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DEVELOPMENT OF E-LEARNING MODULES ON THE WCM METHODS

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“ What would you do if you weren't afraid? ”

Sheryl Sandberg

RESUMO

No contexto atual de globalização, o conhecimento e as habilidades desenvolvidas por empregados representam um valor agregado substancial para as empresas, e se tornaram um elemento essencial para manter a competitividade e a eficiência. Portanto, a formação tornou-se um verdadeiro desafio e um eixo de desenvolvimento para as empresas.

No âmbito do programa global de melhoria continua, World Class Manufacturing (WCM), a empresa objeto deste estudo, uma multinacional francesa no setor de materiais de construção, presta especial atenção ao eixo "Desenvolvimento de Pessoas". De fato, foi estabelecida uma política de treinamento de seus funcionários não apenas quando eles chegam à empresa, mas ao longo de toda a carreira dentro do grupo.

Assim, a equipe central WCM, baseada na Direção Técnica Internacional (DTI), é responsável pela padronização, coordenação e assistência às vinte e cinco plantas da empresa em todo o mundo. Este estudo é baseado no trabalho da aluna como estagiário na equipe central de Métodos e E-learning, na área de Paris. O trabalho possui três objetivos específicos: analisar e melhorar os métodos e padrões WCM atualmente em vigor, desenvolver módulos de e-learning para treinar funcionários nos Métodos WCM e propor um plano de ação baseado na experiência de criar tais módulos.

Para alcançar esses objetivos, foi imperativo começar com uma revisão de literatura seguida de um método para desenvolver os módulos de e-learning que compreende: análise dos padrões atuais, sugestão de melhorias para esses padrões, validação com os Engenheiros Métodos e, finalmente, desenvolvimento e validação de módulos, sendo este último passo um processo iterativo. Dada a natureza do trabalho, baseada em validações, e suas limitações, a autora também propôs uma abordagem metódica para a etapa de design que os futuros estagiários devem seguir.

A subsequente tradução e difusão dos módulos para todas as plantas do mundo significou não apenas que funcionários em diferentes níveis hierárquicos podem ser treinados para utilizar adequadamente as ferramentas WCM e obter suas certificações, como também fazem parte da cultura de Melhoria Contínua infundida na empresa.

Palavras-chave: E-learning. WCM. Métodos. Melhoria Contínua.

ABSTRACT

In the current context of globalization, the knowledge and skills developed by employees represent a substantial added value for companies and have become an essential element to maintain competitiveness and efficiency. Therefore, training has become a real challenge and an axis of development for companies.

Within the framework of the global program of continuous improvement World Class Manufacturing (WCM), the subject company in this study, a French multinational in the sector of building materials, pays particular attention to the axis "People Development". In evidence, it was stablished a policy of training its employees not only at their arrival in the company, but throughout one's entire career within the group.

Hence, the WCM central team based in the International Technical Direction (DTI), is in charge of the standardization, coordination and assistance to the twenty-five plants of the company across the world. This study is based on the student's work as intern in both the Methods and E-learning central team, in the Paris area. It has three specific goals: analyze and improve the WCM methods and standards currently put in place, develop e-learning modules to train employees in the WCM Methods and propose an action plan based on the subject's experience to create said modules.

To achieve these objectives, it was imperative to start with a literature review followed by a method to develop the e-learning modules that comprises: analysis of the current standards, suggestion of improvements to these standards, validation with the Methods Engineers, and finally, design and validation of modules, this last step being an iterative process. Given the validation-based nature of the work and its limitations, the author also proposed a methodic approach for the design step that future developers should abide by.

The subsequent translation and diffusion of the modules to all plants in the world meant not only that employees in different hierarchical levels can be trained to properly make use of WCM tools and obtain its certifications, they are also part of the Continuous Improvement culture infused in the company.

Keywords: E-learning. WCM. Methods. Continuous Improvement.

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1 INTRODUCTION

1.1 Context

In the current context of globalization, the knowledge and skills developed by employees represent a substantial added value for companies and have become an essential element to maintain competitiveness and efficiency. Therefore, training has become a real challenge and an axis of development for companies. According to Peter Drucker in the book Post-Capitalist Society, "The productivity of knowledge is going to be the determining factor in the competitive position of a company, an industry, or an entire country. No country, industry, or company has any 'natural' advantage or disadvantage. The only advantage it can possess is the ability to exploit universally available knowledge. The only thing that increasingly will matter in national and in international economics is management's performance in making knowledge productive." (Drucker, Post-Capitalist Society, 1993, p. 193).

Companies, no matter the sector or industry they act, face the challenge of constantly evolving knowledge and processes. They must provide their employees with effective and adapted training because knowledge is becoming increasingly important in companies' competitiveness strategy. No society can think today of developing itself without having a development axis related to its knowledge, that is, the development of its employees' capacities.

According to article L900-1 of the French Labor Code, "Vocational training throughout life is a national obligation. It includes initial training and further training [...]. These further courses constitute continuous vocational training. The purpose of continuous vocational training is to promote the integration or reintegration of workers into the labor market, to enable them to remain in employment, to promote the development of their skills and access to the various levels of professional qualifications, to contribute to economic and cultural development and their social advancement." (Ministère de l'Intérieur, Code du travail, 2018).

Employee training is an obligation for companies in most countries. But more than its legal character, training is essential to adapt the skills of employees to companies' constantly-evolving needs. From the workers' point of view, training allows them to acquire the necessary skills to thrive in their position and progress.

Training must be seen as a legitimate investment for companies that allows them to gain competitive advantage. It aims to make employees perform better in their work, to allow them to acquire new skills and become more autonomous in their tasks. It makes possible to develop employees' knowledge, and thus to increase efficiency and production. Companies are becoming more and more aware of the value that knowledge possesses.

It is usual for companies, no matter their size, to integrate training into their continuous improvement policy, if there is one already in place. If not, it is common to develop one alongside the other, for the former cannot be dissociated from the latter.

According to Deming (1982), continuous improvement is defined as the ongoing effort to improve products, services, or processes. These efforts can seek incremental improvement over time or breakthrough improvement all at once. It is based on the belief that these incremental changes will add up to major improvements over time, and it is as much about tactics (i.e. specific improvements) as it is about changing the culture of the organization to focus on opportunities for improvement rather than problems (Deming, Quality, productivity, and competitive position, 1982). If an organization is large enough, continuous improvement can become a function itself with an overarching mission to optimize a variety of management systems. For example, business process management, quality management, project management, and program management can all be found under the influence of a continuous improvement team and its instructions. Therefore, it is only natural to associate training to the continuous programs within companies.

With the rise of new technologies, new ways to achieve training have emerged. E-learning is becoming increasingly important in business training programs. In 2012, 84% of companies with more than 500 employees integrated e-learning training modules into their staff training course (survey of companies in France, Belgium, Canada, Switzerland, Luxembourg, Morocco and Tunisia) [A]. However, the effectiveness and usefulness of e-learning programs in companies depends on the commitment and involvement of employees. For the training strategy to be effective, the learner must feel like the e-learning modules make a real difference in their craft.

It is in this complex and everchanging context that the company in this study, a French multinational in the sector of building materials, places itself. The author did her final-studies, six-months internship, within the Continuous Improvement service. Due to confidentiality

[A] Available at: http://sydologie.com/2014/12/e-learning-comment-impliquer-lapprenant-meme-distance-2/. Last visited June 11, 2018.

reasons this study will adopt the fictitious company name of OneWorld.

Faced with the less-than-acceptable turnover rates in one of its Mexican plants, OneWorld decided to launch an e-learning training program in 2001. The objective was to reduce the time spent training operators before they were considered autonomous in a production line, which varied from three months to a year, depending on the position. Before the program's implementation operators were trained through mentoring: they were assigned an experienced colleague and were expected to observe and copy their mentor's actions. There was no structured method, and this not only left plenty of room for variables to interfere with the knowledge transfer, it also did not guarantee uniformity nor cohesion.

With the program's success in the pilot plant – formation time of a new operator was reduced in more than 50% – OneWorld extended it in 2003 to the ensemble of its production sites around the world. Originally intended for operators, today the program forms more than 3000 people a year in different positions within the company.

Despite its size and position as a leader in the market, it wasn't until 2007 that OneWorld designed a service to officially manage a continuous improvement program. It called upon an external consulting company to help establish the chosen program: World Class Manufacturing, or simply, WCM.

The purpose of WCM is to reach both customer satisfaction and operational excellence. The latter is mainly linked to manufacturing cost reduction. If the role of training, or people development, as it is called in WCM, and its integration within said program will be further discussed in this study, a piece of information is factual: e-learning reduces costs of training and therefore contributes to achieving both goals of WCM.

To OneWorld, the knowledge and the skills developed by employees represent an essential element in maintaining its competitiveness and productivity around the globe. Training thus became a real stake and an axis to be developed. The company should therefore, ensure that their employees receive successful and adapted training. In that purpose, diffusion of best practices from plants that have excellent results was chosen as the optimal way of setting up knowledge transfer.

1.2 Problems

OneWorld requires that all its 25 plants around the world follow the same standards created in its French headquarters. It is the job of the WCM Central Methods team to create, apply and ensure follow-up in the use of said standards. This certifies that the materials produced are consistent and possess the quality that is expected from their world-renowned products.

It is a known fact that, across all plants, there are problems that arise during production that have already been faced before and therefore could have been avoided. These problems can lead to various consequences: loss of production, loss of time, loss of energy. These negative effects that could have been averted, had the operators capitalized on the knowledge from the previous experience, is what the WCM Methods team chose to attack.

Even though WCM maintains these standards that production sites should abide by, it is not common to possess training material in how to use them. Usually when a new standard is created, the Central Methods team publishes it in the company's intranet and little to no "how-to" document or explanation goes along with it. Normally, it is during the team's visits to plants that the standard is explained to management and possible questions are answered. This, of course, is not optimal for several reasons; not only is the logistics extremely inefficient and costly, the biggest problem is the following: the knowledge on how to use and deploy these standards, considered so vital for the smooth running of production, is restricted to management and does not flow down to the actual end-user, the operators.

Indeed, even though WCM standards are created, few to no operators know how to use them. And despite the fact that the Central Methods provides week-long in-plant based training, these are not often and usually scheduled only before an audit. The Central team expects the managers to pass the knowledge down to the line chiefs, whom in their turn, would ideally pass it on to shift managers and so on, until it reaches operators. Unfortunately, it has been noted that top management in production sites, under extreme pressure to respond to production demands, do not set WCM standards training as one of their top priorities. Therefore, it is clear that with the arrival of new operators, and the lack of training material in these standards, knowledge is inevitably lost over time.

1.3 Objective of the study

Taking into account the previously described problems the organization faces and its context, this study has as a general goal:

- Analyze, design and develop e-learning material to train around 3000 of OneWorld' production plants employees per year into the WCM Methods.

This objective ultimately ensures operational excellence and customer satisfaction. In order to better structure the work, this general objective can be dissected into three specific goals:

1. Analyze and improve specific WCM methods and standards currently in place;
2. Develop e-learning modules to train all 25 production plant operators in said WCM Methods;
3. Propose an action plan based on the subject's experience to create the modules.

To achieve these objectives, it was imperative to start with a literature review, followed by a method to develop the e-learning modules which comprises: analysis of the current standards, suggestion of improvements to these standards, validation with the Central Methods Engineers, and finally, design and validation of modules, this last step being an iterative process. Given the validation-base nature of the work and its consequent limitations, the author also proposed a methodic approach for the design step that future developers should abide by.

1.4 Justification

The subject of this study was defined in the beginning of 2017, after the WCM Methods team of engineers called upon the E-learning team to create modules allowing to train in the WCM methods. The author was then, recruited by OneWorld as a Continuous Improvement Intern, member of the E-learning team, and appointed responsible for this project. Her role was to, not only develop the actual e-learning modules, but also select the subjects, define the content, propose improvements, and act as a bridge between all parties involved. Other actors involved

in the project were technical experts, WCM Methods local plant's engineers and the pedagogical expert, the author's tutor and her responsible during the internship.

Indeed, the need to train not only operators but shift leaders, line chiefs, and even managers had been constantly expressed for a long time, but due to lack of resources and, more importantly, resistance from those in higher hierarchical positions in some plants, it had never been catered to. This resistance comes, as already stated, due to the low ranking of training in the management's list of priorities.

However, after OneWorld' CEO outlined a new strategy for the group where WCM would take a lead role and the program's results would be of his great interest, it was no longer acceptable to bear a large proportion of illiterate employees in the basics of the program.

That is the enormous irony this study will tackle: for a program that is built around reducing waste, there is a substantial amount of knowledge that is lost without the proper training material. What is more, the program, as it will be further explored, has "People Involvement" as one of its bases, which means WCM can only be successful if there is commitment and personal undertaking from all collaborators. But how is it possible to engage operators to apply the WCM standards if they lack the knowledge to do so?

It is known that the vast majority of problems that cause loss of production could have been detected sooner had the standards been decently followed. When the International Technical Direction decided that training material on the WCM Methods was needed, it was only natural that the first step would be to review and analyze the standards. This ensures that they are up-to-date with the most recent information regarding the plants' needs and that they are generic enough that they can be applied to all production sites.

Providing e-learning training material to all collaborators will allow for an optimal standardization and passing of knowledge. Once operators are trained, with the appropriate support, and completed a real-life experience application, it is undeniable that problems will be reduced and their consequences diminished. This will also lead to better performance indicators, production quality, and ultimately, customer satisfaction and operational excellence.

To conclude, the one of the conditions to a successful WCM program is employee involvement. That can only be achieved if the set of standards and rules they are expected to follow come with the provision of proper training.

1.5 Structure of the work

This study is divided into six chapters. The first one, concluded by this section, is a general introduction to the work, its context, the motivations behind this study and its objectives.

The second chapter is the literature review of the topics which are considered relevant for the body of work.

Chapter three describes the method used in the present study, defining its steps and associated activities to be followed.

A company introduction is made in chapter four, describing the nuance and specificities of its Continuous Improvement and E-learning programs.

Chapter number five consists of the development and results from the applied methodology for the development of the following e-learning modules: Toolbox, Quick Kaizen, 5S, Autonomous Management and 5Whys Kaizen. It also contains the author's proposal for improving the development work, based on her internship experience.

The last chapter is the conclusion of this study, with thoughts on its development and impact on the future.

2 LITERATURE REVIEW

This chapter is a literature review of the topics present in this study. It serves as a theoretical foundation for the work that shall be completed in order to achieve the goals listed in the previous chapter.

It is of utmost importance to present each point in a determined order, following the logical reasoning behind this endeavor. Firstly, continuous improvement will be introduced, seeing that every aspect of the work is within a continuous improvement demarche. Then, WCM will be described: its goals, axis of development and basis.

Since the first concrete goal is to analyze and propose improvements to the WCM Methods standards, this study will go through the theory behind all of them: Tags, Quick Kaizen, 5Whys Kaizen, 5S and Autonomous Management.

In order to develop e-learning modules based on these standards and tools, an understanding of e-learning is necessary, as well as its nuances and intricacies, which will also be thoroughly explained later in the chapter.

2.1 Continuous Improvement

Continuous improvement (CI) is a philosophy that Deming described simply as consisting of "Improvement initiatives that increase successes and reduce failures" (Juergensen, 2000). Another definition of CI is "a company-wide process of focused and continuous incremental innovation" (Bessant et al., 1994). Yet others view CI as "either as an offshoot of existing quality initiatives like total quality management (TQM) or as a completely new approach of enhancing creativity and achieving competitive excellence in today's market" (Oakland, 1999; Caffyn, 1999; Gallagher et al., 1997). According to Kossoff (1993), "total quality is defined as the unrelenting pursuit of CI which is realized by accessing and utilizing the concerted knowledge and experience of managers and employees at all levels", in other words, total quality can be achieved by CI through the involvement of people from all organizational levels.

CI, also known by the Japanese term of *kaizen* can be defined more generally as a culture of sustained improvement targeting the elimination of waste in all systems and processes of an organization. It involves everyone working together to make improvements without necessarily

making huge capital investments. As Baghel (2004) puts it, CI can occur through evolutionary improvement, in which case improvements are incremental, or though radical changes that take place as a result of an innovative idea or new technology. Often, major improvements take place over time as a result of numerous incremental improvements. On any scale, improvement is achieved through the use of a number of tools and techniques dedicated to searching for sources of problems, waste, and variation, and finding ways to minimize them.

2.1.1 History

As Bhuiyan & Baghel (2005) put it, the roots of modern improvement programs can be traced back to initiatives undertaken in several companies in the 1800s, where management encouraged employee-driven improvements, and incentive programs were set in place to reward employees that brought about positive changes in the organization (Schroeder and Robinson, 1991). During the late 1800s and early 1900s, much attention was given to scientific management; this involved developing methods to help managers analyze and solve production problems using scientific methods based on tightly controlled time-trials to achieve proper piece rates and labor standards. The US government then set up the "Training Within Industry" service during the Second World War to enhance the industrial output on a national scale. This included job method training, a program designed to educate supervisors on the importance and techniques of CI methods. This program was later introduced in Japan by management experts like Deming, Juran, and Gilbreth, and by the US forces present there after the end of the Second World War (Robinson, 1990). Eventually, the Japanese developed their own ideas, and quality control, which was used initially in the manufacturing process, had evolved into a much broader term, growing into a management tool for ongoing improvement involving everyone in an organization (Imai, 1986).

While CI initiatives in the past reflected the use of various principles related to work improvement, modern day CI is associated with organized and comprehensive methodologies. These CI programs, in which typically the overall organization, or a large part of it, is involved in change, are also more popularly associated with the introduction of the TQM movement, which also gained leverage in Japan thanks to Edward Deming. In his book "Quality, productivity, and competitive position", Deming (1982) set the basis for several of still today used methods and standards in the industry.

2.2 WCM

In a context of intense competition, the industry is constantly chasing manufacturing costs' reduction and loss mitigation. With this objective, several concepts and techniques related to quality, productivity, engineering and waste reduction have been developed, mostly coming from the study of successful cases. One of these concepts is World Class Manufacturing, or WCM (Hayes; Wheelwright, 1984).

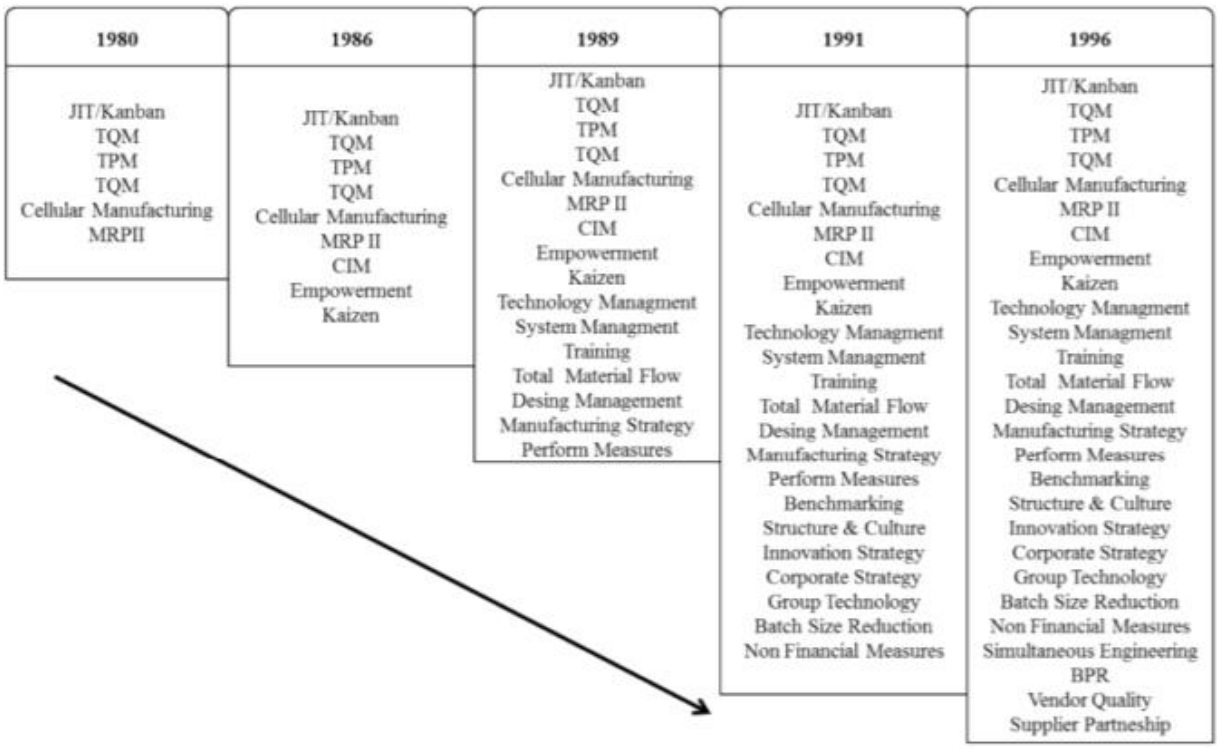
The term WCM was first used by Hayes and Wheelwright (1984), who introduced a set of principles, best practices and techniques - derived from their research conducted in Japanese and German companies - that would lead any enterprise to superior performance. According to the authors, WCM creates the "sense of direction" for a world-class manufacturer: to become a top-performing company, especially in operations management. WCM originates from techniques and production tools that aim to reduce waste, increase quality and production, and improve logistics flow, among other benefits. Many of these techniques originated in the Toyota Production System (TPS) (Hayes; Wheelwright, 1984; Schonberger, 1986; Digalwar; Sangwan, 2011; Muthukumar Et Al., 2014; Chiarini; Vagnoni, 2015).

According to Felice et al (2013), companies attempting to adopt WCM have developed a statement of corporate philosophy or mission to which operating objectives are closely tied. A general perception is that when an organization is considered world-class, it is also considered the best in the world. But recently, many organizations claim that they are world-class manufacturers. Indeed, World Class Manufacturing can be defined as a different production processes and organizational strategies which all have flexibility as their primary concern. For example, Womack et al. (1990) defined a lead for quantifying world class. Instead Oliver et al. (1994) observed that to qualify as world class, a plant had to demonstrate outstanding performance on both productivity and quality measures. Summing up, it can be stated that the term World-Class Manufacturing (WCM) means the pursuance of best practices in manufacturing. On the other hand, one of the most important definitions is due to Schonberger (1986), who coined the term "World Class Manufacturing" to cover the many techniques and technologies designed to enable a company to match its best competitors.

When Schonberger (1986) first introduced the concept of "World Class Manufacturing", the term embraced the techniques and factors listed in Figure 1. Its substantial growth is attributed to the growing influence of manufacturing philosophies and economic success of Japan from

the 1960s onwards. What is particularly interesting from reviewing the literature is that, while there is a degree of overlap in some of the techniques, clearly the term has evolved considerably.

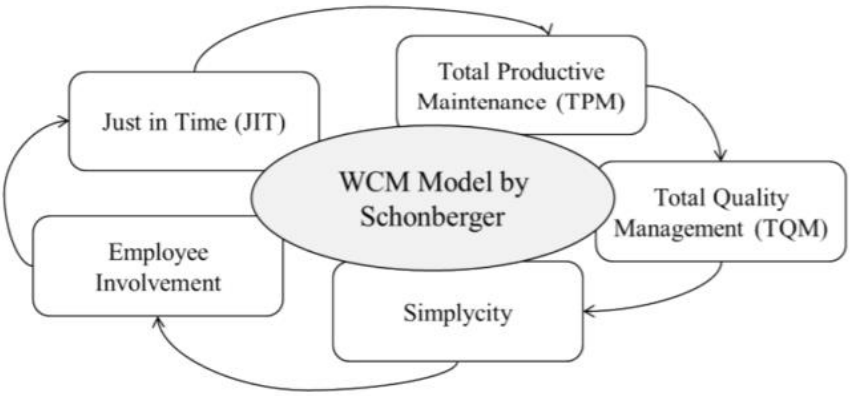
Figure 1 – The growth of techniques associated with the WCM concept



Source: Felice et al. (2013)

Although these techniques were already present, Schonberger (1986) obtained a perfectly integrated and flexible system, capable of achieving company competitiveness and high-quality products. His model is illustrated in the following figure.

Figure 2 – WCM model by Schonberger

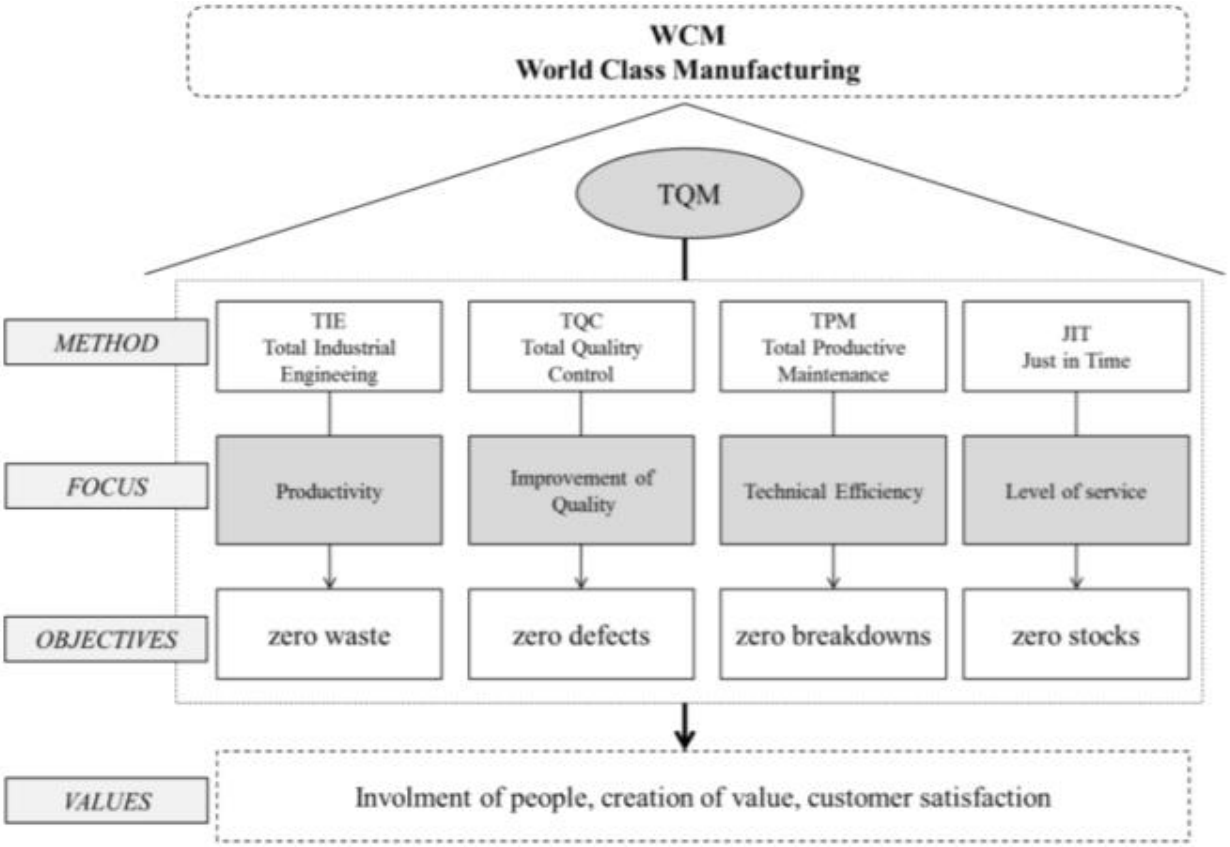


Source: Felice et al. (2013)

According to Fiat Group Automobiles (2005), World Class Manufacturing is: "a structured and integrated production system that encompasses all the processes of the plant, the security environment, from maintenance to logistics and quality. The goal is to continuously improve production performance, seeking a progressive elimination of waste, in order to ensure product quality and maximum flexibility in responding to customer requests, through the involvement and motivation of the people working in the establishment".

