com.

A équipe SS está a sua disposição para ajudá-lo a compartimentar o seu container principal. N’hésitez pas à nous contacter afin qu’un vous accompagne dans cette démarche, à l’adresse suivante : info@cooelec.com.

Rangements Scie / Arrumação das Serras

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

Félicitations à toutes les équipes !

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

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

Parabéns a todas as equipas !

Beneficios :
- Proteção contra à chuva
- Maior durabilidade dos serras
- Acesso fácil e rápido às serras. Mais próximas da mesa de corte e de fácil utilização.

Tri des déchets sur zones de travail

Separação de resíduos na área de trabalho

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

Parabéns às equipas que criaram latas de lixo para facilitar a separação de resíduos nas áreas de trabalho.
REALISATIONS / REALIZAÇÕES

<table>
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<tr>
<th>ANÉE / ANO 2019</th>
<th>1er TRIMESTRE 2020</th>
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<tr>
<td><strong>ÉQUIPES FORMÉES</strong></td>
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<td>+4 Équipes / Equipas</td>
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<td><strong>Domm GO</strong></td>
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<td><strong>Domm VRD</strong></td>
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<td><strong>GITTEBOXES COMPARTIMENTÉES</strong></td>
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<td><strong>CAIXAS-PALETE COMPARTIMENTADAS</strong></td>
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Appendix H: Survey, question and answers

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

| 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 more organized environment | SS 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 | Have you noticed improvements in the management of: |
|--------------|----------|--------------------------------------|---------------------------------------|----------------------------------------|----------------------------------------|--------------------------------|-----------------------------|---------------------------|-----------------------------|-----------------------------|--------------------------------|---------------------------------|
| Luxite       | Foreman of the works | 3 | 4 | 4 | 4 | 4 | 3 | 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 | 4 | 3 | 3 | 4 | 3 | 3 | 3 | 3 | 3.3 |
| Stugalux     | Foreman of the works | 4 | 3 | 3 | 3 | 4 | 3 | 4 | 4 | 4 | 3.6 |
| Mella        | Site Foreman | 4 | 3 | 3 | 4 | 4 | 3 | 4 | 3 | 3 | 3.4 |
| Mathendahl   | Project Responsible | 3 | 4 | 3 | 4 | 3 | 4 | 3 | 3 | 3 | 3.4 |
| Bascharage   | Team Leader | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3.2 |
| Bam Cim      | Team Leader | 4 | 3 | 2 | 1 | 2 | 4 | 3 | 3 | 3 | 3.1 |
| Luxite       | Worker | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3.0 |
| Luxite       | Worker | 4 | 4 | 3 | 1 | 4 | 3 | 3 | 3 | 3 | 3.2 |
| Luxite       | Worker | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3.2 |
| Noah         | Worker | 4 | 3 | 4 | 4 | 3 | 3 | 3.0 |
| Noah         | Worker | 2 | 2 | 3 | 3 | 3 | 2 | 2.8 |
| Noah         | Worker | 3 | 3 | 3 | 3 | 3 | 3 | 3.3 |
| Noah         | Worker | 3 | 4 | 3 | 3 | 4 | 3 | 3 | 3 | 3.2 |
| Noah         | Worker | 3 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 3.0 |
| Noah         | Worker | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3.1 |
| Noah         | Worker | 4 | 3 | 4 | 4 | 4 | 3 | 4 | 4 | 4 | 3.9 |
| Noah         | Worker | 3 | 3 | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3.1 |
| Noah         | Worker | 3 | 4 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 3.5 |
| Stugalux / Mathendahl | Worker | 3 | 3 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 3.5 |
| Stugalux / Mathendahl | Worker | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3.2 |
| Stugalux / Mathendahl | Worker | 4 | 4 | 3 | 3 | 4 | 3 | 3 | 3 | 3 | 3.0 |
| Mathendahl   | Site Foreman | 3 | 3 | 3 | 2.5 | 3 | 3 | 3 | 3 | 3 | 2.8 |
| Stugalux     | Site Foreman | 3 | 3 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 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: 0.2, 0.2, 0.5, 0.5, 0.5, 0.5, 0.5, 0.5, 0.4, 0.4, 0.3, 0.3, 0.3, 0.4, 0.4, 0.2

Coefficient of variation: 0.09, 0.08, 0.15, 0.16, 0.16, 0.15, 0.14, 0.00, 0.13, 0.13, 0.07, 0.09, 0.16, 0.13, 0.19, 0.33, 0.07