The WCM program was designed by Prof. Hajime Yamashina in 2005 for the Fiat Group Automobiles. He defines it as a model of deployment of resolution of losses and maintenance improvement tolls. According to him "WCM is a comprehensible system to improve productivity, reduce breakdowns and increase quality by implying all teams in the resources and times lost […]. The power of WCM comes from improving all teams' engagement. To be able to produce good products, we need to have good people and involve them in continuous improvement" (Yamashina, 2005). The program is shown in the figure below.

Figure 3 – World Class Manufacturing in Fiat Group Automobiles

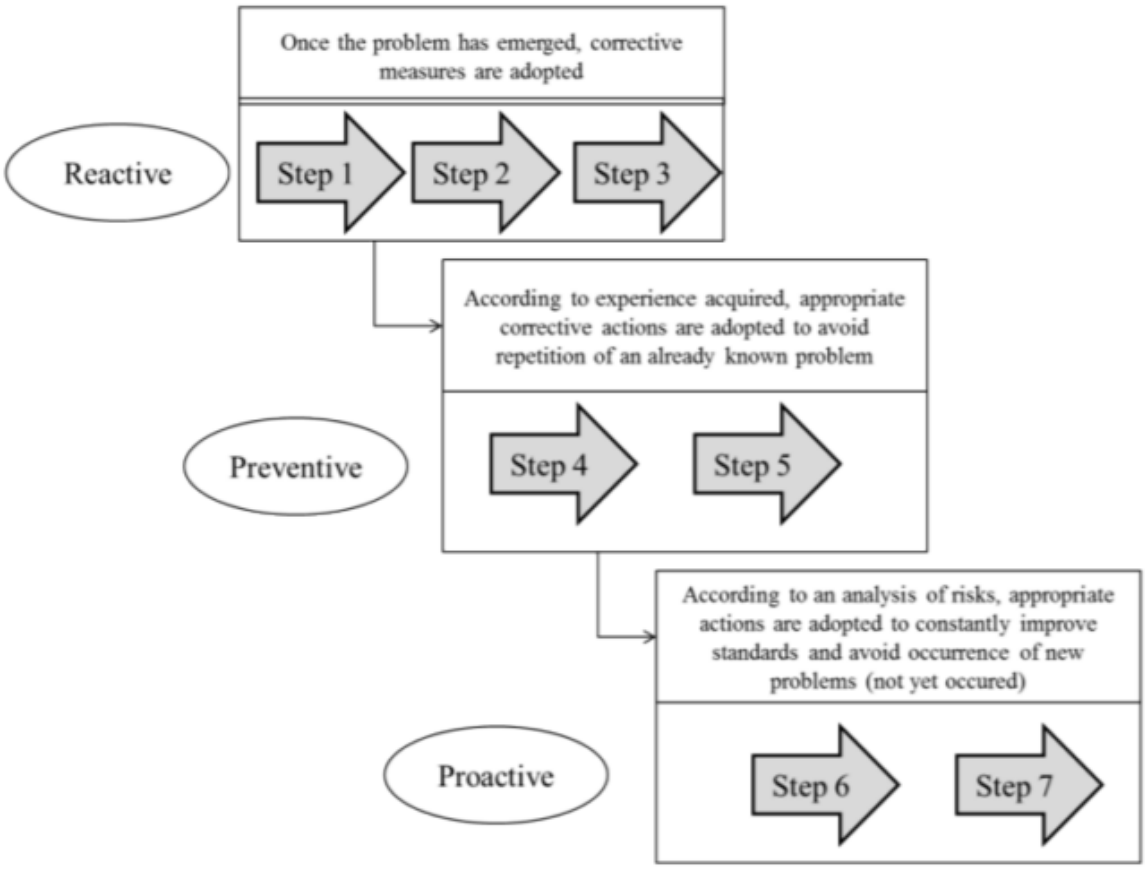


Source: Felice et al. (2013)

As seen in Open University of Hong Kong's Operations Management (2013), Fiat customized the WCM approach to their needs with Prof. Yamashina, redesigning and implementing the model through two lines of action: 10 technical pillars and 10 managerial pillars.

The definition proposed by Yamashina (2005) appoints a company that excels in applied research, production engineering, improvement capability and detailed shop floor knowledge; integrating these components into a combined system. In fact, according to Yamashina (2005), the most important element continues to be the ability to quickly change and adapt. WCM is developed in 7 steps for each pillar and these are identified in three phases: reactive, preventive and proactive. In Figure 4 an example of a typical correlation between steps and phases is shown, but this can change for each different technical pillar. In fact, each pillar can have a different relation to these phases. The WCM approach starts from a model area and then extends to the entire company. WCM is based on a system of audits that give scores that allows to get to the highest level, which is represented by the world class level (Open University of Hong Kong's Operations Management, 2013).

Figure 4 – World Class Manufacturing steps



Source: Felice et al. (2013)

2.2.1. Principles

Even though World Class Manufacturing is a program that was designed specifically for Fiat Group Automobiles, today there are many different variants to it, each one adapted to the needs of their user. However, the process to achieve WCM has a number of philosophies and elements that are common to all companies.

As Felice et al (2013) put it, customer needs and expectations are a very important element in WCM. The manufacturing strategy should be geared to support these needs. These could be dealing with certification, market share, company growth, profitability or other global targets. The outcomes should be defined so that they are measurable and have a definite timetable. These are also a means of defining employee responsibilities and making them feel involved. Another essential element in a World Class Manufacturing company is employee education and training. They must understand the company's vision and mission and consequential priorities.

World Class Manufacturing is based on a few fundamental principles (Felice et al, 2013):

- the involvement of people is the key to change;
- it is not just a project, but a new way of working,
- accident prevention is a non-derogated “value”;
- the customer's voice should reach all departments and offices;
- methods should be applied with consistency and rigor;
- all forms of waste are not tolerable;
- eliminate the cause and not treat the effect.

2.2.2. Pillars

WCM foresees ten technical pillars and ten managerial pillars. The levels of accomplishment in technical fields are indirectly affected by the level of accomplishment in administrative fields. The pillar structure represents the WCM Temple, and points out that, to achieve the standard of excellence, a parallel development of all pillars is necessary. Each pillar focuses on a specific area of the production system using appropriate tools to achieve global excellence (Open University of Hong Kong’s Operations Management, 2013). The technical pillars are described in the following table:

Table 1 – WCM Technical Pillars Description

Pillar	Meaning	Purpose
Safety	Safety improvement	To drastically reduce accidents and develop a culture of prevention. To improve ergonomics of the workplace.
Cost Deployment	Analysis of the losses and costs	To identify the main losses in the system. To address the resources and tasks with greatest potential.
Focused Improvement	Loss management	To reduce drastically the most important losses. To eliminate non-value-added activities.
Autonomous Activities	Continuous improvement of workplace	It is constituted by two pillars: Autonomous Maintenance (tackles efficiency through maintenance policies) and Workplace Organization (improvements in the workplace).
Professional Maintenance	Reduction of downtime	To increase efficiency and facilitate cooperation to reach zero breakdowns.
Quality Control	Quality improvement	To ensure quality products. To reduce non-compliance. To increase the skills of the employees.
Logistics & Customer Service	Optimization of stocks	To reduce significantly the levels of stocks. To minimize the material handling, even with direct deliveries from suppliers to the assembly line.
Product Management	Optimization of time and costs	To reduce the Life Cycle Cost (LCC). To design systems easily maintained and inspected.
People Development	Continuous improvement of the skills of employees	To ensure, through a structured system of training, correct skills and abilities for each workstation. To develop the roles of maintenance workers, technologists, specialists such as major staff training.
Environment Energy	Environmental management	To comply with the requirements and standards of environmental management. To develop an energy culture and to reduce the energy costs and losses.

Source: Adapted from Felice et al. (2013)

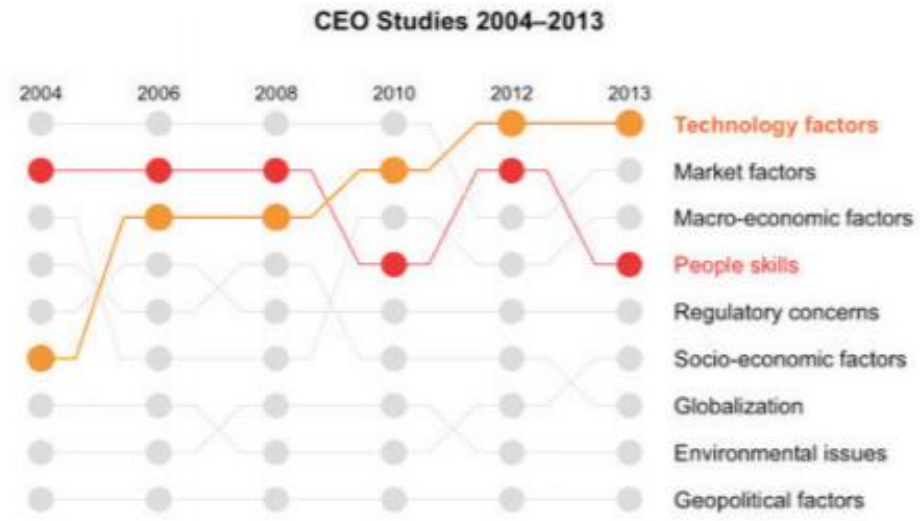
This study will not address the Managerial Pillars, they will only be listed, as following:

- Management Commitment;
- Clarity of Objectives;
- Route map to WCM;
- Allocation of Highly Qualified People to Model Areas;
- Organization Commitment;
- Competence of Organization towards Improvement;
- Time and Budget;
- Detail Level;
- Expansion Level and
- Motivation of Operators

2.2.3. The People Development Pillar

Top performing companies not only recognize the importance of their people but also the need to provide the right skills to enable them. In IBM's The Value of Training (2014), a C-suite study with 4,183 leaders in 70 countries and more than 20 industries, 71% of CEOs cited human capital, ahead of products, customer relationships and brands, as the leading source of sustained economic value. In fact, from 2004 through 2013 across all of the C-Level, people skills rank high on the list of external factors that will impact performance, as seen on the figure below.

Figure 5 – External factors that impact performance



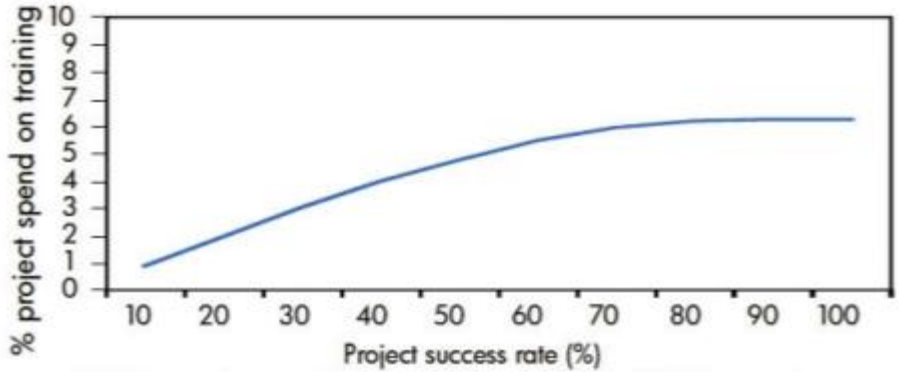
Source : IBM C-Suite Survey (2014)

It was also found, in a study conducted by Bersin & Associates (2010), that companies and organizations that did have a strong learning culture did better in their market than those who do not. For example, these organizations are 46% more like to be the leader in their industry, note a 34% increase in their ability to respond to the needs of the customer, and are 17% more likely to become the market share leader. That is also asserted by a survey conducted by IBM (2011), which says that 84% of employees in Best Performing Organizations are receiving the training they need compared with 16% in the worst performing companies.

Contrary to popular belief, the amount of training does not need to be colossal to see results. According to IDS's survey Impact of Training on Project Success (2011), when preparing for a project, teams receiving 40 hours of training per member met their significant project objectives three times as often as teams that received 30 hours of training or less.

Towards Maturity Benchmark Study "Integrating Learning and Work" (2012-2013) asseverates that objectives will be met 90% more often by increasing team skills. Not only that, but, increasing team skills by 1/3 increases likelihood of stakeholders meeting their objectives from 10% to 100%, as show in the following figure.

Figure 6 – Relationship between team skills and stakeholder objectives



Source: IDC's Training Impact on Projects Survey (2011)

As previously stated, not only are organizations that provide appropriate training outperforming their peers, they are also much less impacted by high turnover rates. Indeed, as described in IBM's C-Suite Survey (2014), training and an investment in developing a skills-building culture dramatically impacts employee retention. Only 21% of new hires intend to stay at companies that do not offer training for their current jobs. However, the study reveals that 62% of new hires intend to stay when training is provided. This nearly three-fold increase is a powerful

example of the positive impact of training on new hire retention. In today's dynamics of the modern workforce, where companies have extreme difficulty to find and keep talented collaborators, to deploy measures to increase employee retention is a priority.

Knowledge leak is another critical problem that can be solved with providing proper training. Most research on retention suggests nearly 30% loss of skill annually for skills that are not routinely reinforced, though significantly less when skills are routinely (and correctly) performed. The starting skill of an organization can range anywhere from nearly 100% after extensive organizational training to as little as 50% or 60% after several years of little investment in training and normal turnover (Knowledge Leakage: The Destructive Impact of Failing to Train on ERP Projects, IDC, 2013).

Finally, after the innumerous data presented to support training within organizations, it is only clear as to why it is such an important axis of development for WCM. According to IBM's report (2014), a few leading organizations adopt the following best practices to create a culture that fosters continuous learning, in other words, practices which lead to better and faster business results:

- **Fully training the team**. The most important factor in reducing the effect of knowledge leak is fully training everyone.
- **Provide ongoing training/access to reference resources**. The obvious method to reduce leakage is to provide "refresher training" continuously.
- **Document processes**. Documented processes or routines can mitigate the absence of individual skill.
- **Train consistently**. Training new hires, promotions and transfers, regardless of their "source" is important to ensure consistent application of policy and system success.
- **Train efficiently**. The acclimation of new users is exacerbated when positions turn over.
- **Train globally**. Training on a global basis is a never-ending cycle.
- **Train conveniently**. Technology-based training, including informal or search learning, supports delivery as closely as possible to the time when the employees will use the new system or procedure, ensuring the most value of the training.
- **Explain thoroughly**. Users may not always have access to mentors and may need access to reference material, search tools or expanded training to address areas of need whenever problems arise. (Knowledge Leakage: The Destructive Impact of Failing to Train on ERP Projects, IDC, 2013).

2.3 WCM Problem Solving Tools

In order to achieve world-class performance and address all the manufacturing components in a plant, it is not possible to use only one specific single tool, but rather a vast array of standards and methods is necessary. WCM requires all decisions to be made based on objective measured data and its analysis. Therefore, all the traditional data analysis tools such as scatter diagrams, histograms and checklists are used, but several others exist. Only the vital tools to the development of this study will be described, as follows.

2.3.1. Tags

It is a sheet which, suitably completed, is applied on the machine, in order to report any anomaly detected (Felice et al, 2013). Tags are used to highlight anomalies on machines and are one of the simplest tools of problem solving. They should be a part of a continuous tagging system which means that their use should be active, continuous and be part of the operator's routine. Deploying tags has as objectives:

- Decrease idle time due to breakdown;
- Reduce risks;
- Restore the basic conditions.

According to Dennis (2016) tags must be recorded, analyzed, prioritized, solved, and removed when the countermeasure has been completed. In the name of doing so, a system of tag management has to be deployed. What follows is an example of six activities that compose a tag management system; however, it should be kept in mind that this structure is adaptable and should be bespoke to each company and production site.

1. Define what to tag, prepare the tag map and register
   Tags highlight anomalies on machines. There are two approaches to know what to tag: anomalies that can be easily and quickly removed, and anomalies which require a deeper analysis and more time to be solved. Either way, a map tag should be prepared, with a sketch or a figure of the machine; and a tag register needs to be drawn up, with the indication of machine areas and the person responsible for it (Dennis, 2016).

2. Write the tags

   Dennis (2016) writes that three types of tags that can be fashioned: safety tags, used for any problem that revolves around safety; operator tags, used for problems the operators can solve; and maintenance tags, used for problems that require technical assistance.

3. Attach the tags, mark on the tag map, place tags on the area board

   A tag should be attached to the machine component where the anomaly has been observed, or as close as possible when the component has movement. Every time a tag is filled, a duplicate should be done as well and placed on the tag board, to facilitate its analysis and management (Dennis, 2016).

4. Fill the tag register, and analyze the tags (Dennis, 2016)

   If the root cause of the problem was not clearly found or if there is the slightest doubt the problem might reoccur, another problem-solving tool should be deployed, like a Quick Kaizen (refer to the next section).

5. Prioritize and implement the countermeasures

   A prioritization matrix should be used in order to determine the countermeasures' implementation order. Once the order set, it should be recorded in the tag register and the countermeasures implemented. Then, the solution needs to be registered on both tags and finally, the tag from the component should be removed (Dennis, 2016).

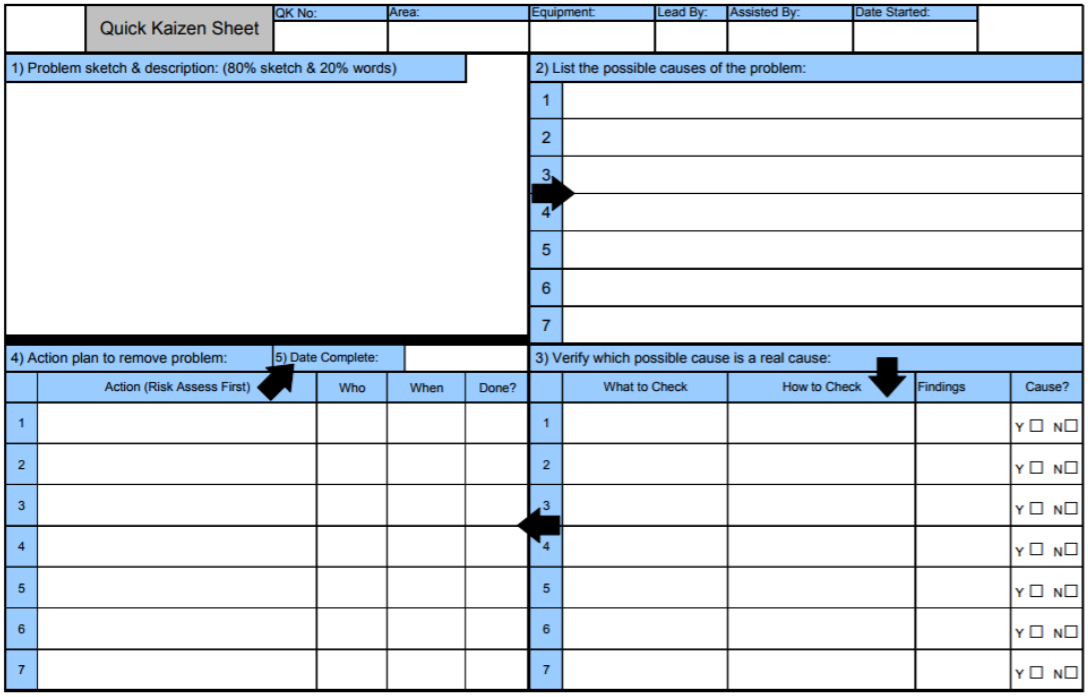
6. Use analysis to ensure the problem identified does no reoccur

   Once the check is done to ensure the countermeasures are effective, the tags board is to be updated at the moment, with the tags moved from the pending to the solved section (Dennis, 2016). The date of every action is to be recorded as well.

2.3.2. Quick Kaizen

Quick Kaizen is method of recording progress in solving a simple problem. It is a daily process, the purpose of which goes beyond simple productivity improvement. According to KCTS Knowledge Sheet (2009), the Quick Kaizen gives focus to an area or activity problem and allows to monitor the potential solution methods. This helps keep track of reported proof tests and to logically decide on the best solution(s).

Figure 7 – Quick Kaizen sheet



Source: KCTS Knowledge Sheet (2009)

According to the previous figure from the standard adopted by KCTS (2009), it is possible to distinguish the following steps to fill in the sheet:

1. Draw/Sketch the problem and add any necessary comments to clarify the precise issue. The problem should be described 80% by photo or sketch and 20% via text. By uniquely identifying the problem that needs to be tackled, including the area and equipment description, it makes it far easier to then find the real root-cause (KCTS, 2009).

2. List the potential causes of the problem (Dennis, 2016).
   After reaching consensus on how the equipment or process should optimally work, a list of all the possible causes is made on the top right-hand side of the sheet. In some cases, it is advised to carry out an Ishikawa diagram to structure the brainstorming process. Once the team brainstorm has finished, the next step would be to allocate the ideas to one of the 7M's categories of an Ishikawa diagram: Mother Nature, Man-Operator, Man-Management, Machine, Method, Material and Measure. These categories can vary and be adapted but the general idea stays the same.

3. For each cause, identify a test/check and how to perform it. (Dennis, 2016).

4. Assign each test/check to an individual and record whether each is a cause Yes/No (Dennis, 2016).

5. Agree on a list of actions to solve all identified causes (Dennis, 2016).
   The goal is to create a provisional action list that includes any physical improvements and modification to be made to the current standards, procedures, training, etc.

6. Assess the risks of all potential solutions (KCTS, 2009).
   The people in charge of the risk assessment are to be identified in the bottom square of the left-hand side of the standard sheet in the previous figure. A list of hazards or possible negative consequences from the provisional actions should then be produced. For each hazard, determine the impact it may have by identifying who or what can be harmed. Afterwards, using appropriate scoring criteria, evaluate the impact and the likelihood of occurrence. For high risks, it should be determined what further action is required by whom and when, countermeasures should be considered, and then the risk reassessed. When the risks are found to be acceptably low, then it is possible to move on to the final activity. This ensures that by applying the solutions, no significant collateral effect will appear inadvertently.

7. When all actions are complete, monitor that the problem is solved and enter the completion date (Dennis, 2016).

According to Dennis (2016), that can be a tendency to use "experience" as a verification method, which should not be the case. The possible causes should be logically linked to the problem description because time is saved during the verification part. Besides, practical comparison with data should be used when possible. Lastly, a good practice when deploying a Quick Kaizen is being able to recognize when the tool is insufficient to solve the problem and therefore more sophisticated methods are required. Indications of this include: the problem is unclear and not specific enough, so there may be a need to describe the problem using a 5W+1H; there is insufficient knowledge of how the equipment or system works; and finally, a single "Why" does not pinpoint the root cause. This last indication is a good evidence that a 5Whys Kaizen should then be called upon.

2.3.3. Five Whys Kaizen

The Five Whys Kaizen is a simple question asking method that explores the cause-and-effect relationships behind problems. It is used to analyze the causes of a problem through a consecutive series of questions. It is applied in failures analysis, analysis of sporadic anomalies, and analysis of chronic losses arising from specific causes. According to the Asian Development Bank (2009), there are three key components whose performance have repercussions on the effectiveness of the Five Whys: accurate and complete statements of problems, complete honesty in answering the questions, and the determination to genuinely comprehend the problems and resolve them. It is common knowledge that the Kaizen can, and should, be adapted according to the nuances of every problem; nonetheless, it is also stated that there are five base steps to conducting it:

1. Gather a team and develop the problem statement in agreement. After this is done, decide whether or not additional individuals are needed to resolve the problem (Serrat, 2009).

   It is quite common that in this first activity teams are asked to perform a 5W+1H analysis in order to help in the problem description and clarification. A table should be produced, based on the answers to 6 basic questions: what, why, who, where, when and how. Each question has its own column and the tasks to analyze are to be placed in the What column. The idea is to get an overall visibility of each task, or, in this case, when it is applied to the 5Whys Kaizen, assist in the problem description part of the standard.

Figure 8 – 5W+1H table

N°	What (Description of the tasks)	The current situation				
		Why?	Who?	Where?	When?	How?
1	Prepare machine components and raw materials	Needed for the product production	Operator A	Zone C	Before the set up	SOP
2	Change machine parameters	Product change	Operator A	Zone D	Beginning of product change	SOP
3	Measure the product	Check if the product is in-spec	Operator B	Zone A	After setting machine parameters	SOP for measurement
4	Make final adjustments	Product off-spec	Operator B	Zone B	After measurement	Standard adjustment method

Source: Elaborated by the author

2. Ask the first "why" of the team: why is this or that problem taking place? There will probably be three or four sensible answers: record them all on a flip chart or whiteboard.

3. Ask four more successive "whys," repeating the process for every statement. Post each answer near its "parent". The root cause will have been identified when asking "why" yields no further useful information. If necessary, continue to ask questions beyond the arbitrary five layers to get to the root cause (Serrat, 2009).

4. Among the dozen or so answers to the last "why" look for systemic causes of the problem (Serrat, 2009). Discuss these and settle on the most likely. Follow the team session with a debriefing and show the product to others to confirm that they see logic in the analysis.

5. Develop appropriate corrective actions to remove the root cause from the system. The actions can (as the case demands) be undertaken by others but planning and implementation will benefit from team inputs (Serrat, 2009).

A critical point to be considered, as stated by the Asian Development Bank (2009), is that evidently, the Five Whys Kaizen will suffer if it is applied through deduction only. The process articulated earlier encourages on-the-spot verification of answers to the current "why" question before proceeding to the next and should help avoid such issues.

2.4 WCM Continuous Improvement Projects

2.4.1. 5S

It is used to achieve excellence through improvement of the workplace in terms of order, organization and cleanliness. It is a methodology developed in Japan and as described by Hiroyuki Hirano, in his book 5 Pillars of The Visual Workplace (1995), is a series of steps, each one building on its predecessor. The method is based on five Japanese words which are: Seiri (separate and order); Seiton (arrange and organize); Seiso (clean); Seiketsu (standardized) and Shitsuke (maintaining and improving).

1. Sort

The objective of the first step is to separate necessary from unnecessary items, whilst eliminating all unidentified and useless objects (Hirano, 1995) It requires an initial inspection in order to identify waste, followed by a tagging process that classifies all elements in the area. The ultimate activity is the removal of all items that do not belong, meaning the work environment is improved, accidents are reduced and the area is freed-up from clutter.

2. Set in Order

The second step consists of assigning a place for every item remaining, in order to reduce search time. This process of arranging items in an efficient manner, through the use of ergonomic principles, ensures that every element "has a place and that everything is in its place" (Hirano, 1995). There are three main activities to accomplish: classify items by frequency of use; find suitable locations; and identity each location and ensure compliance with the new order. Not only "setting in order" improves the work environment, it also saves time spent looking for items, and ideally, reduces unnecessary movements because of the newly-found access to frequently used items.

3. Shine

It is inevitable that with time, workplaces, machines and equipment get dirty. Dirt, puddles and dust hide anomalies, impact the quality of the workplace environment, increase safety hazards and are sources of contamination for products and raw materials. By routinely cleaning the machine area, external sources of dirt are eliminated and materials do not get dirty as quickly and as much. Therefore, the objective of the third step is to clean and orderly arrange the workplace (Hirano, 1995). In pursuance of completing the step, a few activities can be highlighted: clean and check if the order set in the previous step is maintained; tag all deviations from the desired situation; analyze repetitive tags in to find the root cause of the deviations; define and carry out the countermeasures; and lastly, list all required standards. Cleaning is an essential activity in 5S which allows to increase safety and health at work, preserve machines from external sources of dirt, improve the company's image to visitors, and eliminate contamination sources.

4. Standardize

At the end of the third step, the working area is clean and free from useless items. However, if the 5S project stops here, the area would become gradually dirty and disorganized again. That is why is it important to apply standards, they remind workers to sort, order, and clean their workplace; thus, basic conditions will be maintained. The fourth step aims to: define and formalize standards for cleaning, order and stock management; ensure they are simple and their results visible. More than the formalization of the standards, to complete the step it is also necessary to define a checklist to verify these are being respected, and to improve the visual management of the workplace. The benefits of developing standards are: cleaning operations are simplified, time is not wasted to look for something, and inspection is eased due to elaboration of a visual management (Hirano, 1995).

5. Sustain

This last step of the route enables to consolidate achievements and make 5S a habit for operators and managers, making sure that standards are closely monitored and developing a continuous improvement culture (Hirano, 1995). The activities proposed by this last step are: planification of audits to verify that standards are being followed, continuously analyze problems and identify countermeasures, monitor audit scores and set new targets.

2.4.2. Autonomous Management

Autonomous Management, or AM, is one of the pillars of the WCM whose objective is to train operators to restore and improve their own machines. Because operators are closer involved to their equipment than anyone else, they are able to quickly notice any abnormalities (Hamacher, 1996). The main objective is to assign tasks to the production operators rather than the maintenance staff, in order to increase their skills and simultaneously reduce their dependence on the maintenance team. By making line employees skilled to perform tasks such as daily cleaning, inspecting, lubricating and tightening of equipment, the ultimate goal is to implement a continuous improvement culture and achieve people involvement. In their handbook on maintenance, Ben-Daya (2009) mentions AM as a method that allows to:

- Fosters operator skills and ownership
- Perform cleaning, lubricating, tightening, adjustment, inspection, readjustment on production equipment.

AM consists of a seven-step program (Gotoh & Tajiri, 1999). The first three stare related to maintenance operations and therefore called Autonomous Maintenance. This subgroup mainly concerns production operators and are linked to the Reliability pillar. The last four steps revolve around management issues and therefore are mostly intended for line managers and team leaders. This study will discuss exclusively the first three steps and its activities.

1. Initial Cleaning

   The objective of the first step is to restore the equipment to its original conditions. This eliminates losses due to poor cleaning, since removing dirt and grime uncovers problems within the machine. According to Gotoh & Tajiri (1999), during this step the operator will learn to identify problems and contamination sources, understand that cleaning is inspection, and get better acquainted with their equipment. At the end of it the expected results are: 80% of the tags raised were resolved, an initial continuous tagging system was put in place, temporary cleaning standards were defined and applied, and, finally, a list of sources of dirt and hard to clean areas was defined.

2. Eliminate Sources of dirt, hard-to-clean and inspect areas (Gotoh & Tajiri, 1999)

   Sources of dirt contaminate machines and lead to poor condition and waste of time due to excessive and unnecessary cleaning. The objectives of the second step are to simplify inspection and reduce cleaning time. It is also in its agenda to sensitize operators to the importance of cleaning and to set up training. The activities of the second step are the following: analyze sources of dirt and hard-to-clean areas; implement solutions, update cleaning standards, monitor results; and, improve hard-to-inspect areas.

3. Create and maintain cleaning inspection & lubrication standards

   It is possible to pinpoint six objectives of the third step in the Autonomous Management loss reduction route (Gotoh & Tajiri, 1999):

   - integrate cleaning, inspection and lubrication in operator’s daily schedule
   - define the final cleaning and inspection standards
   - simplify the lubrication system, so that lubrication becomes effective and quick
   - make lubrication operations accessible to production operators
   - define lubrication standards and its management system
   - train the operators on the CIL (cleaning, inspection and lubrication) operations

According to Gotoh & Tajiri (1999) at the end of this step not only is expected that the CIL standards are applied, it is also assumed that the number of lubrication points is reduced, thus decreasing lubrication time. Besides, it is predicted that by the end of this step the number of lubricants used is cut down, and if not the case, they are at the very least, made visible to avoid mistakes. Moreover, the operators should be autonomous on CIL activities; but more importantly, cleaning, inspection and lubrication tasks have become part of their routine.

2.5 E-learning

In France the official term for e-learning, recommended by the General Delegation on the French Language and the Languages of France (DGLFLF), is *formation en ligne*. However, the Anglicism, e-learning, is very much part of the day-to-day vernacular. The European Commission defines it as the use of new multimedia technologies and the Internet to improve the quality of learning by facilitating access to resources and services as well as remote exchanges and collaboration.

According to Beatrice Ghirardini (2011), "E-learning can be defined as the use of computer and Internet technologies to deliver a broad array of solutions to enable learning and improve performance".

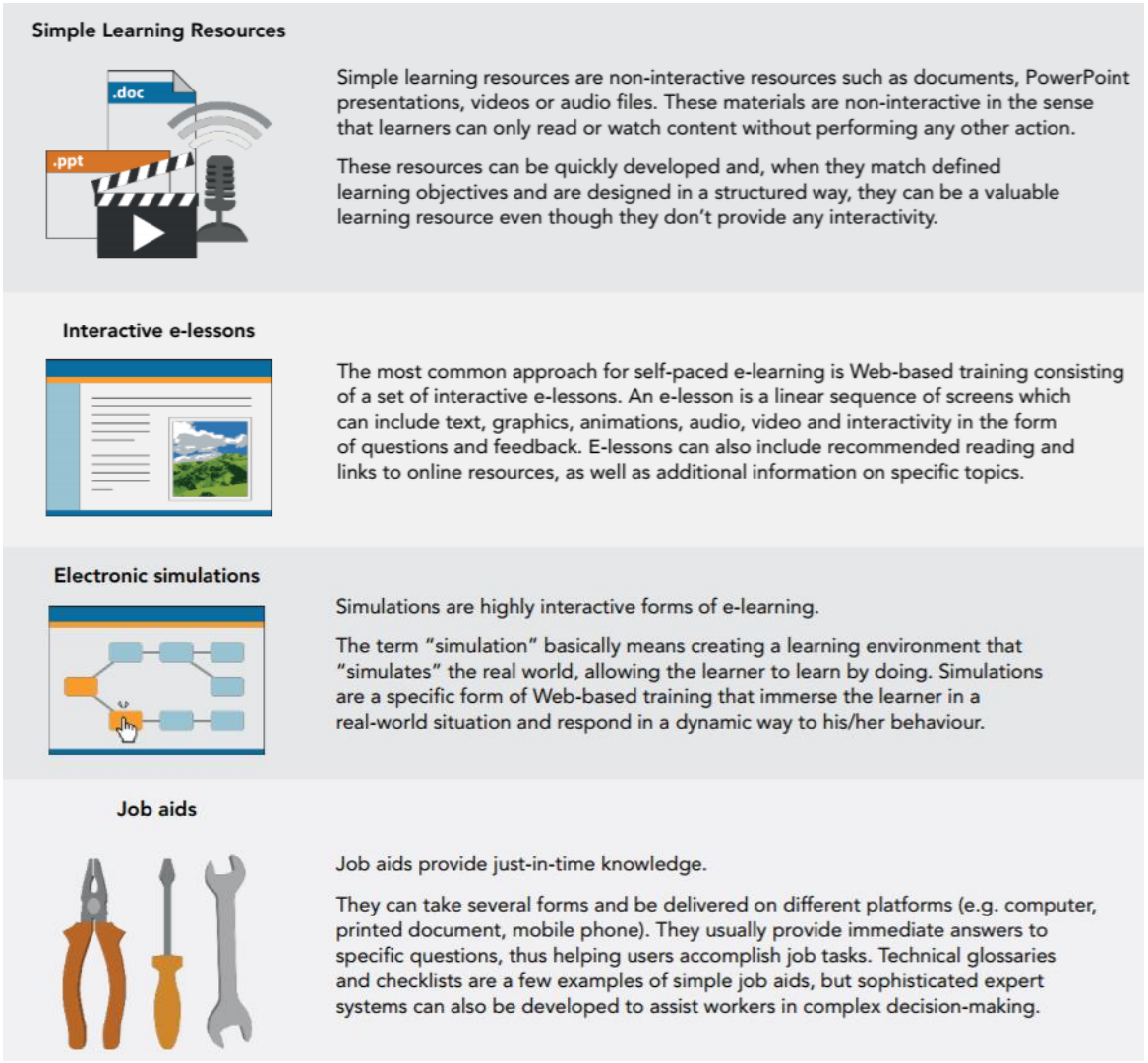
As it is reported by Renaud Phelizon (2001) in behalf of the CIGREF, or the French Corporations' Computer Association, "E-learning can be defined as the set of tools and information that can improve performance through the use of the Internet and information technology".

The Guide for Developing E-Learning Content (2011) from the Food and Agriculture Organization of the United Nations (FAO) says that a training program may aim at developing different types of skills:

- cognitive skills, which can involve knowledge and comprehension (e.g. understanding scientific concepts), following instructions (procedural skills), as well as applying methods in new situations to solve problems (thinking or mental skills);
- interpersonal skills (e.g. skills involved in active listening, presenting, negotiating, etc.);
- psychomotor skills, involving the acquisition of physical perceptions and movements (e.g. making sports or driving a car).

Most e-learning courses are developed to build cognitive skills because it is the most suitable domain for e-learning (Food and Agriculture Organization of the United Nations, 2011). But, within the cognitive domain, thinking skills may require more interactive e-learning activities because they are learned better "by doing". The content of a e-learning material varies according to the needs of the final user and his limitations. As show in the figure below, e-learning usually can be distinguished between four categories, which include: simple learning resources, interactive e-lessons, electronic simulations and job aids.

Figure 9 – Types of e-learning content



Source: Ghirardini (2011)

The Food and Agriculture Organization of the United Nations (FAO) says in its Guide for Developing E-Learning Content that the quality of an e-learning course is enhanced by:

- **learner-centered content**: E-learning curricula should be relevant and specific to learners' needs, roles and responsibilities in professional life. Skills, knowledge and information should be provided to this end.
- **granularity:** E-learning content should be segmented to facilitate assimilation of new knowledge and to allow flexible scheduling of time for learning.
- **engaging content:** Instructional methods and techniques should be used creatively to develop an engaging and motivating learning experience.
- **interactivity:** Frequent learner interaction is needed to sustain attention and promote learning (FAO, 2011)
- **personalization:** Self-paced courses should be customizable to reflect learners' interests and needs; in instructor-led courses, tutors and facilitators should be able to follow the learners' progress and performance individually.

In fact, to assess the quality of an e-learning content, an international quality standard for e-learning programs, called Open ECBCheck, was released in 2010. ECBCheck is an accreditation and quality improvement scheme for e-learning programs which supports organizations to measure how successful their e-learning programs are and allows for continuous improvement though peer collaboration and bench learning. It was developed through an innovative and participative process involving more than 40 international, regional and national capacity-development organizations.[B]

Guirardini (2011) says that e-learning is a good option when:

- there is a significant amount of content to be delivered to a large number of learners;
- learners come from geographically dispersed locations;
- learners have limited mobility;
- learners have limited daily time to devote to learning;
- learners are required to develop homogeneous background knowledge on the topic;
- learners are highly motivated to learn and appreciate proceeding at their own pace;
- content must be reused for different learners' groups in the future;
- training aims to build cognitive skills rather than psychomotor skills;
- there is a need to collect and track data (Guirardini, 2011).

[B] Available at: http://www.ecb-check.net/. Last visited June 11, 2018

Given these arguments, it is quite clear as to why e-learning fits so well into big companies' training programs: employees are numerous and located across the globe, making travel an unrealistic and expensive solution; it is important to convey consistent information that is aligned with the company's policies; the content is reused with every new collaborator, and lastly, it is important to collect and track data on employee's skills set.

2.5.1. Advantages for Companies

Just as the FAO (2011) states, nowadays it is common for many organizations and institutions to use e-learning because it can be as effective as traditional training but at a lower cost. What is more, once a company relies on e-learning, it takes away the human variable that may not ensure that all learners receive the same quality of instruction or verify of information, because there is no dependence on a specific instructor. Some companies, usually of relatively large size, even take advantage of it at its full extent and develop their own content and training program. According to a survey, from the State of the Industry report, 38% of the training in organizations is delivered using technology-based solutions (ASTD, 2014). It is reported that over 47% of the Fortune 500 companies now use some form of education technology (Pappas, 2013).

As Phelizon (2001) describes, the knowledge capitalization makes it necessary to better control learning processes within a company, which are often neither implemented nor supported. E-learning brings together activities based on computer applications that enable distance education. Learning has a direct impact on individual and collective performance and training is only one of its modalities. It is often better to allow better access to relevant information or to better manage knowledge." In a competitive world where the goal is always to increase revenue, the fact that e-learning is a much less expensive way to ensure training is where the real interest lies. And this fact is assured by two arguments: delivery costs and Time to Proficiency.

The Food and Agriculture Organization of the United Nations (2001) states that even though developing e-learning can be more expensive than preparing physical content and employing trainers, especially if multimedia or highly interactive methods are used, delivery costs are much lower. Indeed, delivery costs for e-learning (including costs of web servers and technical support) are substantially lower than those of classroom facilities, instructors' time and travel, and work time lost to attend training sessions.

Moreover, e-learning enables to reach a wider target audience per content developed, because they are not restricted to any physical or human condition limitation. In the words of the FAO (2011), its content can engage employees who have difficulty attending conventional training because they are:

- geographically dispersed with limited time and/or resources to travel;
- busy with work commitments which do not allow them to attend courses on specific dates with a fixed schedule;
- located in conflict and post-conflict areas and restricted in their mobility because of security reasons;
- limited from participating in classroom sessions because of cultural or religious beliefs (FAO, 2011);
- facing difficulties with real-time communication (e.g. foreign language learners or very shy learners).

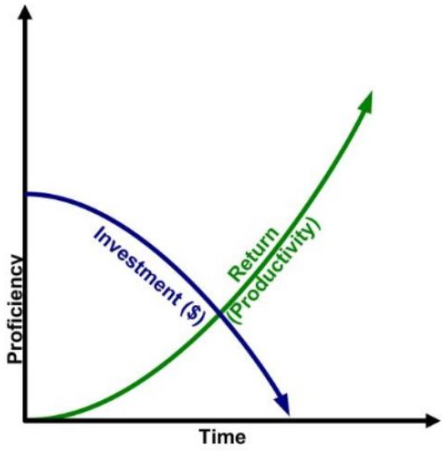
Therefore, with a wider audience, that even has the flexibility to review the contents taught at a later time, it is clear that the cost of delivery per student is much smaller.

The second factor that makes e-learning so much more attractive to companies is the fact that it reduces Time to Proficiency. Williams & Rosenbaum (2004) describe Time to Proficiency (T2P) as the length of time from the first day in a new job role to the day that the employee becomes proficient. Proficiency is reached when an employee can perform tasks without assistance and without errors. Essentially proficiency is reached when the employee is independently productive. An employee is termed ‘proficient’ when he demonstrates superior performance which is reliable, repeatable, reproducible and consistent to a high degree regardless of the situations and nature of problems (Dreyfus, 2008).

Although there are no deterministic studies, there is a consensus that the ‘Time-to-Proficiency’ in a given job could be very long depending upon the complexity of the job (Klein and Hoffman, 1992; Hoffman and Militello, 2009). Therefore, it is only natural that organizations are searching for new ways to accelerate the cycle of proficiency acquisition. Training and learning interventions being the first line of defense, it is logical to expect training to play a big role as stated by Rosenbaum and Williams (2004), “we also believe that reducing Time-to-Proficiency is the most significant contribution the training function can deliver to the organization”.

In companies, especially when it comes to big groups, when a new employee is hired there is already a substantial investment expended on that employee through the recruitment process. An additional investment is made in training for their new job role (Williams & Rosenbaum, 2004). Conversely the productivity that the employee is able to provide is non-existent to very low. As the employee is trained and works on the job, the investment declines and productivity rises to a point at which it exceeds the investment (see the following figure). When the employee reaches proficiency, the investment is at its lowest level, and the productivity is at its highest level for that employee. This initial investment is a real expense for the organization.

Figure 10 – Proficiency vs. Time graph



Source: Adapted from Williams & Rosenbaum (2004)

Attri & Wu (2015) affirm that with faster pace of business demanding shorter time-to-market of products and services, most of the organizations are highly pressed to reduce time-to-proficiency of its employees. The reduction in Time-to-Proficiency translates to revenue dollars, productivity and gains in time-to-market, as asserted by Rosenheck (2005) that, "if we can reduce the time it takes to become expert or at least proficient performers, we can save our organizations a lot of money, increase retention rates, reduce errors, and improve customer satisfaction". As seen beforehand, customer satisfaction is one of the goals of WCM.

E-learning technologies and methods cut down training time. A survey conducted in 2013 shows that e-learning reduced the instruction time by 60% and, compared to the instructor-led training, students who were using e-learning modules reported 60% faster learning curve. Therefore, if the above evidence shows that e-learning allows for a lower Time to Proficiency, it means that it also takes less time for the employee to return what it was invested in him as productivity. According to a report released by IBM (2004), companies who utilize e-learning

tools and strategies have the potential to boost productivity by up to 50%. For every $1 that company spends, it's estimated that they can receive $30 worth of productivity.

So not only e-learning cuts downs costs and allows to reach a broader audience, it is also eco-friendly. Recent studies conducted by Britain's Open University (2005) have found that e-learning consumes 90% less energy than traditional courses. The amount of CO_2 emissions (per student) is also reduced by up to 85%. This is mainly due to a major reduction in the amount of student travel, economies of scale in utilization of the training site, and the elimination of much of the energy consumption per learner. In a context where climate change and CO_2 emissions are very much into people's minds, reducing greenhouse gas emissions is not only vital for the planet, it is also a competitive advantage.

2.5.2. Limitations

Since e-learning is not ideal for all purposes, it is unlikely that it will replace classroom training completely in an organization. The most cost-effective application of e-learning may be to complement conventional training in order to reach as many learners as possible. According to the Food and Agriculture Organization of the United Nations (2011), adult learners share some characteristics that are different from those of fulltime students, which influence the design of learning modules. In particular, adult learners:

- need to know the benefits of learning (why they have to learn something);
- like to learn experientially and approach learning as problem-solving;
- learn better where they can see the immediate value and application of content; and
- prefer to study at a time, place and pace convenient for them.

However, according to Henri & Lundgren-Cayrol (2001), "distance learning is most often described as a mode of economic formation that uses technologies to cross the spatio-temporal distance, thus improving accessibility in an ideal of democratization of education. In distance education, everything is done to overcome the absence, which is seen as the greatest weakness of the concept. And if in distance education, absence was not something to fill? If the distance was the result of a choice inherent to the training? Then the distance would no longer be reduced to a spatio-temporal distance; it would become a necessity, a contribution to the specificity and the foundations of training" (Henri F. and Lundgren-Cayrol K., 2001, p. 4).

While e-learning has been proven efficient in delivering compliance or 'informational' type of content very effectively in self-paced manner, many researchers even questioned whether or not e-learning is a plausible media to deliver complex cognitive skills. Jobs are becoming increasingly complex at workplace. Karoly & Panis (2004) emphasize the changing nature of workplace requires non-routine cognitive skills.

According to Attri &Wu (2015) common reason why e-learning fails to develop complex skills of learner is that designers sometimes get into trap of generalizing strategies applicable to simpler skills into complex skills when designing e-learning. Wulf & Shea (2002) in their study argued that "principles derived from the study of simple skills do not generalize to complex skill learning" (p.185). Therefore, it is imperative to explore the e-learning strategies that can build proficiency in complex skills. Sims et al. (2008) favored using blended learning when skills or knowledge to be delivered is complex in nature. They argue that "…. a blended learning approach may be more effective than a training session that relies completely on one mode or strategy" (p. 26).

2.5.3. Designing Content

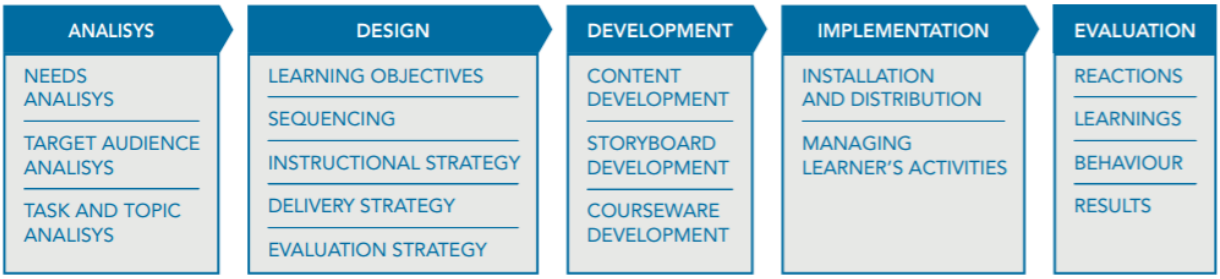
Good and adaptable design and planning are crucial for e-learning projects. Materials should be self-contained and able to be used multiple times without making ongoing adjustments. An instructional design model can and should be used to define the activities that will guide e-learning development projects.

Siemens (2002) defines instructional design as the art and science of creating an instructional environment and materials that will bring the learner from the state of not being able to accomplish certain tasks to the state of being able to accomplish those tasks. He also affirms that instructional design is based on theoretical and practical research in the areas of cognition, educational psychology, and problem solving.

Another definition is that instructional design is a technology for the development of learning experiences and environments which promote the acquisition of specific knowledge and skill by students. "Instructional design is a technology which incorporates known and verified learning strategies into instructional experiences which make the acquisition of knowledge and skill more efficient, effective, and appealing" (Merrill, D.; Drake, L.; Lacy, M; Pratt, J., 1966).

In the context of comporate training, instructional design's goal is to increase operators' performance and to improve organizational effectiveness and efficiency. Even though most instructional design models are based on popular ones such as the ADDIE model, which is represented in the following picture, there are innumerous different ones to choose from. However, this study will concentrate itself in the ADDIE model, which includes five stages, as Ghirardini (2011) describes: Analysis, Design, Development, Implementation and Evaluation.

Figure 11 – The ADDIE model



Source: Ghirardini (2011)

1 - Analysis

At the start of any development project, a needs analysis should be conducted to determine whether:

- training is required to fill a gap in professional knowledge and skills; and
- e-learning is the best solution to deliver training.

As Ghirardini (2011) says, the needs analysis allows the identification of general, high-level course goals. Target audience analysis is another crucial step. The design and delivery of e-learning will be influenced by key characteristics of the learners (e.g. their previous knowledge and skills, geographical provenience, learning context and access to technology). Analysis also is needed to determine the course content:

- Task analysis identifies the job tasks that learners should learn or improve and the knowledge and skills that need to be developed or reinforced. This type of analysis is mainly used in courses designed to build specific job-related skills.

- Topic analysis is carried out to identify and classify the course content. This is typical of those courses that are primarily designed to provide information.

As Ghirardini (2011) sums up, task analysis is defined differently in different contexts. In the context of instructional design, a task analysis is a detailed analysis of actions and decisions that a person takes to perform a job task, which includes identifying the knowledge and skills needed to support those actions and decisions. By identifying course content through task analysis, the developer is able to: create a learning course that is job centered, focus attention on skills, and create case-based examples that build on realistic job contexts. As a result, learners can better integrate the new knowledge into their daily routine.

2 - Design

The design stage encompasses the following activities:

- formulating a set of learning objectives required to achieve the general course objective;
- defining the order in which the objectives should be achieved (sequencing); and
- selecting instructional, media, evaluation and delivery strategies.

A learning objective is a statement describing a competency or performance capability to be acquired by the learner (FAO, 2011). According to the revised Bloom's taxonomy of the cognitive domain presented in the following table, learning objectives can imply six different types of cognitive performance, ranging from the lowest performance level (remember) to the highest (create).

Table 2 – Performance levels for the cognitive domain

Remember	The learner is able to recognize or memorize information.
Understand	The learner is able to reformulate a concept.
Apply	The learner is able to use the information in a new way.
Analyze	The learner is able to decompose and define relationships among components.
Evaluate	The learner is able to justify a decision according to a criterion or standard.
Create	The learner is able to realize a new product or approach.

Source: Adapted from Anderson and Krathwohl (2001)

There are innumerous ways to sequence the learning objectives when structuring a course. Siemens (2002) says that one of the most popular methods used is the prerequisite method, which uses a learning objectives hierarchy, teaching first those skills that seem to be prerequisites for all other skills. Interactive e-lessons are the most common method for delivering e-learning content because they offer a medium level of interactivity and allow designers to use a variety of instructional techniques and media. The outcome of the design stage is a blueprint that will be used as reference to develop the course. The blueprint illustrates the curriculum structure (e.g. its organization in courses, units, lessons, activities); the learning objectives associated with each unit; and the delivery methods and formats (e.g. interactive self-paced materials, synchronous and/or asynchronous collaborative activities) to deliver each unit.

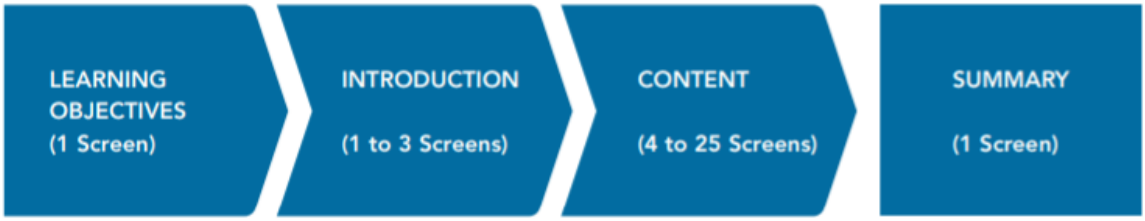
3 - Development

In this stage, the e-learning content is actually produced. The content can vary considerably, depending on the available resources. For example, e-learning content may consist of simpler materials (i.e. those with little or no interactivity or multimedia, such as structured PDF documents) which can be combined with other materials (e.g. audio or video files), assignments and tests. In that situation, storyboard development and the development of media and electronic interactions would not be conducted. As Anderson and Krathwohl (2001) put it, the development of multimedia interactive content is comprised of three main steps:

- content development: writing or collecting all the required knowledge and information;
- storyboard development: integrating instructional methods (all the pedagogical elements needed to support the learning process) and media elements. This is done by developing the storyboard, a document that describes all the components of the final interactive products, including images, text, interactions, assessment tests; and
- courseware development: developing media and interactive components, producing the course in different formats for CD-Rom and Web delivery and integrating the content elements into a learning platform that learners can access.

Storyboards can be created with several software but the most commons are Microsoft PowerPoint or Word. By creating this script, the developer organizes the content provided by the expert into a sequence of slides, which will correspond to the screens the student will see in the final interactive lesson. The following figure represents the typical e-lesson structure:

Figure 12 – Typical module structure



Source: Adapted from Ghirardini (2011)

As seen, the first screen usually contains a clear and informal description of the learning objectives for the lesson. Then, one or more introductory screens follow, describing how the knowledge gained from the course will be used and its benefits. The purpose of the introduction is to motivate learners to proceed with the lesson (Clark & Al, 2011).

Next comes the set of screens which make up the core of the lesson. These combine: text, media elements, examples and practice questions; and instructional techniques should be used to present this content. Finally, at the end, frequently comes a list of the module's key points. The goal of the summary is to help the student memorize the main topics presented throughout the course.

A vital feature in every e-learning module is the presence of examples. They ensure that learners can understand the illustrated information and can be presented in a deductive or inductive way. Deductive examples illustrate a concept or show the steps of a procedure which has been previously introduced, whilst inductive ones stimulate thinking and reflection before providing definitions and principles. Both can be seen in the following figure.

Figure 13 – Deductive and Inductive sequences

Source: Adapted from Ghirardini (2011)

As Siemens (2002) describes, deductive sequences reflect a behavioral approach, which emphasizes response strengthening, while inductive sequences reflect a constructive approach, where emphasis is on the active processes learners use to build new knowledge. In self-paced e-learning, exercises and evaluations mainly consist of questions associated with response options and their associated feedback. Usually, the structure is as follows:

- a question or statement;
- a message that indicates how to perform the required tasks (e.g. click, drag, press key);
- a series of options;
- the correct answer; and
- feedback for the correct and incorrect answers.

Innumerous question formats exist, but the most common are: true or false, multiple choice, multiple responses, matching, ordering, fill-in-the-blanks, and short answer/essay. The following table summarizes the main characteristics of each type.

Table 3 – Types of exercise and pros and cons

Type	Pros	Cons
True or False	Easy to create Can differentiate feedback for each option	Learners have a 50 percent chance of selecting the right option The answer is not created by the learner
Multiple choice	Very flexible Can differentiate feedback for each option	Difficult to create The answer is not created by the learner
Multiple responses	Very flexible (can be used for several purposes)	Quite difficult to create The answer is not created by the learner
Matching	Quite easy to create	Risk of being too easy for learners The answer is not created by the learner
Ordering	Quite easy to create	The answer is not created by the learner
Fill-in the blanks	Easy to create	Rarely appropriate Difficult to measure
Short answer	Answer created by the learner	Very difficult to measure

Source: Adapted from the FAO (2011)

4 - Implementation

At this stage the course is delivered to learners. The courseware is installed on a server and made accessible for learners. In facilitated and instructor-led courses, this stage also includes managing and facilitating learners' activities.

5 - Evaluation

An e-learning project can be evaluated for specific evaluation purposes. You may want to evaluate learners' reactions, the achievement of learning objectives, the transfer of job-related knowledge and skills, and the impact of the project on the organization.

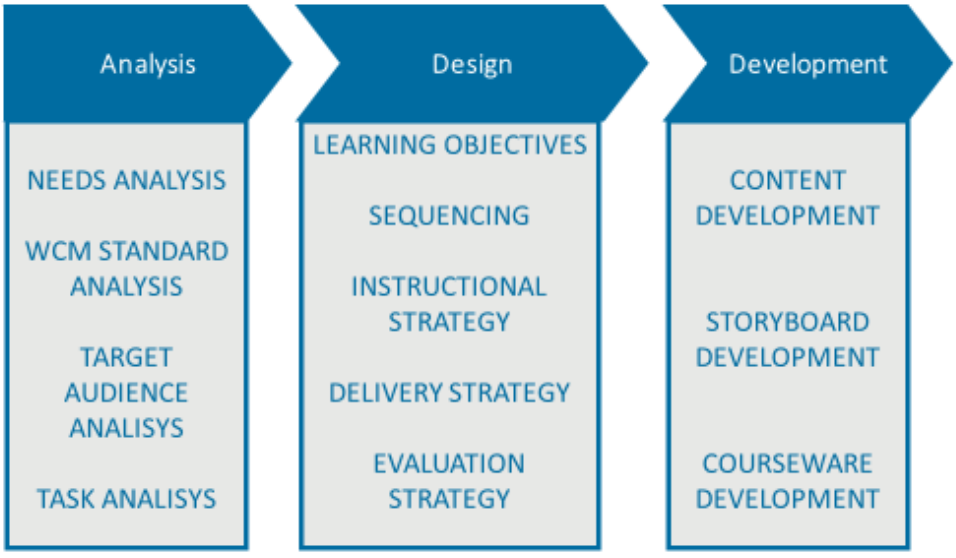
These are the five steps of the ADDIE model, but as previously mentioned, this is only one of innumerous methodologies to design content. Regardless the base model chosen by a developer and/or company, the essential element that always needs to be present is the adaptation to the content and the customer's needs.

3 METHODOLOGY

This chapter presents the methodology adopted for the development of this study. As previously stated, the problem to be solved revolves around the analysis and improvement of the current WCM methods and standards and the creation of e-learning modules in said tools and methods. In this regard, the method adopted is based on the concepts presented in the second chapter, with a special nod to the work of Ghirardini (2011), in her guide for developing e-learning courses for the Food and Agriculture Organization of the United Nations.

The proposed method can be divided into three major steps: analysis, design and development. All activities are to be pursued by the developer; in the case of this study, by the author, during her internship at OneWorld in France; whenever additional actors are involved, or set in different locations, it will be explicit. All three are iterative and should be repeated until its objectives are attained. The following figure is an illustration of the contemplated method.

Figure 14 – The three-step method



Source: Elaborated by the author

Clearly this is an adaptation of the first three steps of Ghirardini's method to create e-learning modules. Given the fact that the scope of the author's internship did not encompass the fourth step of implementation, it will not be a part of this study whose objective stops at structuring training for employees and not deploying it. Nevertheless, the fifth step of evaluation will be briefly discussed in the results section.

The first step consists of analysis. It is through this initial investigation and dissection that the author planned and structured the work. The first activity is to identify the need, the demand that is the commencement of all following sections. Because all projects are to be conducted with the WCM Methods team as clients, what follows is the analysis of the standard or method to be taught, or more concretely, the analysis of subject of the ultimate e-learning module. Then, the next activity is to define the target audience: depending on the final client's job position, an adapted format and speech is to be adopted in the module. Finally, what ends this step is the dismemberment of the future work into several tasks and activities.

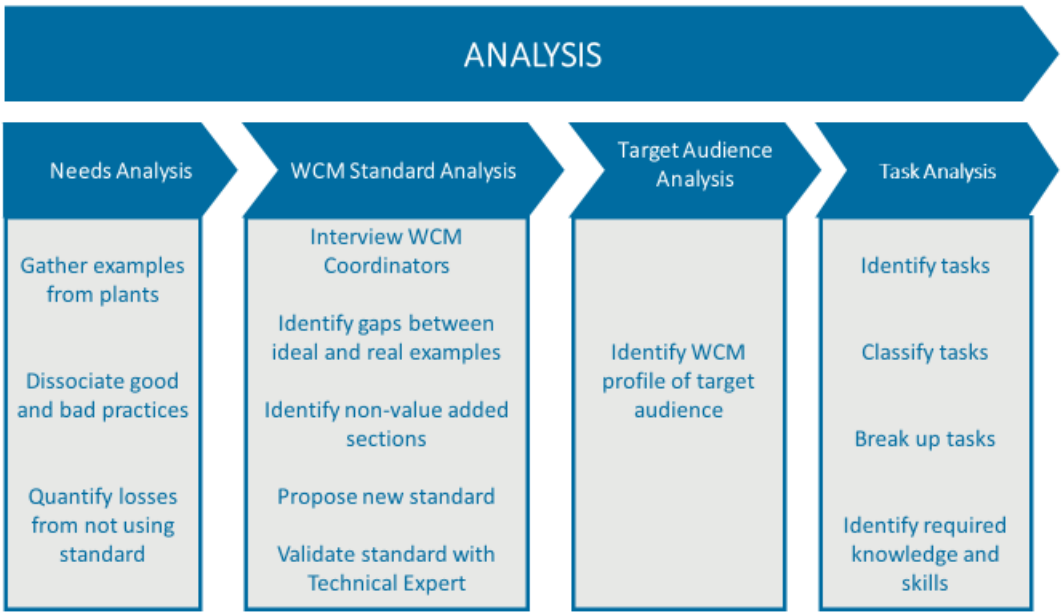
The second step is the design of the module. The first activity of this step if vital for the project: defining the learning objectives to be achieved by the student at end of the training. Once the goals are clearly set and determined, it is time to formalize the order in which the objectives should be achieved. What ensues is the selection of the instructional, media, evaluation and delivery strategies. The result of the design step is a blueprint that will be used as a reference to develop the course. It is essentially a plan that illustrates the curriculum structure (e.g. its organization in courses, units, lessons, activities); the learning objectives associated with each unit; and the delivery methods and formats to deliver each part.

The third step, or the development is when the content will actually be produced. Let it be clear that it is not uncommon to have overlap from step two and step three: once the developer has commenced the building of the modules she might be persuaded to come back and modify elements of the structure or delivery format. Even though this step is very much already structured because the content development has to be in line with the standards applied by OneWorld, there is space for customization according to the public and general idea of the module. The third and final step is comprised of three main activities: content, storyboard and courseware development. The content development consists of collecting and writing all the required knowledge and information that will be present in the final module. The storyboard development is about integrating all the pedagogical elements needed to support the learning process with the media elements, in other words, creating the document that describes all the components of the final module, including images, text, interactions, exercises and assessment tests. The final activity is the courseware development, meaning, the integration of the final validated work into the learning platform that learners can access.

3.1 The Analysis

The following figure shows the activities to be completed by the author in order to achieve the first step of the methodology:

Figure 15 – Activities of the first step



Source: Elaborated by the author

3.1.1. Needs Analysis

In general terms, it can be said that every project in a company starts as a way to address a demand. To put it in another way, it comes from either an external or internal need to satisfy requirements. This is no different in OneWorld or in the WCM department. To be more specific, when a gap is noticed between someone's skills and their job requirements, an appeal is made for them to be trained.

This study will not get into the details of a general need analysis and the infinite ways we can undertake them. However, this kind of analysis is crucial to validate the need for an e-learning intervention and to provide important information regarding which gaps need to be addressed to ensure that the intervention is targeted to organizational needs. Therefore, this study considers e-learning as the appropriate way to deliver training for OneWorld' employees. With that in mind, once the demand was sent to the WCM E-learning to address a gap in an area, it should be considered that the analysis was previously carried out and that, indeed, e-learning is the best solution to deliver the training.

Within this activity, the author's first task is to collect examples from the different production sites worldwide. That is, once the subject defined and the project launched, the developer reaches out to all production sites that have applied the standard or method to collect examples. In order not to add the task of translation, the author chose to concentrate in examples that were already in English. After the harvest comes the task of dissociating the good from the bad practices when using the standard. Even though the theory was always previously studied, almost always there are cases that should be treated one by one, analyzing the context and the actual problem at the time. Finally, in order to give weight to the request of development of the module, an important task is to quantify the losses from the lack of knowledge or the incorrect use of the standard. Even if they seem only qualitative, it certainly can be translated somehow into numbers; either material, money or time losses. This activity helps measure the potential positive impact of the module.

3.1.2. WCM Standard Analysis

The next activity is the WCM Standard analysis. Each project will have a different subject and it is imperative to develop a deep understanding and knowledge base before looking at it through a critical eye. There are five tasks to complete in order to analyze a WCM standard.

In the first task the author interviews the WCM Methods Engineers and Coordinators from several production sites. By doing so, one not only has the theoretical knowledge, but also the view from someone who is actually coordinating WCM projects on real life. Even though the former have all begun their career on a plant, it is said that it is easy to dissociate oneself from the real-life problems that happen in the shop floor and forget the day-to-day obstacles one faces when trying to apply the standards set by the central team. Therefore, by interviewing both parties, the author is able to grasp the two distinct points of view that need to be taken into account when formulating instructions on how to deploy each method. These interviews were conducted either via telephone, Skype or face-to-face during the author's plant visits.

After the interviews are conducted comes the part of identifying inconsistencies between the ideal, theoretical, directives set by the Central Methods Team and the real-life examples, that were executed in a production setting, collected during the previous activity. Once more, this enables sensitization to the fact that standards should be adapted to the real-life settings of a plant, and not written up in a meeting room of the company's headquarters, without taking into account challenges faced by sites.

Afterwards the author does the cataloguing of sections, in the case of a standard, or tasks, in the case of methods that add very little to no value. In other words, pin point the sections or tasks whose effort to complete is not worth it when compared to the value they add to the method. A good indication of activities that fall into this category are those who are not completed or commonly left aside. During interviews the WCM Coordinators they argue that these activities are not performed because, either they take too much time and are clearly not a priority on a busy production site, or simply because they cannot see the objective of carrying them out.

The next task is about consolidating all the knowledge build up from the previous activities into a formal proposal of a new version of the respective subject. During her internship the author was given the liberty and the responsibility of proposing improvements to the company's methods; consequently, new ideas were very much welcomed and appreciated by the team.

Finally, modifications must be validated before being acknowledged as the new standard to be diffused and followed by plants. The person to do so is the engineer in charge of the standard in the Central Team and with whom the author worked since the very beginning of the project. Clearly the last two activities are a crucial part of the project and iterations between them are necessary in order to achieve the last version of the method. Being in the critical path of the work, often it will be a blocking point since the author is unable to advance until the final version of the model is approved.

3.1.3. Target Audience Analysis

The target audience analysis step is fairly simple and should not cause much dilemma. Usually the target audience is already pre-defined by the client when they fill out the demand for the creation of the e-learning module. What needs to be clarified by the developer is the scope of the audience and their ambitions: is the final user a production employee that has already completed all basic WCM training courses? Are they managers revising theory for a certification? Or even someone who does not have any previous WCM education?

According to the final audience there are certain guidelines put in place by OneWorld that should be taken into account when developing. Identifying the learners' previous knowledge and expertise on the subject is important, as well as the amount of time available for e-learning and the context. Delimitating and categorizing the final user as much as possible can only help standardize and unify the training experience of the company's employees around the world.

3.1.4. Task Analysis

A very important task for a developer is to identify the detailed course content in order to achieve the proposed goals of the module. The content analysis is a prerequisite for developing learning objectives and the curriculum outline and it must consider the learner's conditions which emerged from the previous activity. In this activity the developer and the respective WCM Method Engineer work together to perform the analysis. This process helps the author to familiarize with the content; moreover, it forces the expert to work through each individual element and indicate the most important and challenging aspects to be considered. During this process, both have the opportunity to view the content from the final user's perspective.

In the first step the author identifies and describes the tasks that students should learn or improve by the end of the module to achieve the course goal.

The second step is to classify the tasks into two groups, as either procedural or principle-based. Procedural tasks are the ones that are performed by executing an ordered sequence of steps, whilst principle-based are tasks that require judgments and decisions that are made in different situations and under distinct settings. It can be argued that the most difficult tasks to carry out are those from the second group: more than execution, they require the capability of adaptation and sensible judgement from the employee.

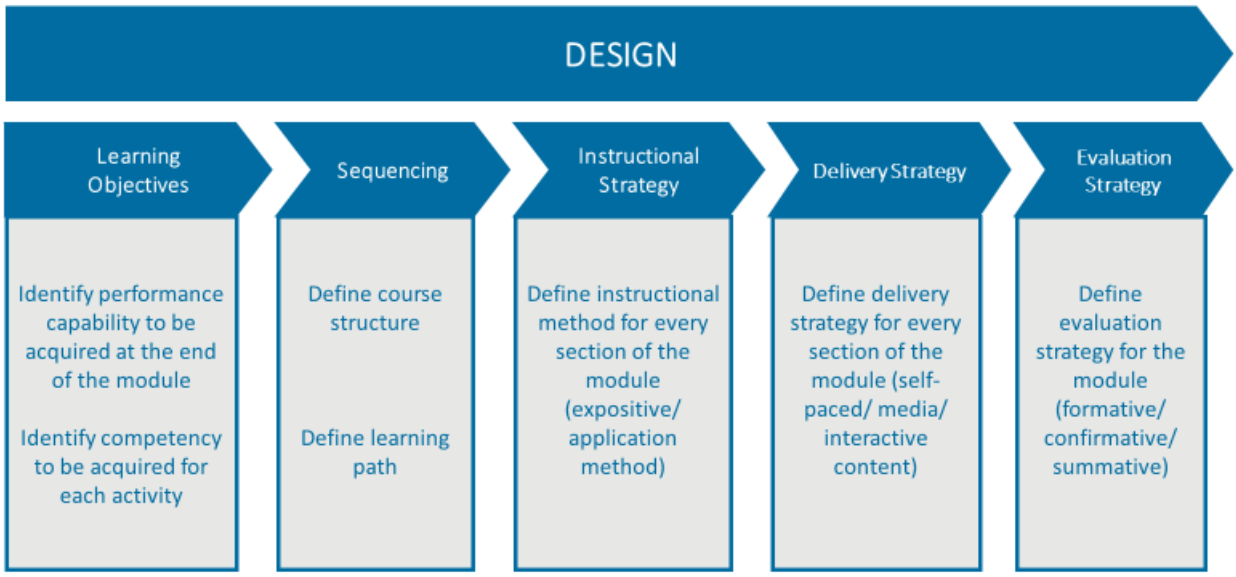
Once the tasks are segmented comes the step of breaking the up. They should either be broken into steps, for procedural tasks, or guidelines, for principle-based tasks. For complex tasks, that require the application of strategic or interpersonal skills, different points of view are necessary to formalize the instructions. That is why the previous knowledge from the interviews is once more useful because the developer has certainly asked the experts about their approach to challenging situations. Also, given the number of conducted interviews it is easier to look for commonalties among the various approaches to identify the skills that can help in those situations.

In the final step, the author identifies the knowledge and skills needed to best perform the steps or apply the defined guidelines. Once again, this activity is very much fruit of a collaboration between the developer and the engineers either in production plants or in the central methods team.

3.2 The Design

Through the activities and elements identified in the task analysis, it is possible for the author to translate the overall course goal into more specific learning objectives. The following figure shows the activities to be completed in order to attain the second step of the methodology:

Figure 16 – Activities of the second step



Source: Elaborated by the author

3.2.1. Learning Objectives

Objectives should be specified for the course as well as for each single activity. To facilitate the author's task of defining the learning objectives to each module, they are usually the combination of two main elements: the learning content and the expected level of performance. The learning content is, simply put, the type of knowledge or skills that must be learned by the end of the course, such as "how to deploy a Quick Kaizen". The expected level of performance is explicit through an action verb, such as "describe" or "explain".

Remembering Bloom's taxonomy of the cognitive domain, the objectives set by OneWorld are clearly at least on the second to highest level: the employee must not only understand, apply and analyze the new information, he should also be able to justify his decision-making process. Clear learning objectives allow the developer to focus on learning activities which are catered to learners' needs and provide the basis for exercises and evaluation tests. It is needless to say that the activities and test present in the modules should be aligned with the learning objectives and assess the same type of performance required.

3.2.2. Sequencing

Because the courses developed within this study were all in a job-oriented context, the main method used by the author is to follow the order of the actions to be performed in the real job environment. This is called the job-context principle (FAO, 2011). For instance, when defining the sequence of the module about the 5S method, it means that it will follow the order of the tasks to be achieved when genuinely deploying it on a production site.

Naturally, the courses will not be exclusively focused on the tool they aim to present; but they will also have content on more wide-ranging topics, for example, WCM and Continuous Improvement. In such cases, the proposed method will also make use of the zoom principle: the curriculum starts with a general overview, then focuses on specific topics, and at the end it goes back to the general conclusion. The outcome of sequencing is a course structure where each element corresponds to a specific learning objective and contributes to the achievement of the overall course goal.

Once the course structure is set and because, as seen previously, the modules in OneWorld are developed using a modular approach, it is time to define the possible learning paths that can respond to the different individual interests and learning needs. As said before, naturally the sessions will be displayed in the order that the tasks are expected to be achieved when using the WCM standard; however, it should be possible for a student to do a detour to revise a topic that was mentioned, should he feel the need to do so. For example, the course structure for the 5S module will follow the five steps in their order, but in the first step, when the tagging activity is mentioned, is should be possible for the learner to do a deviation and revise on the basics of the tagging process.

3.2.3. Instructional Strategy

Once the course structure has been defined, the developer must propose the best mix of methods and techniques for a specific e-learning course. According to the Food and Agriculture Organization of the United Nations (2011), there are three instructional methods that can be combined to design a module:

- **Expositive methods** - which emphasize “absorption” of new information. Expositive methods include presentations, case studies, worked adapted examples and demonstrations.

- **Application methods** - which emphasize the active processes learners use to perform procedural and principle-based tasks and build new knowledge. Application methods include demonstration-practice methods, job aids, case-based or scenario-based exercises, role play, simulations and serious games, guided research and, of course, project work.

- **Collaborative methods** - which emphasize the social dimension of learning and engage learners sharing knowledge and performing tasks in a collaborative way. They include online guided discussions, collaborative work and peer tutoring.

The method proposed for the e-learning modules in OneWorld is a mixture of the first two: expositive methods are used for acquiring information, to provide orientation and basic concepts before going into more practical and complex stages with application methods. As seen previously, the formation of a new operator requires peer tutoring as well, therefore, implying collaborative methods at a later time.

3.2.4. Delivery Strategy

When choosing delivery formats, three main factors must be taken into account by the developer: learner-related factors, technology aspects and organizational requirements.

The variants that should be considered about learners are their job position and available time. Since all modules produced within this study whose final users are mainly production operators, are to be translated into different languages, the developer should be aware not to use too formal of a language and attain to standard English. Also, when developing modules for other categories, one must remember that other than production operators, no one has an allocated fixed time to follow e-learning courses. As a consequence, contents should be kept compact and easy to break into different séances.

The technological aspects that are to be acknowledged are infrastructure, connectivity and learners' computer's capabilities. Because OneWorld provides the same basic infrastructure to all its plants across the globe, as a developer, there are no limitations to consider apart from following the guidelines from the company. It is important to remember that making use of several media does not necessarily improve the effectiveness of an e-learning activity. Good instructional design is more decisive to achieving learning effectiveness than special multimedia effects. For example, while interactivity is generally recommended, video and complex animations might not be required and could instead be replaced by a series of images.

Since time and budget are the main factor that will impact on the choice of the delivery format, and these decisions are not in the scope of the author's work as an intern, in this study organizational requirement and constrains will not be addressed.

3.2.5. Evaluation Strategy

It is important to start developing the evaluation strategy for the course from the design stage of the method. The purpose of the evaluations at the end of the modules is to measure the effectiveness of the training and learning immediately after the course has been implemented, or as it is called, a confirmative evaluation.

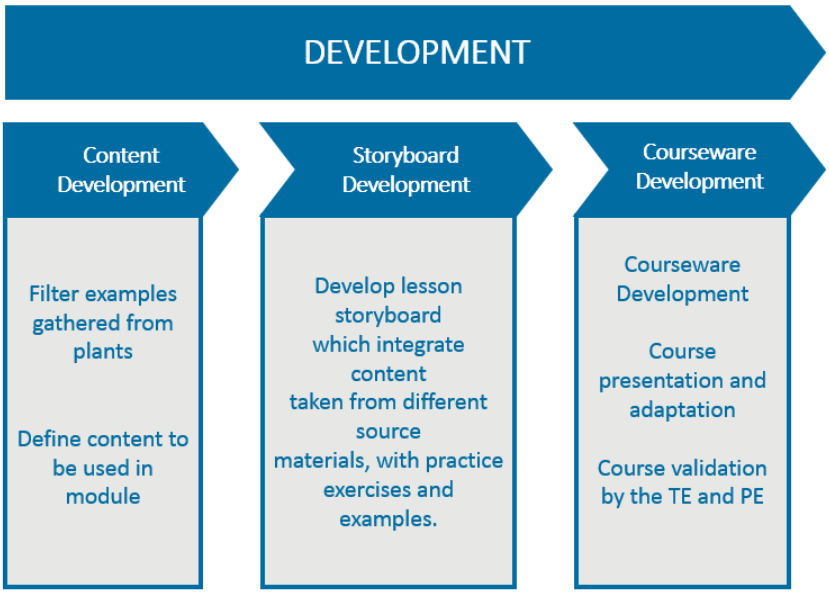
As a rule, it was decided in OneWorld that exercises are spread evenly during a module and the learner should be able to repeat them until the right answer is found, without penalty or being scored. At the end of the course there is always the evaluation scene that consists of a compilation of the same exercises; this time, however, only one chance is given and the student is graded at the end. The minimum score to validate a module is 80%. If the result is not satisfactory, the student needs to retake the course to have another chance to pass the evaluation.

3.3 The Development

The third and last step of the proposed methodology is the actual development of the e-learning module. Instructional techniques should be used creatively to develop an engaging and motivating learning experience. While e-learning content can consist of different elements, this section will focus mainly on the development of interactive e-lessons, since it is the chosen

method in OneWorld. The following figure illustrated the three activities to be completed in order to attain the last step of the methodology:

Figure 17 – Activities of the third step



Source: Elaborated by the author

3.3.1. Content Development

In e-learning, experts provide developers with the information and base knowledge they need in order to prepare the materials and activities. For courses where domain-specific knowledge and skills are demanded, which is the case of OneWorld, the technical experts must provide high-quality and definitive content. However, the extent of an expert's contribution can vary, depending on the amount and quality of existing material and their implication with the projects.

For the specific modules developed in this study, examples in the use of WCM standards were recovered from production sites. Moreover, visits to the different plants can be arranged in order to collect photographs or other illustrative materials. In addition to that, OneWorld, like any other multinational company, possesses plenty of technical documentation, training guides, presentations and reference materials that all developers can and should use as base. Therefore, the first activity of this step is to filter all gathered material to ensure that the content of the module stays relevant. After that, two situations can occur, as described in the following table:

Table 4 – Expert and developer's tasks after during development

If	The technical expert provides:	And the ID will:
Existing materials provide quality content sufficient to cover each e-lesson	linkages between existing source materials practice exercises and additional examples glossary terms and relevant descriptions. recommended reading and resource pointers	develop lesson storyboards which integrate content taken from different sources, with exercises and examples provided by the experts.
Existing materials do not adequately cover the content	core content to adequately cover the subject practice exercises and additional examples recommended reading and resource pointers	develop lesson storyboards which integrate content, exercises and examples prepared "ad hoc" by the TE.

Source: Adapted from Ghirardini (2011)

In either case, the experts must also review the storyboard and provide continuous support to verify that the developer has correctly interpreted the content. As a rule of thumb, a single lesson should not take longer to complete than 30 minutes to be completed by the student.

3.3.2. Storyboard Development

After collecting all possible content and having filtered examples, it is time for the developer to use instructional techniques, media and interactive elements to develop the lessons' storyboards. Also called scripts, storyboards are a screen by screen visual representation of what will consist the final e-lesson.

For each module is the developer's job to: review the content available, select the instructional technique which is more appropriate, determine the lesson's content sequence and, finally, create a storyboard which specifies which elements will appear in each screen of the e-lesson. These elements include: text, images and other media, interactive questions, "more information" windows, exercises, glossary and annexes.

There are several techniques to present content in the form of storyboards and they can be adapted to fit with the type of content and the desired instructional approach. Since the work presented in this study revolves around WCM standards and methods, the chosen technique is a mixture between storytelling and scenario-based approach. The former provides information through a story narrative which places content in a realistic environment and illustrates the necessary decisions to be taken; while the latter is about presenting information that is built around a scenario: typically, the scenario is a challenging situation in which learners are required to make decisions by choosing amongst different options, and feedback is provided to explain why their choices are correct or incorrect.

Lastly, it is an OneWorld standard to insert as many relevant exercises as possible within a module. The recommended ratio is that every three theory slides comes one consisting of an exercise. Therefore, practice and assessment questions are to be designed to reinforce the achievement of learning objectives. In job-oriented courses, which is the case, questions should be placed in a job-realistic context to build knowledge and skills that can be transferred to the profession.

When it comes to exercises, the developers are completely free to choose the style they think best fits the topic or task. The only imposed rule by OneWorld is that for each question they provide explanatory feedback; that is, after the learner responds to a question, provide feedback saying whether the answer is correct or not, with a succinct explanation as to why.

3.3.3. Courseware Development

Once the storyboards are ready, it is time for the developer to create the final interactive e-lesson. The authoring tool used by OneWorld is called Articulate Storyline and it is specific to developing e-learning courses. More on it will be seen in the next chapter.

The software is a template-based tool that offers a gallery of pre-built, default templates for different types of screens, both static and interactive (e.g. tests and question screens). OneWorld has its own set of templates for each type of module, and the developer's first task is to select the right template for each screen. Templates provide visual and cognitive consistency - all screens in one course will not be identical, but they will have very similar features, color schemes, themes, layout, etc. This system is beneficial for both course designers and learners.

Using templates and skins dramatically reduces production time and simplifies workflow. For designers this ensures that course elements are consistently and appropriately added in each screen, while learners become familiar with course elements and structure, thus avoiding unnecessary efforts while navigating from one screen to another (FAO, 2011).

The next task of this activity is a continuous one that overlaps the courseware development. It is according to the technical experts' availability that the developer will gradually present the module in course and receive feedback. The suggested modification should then be taken into account and usually, the expert, as the developer's client, will proceed to provide more specificity in his request. This step of verification and modification continues on until the expert is fully satisfied; that is when the developer receives the technical expert's validation. By then, generally the developer has already received the pedagogical expert's validation because he is the person to whom all developer's report on a weekly basis.

4 COMPANY INTRODUCTION

This section is a brief description of the subject-company in this study. The following sections will address the area of the company in which this study was conducted and the specificity of its WCM and E-learning programs.

4.1 The DTI

The International Technical Direction, or from the French *Direction Technique Internationale* (hereafter named systematically DTI) of OneWorld, located in Aubervilliers, France, has the function to give plants the necessary technical assistance and support to improve the quality of production. It is a cross-functional entity of the group that is in charge of optimization and follow-up of performances of production lines and that coordinates the industrial activities at a global level. It also defines the standards and objectives to be achieved by all plants.

The DTI counts with approximately eighty employees who regularly go to the various plants' sites to conduct technical consultancy, in situations that are either preventive (audit of lines), or curative (resolution of technical problems). It also has as mission to be a driving force in the application of WCM, its role being to spread best practice across plants. The central WCM team at the DTI is divided into four parties:

- The **IT team** (information technology) ensures database development and smooth running of all production and quality information, which feed the reports and dashboards of the performance team.
- The **Performance team** develops, in collaboration with experts, dashboards and reports that are used for production piloting. This visual system allows for a fast control of a plant's performance indicators.
- The **E-learning team** is in charge of developing trainings modules for managers and operators in all plants. The main objective is to propose fast training in order to reduce formation time of new employees, homogenize and transmit knowledge.
- The **Methods team** implements and develops the WCM method in OneWorld' plants. It creates and diffuses standards as well as best practice that allow to improve performance and eradicate losses. It is also in charge of audits and trainings in the plants to help them appropriate and set up the WCM methodology of continuous improvement.

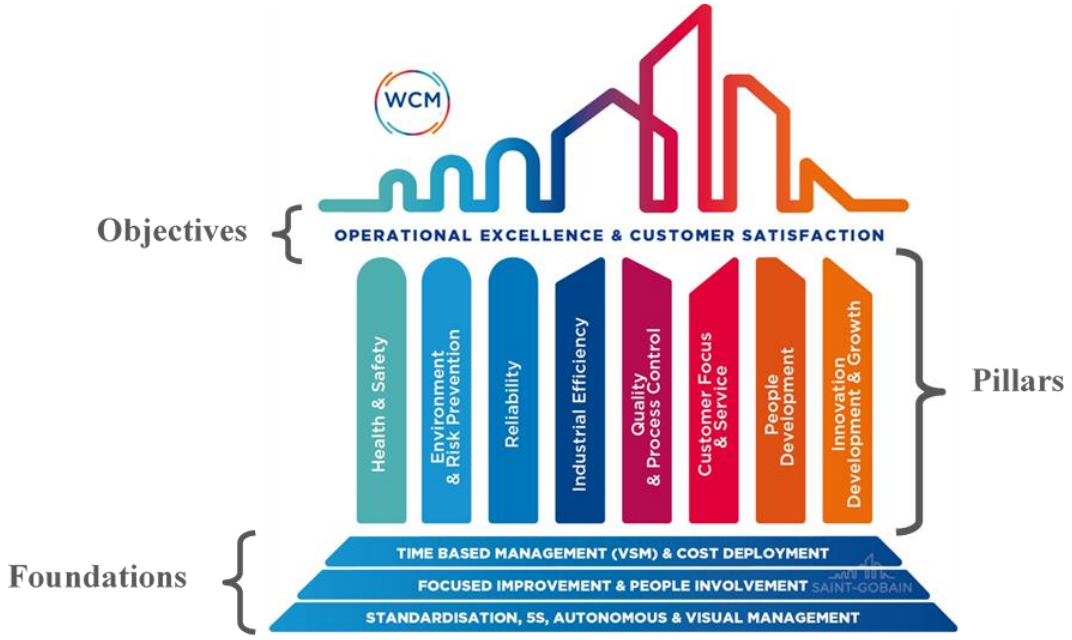
4.2 OneWorld's WCM

WCM was the program of continuous improvement chosen by the group OneWorld in 2007. To help with its implementation within the group, it temporarily called upon an outside consultancy company. Together, both companies created a program adapted to OneWorld's needs. As seen previously, even though World Class Manufacturing is a program that was designed specifically for one company, each variation is adapted to the needs of their user. The program that was created for OneWorld has two main objectives:

- **Operational excellence**
- **Customer satisfaction**

WCM thus defines itself as an approach allowing the group to outperform competition in the business, improve production quality, to therefore produce better-quality products whilst optimizing production costs. Indeed, production costs are closely linked to operational excellence and their reduction is of significant importance for the program. In order to achieve these goals, OneWorld' program has an approach based on eight pillars which represent the domains in which it must excel. These pillars allow for personal involvement from each individual in the group: it is the necessary condition to be successful in this method. In the interest of illustrating these eight pillars, the WCM temple illustrated in the following picture was created.

Figure 18 – OneWorld's WCM Temple



Source: Elaborated by the author

OneWorld's WCM Temple is based on solid foundations that allow, through the pillars, to achieve the ultimate objectives of operational excellence and customer satisfaction. In general, these foundations are based on standards tolls and methods of Lean Manufacturing, for instance the 5S, the 5Whys Kaizen, Visual Management and, first and foremost, involvement of all company's members in their level.

Since its implementation, the WCM program allowed OneWorld to gain 700 million euros, which represents about 2% of the group's turnover in 2016. The specificity of OneWorld's WCM is that it focuses on the company's losses which are treated as opportunities or, in other words, hidden treasures. Losses are defined as costs that do not bring added value to the products or to the customers. These losses cannot be all eradicated but the segment that can is the one in which WCM is interested in. Therefore, in each one of the eight pillars of the temple, losses are eradicated in a three-step process:

- **Identification** of losses: detailed data analysis, highlighting of losses, determination of their possibility of reduction, prioritization and proposal of solutions. In that purpose, it is common to make use of Pareto charts.
- **Eradication** of losses: reduction of losses step-by-step following the procedures. These procedures, called "routes" determine every single step to be followed in order to eliminate each type of loss.
- **Prevention** of losses' reappearance: introduction of a follow-up system with diffusion of best practices that ensure the definitive extinction of losses.

4.3 E-learning program

OneWorld' e-learning program, which, for confidentiality reasons, will remain unnamed, is affiliated to the "People Development" pillar of WCM. It was introduced in the company in 2001, in a pilot plant in Mexico, to face a significant problem: the plant had an expressive operator turnover, and time dispensed in training of a new employee was significantly long.

At that time, employees spent three months in training period for, on average, a year within the company. Operators' training was carried out under the tutelage of a team leader or a more experimented operator. The extension of the training period implied inevitably a reduction in time spent in production tasks not only from the new employee but also from his/her tutor. Another problem associated with tutored formation was the standardization, or better yet, lack

of it. When it comes to ensuring training to all the different plants around the world, standardization is a vital criterion that needs to be taken into account. The quality of an employee's training needs to be certified by all plants in order to fulfill the requirements in terms of quality, deadlines and costs of production. The targeted objective for the pilot-project in Mexico was to reduce training time by 50%.

With the success of the pilot-project, the program was expanded in 2003 to all OneWorld' plants. The objectives and the contents of the program were adapted to correspond to a population of experienced operators, that were already in position for several years, and who did not necessarily understand the interest of revising certain theoretical notions of their function. De facto, an internal survey conducted on the skills of these operators revealed that they rarely knew the reasons behind daily basic tasks inherent to their job. In these plants, emphasis was put on an initial theoretical training and on a continuous training that dealt with more difficult-to-manage situations. Hence, the e-learning program is organized and deployed in very different ways according to the seniority of the plant and the experience of its operators.

The program grew, evolved, and at the moment involves all operators working on the 25 OneWorld plants worldwide. Every year, about 3000 people are trained, supervised by 22 project managers and around 30 developers.

The program has three main objectives. The first is to make new operators autonomous in normal production situation as quickly as possible, that is, ensure that they know how to perform basic technical tasks, and, in abnormal situations, to be capable of solving simple and/or common problems. The operators must acquire knowledge in the following fields:

- Technique (machinery operation, use of informatic systems)
- Quality (identify glass defects)
- Safety (own behavior and towards others)
- Notions of productivity and yield
- Fundamental Knowledge (glass-making process, properties of the product)

Another purpose of the program is to formalize the experience which experimented operators acquired. For that purpose, best practices are identified then listed so that it can be distributed and broadcasted to all plants. In this way, operators have access to references, which they can consult promptly, as needed.

Finally, the third objective of the program is that, on similar production lines, regardless of their geographical location, the same technical tasks are performed. This facilitates communication and exchanges between the various sites of the group immensely, which can only be positive.

According to managers that were active in the implementation of the program from its genesis, the idea was to develop a training that included a part of tutored formation - in the workplace - and a part of e-learning. The latter, performed on computers from standard contents created by the central developers, does not replace the tutelage of a more experienced operator. However, it allows to partly form the operators, thus reducing time and costs associated with training. The contents are therefore created in English by the central developers at the DTI, then transmitted to the local developers attached to the various sites, who then are in charge with the adaptation and translation of the modules. Once translated, the contents can then be used in the plants for training of the concerned operators.

4.3.1. Articulate Storyline 2

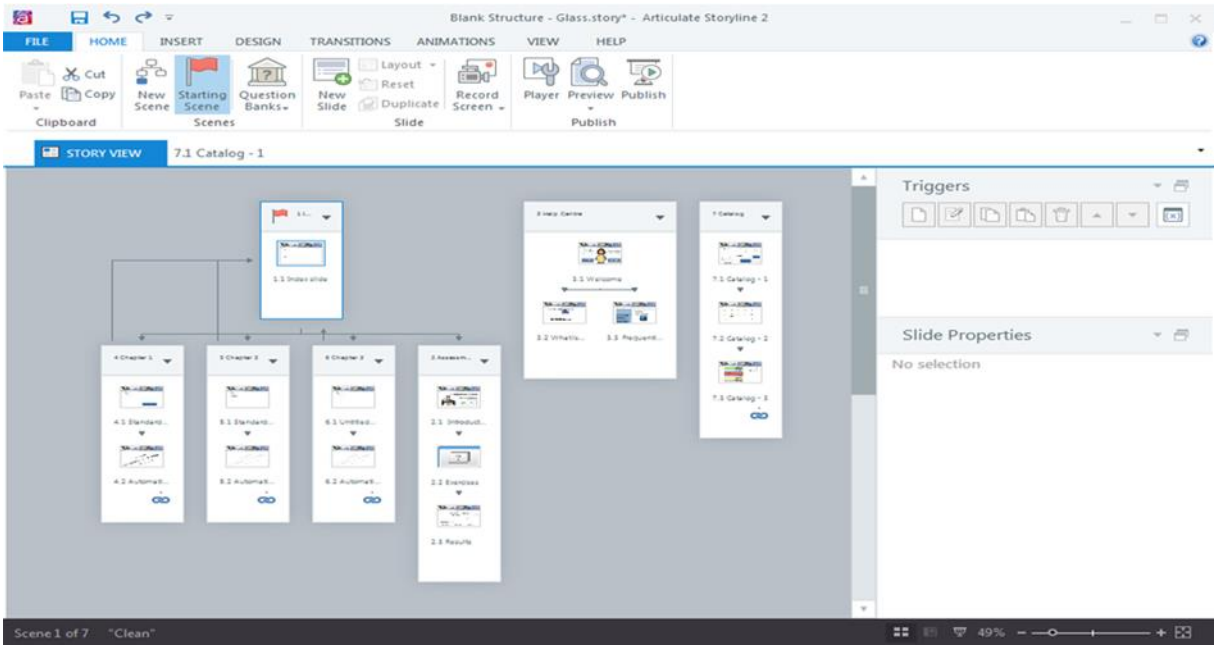
OneWorld' software of choice to create e-learning contents is Articulate Storyline 2. This software, designed especially for the creation of e-learning modules, allows for the necessary interactivity of training contents.

The structure of an Articulate Storyline file is divided into two levels: the contents are written on slides which, in turn, are grouped into scenes, generally thematic, resembling chapters of a book. Once the various scenes are created, it is then possible to organize them, by choosing, for example, a viewing order by the means of bridges from a scene to the other. In this way, at the end of the slides of a scene, the learner is automatically redirected towards the following one, or sent back to a previous scene. In a more general way, Articulate Storyline allows for ease in the navigation within the various levels that compose the file, by means of triggers (buttons, indexes, links and automatic cross-references), that allow to pave out very precisely the route of the learner. Once finished, an Articulate Storyline file must be published, to be able to be seen by the learner, who will then have no access to the interface of management/creation of content, but will view only the contents in full screen, as a slide show.

Within OneWorld' e-learning program, it was decided, as a standard, to keep only two levels in every file. First, an index slide, which allows the learner to access the various thematic scenes

constituting the second level. At the end of every scene, the learner is then automatically sent back towards the index to continue the course. This can be noticed on the following figure, a demonstration of the structure of an Articulate Storyline file: the first scene consists of one single slide (the index), which is decorated with a red flag. This red flag specifies the departure scene, in other words, the one which will be seen first by the learner. Below the first level, it is noticeable the various thematic scenes, accessible via the index, and at the end of which there is an automatic slide rerouting towards it (bridges between scenes are illustrated by arrows).

Figure 19 – Articulate Storyline 2's interface



Source: Elaborated by the author

The specificity of the software is also attested in the diversity of objects which are possible to incorporate into a slide: as on PowerPoint, it is capable of adding photos, videos and flash animations; but also, buttons (with diverse functions, which can also be manually configured), and screen video records. Finally, Articulate Storyline 2 allows to integrate into a file numerous exercises, in the most diverse forms possible. The software supports the creation of evaluations and to register the respective scores. These features are obviously quite interesting in the training content's creation framework, and thus very used.

The modules are managed by a knowledge management system which will remain unidentified for confidentiality. MKT² Pass, on which every operator can connect with an account of his/her

own, what allows to register their results. It is an intranet database which records automatically the various parameters of each training session attended by an operator on site. Every operator can therefore connect through a unique account and follow training programs adapted to his/her skill level. OneWorld' e-learning program is used by all operators, with the objectives of the training program being adapted to their skill level.

4.3.2. The Team

In order to introduce the team involved in an e-learning project within the company, this study adapted the terminology and definitions used by the Food and Agriculture Organization of the United Nations in its Guide for Designing and Developing E-Learning Courses (2011). Naturally, the composition of the team varies from project to project, however a few roles are consistent and required to perform the ADDIE model's activities:

- E-learning Global Manager

  This managerial-level person conducts needs and audience analyses before starting the e-learning project, coordinates all activities and roles in the different stages of the process and evaluates the degree of transfer on the job and the results for the organization/institution. The particularity in OneWorld is that this person, working at the DTI, coordinates all e-learning projects taking place in all production sites.

- E-learning Developer (ED)

  EDs are responsible for the overall instructional strategy. They work with managers to understand the training goal, collaborate with TEs to define which skills and knowledge need to be covered in the course, choose the appropriate instructional strategy and support the team in defining delivery and evaluation strategies. EDs are responsible for designing activities and materials that will constitute the e-learning course, including storyboard development. At this stage, content provided by TEs is pedagogically revised and integrated with instructional techniques and media elements which will facilitate and support the learning process. At the DTI all EDs are engineering students working on their final-year internship; however, in most of the 25 sites of the company the EDs are also the local e-learning project coordinators.

- Technical experts (TEs)

TEs contribute the knowledge and information required for a particular module. They collaborate with EDs to provide the technical material necessary to be included in the modules, and validate the technical content before the module is published. In OneWorld, TEs are engineers working at the DTI and whose main function is to provide technical assistance for all plants of the group around the world.

- Pedagogical expert (PE)

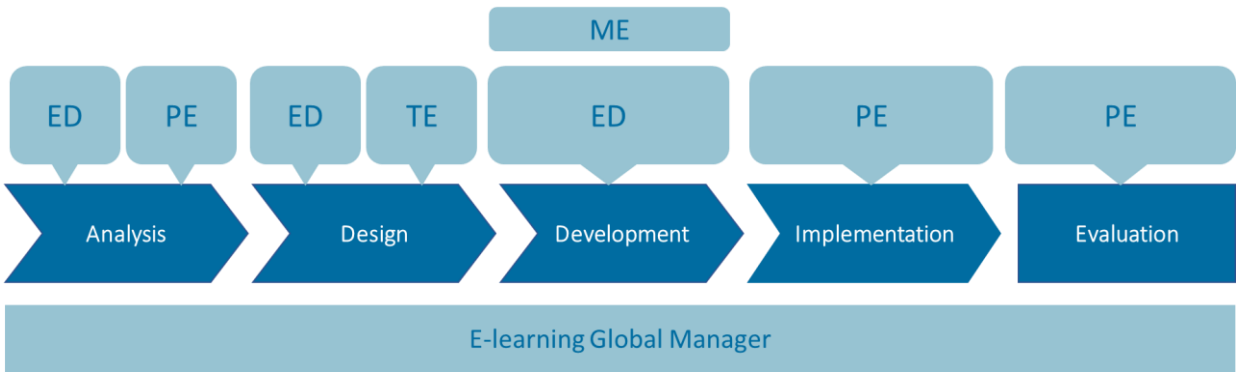
The pedagogical expert works at the DTI and is responsible for validation of the pedagogical element from the e-learning modules developed in all 25 plants of the company. His role it is also one of support to the Global Manager in the coordination of all e-learning projects and, at the DTI he is the one to whom all Central Developers must report to; making him responsible for all content developed at the central.

- Media editors (ME)

Media editors are responsible for developing self-paced courses; they assemble course elements, develop media and interactive components. OneWorld works with self-paced courses exclusively for modules destined to managerial positions. However, in specific modules, media editors might interfere to help develop media for other modules, as it was the case in a project that will be described later in the study.

These roles are attributed to the ADDIE process as illustrated in the figure bellow:

Figure 20 – Areas of responsibility for key roles in the ADDIE process



Source: Elaborated by the author

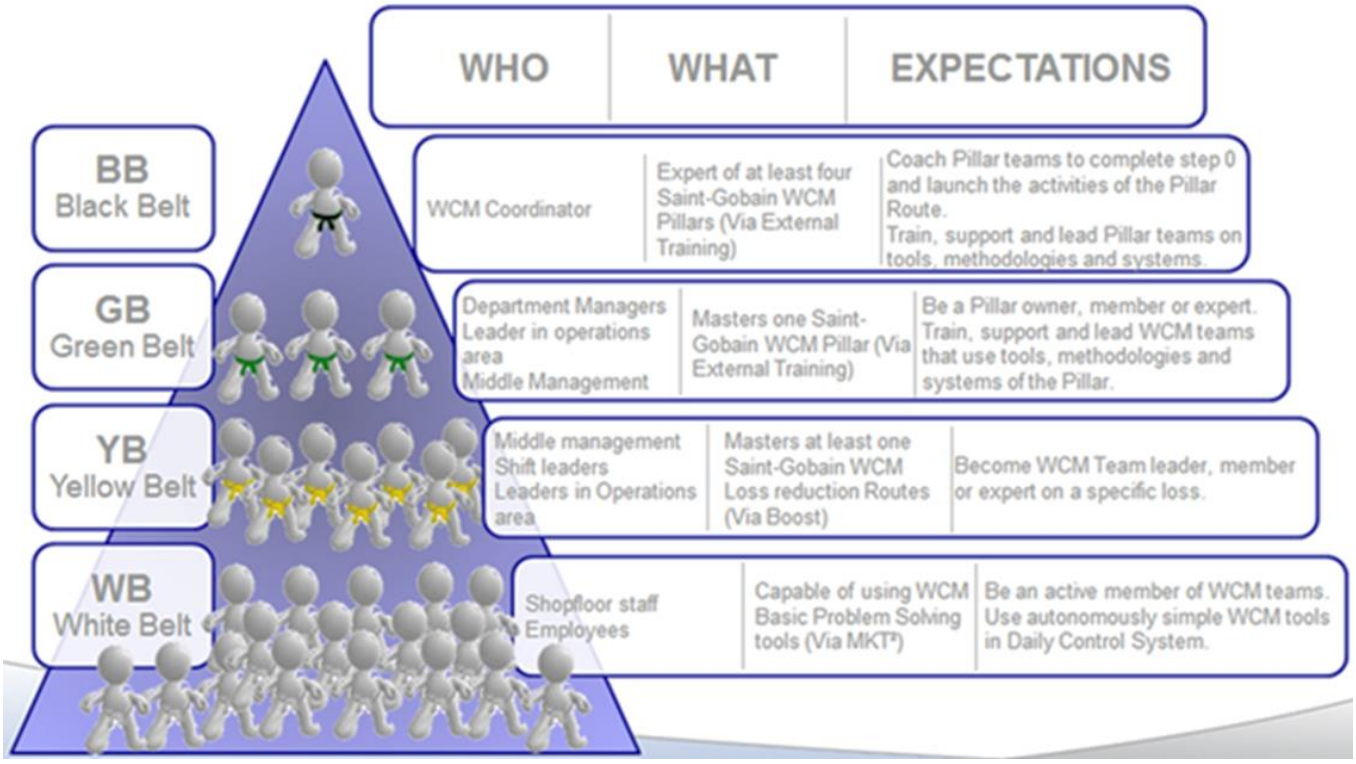
4.4 The WCM hierarchy

As seen previously, one of the bases of WCM is the involvement of all members of the company at their own level. To organize into a hierarchy the actors of the program according to their Lean Manufacturing knowledge, levels of "know-how" were defined. The OneWorld staff can obtain a Quality Belt certification recognized in the industry for which there are four levels of certification:

- Black Belt: employee certified in at least four pillars of the WCM temple
- Green Belt: employee certified in one pillar
- Yellow Belt: employee certified in at least one loss reduction route of one pillar
- White Belt: employee capable of using the basic WCM tools

The following figure describes the four levels of belt recognized by OneWorld, who they are destined to, and the capacities expected from its bearer.

Figure 21 – The WCM Belts



Source: Elaborated by the author

To obtain the White Belt certification, it is only necessary to validate the corresponding training modules. The courses to obtain this certification will be further developed in detail in this study. However, in order to obtain a Yellow Belt, a more robust path is expected to be pursued.

WCM aims at spreading a philosophy of performance improvement. To do so, continuous improvement projects are launched on OneWorld sites through Yellow or Green Belt certifications, in order to validate the theoretical training done by an outside body (allowed to certify Yellow, Green, and Black Belts). These projects, whose target is to optimize production performance and considerably reduce waste, allow to observe a clear improvement within a plant and to generate gains due to loss eradication. It also favors the involvement of the production staff in the continuous improvement approach fixed within the WCM framework.

However, the Green Belt certification based on one of the pillars of the WCM temple carried out by an outside body remains very expensive, which goes against the cost reduction culture that the company strives for. To spread, more effectively, the continuous improvement approach in plants, the idea to combine at the same time the Green Belts know-how and e-learning via OneWorld' successful e-learning program came to light.

Since a few years ago, OneWorld fixed the objective to train Yellow Belts in-house. In that purpose, the company created an internal training program composed of a theoretical part (the e-learning modules) and a practical part, which consists of leading a continuous improvement project in a production site.

All profiles (operators, technicians, managers) within the company are apt to be formed and certified Yellow Belt. To do so, they must be selected according to their skills, their availability and experience in the spectrum of the WCM structure, as well as naturally, have concluded the White Belt modules. The WCM formation to certify Yellow Belts is in agreement with the basic training of Belts according to Six Sigma. Currently, the Green and Black Belts certifications are reserved for engineers and managers.

To be Yellow Belt certified, two elements need to be completed:

- Validate the theoretical e-learning training associated, by obtaining a score of more than 80% of good answers in the evaluation.

- Deploy a practical continuous improvement project in a plant, implementing on a production line what was studied during the theoretical part.

Immediately upon obtaining the minimum score of 80% in the theoretical evaluation the candidate deploys his on-site project. Once the continuous improvement project is evaluated by his tutor (a Green or Black Belt), and scores no less than 80%, the candidate is qualified to defend his project in front of a panel. This panel, which will judge if the candidate will obtain the certification, comprises the tutor, the person in charge of the concerned WCM pillar, the plant manager and one Black Belt. Therefore, to be certified Yellow Belt, the candidate will have to follow a process divided into three stages, as follows:

1) Theoretical training

Consists of modules based on the loss reduction methodology of WCM, on the problem solving or improvement tools and on the WCM projects already completed in plants. The modules are created by the e-learning program, allowing for a simple, fast and less expensive training. This study will go further in detail about these modules in the following sections. To make sure that the candidate validated the theoretical part, exercises distributed throughout the module allow to create a final evaluation, which one must succeed in, as previously explained. This theoretical training consists of e-learning modules that, in total, should last approximately 10 hours. Ideally, the modules are to be completed within the first month of the Yellow Belt process.

2) Plant project

This project should be deployed by the candidate, supported by a tutor certified on the pillar concerned by the training. This continuous improvement project applies directly the theoretical course and allows for a regular follow-up of the guardian. It consists of deploying a continuous improvement demarche in an area of the production site, like a 5S or a Major Kaizen, and it usually lasts for at least three months.

3) Evaluation

When the candidate obtains the minimum score of 80% on the theoretical evaluation and on his on-site project, according to the score of his tutor, he can present the results of his project in front of a jury to obtain the certification. This panel, composed by the tutor, the person in charge of the pillar, the plant manager and the Black Belt (internally or externally recognized to certify Belts), if successful, will officially sign the Yellow Belt certificate.

5 WORK DEVELOPMENT AND RESULTS

This chapter consists of the application of the previously proposed method and the presentation of the consequent results obtained in the development of e-learning modules in the WCM Methods. For every course it was first conducted the analysis, followed by the design, and the development closed the author's work on the project. In order to better structure this study, each one of these steps will be presented under every project section.

5.1 White Belt

As previously stated, the White Belt certification is the first level in the WCM hierarchy and it validates that the employee is capable of using the basic WCM tools. In order to attain this certification in OneWorld the employee has to pass two e-learning courses about common standards and practices that are very useful on a production plant environment.

The first module is called Toolbox and, as the name states, its goal is to introduce the student to a number of basic apparatus that can be used to reduce waste or solve problems. The second module is the Quick Kaizen, whose objective is to educate the learner on how to use the eponym tool and when to deploy it.

5.1.1. Toolbox

The Toolbox module curriculum encompasses six subjects: 5W+1H, Cause-Effect diagram, Pareto analysis, Tags, One Point Lesson and Daily Control System. In order to limit the subjects to address in this section, only the development of the 5W+1H, Cause-Effect diagram and Tags will be presented in this study. These three were chosen because they are either mentioned or a component of other modules that will be introduced.

As stated by the proposed methodology, the first step of a module development is the need analysis. The demand to develop this course comes from the WCM Methods team after it was noticed that production operators lacked basic skills on the deployment of standards and problem-solving tools. Because these three basic tools are a part of other standards and very rarely applied on their own, real examples from plants were not gathered specifically for this project. However, it is important to tackle this knowledge gap because not only are plants noted on their WCM level during audits, ultimately the goal is to contribute to the continuous improvement culture and waste reduction.

The next step in the standard analysis. Since the tools are basic lean techniques and not specific to OneWorld, it would be a waste of time to try and develop new methods of deployment or practice. The interviews with the WCM Coordinators and Central Engineers were mostly in the benefit of cementing and validation of the author's knowledge on these theories.

As for the target audience analysis, even though the Toolbox module is specifically designed for production site operators, it is highly recommended that all plant employees validate the modules as a part of the continuous improvement demarche put in place. Therefore, the examples used during the course of the module will be mostly factory-environment based; however, the instruction is that they should be generic enough as to be comprehensible to all types of job description.

The final activity of the analysis step is the task analysis. The tasks that students should learn or improve at the end of the module are how to properly deploy and make use of all six tools listed previously. For each one of the tools it was stablished the sequence of tasks to perform (procedural) and the decisions that need to be made in order to complete them (principle-based). The identification of the knowledge and skills needed to best perform the steps or apply the defined guidelines was pursued in collaboration with the Methods team.

Then comes the second step. The first activity is to identify the learning objectives for each section. Clearly the objective is to, by the end of the module, the learner will be at the last to highest performance level of the cognitive domain on every addressed subject. Nonetheless, the ultimate objectives of deploying a 5W+1H, Cause-Effect diagram and Tags are, in a corresponding sequence: to formalize and improve organization and working methods, classify and display the causes of any type of effect, and, highlight anomalies on machines.

Next, when it comes to sequencing, the method to define it was the job-context principle: within every section, the tasks are presented in the order to be performed in the real job environment. The learning path definition was facilitated by the fact the modules are structured in a modular approach: in this particular course, where the tools are neither correlated nor depend on the know-how from one another, it was decided that the student should be able to stablish his own learning route. Therefore, the module allows for the learner to choose the order of the sections to be completed. Nonetheless, it is important to note that once the student has chosen a section, it needs to be completed in order to validate it; if one leaves it in the middle to go back to the index page, one will have to start the section over once he/she decides to go back to it.

The following activity is to define the instructional strategy. Seeing that the module is mostly about teaching the correct way to make use of the tools, therefore the emphasizing the absorption of new content, the Expositive method was chosen. As a reminder, it includes presentations, case studies, worked examples and demonstrations.

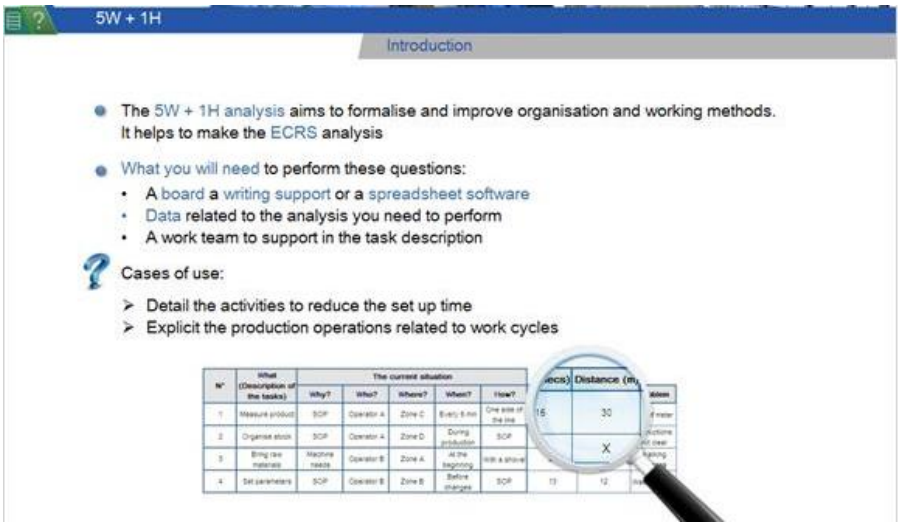
Ensuing comes the delivery strategy. For the Toolbox, because the goal is to reach as many people as possible without facing obstacles or limitations, the delivery strategy will be the standard chosen by OneWorld for its MKT² program: simple, clear and concise e-learning courses, that are a mixture of text and real-production examples which speak to everyone.

Finally, the last activity of the Design step is defining the evaluation strategy. As previously stated, OneWorld has decided on the same evaluation strategy for all its modules, therefore this specific activity will be skipped in the description for the next courses presented in this study.

The Development step ensues. The first activity is content development and because no examples were gathered from plants for these very basic tools, since they are integral part of more complex standards, the basic theory comes from Lean Management. The fact that there were no real examples is convenient for the simple reason that the course needs to cover six different tools and it needs to stay within a reasonable time limit.

Following is the storyboard development. In order to facilitate development and, seeing that is unviable to wait for the expert's validation to commence the courseware development, the author decided to develop the storyboard directly with Articulate Storyline.

Figure 22 – 5W+1H scene storyboard

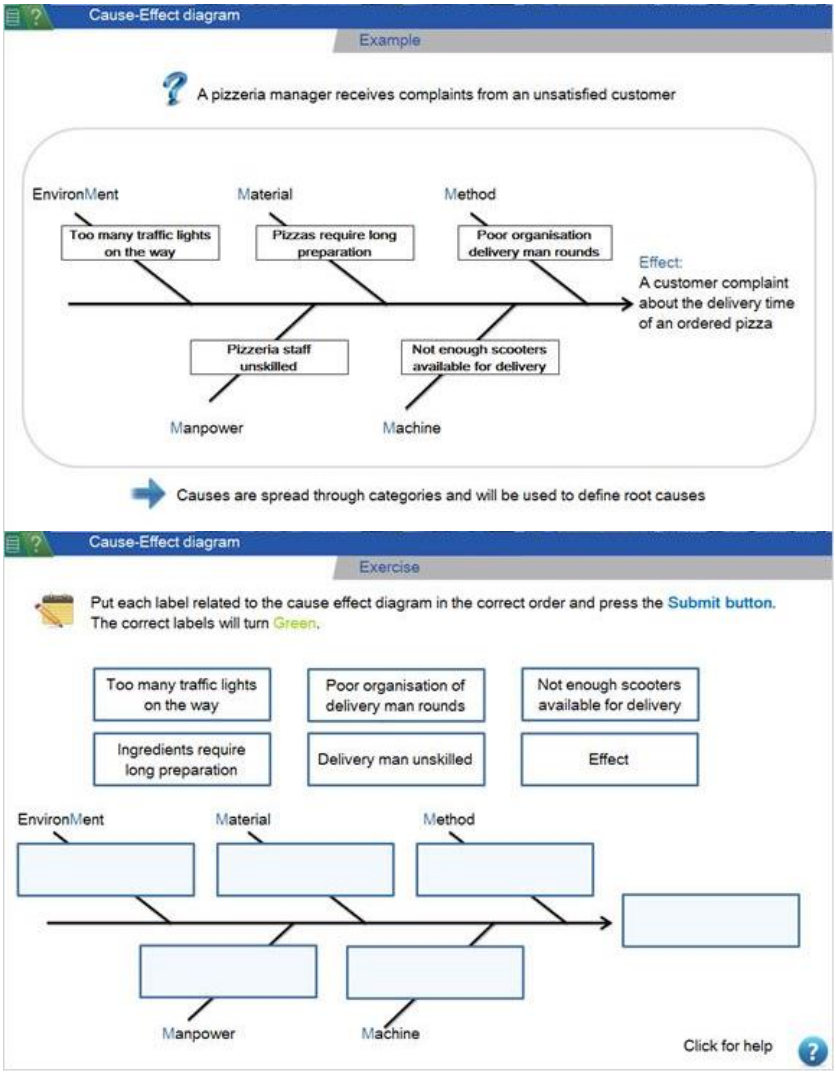


Source: Elaborated by the author

The previous figure is an example of the storyboard from the 5W+1H tool scene. As it can be seen there are elements that needed validation (indicated by the question mark) before being officially settled in the final e-learning course. The magnifying glass suggests that the following slide will be a closer look into the given example. As this would be the very first slide into the tool scene, it is clear that an inductive approach was chosen for this particular example: first, stimulus of thinking and reflection before providing definitions and principles.

Given that there is a long path to pursue with several different concepts to be presented, the author made the choice of placing maximum two exercises per scene. The following figure is an example given in the Cause-Effect diagram scene, which, in the following slide was transformed into a matching exercise.

Figure 23 – Cause-Effect diagram example and exercise slides



Source: Elaborated by the author

The last activity, which, as seen, overlaps the previous one, is the courseware development. For this module, the course adaptation and validation were made quite swiftly: there were not many adaptations to make and the Technical Experts were satisfied by the examples and exercises proposed. The final version diffused to the plants consists of 42 slides and should take no longer than 30 minutes to be completed.

5.1.2. Quick Kaizen

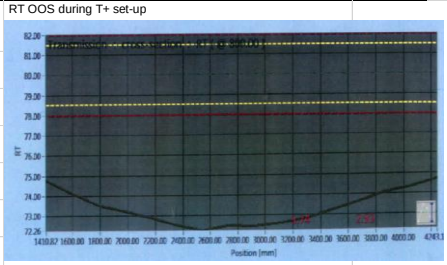
The Quick Kaizen is the second module to be completed in order to achieve the White Belt certification. It is one of the simplest problem-solving tools and should be used when the problem can be identified relatively easily. Being part of the White Belt certification route, the demand for the development of this e-learning course comes in the same context that the Toolbox module. However, this time, he first activity was be more robust seeing that examples could be collected from the different production sites.

Figure 24 – Quick Kaizen from production plant

Quick Kaizen Sheet	QK No:	Area:	Equipment:	Lead By:	Assisted By:	Date Started:
	8_17	Coater	Coater process	SP	MB	21.01.17

1) Problem sketch & description: (80% sketch & 20% words)

RT OOS during T+ set-up



2) List the possible causes of the problem:

1	Vacuum not ready
2	NiCr (compartment/target/shields)
3	Thicker Ag
4	Water not-released inside the Coater
5	
6	
7	

4) Action plan to remove problem: | 5) Date Complete:

	Action (Risk Assess First)	Who	When	Done?
1	RGA3 - to be send for repair	CN	10.02.17	
2	RGA3 to be replaced with RGA4 (CP29)	DH/MG	after T+ production(26-27.01.17)	Y
3	Update "Post SD handover sheet " with RGA /H2O partial pressure target ≤2E-5	SP/TG	6.02.17	
4				
5				
6				

3) Verify which possible cause is a real cause:

	What to Check	How to Check	Findings	Cause?
1	Check base pressures	Use IFIX /printouts	CP 28/31 -water leaks ; not burnt in	Y
2	NiCr monolayer	Aim for TL=75%	17 A	N
3	Sheet resistance /homogeneity (ΔRsq =0.7)	NiCr -try 3 different current levels (18A,19A,20A)	19 A (ΔRsq =0.15)	Y
4	RGA's readings (RGA2 =CP10 ; RGA 3=CP18)	Water partial pressure content ≤ 2E-5	RGA 3 Not working ; RGA2 H2O higher level	Y
5				
6				

Source: OneWorld production plants

The demarche to collect examples from production plants follows the same steps for every module in this study: contact the WCM coordinator of all concerned production sites via e-mail; if there is no answer within a week, contact again until one receives an answer. Then, the good and the bad practices must be dissociated. Some poor manners can be easily spotted: a

neglected case, an illogical answer, a deadline missed. The hardest part of the first activity to pin-point is quantifying losses because not only is every example different, the context and environment in which the problem happened have to be taken into account. In the figure above the problem was machine-related, could have been prevented had a maintenance routine caught it, and, consequently, made for lost time.

Moving on to the next activity, ideally one will have already established contact with the local WCM coordinators in several distinct factories. Therefore, interviewing them should not be an obstacle: either by phone, Skype or mail, most of them are open to answer questions and very helpful in understanding what sections of the standards are not adequate to the everyday life of a production site. With that invaluable information, one can spot gaps between what is demanded on paper and what is appropriate for a plant environment.

In the case of the Quick Kaizen, after collecting several dozens of examples from different locations the author realized that, more often than not, real root causes of the problem were simply forgotten. Indeed, although it was quite rare to come across examples where no root-causes to the problem were identified, oftentimes, with problems that could come from several sources, one of these was commonly neglected. Therefore, the author proposed a new standard, that would force operators to brainstorm possible causes before officializing them on paper: the addition of a Cause-Effect Diagram in between steps one and two.

The arguments are that, by encouraging the team to contemplate the most common areas where a problem can be originated, that is, the 7M's categories of an Ishikawa diagram, oblivion is diminished and all possible branches are developed. As a reminder, the categories are Mother Nature, Man-Operator, Man-Management, Machine, Method, Material and Measure, and allocating ideas to them makes for a more structured brainstorming end-result. Because the original standard adopted by OneWorld used all available space from the front of a A4 paper, the author suggested that the Cause-Effect Diagram should be formalized in the back of the same sheet. However, an indication would be made in the front that this additional step should be completed by turning the page.

After presenting the proposal to the central Methods engineers and making a convincing case for it, the new standard was validated. The author was allowed to make the necessary modifications, prepare communication and diffuse the new version that is to be taken-up by all 25 production plants around the world. The new standard of the Quick Kaizen tool, with the Ishikawa Diagram can be found in Appendix A.

Following, the target audience analysis is the same as for the previous module. Even though the Quick Kaizen can be applied to innumerous scenarios and in different settings, in this particular case, all present examples are real-life and happened in production plants.

Lastly, one enters the final activity of the analysis step. The first endeavor of the task analysis, identifying and describing the tasks that students should learn or improve at the end of the module, has an end-result which is quite simple in theory: master the steps of using a Quick Kaizen. In general terms, the steps to do so are procedural, that is, they must be executed in the ordered sequence of the standard. However, when one dives into the nuances of each section, every step requires the team to step back and put things in perspective, making judgement and decisions that are distinct depending on the context. For example, listing the possible causes of the problem, which is step three of the new standard, is a procedural task that can be considered a formality after having finished the Cause-Effect diagram, clearly a principle-based activity.

Since the module is based on an already very structured problem-solving tool standard, the following activity of breaking up every step into guidelines was more or less complete: it was only necessary to follow the instructions regarding every part of the tool and its implementation, and demand clarification from the Methods team in sections that left room for doubt.

It is important to point out that the knowledge and skills needed to perform the steps properly in the courses leading to the White Belt certification are inexistent. There is no need for previous education or expertise in any of the tools, not even in WCM, and, better yet, when the learner comes without antecedent, it ensures that no mannerisms or old habits might interfere with the results. All necessary knowledge will come from the e-learning courses and only practice will cement the information acquired. Havin said that, the Analysis is complete and now it is possible to move on to the Design.

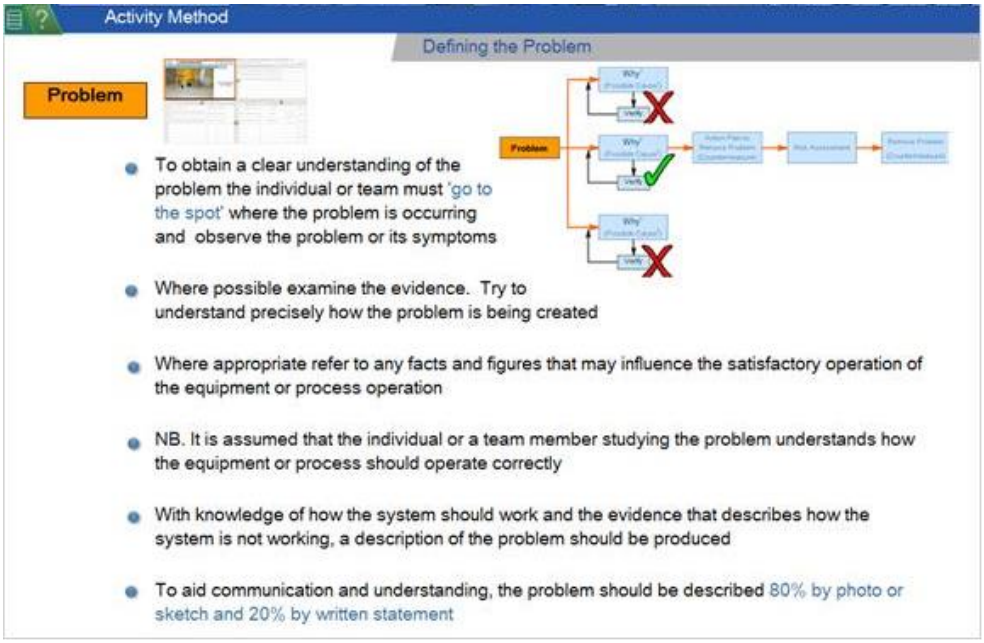
The learning objective of the module is for the learner to be able to analyze and correctly deploy a Quick Kaizen. Looking at the bigger picture, by correctly using the tool, the student will find the real root cause of the problem and will therefore be able to correctly eradicate it by deploying the appropriate countermeasures.

As far as sequencing goes, nothing changes from the Toolbox module: in every section, the tasks are presented in the order to be performed in the real job environment, following the order stablished by the standard (job-context principle). However, differently from its counterpart,

the modular approach does not prompt for great added-value: the learning path should be the one decided by the developer; that is, in accordance to the sequence of the standard.

The next step is to define the instructional strategy for every section of the module. Because the course is mostly about presenting new information to the student, the vast majority of slides will be based on Expositive methods. One example can be found in the figure below, where the slide essentially consists of text.

Figure 25 – Slide based on Expositive methods



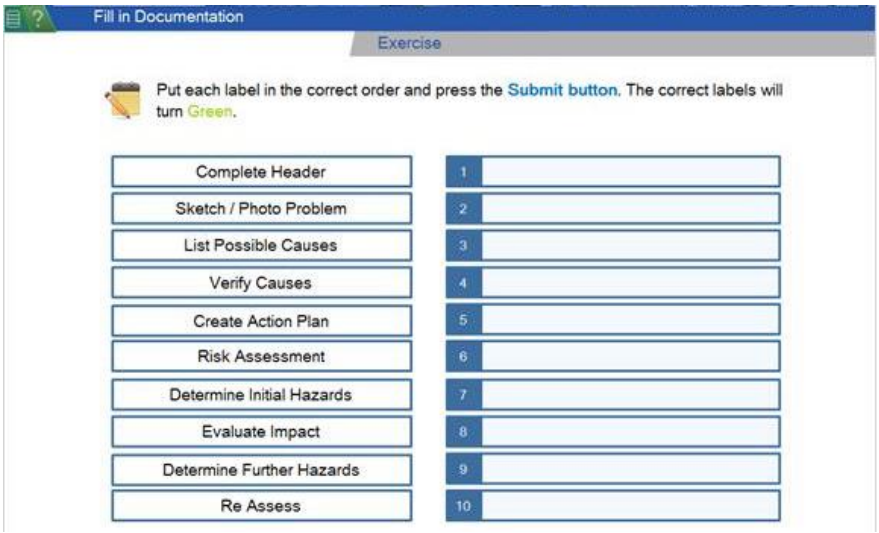
Source: Elaborated by the author

Next, it is time to define the delivery strategy. It follows along the lines of those defined for the previous course. All the same, something to add to the Toolbox paragraph regarding this step is that, OneWorld, at the very beginning of its e-learning program implementation, decided that courses devoted to operators would not make extensive use of animations and dynamic slides. This is due to the fact that modules need to be translated in several languages and, having to constantly verify animation paths and relationships would greatly decrease developer's cadence. Also, by choosing to keep the design of the courses quite simple, the company made it easier for its developers to attain to the defined standard, consequently placing the student in a familiar learning environment.

As formerly stated, the evaluation strategy remains alike for all modules, hence why this study will go directly to the Development phase. The first activity, filtering the examples gathered from plants, was quite time consuming and onerous. Indeed, if the first module had no real examples from production sites, the Quick Kaizen was, overwhelmingly, the one which most examples could be harvested. That is because it is a very basic problem-solving tool, one which all collaborators should be able to deploy once they face an issue, and, consequently, one that has innumerous plant examples. What makes this activity laborious is that, the task of examining and separating all of them either in good or bad is not binary: each section must be analyzed on its own, according to its circumstances, and judged as liable to be used as or not. It might not seem evident, but poor examples are just as important to be present in an e-learning module as exceptional ones: instructions are quite easily grasped but it is from mistakes, and exposing what not to do, in difficult and out of ordinary situations, that people learn the most.

After the examples were filtered down to the ones that would serve as base for exercises and illustrations, it was time to define the content that would be present in the module. Again, this must be done taking into account the constraint of time. A module about one basic tool such as the Quick Kaizen should take no longer than 20 minutes to complete. Besides the ever-present introduction, is was decided that this course would consist of a scene to explain the method behind the standard, a scene describing how to fill it out and, a final one, providing hints and tips. Each one of these sections must contain exercises based on the content presented and, as expected, the scene on how to properly complete the standard is the one which provides the most exercises, being the one with the most content and, therefore, the largest number of slides.

Figure 26 – Drag and drop exercise

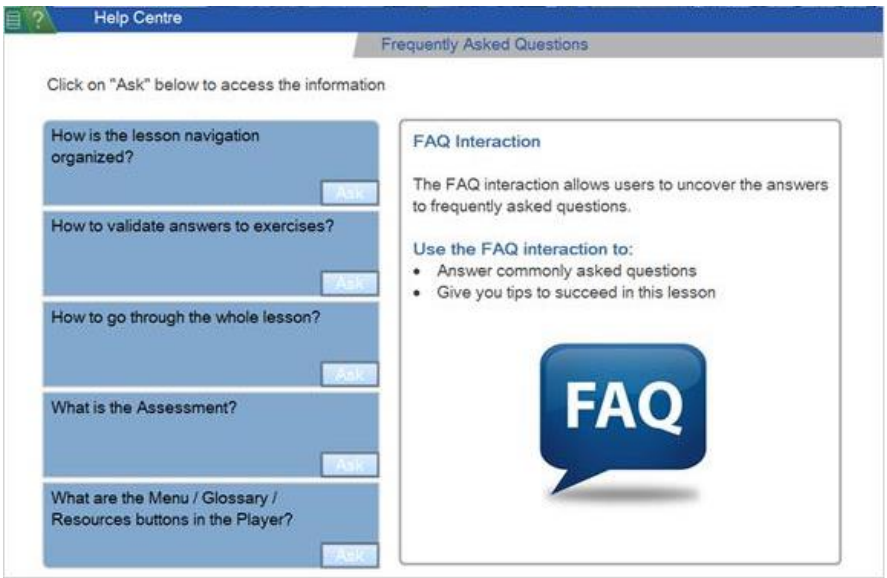


Source: Elaborated by the author

What follows is the storyboard development. This time the author decided to do a first version of it on paper and, eventually, after waiting for the validation of the experts, judged it would be counterproductive to be kept blocked by their unavailability. Therefore, again, the storyboard and courseware development were overlapped. In other words, as the text was being written, gradually, the author added animations and sequences, when she felt it would be suitable or necessary. Of course, that is by no means a final version of the courseware development, and one is not obliged to keep all dynamic elements in the course as it develops in time. It is definitely a personal preference, and it goes with the inclination of every developer, but the author found it easier to progressively build modules from a previous version, even if it is only a rough draft. Other people might find it easier to wait and have everything validated on paper before officializing in the software.

It is quite difficult to convey to the reader the experience of developing an e-learning course: not only it is impossible to demonstrate animations and triggers, because that would mean a study filled with images, it is also impractical to show the entire course content. One hopes that with the few images and detailed method description, the reader can sense the work that was put into it. The figure below shows one of the slides that consists the Frequently Asked Question scene. Even though these slides are already present in the standard OneWorld templates, the developers have to possibility to modify and adapt them according to specific subjects or questions that might arise. This scene is by default present and the reader should assume it does not change unless it is specified in a certain module.

Figure 27 – Frequently Asked Questions slide



Source: Elaborated by the author

The Methods engineer that demanded the Quick Kaizen module was, as it is expected, the technical expert allocated for this module. Once more, it would have been unproductive to have waited to receive her validation before writing the course in Articulate Storyline. Ironically, the fact that the author waited for a substantial amount of time induced her to rewrite the course several times, always making improvements and enhancements; therefore, when it was finally time to have it reviewed, the technical validation came instantly. The pedagogical validation was done a week later and, once more, there were almost no modifications to be made because of the constant accompaniment of the author's tutor during the six months of her internship. The final version of the module diffused consists of 31 slides and should take no longer than 20 minutes to be completed.

5.2 Yellow Belt

The Yellow Belt certification is the second hierarchical level in the WCM program and it is internationally recognized across the industry. Issued by an independent third-party certification association within the Lean Six Sigma Industry, it is valid perpetually and it attests that the professional is well versed in the advanced elements of the Lean Six Sigma Methodology, leads improvement projects and serves as team member of more complex improvement projects lead by a Black Belt. In OneWorld, it means the employee is certified in at least one loss reduction route, and in order to attain it, two elements need to be completed:

- Validate the associated theoretical e-learning, by obtaining a score of more than 80% of good answers in the evaluation.

- Deploy a practical continuous improvement project in a plant, implementing on a production line what was studied during the theoretical part.

The Yellow Belts modules are based on the loss reduction methodology of WCM, on the problem solving or improvement tools and on the WCM projects already completed in plants. This theoretical training should last approximately 10 hours and, ideally, the courses are to be completed within the first month of the Yellow Belt process. The author was responsible for the development of two of these e-learning courses: 5S and Autonomous Management, both of which aim at educating the learner on its respective project.

5.2.1. 5S

5S is a workplace organizational method, abbreviated from the Japanese words: Seiri, Seiton, Seiso, Seiketsu and Shitsuke. It is a system to reduce waste and improve workplace efficiency through maintaining order and cleanliness. Being one of the foundations of the WCM program, the importance of creating a e-learning course on it is indisputable.

Employing once more the proposed methodology previously described, the first step of an e-learning module development is the need analysis. The request to develop this course comes, as expected, from the WCM Methods central team, in line with the company's strategy to spread the continuous improvement culture. More specifically, OneWorld has an enormous interesting in forming and providing the Yellow Belt certification on the 5S loss reduction route: being an indispensable element of the program, it legitimizes plants' engagement and attests employee's progression throughout one's career.

Gathering examples from production sites was the first activity associated and quite an interesting one. Seeing that 5S is a method supposed to be deployed as a three-month long project, the examples collected are noticeably evidence of concrete and positive results. Not only the author had access to an overwhelming number of photos, videos and documentation that confirmed the results obtained, she also had the opportunity to visit production plants and testify for these improvements.

The task of then dissociating good from bad practices was a complicated one. Firstly, because no one likes to admit to errors, therefore WCM coordinators would only send evidence of the ultimate positive outcome; secondly because the method in itself is foolproof: when sorting, cleaning and eliminating useless objects, one must make a real effort to do it wrong; therefore, most results stay within the scale of excellent to acceptable. Then, the quantification of losses from not using the standard is particular to each case. This is done already as a trigger to the deployment of such method in a production plant area, however, in general terms it is possible to talk about opportunity cost: by not deploying 5S in all its production plants OneWorld loses material and wastes money.

Following, we enter the standard analysis part of the first step. As it happened with the Toolbox module, 5S is a confirmed, internationally approved methodology not specific to OneWorld. Therefore, it would be borderline pretentious to try and develop new methods of deployment or ways of practice. Consequently, the interviews with WCM Coordinators from production

sites and Central Engineers had the intent of cementing the author's knowledge on the method theory and providing an experimented view of someone who has job-related knowledge.

The target audience analysis was relatively straightforward. All profiles (operators, technicians, managers) within the company are apt to be formed and certified Yellow Belt, therefore, all of them compose the target audience. However, in order to have access to the modules, one does not have to be selected to pass the associated certification, the basic condition is to have concluded the White Belt modules. This is due to the company's strategy of continuous improvement culture implementation and democratization of education. Therefore, when developing the associated module, the author had in mind that the audience had already some basic knowledge of WCM and its associated tools.

The final activity of the first step was, once more, quite clear. When working with standards and methods that are already extremely well stablished and considered virtually as untouchable, one does not have trouble to find correlated material. The sequence of tasks to perform (procedural) and the decisions that need to be made in order to complete them (principle-based) are already very well set. The identification of the specific OneWorld knowledge and skills needed to best perform the steps or apply the defined guidelines was validated in collaboration with the Methods team.

An observation that needs to be made is that it is quite different working with methods and standards that are already very well stablished from working with a standard specific to a company. The analysis part is indeed, much less heavy and already set in a mold from which one must attain; however, on the other hand, there is a substantial amount of material one must revise and synthesize in order to create the module.

Moving on to the next step, the Design, the first activity is defining learning objectives. The global learning objective is for the learner to be able to correctly deploy a 5S. Ultimately, implementing the method will improve quality and productivity by reducing non-added value activities, making the workplace more ergonomic and creating a safer and more pleasant environment. Each step has a goal and correlated activities that must be practiced in a specific order. To see the goals of each step the reader should refer back to the literature review.

Once again, the sequencing of the e-learning course will follow the sequence of tasks to be performed in the real job environment, following the order imposed by the method (job-context principle). It was in this step that the author decided to divide the originally intended 5S module

into six e-learning courses: a first one consisting of an introduction to the method; presenting its objectives, benefits, where it fits into WCM and the Yellow Belt certification, and the route steps in order to put it in place; and five others, one for every step of the 5S route. This is because a single course to present all activities of the method would either last two hours, which is completely irresponsible; or, if it stayed within the time limit, it would be incomplete and ineffective in its task of educating the student.

Still in the scope of this activity, the defined learning path is unique and in accordance to the sequence of the 5S, that is, the learner will start with the introduction module, followed by the other five envisaged by the method sequence. It is worth mentioning that, by no means, the learner is asked to complete them all in a specific time limit. For availability reasons, those pursuing the certification might be given a deadline because the defense of the project in front of the panel can only be done in specific dates of the year; however, the candidate will never be expected to complete all ten hours of the e-learning training in under a month. For those who are not seeking the certification and only following the modules for personal cultivation, there are, of course, no requirements.

The next step is to define the instructional strategy for every section. Because the courses are within the framework of attaining a WCM certification and following their completion, the student will be asked to conduct a plant project on the respective loss reduction route, the majority of slides will be based on Expositive methods. That is, the Application methods will be ensured by the practical project to be led in the determined area of a production plant.

Once the instructional strategy is set, it came the time to define the delivery strategy. More than the previous courses, the Yellow Belt modules will make use of several media. This comes from the fact that not only a more robust module requires the developer to use every tool on their arsenal to retain the student's attention, but also because another level of interactivity and dynamism in the slides indicate to the learner they are in another stage of their WCM journey. Another contributing factor was the nature of the courses' subject in itself: a loss reduction route project is the deployment of a WCM method that, in the case of the Yellow Belt certification, lasts for three months, and during its implementation, should be heavily documented in order to attest for the positive outcome. This means examples are no longer limited to photos of handwritten sheets of paper, there is now before-and-after evidence, videos and PowerPoint presentations, all authenticating the progress that was made during every part of the project.

The Development phase ensues. Filtering the examples gathered from plants, which is the first activity of this step, was a delicate task. As previously stated, gathered examples from production sites were evidence of the method's positive outcome after three months of project deployment; however, for the developer's interest this was not ideal. Indeed, even though the excellent results attest for the 5S performance results and support the method, from a learning point of view, it is also stimulating to include actions that were not in the method and that led to mediocre results. Therefore, all warnings and texts that alert the student in what not to do come from the WCM Methods Engineers' experience and cooperation during this step.

The next activity is to define the content that will be present in the e-learning course. It was already previously stablished that there would be six modules in total, and the validation from the experts was received. It is worth mentioning that one of the reasons behind this suggestion is that once one moves up levels in the WCM hierarchy, one is expected to be faced with modules that have more body and content than those of the White Belt. Consequently, the developer's concern is no longer how to filter content in order to respect the time limit, but how to make an e-learning course that is complete and exhaustive, all being able to retain the student's interest.

The second to last activity is the storyboard development. Seeing that the extent of content to be presented in the modules is enormous, the author worked directly with Articulate Storyline to develop a rough sketch of each module. Each course would consist of an introduction, a scene for each activity of the step and the final evaluation. The introduction module however, will also possess a few elements as reminder of WCM and its basic concepts and tools.

An interesting point to mention is that, seeing the extent of the literature available on the subject, the author was not blocked as much by the Methods expert. Indeed, when one realizes the extent of the material on 5S, not only on books, websites and even the company's own material, the unavailability of the client is not an issue when it comes to developing. It was however, obstructive in the validation part, as one might expect.

The courseware development was definitively the activity which required the most effort and time. The true challenge of developing the Yellow Belts modules is ensuring the courses are engaging and successful in retaining the learner's attention. That being said, the pedagogical expert's support was invaluable in accomplishing this particular task. Not only was he able to direct the author in the best route to take, he also allowed for beta-tests to be conducted with the module, in order to better orientate and provide priceless comments in the development

route. Indeed, testing was done with two data engineers at the DTI, that had already completed the White Belt courses but had no short-term intention of pursuing the Yellow Belt certification due to the nature of their work (data analysis, not in a production plant environment).

The final version of the module quickly received the validation of the experts but on the methodological side this came at almost the end of the author's internship. The final modules consist of 167 slides for a total of approximately two hours of e-learning course.

5.2.2. Autonomous Management

Autonomous Management, or AM, a loss reduction route whose objective is to train operators to restore and improve their own machines. As the 5S method, is it one of the pillars of the World Class Manufacturing Program, and a path to the Yellow Belt certification.

As one might already expect, the development of the e-learning course begins with the need analysis. It comes from the same demand logic as for the previous module, therefore this topic will not be lingered. It can be argued, however, that the Autonomous Management module might be even more important in spreading the continuous improvement culture within a company. Indeed, even though the previous Yellow Belt route does include production operators in its activities and has positive outcomes that will impact their work environment; Autonomous Management, and particularly the section which will be discussed in this study, asks for total engagement from line employees and demands ownership in their actions.

When gathering real-life examples from production plants for this module, the author faced the same issue as the previously detailed course: even though there were a number of examples and documentation available to vouch for the excellent results provided by the method, there were simply no records on cases of mistakes or misjudgment. However, given the method's own nature, particularly of the first three steps (Autonomous Maintenance), it leaves room for deviations in standards associated with machines. Consequently, it will be easier to build upon negative events or incidents that happened from not correctly following the method.

Later on, in trying to quantify the losses from not deploying the Autonomous Management, one can pinpoint a common thread: the cost of sustaining a Maintenance team to take charge of problems that could very well have been avoided, had a set of actions been put in place that the operators should go through on a daily basis. Also, there is the even bigger cost of deterioration and machine repair that could be drastically diminished with the existence of preventive actions.

Following, comes the standard analysis activity. Once more the standard was considered as "untouchable" and, therefore, no attempt to modify it was made. This time, however, the ensuing interviews with the local and central WCM Engineers had the clear intent of not only binding the theoretical knowledge, but also conveying the particularities and intricacies of deploying the method in the OneWorld plants.

The target audience analysis is the same for the previous module. Perhaps the only difference, which is worth mentioning, is that, since the sections of the method that will be developed in the scope of this study are mainly devoted to the actions the operators should take, it is only correct to assume production line employees will also have access to the course. That is, even though they are not the profile of the primary end-user, candidates for attaining the Yellow Belt certificate, it is only natural to assume that the official candidate, in his/hers quest to achieve the best possible performance in the project, will share the e-learning content with the concerned collaborators of the plant.

Once again, the final activity of the Analysis was straightforward. The abundance of material on the subject one can find can be overwhelming but it only legitimates the tasks that need to be completed and the required knowledge in order to achieve them. The singularities of applying the method to OneWorld were collected from the Methods team, with the help of several local engineers.

The first activity of the Design step is to define learning objectives. By correctly implementing the method, specifically the first three steps, operators will be trained to restore and repair their machines themselves. This means the maintenance staff will have more time to do preventive maintenance and, in the long run, by adding maintenance standards to operators' routine, risks will be reduced and so will maintenance operations. But speaking on more general terms, the global learning objective is to form the student on how to correctly deploy the Autonomous Management first three steps. Again, each one of the steps has a specific objective and they must be practiced in a specific order.

The sequencing of the e-learning course will, as expected, follow the sequence of activities to perform in the method, as if the learner is already applying it to their real job environment. This follows the job-context principle. In the same line of thought from the previous module, the author decided to divide the module into four courses: the first one, always being the introduction to the method; presenting its objectives, benefits, where it fits into WCM and the Yellow Belt certification, and the route steps in order to put it in place; and three others, one

for every step of the Autonomous Maintenance. That way, the developer ensures the modules will stay within the time limits and not be a huge burden for the audience when pursuing it.

The defined learning path is unique and in accordance to the sequence of the method, meaning that the student will complete first the introduction module, then follow with the other three constituting the Autonomous Maintenance. It is worth re-mentioning that there is no deadline to complete all modules and the learner should do it at a comfortable pace, ensuring that every new information is acquired before moving on to another course.

The next step, the definition of the instructional strategy for every section is virtually the same as for the previous module. Both courses are within the framework of attaining a WCM Yellow Belt certification and for that, the candidate must put to the test the acquired knowledge with a real plant project. The delivery strategy is the last step of the Design step. Once more, whatever can be applied to the 5S module should also be considered true for the Autonomous Management ones. Photos, short videos and testimonials will all be present in the courses in order to make it as dynamic and engaging as possible for the learner.

Once the delivery strategy was set, one can start the Development phase. The first activity of this step is filtering the examples gathered from plants. The same dilemma was faced when trying to find poor examples, as in the preceding course. Harvested illustrations only showed the constructive outcome from the method, never highlighting the obstacles or difficulties confronted. Given the fact that the Autonomous Maintenance is about the operators' commitment and taking charge of new tasks connected to the maintenance of their own machine, it is, nevertheless, easier to spot issues that could have been prevented had the method been correctly applied beforehand.

The next activity is to define the content that will be present in the e-learning course. For each one of the three modules regarding the steps of the Autonomous Maintenance, the composing scenes are those corresponding to the step's activities, as well as the mandatory assessment. It would be wrong to make assumptions regarding the order in which the learner has followed other Yellow Belt courses or his/her knowledge referring to the WCM program. Therefore, for the remaining introduction module, a quick reminder of the necessary concepts for AM is expected, as well as the indispensable differentiation between Autonomous Management and Autonomous Maintenance.

The storyboard development was the following activity. Again, the author prefers to sketch the storyboard directly on Articulate Storyline and then develop the courseware on top of it. Normally, it would be advised to wait for the storyboard validation before proceeding to the courseware development step, however, as it has been pointed out innumerous times along this study, the unavailability of the technical experts incited the author to take this initiative.

The same challenge presented by the courseware development in the precedent module is applied to the Autonomous Management one. It is not an easy mission to remain relevant and captivating when developing such heavy and long content. Thankfully, the author had the support of actors previously mentioned, as well as the possibility of coordinating beta-tests.

The final modules consist, in total, of 124 slides for a target of one hour and a half of e-learning course. The final version of the module quickly received the validation of the experts but on the methodological side this came, once more, at the end of the author's internship.

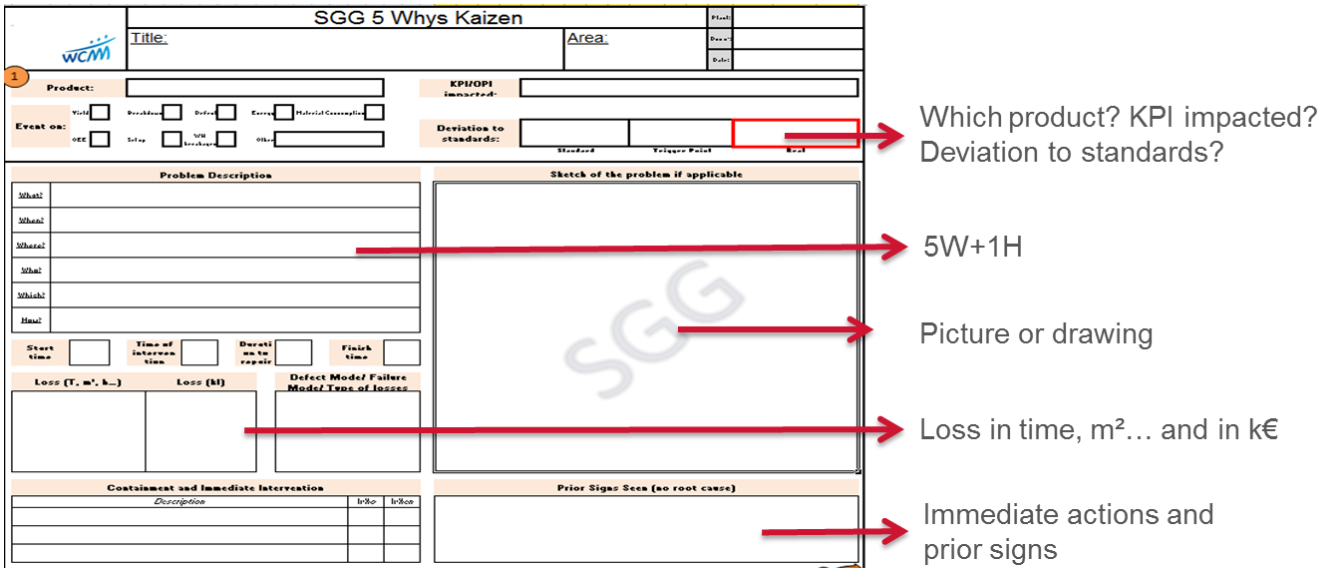
5.3 5Whys Kaizen

The 5Whys Kaizen is a problem-solving tool whose method is to find and tackle the real root causes of problems. Even though this study has already introduced some of the theory behind it, there are specificities of the standard implemented in OneWorld that should be presented.

As previously described, the 5Whys is a simple question asking method that explores the cause-effect relationships behind problems. It is used to analyze the causes of a problem through a consecutive series of questions and, implemented on its own, has limitations. That is the reason why most commonly the five "Whys" are usually complemented by the "Kaizen" part, in other words, the sections of the standard that ensure the problem is resolved. As a reminder, the sections that usually complement the questions are: problem description, verification of the possible causes, root cause(s) definition and implementation of corrective actions. The standard adopted by OneWorld is divided into five sections and they will be presented before one passes to the application of the proposed method to develop the e-learning course.

The first section of the standard is the problem description. It is a key component whose performance has repercussions on the effectiveness of the entire method, therefore one needs an accurate description of the event in order to have decent problem analysis. In the following figure it is possible to observe this section of the standard and its composing elements.

Figure 28 – 5Whys Problem Description

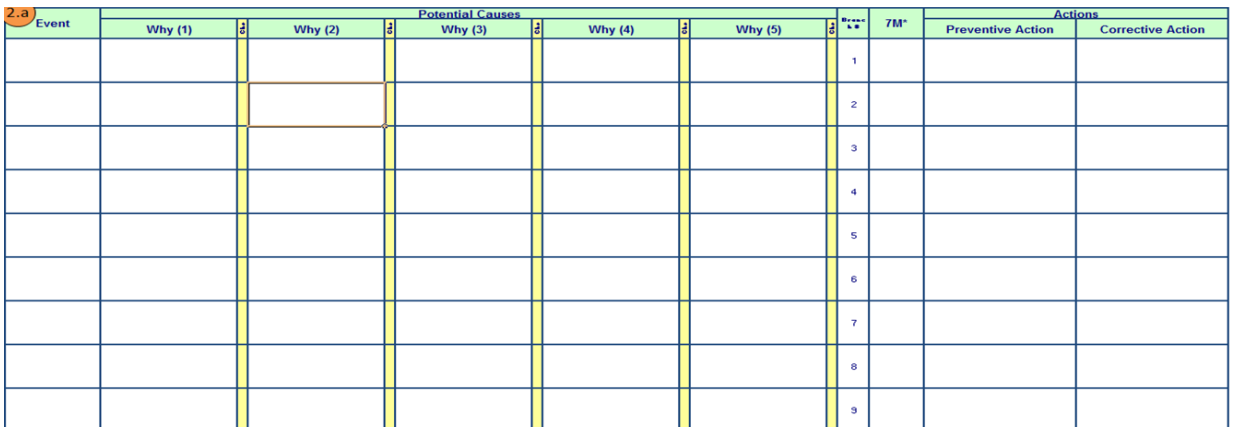


Source: Elaborated by the author

As it is noticeable, more than a 5W+1H, the standard adopted by OneWorld also asks the team to determine the impacted product, KPI and deviation to the norm; provide a picture or a sketch of the problem; quantify the associated losses and detail the prior signs and immediate actions carried out. All these aspects combined contribute to a good problem description and therefore to a satisfactory comprehension of the problem by all actors involved in the method.

The second part of the standard is the 5Whys Analysis. The utmost left-hand side column is reserved for the description of the event and, travelling from left to right, the team will gradually complete the other cases as they answer the "Whys". On the right-hand side, the team should indicate to which of Ishikawa's 7Ms categories each possible final cause belongs to. Then, on the third section, the associated preventive and corrective actions put in place will be listed.

Figure 29 – 5Whys Analysis



Source: Elaborated by the author

The fourth part of the standard is completing a series of questions to formalize the sustainability part in what concerns the production plant routine. For example, the team will be asked to answer yes or no to questions such as “Has the problem been communicated to the DTI ?”. This part is very much specific to OneWorld, therefore it will not be further discussed in this study.

The last part is an assessment to verify the quality of the 5Whys produced. It is a series of 18 questions, each about a part of the standard, that need to be noted according to the quality of the answers given in the standard. The team will assign a note of either zero, two or five, in consonance with the proposed quality scale. An extract of this assessment, and the composing questions for the 5Whys Analysis part, can be seen on the figure below.

Figure 30 – 5Whys Analysis Assessment

Analysis	Analyse is Technically logic and consistent	0	Not fully logic	
		2	Partially	
		5	Fully consistent	
	Analyse explains the technical origin of problem AND reason for duration	0	Only technical root cause of problem is analysed	
		2	Only Duration / impact of event is analysed - Why so long impact ?	
		5	Analysis consider both aspects: Technical root cause and impact/duration	
	Analyse is Based on Facts and figures	0	Opinion	
		2	Theory or Data analysis	
		5	Facts and figures based on observations with Physical observations/confirmatio	
	Reverse direction "using SO" is possible	0	Not consistent	
		2	Partially consistent / Not for all branches	
		5	Completely consistent	
	The analysis is attacking only Symptoms, not root causes	0	Only effects attacked	
		2		
		5	All root causes attacked	
	Did we identify Root causes with the Different M	0	Only 1 M in Machine or Material	
		2	2 M at least	
		5	Man and Method are covered	

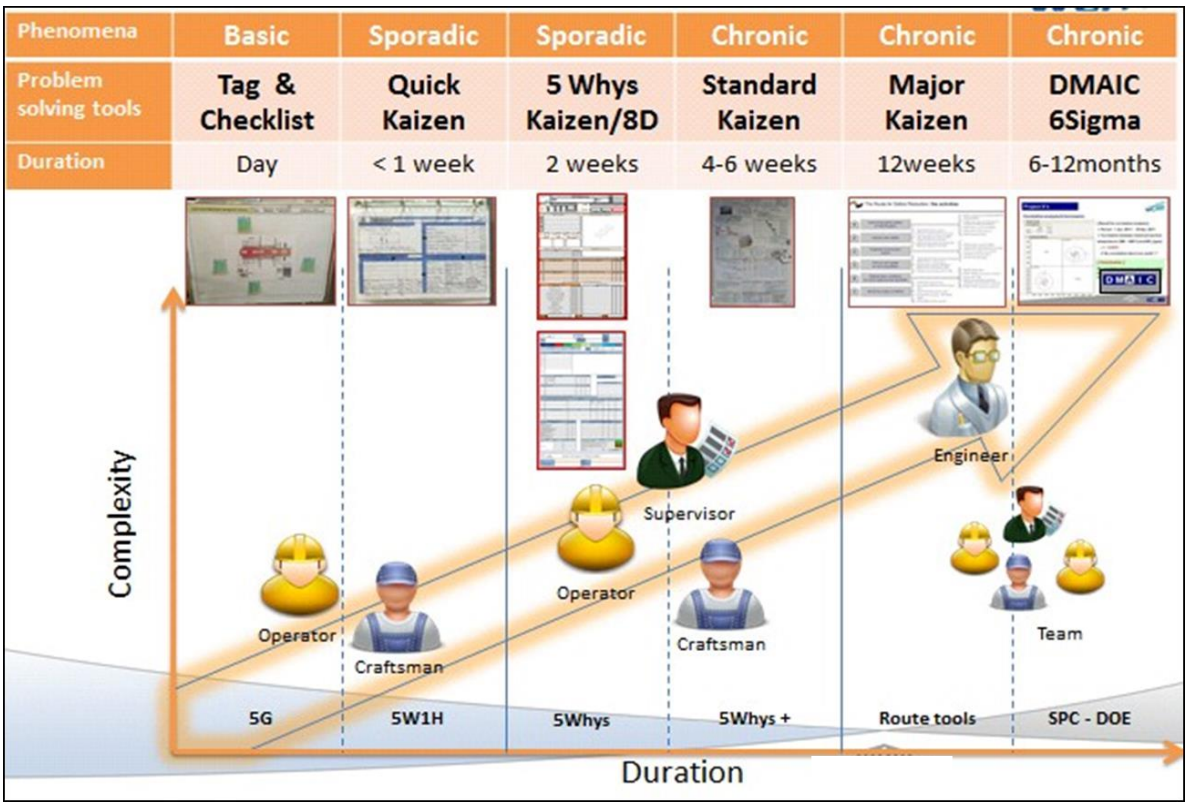
Source: Elaborated by the author

The final score of a 5Whys Kaizen that is considered acceptable is 75%. If the team does not reach this score they should return to the standard and work on the poorly noted sections. There are a few instructions on how to construct a good 5Whys Kaizen but these will be discussed later in the standard analysis.

In OneWorld the directive is to deploy a 5Whys Kaizen on the occurrence of one of three cases: the trigger point is reached on a major KPI, there is a deviation on the rules of the sustainability board or the Quick Kaizen was not enough to resolve the problem. The first two are in the ambit of the production line and not of much interest for this study. However, the previous use of a Quick Kaizen and the realization that it was not sufficient clearly shows a hierarchy between problem-solving tools. Indeed, it is very much possible to classify a tool according to the

complexity of the problem that it tackles and in how long it is supposed to suppress it. The following figure is an illustration of the mentioned hierarchy applied in OneWorld.

Figure 31 – Problem-solving tools hierarchy



Source: Elaborated by the author

As stated in the proposed methodology, the first step of a module development is the need analysis. The demand to develop this course comes from the WCM Methods team after it was pointed out that, once the standard was diffused to the plants in the beginning of 2017, no material on how to correctly deploy it was provided. Indeed, the Central Methods Team developed the standard, communicated it to all plants and required local WCM Coordinators to make use of it, even though they provided no information on how to do it properly. This standard is supposed to be the new guide for developing Mini-Anomalies modules, that is, developers will base themselves on the information provided on the 5Whys to create continuous training material. That shows the importance of the standard for the E-learning Team. However, more than that, the standard in itself is a problem-solving tool: if it is not correctly deployed the true problem will not be eradicated.

Collecting examples from production plants was not an easy task: not only was the standard extremely young at the time of the author's internship; due to lack of material on how to use it, employees simply ignored it for a long period of time. Therefore, there were not many examples to work with at the beginning; however, gradually, as the WCM Central Team started taking measures to correct its mistake and scheduling training sessions on the tool, managers started to get more comfortable with it and deploy it. By consequence, the harvesting of examples was prolonged until the end the of the developing of the module, when, if an example was pertinent and better than the ones already present in the course, it could still be included.

Even though there was not an abundance of examples collected, it was still possible to pinpoint good and bad practices, which will be discussed later. The losses from not using the module are, is safe to say, enormous. If one cannot find the real root-cause of the problem, and only temporary measures are taken, it will naturally not go away. Therefore, one is still susceptible to all the misfortunes and losses caused by the problem until it is solved.

The next activity, the standard analysis was the most laborious one by far. Interviewing WCM Coordinators is a key component to understand the challenges and obstacles of applying the standard to the everyday life in a production plant. With this new invaluable information, the author could spot already a few gaps between what was demanded on paper and what is appropriate for a factory environment. For example, after analysis of several 5Whys from different locations it was clear that, more often than not, real root causes of the problem were left aside. Indeed, oftentimes, with problems that came from several different sources, one of these was commonly neglected because not all branches of the standard were developed until the end. That is why one of the modification proposed by the author was to demand the team to do a brainstorming session before completing the first Why column. Then, each one of the possibilities will turn into a second Why question. The next answer becomes a third question and so on. Five is really just a role of thumb and the team should ask more or less Whys until all possibilities are explored. By refusing to be satisfied with each answer, one increases one's chances to discover the real root causes of the event. The goal is that unconsciously, the method used will be that of the Why Tree, developing all possible branches.

Therefore, the author proposed a new standard, taking measures that would incite the team to brainstorm possible causes before officializing them on paper, and adding and suppressing cases that would help the implementation of the method in the production environment. The new proposed standard got the validation of the Methods team and it was quickly diffused to

all production sites around the world. The 5Whys Kaizen can be found on Appendix B and it ideally in should be the size of an A3 sheet.

Following, the target audience analysis had a different outcome than the previously described modules. As it can be seen on the Problem-Solving tools hierarchy, the standard in itself is supposed to be used by "supervisors" or Green Belt managers. The Green Belt certification is one level higher than the Yellow Belt and it means the employee is educated in all loss reduction routes of one pillar. This means the e-learning course has to be adapted to this specific public, meaning, managers who have very limited time and possess extensive previous knowledge and experience on WCM and its tools. This impacts on the Design step of the method.

Lastly, one enters the final activity of the analysis step. Identifying the tasks that one must accomplish in order to achieve the end goal of deploying the method was, again, very straightforward. It is enough to possess the instructions on how to approach the 5Whys and apply them in order. The singularities of applying the method in OneWorld production plants were already taken into account in the Sustainability part of the standard.

It is important to point out that the knowledge and skills needed to perform the 5Whys properly depend on the team members. Clearly it will not be demanded of an operator to have the same technical knowledge on WCM than a manager; however, every point of view is invaluable when looking to resolve problems. That is why the team must be composed of members in different job roles. But seeing that the ultimate learner of the module are managers already Green Belt certified, the developer can assume they possess an elevated level of WCM knowledge. Having said that, the Analysis is complete and now it is possible to move on to the Design.

The ultimate learning objective of the module is for the learner to be able to correctly deploy a 5Whys Kaizen. This means that in cases where is applicable, the team, under the learner's guidance, will hopefully find the real root cause of problems and therefore be able to correctly eradicate it by applying the appropriate countermeasures.

As far as sequencing goes, it will follow the order of activities to be performed according to the method (job-context principle). There will be five scenes, one for every section of the standard, and their order of completion is mandatory. The next step is to define the instructional strategy for the module in its entirety. Expositive methods are the strategy of choice for the course and, seeing that the students are already greatly experienced population, they should have no problem applying the theory to their everyday work environment.

As for the delivery strategy, this was a key step in the module development. As previously remarked, managers do not have a fixed allocated time to pursue continuous learning, nor they place it as a priority on their agendas. Therefore, in order to attain adherence and support, it was necessary to leave the standards behind and present a different and alluring element. After much discussion and thought, it was decided that the theory, usually presented in the form of text, would be introduced in a video format. That is, the course would still be developed with Articulate Storyline and would maintain the modular structure; however, in some slides, instead of being presented with timed text boxes to introduce information, the student would be invited to click on and watch a short video. The intricacies of these videos and their format will be further discussed during the Development phase. The evaluation strategy remains alike.

Advancing into the last phase of the module development, it can be said that all three activities were merged into one. It was not a conscious decision made by the author but more of a product of circumstances. Unlike other courses, the development of the 5Whys Kaizen lasted for the entirety of the author's internship in OneWorld. Until the very last day examples were still being received and modification were being made. Therefore, the process of deciding the content and building on examples walked hand in hand with the courseware development.

The same constrains that were applied to the development of other modules were also present for this one. The main goal was to remain under 30 minutes for the completion of the course; videos, exercises and assessment included.

For the storyboard, it was composed by two main elements. The first, the traditional Articulate Storyline draft, and this time, it was complemented by a scrip. Indeed, a scrip was needed in order to speed up and structure the shooting process. Various scenarios were considered, and many explored (including the possibility of recreating a problem in a production plant); however, once more, due to the unavailability of the technical experts, they were judged unviable. By consequence, it was decided that the video would be a case-based example, were the Central WCM Methods Manager would present a generic problem and go through all the steps of deploying the 5Whys Kaizen.

The choice of the problem starred in the module had to be one that spoke to the majority of managers, that is, that could have happened already in their production site. This study will not go into further details due to confidentiality reasons.

The video shoot required the presence of WCM Methods manager, the E-learning Program manager, two multimedia engineers and the author. It lasted two days and the end result was one full hour of video content. Clearly not the entirety of the end-product was used in the e-leaning module, which in its turn consists of 25 slides, nine with video content, and in total should take no longer than 35 minutes to complete. Given the video shoot was done in the last week of the author's internship, the module quickly received the validation from both experts.

Figure 32 – 5Whys Kaizen Video Shoot

Source: Taken by the author

5.4 Route Proposal

As it is noticeable, throughout the entirety of this study's development, a common thread is present: the unavailability of the technical experts. Indeed, not only was this an obstacle to the work's progress, it is also a motive of complaint and demotivation from OneWorld' interns. This is due to the expert's work nature, that is, traveling all over the world to give support and evaluate production plants. When one's job is to solve urgent problems, ensuring that production does not comes to a halt, clearly, providing assistance to the E-learning team is not a priority. The following figure shows the SWOT Analysis for the internship and it is of general agreement that the only weakness is the experts' unavailability.

Figure 33 – Internship's SWOT analysis

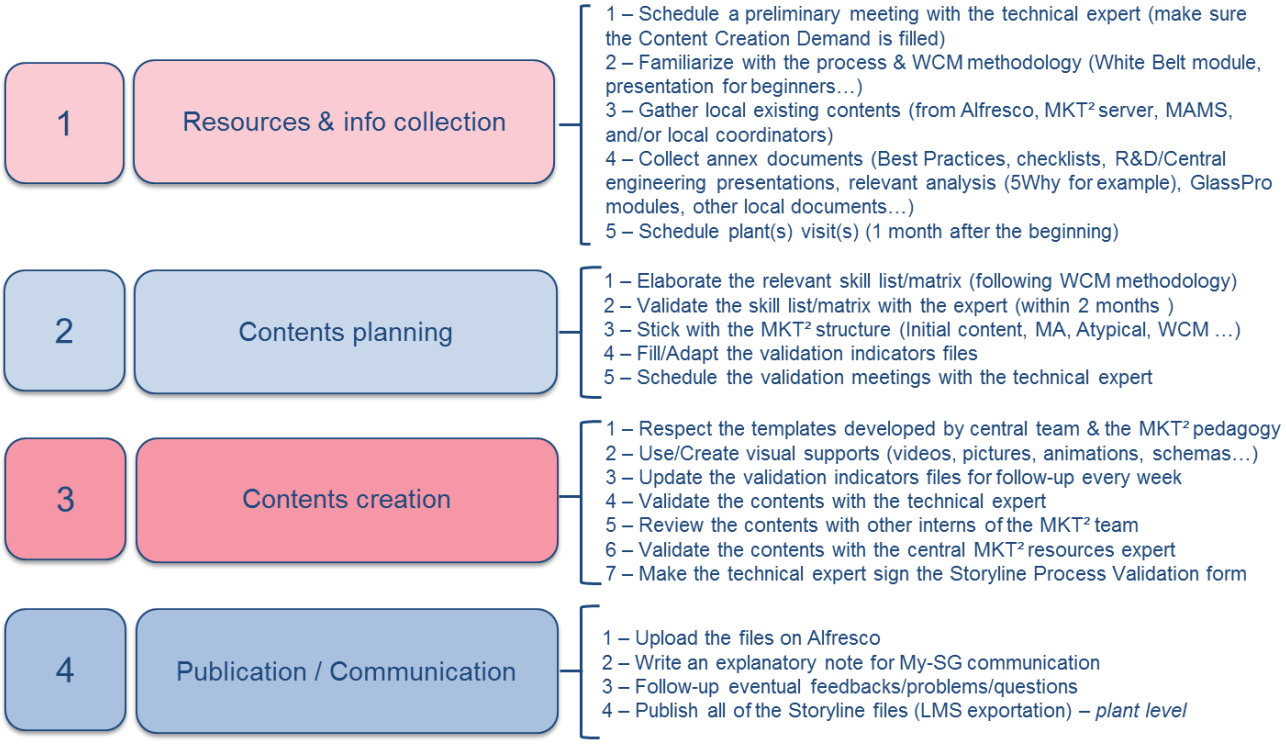
Source: Elaborated by the author

This has long been an intrinsic problem of the DTI and the author was warned about this hurdle during the recruitment process. However, one cannot help but notice the irony surrounding this dynamic: within a service whose job is to incentive continuous improvement and mitigate all forms of losses, resources are wasted and nothing has been done to improve this situation. Therefore, in an effort to reduce the time an intern stays blocked because of the experts and, hopefully, improve the work satisfaction, the author assembled all E-learning interns and decided to deploy a 5Whys Kaizen.

As a problem-solving tool, and one the author had been studying for the prior five months, it was only natural that it would be used to propose an action plan. The problem description was made relatively easily, and the element which should be brought to attention are the losses: not only the company loses the interns' motivation, it also loses possible future employees. Indeed, it is quite common for interns to be reluctant to stay in OneWorld after the end of their contract.

Based on the description and given the fact that there are no hidden root-causes for the problem, the proposed counter-measure was to officialize a module development route. The idea is that by cementing a path to be followed during the six months of internship, all actors will be more committed to follow the set deadlines and have a new sense of accountability. After much effort and with the aid of all interns, the following route was proposed.

Figure 34 – Content Development Route



Source: Elaborated by the author

Its goal it to set steps and activities to be followed by all members involved in the module development process, consequently making it leaner and less burdensome for the interns. The proposed planification and the deadlines associated should make a positive impact in the courseware development phase and the associated validation. The route was presented to the E-learning Director and received his validation, which means all future students will be required to follow it. As of May 2018, 13 e-learning interns at the DTI have used the route with positive results and appreciative feedback.

6 CONCLUSION

The objective set by this study was to develop e-learning modules to train 3000 employees per year into standards and tools of the WCM program. In order to do so, a method based on the knowledge acquired via the literature review was proposed and deployed for each one of the five projects: Toolbox, Quick Kaizen, 5S, Autonomous Management and 5Whys Kaizen. Every subject had its own goals, target-public and previous knowledge requirements attached to the WCM hierarchy.

For each of the three steps of the method (Analysis, Design and the Development), every project presented different challenges and outcomes, but the common goal was always to develop a course that would retain student's attention and pass knowledge in an efficient and meaningful way. The unspoken rule surrounding the author's work was that it was inserted in a continuous improvement program whose main influence would be in the operational excellence objective. Therefore, ensuring that the courses were not only relevant to the employee but also interesting was the ultimate challenge.

As of May 2018, the ensemble of the modules developed by the author were viewed 11740 times by 3478 different users across all 25 production plants in the world. As previously seen, given the obstacle faced in the development of the content, the author also proposed a route to combat the expert's unavailability to the WCM interns, which also has collected positive results so far.

For the future, one hopes the work described in this study will serve as a base for subsequent e-learning content development, not necessarily attached to WCM and its methods; and that the proposed Content Development Route leaves a fruitful heritage for the next interns in the company, facilitating and hopefully guiding content construction.

In conclusion, this study allowed the author to deepen her knowledge of Continuous Improvement, WCM and e-learning, all while participating in concrete projects whose results have a positive impact in learner's professional life.

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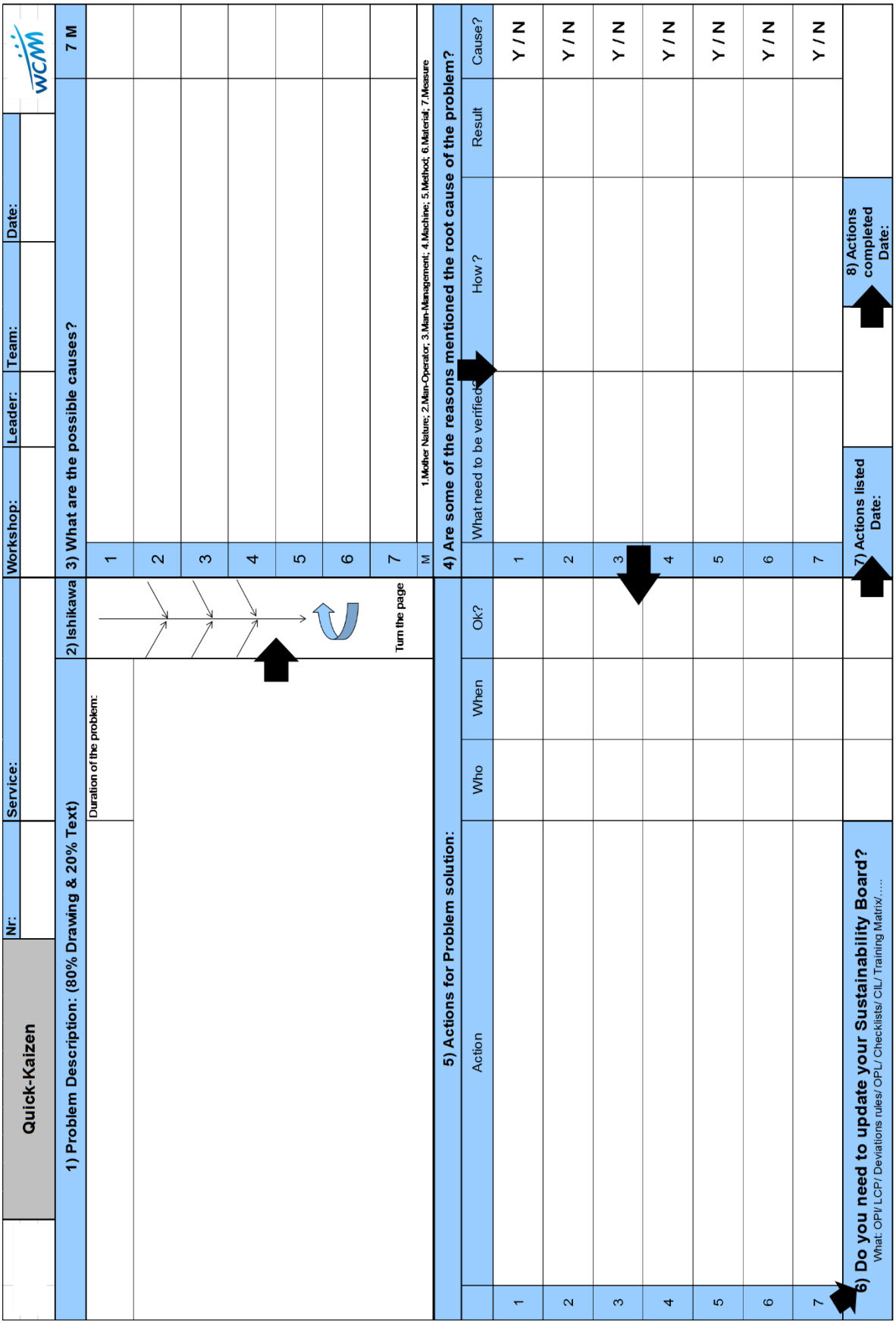
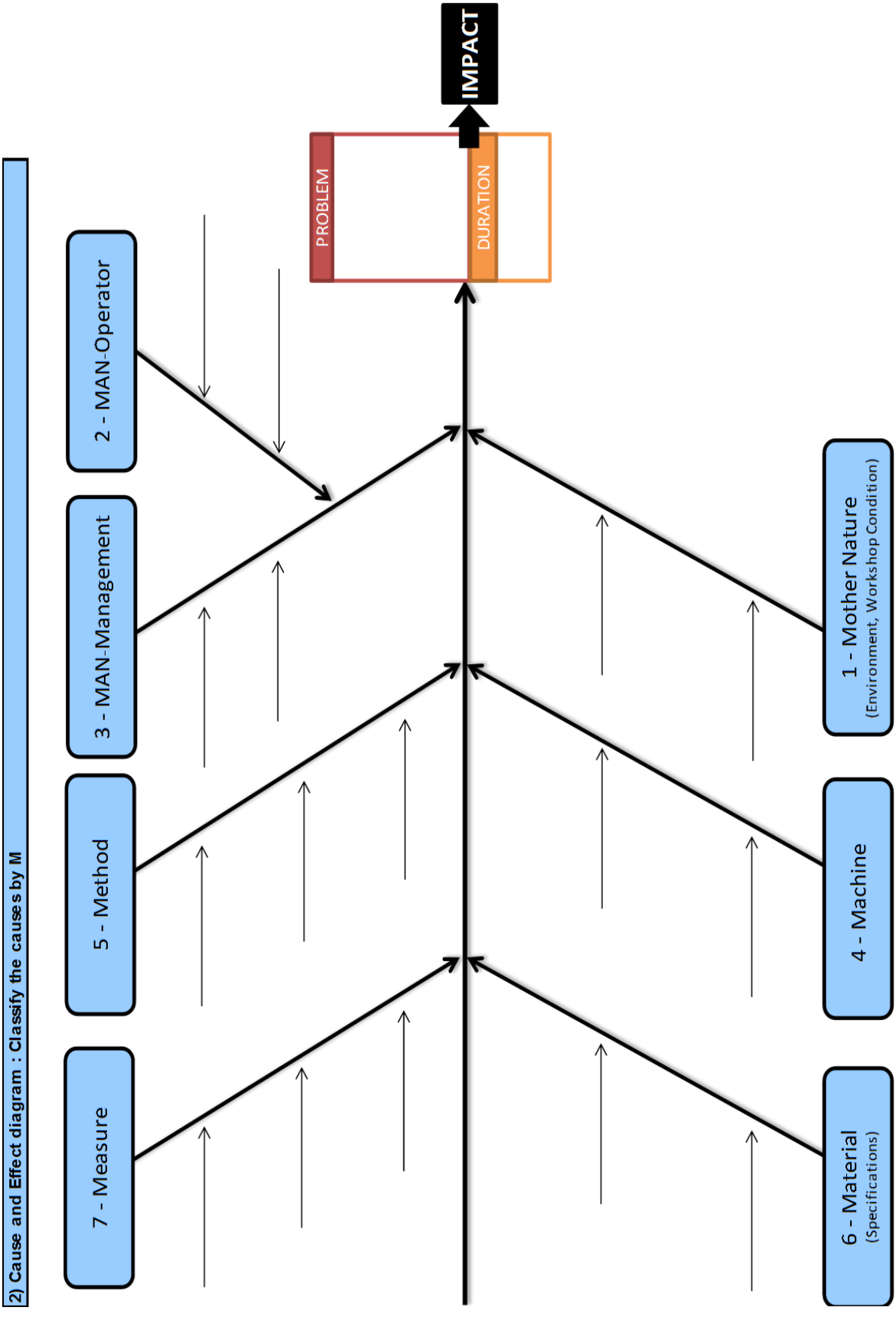
APPENDIX A – New Quick Kaizen sheet

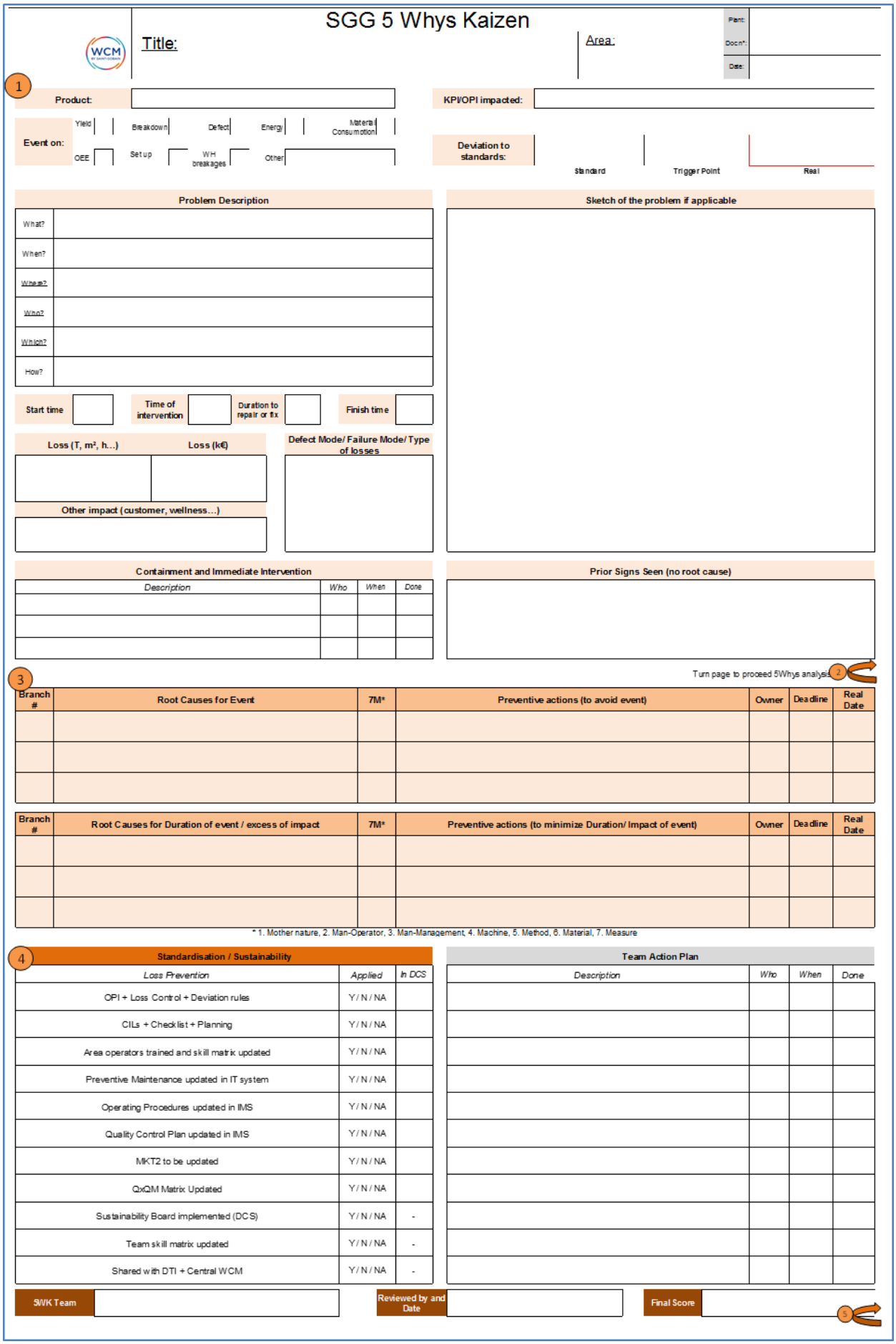
(Source: Elaborated by the author)




2) Cause and Effect diagram : Classify the causes by M
7 - Measure
5 - Method
3 - MAN-Management
2 - MAN-Operator
6 - Material
(Specifications)
4 - Machine
1 - Mother Nature
(Environment, Workshop Condition)
PROBLEM
DURATION
IMPACT

APPENDIX B – New 5Whys Kaizen sheet

(Source: Elaborated by the author)



SGG 5 Whys Kaizen

Title:

Area:

Plant:
Doc n°:
Date:

1

Product:

KPI/OPI impacted:

Event on: Yield | Breakdown | Defect | Energy | Material Consumption | OEE | Set up | WH breakages | Other

Deviation to standards: Standard | Trigger Point | Real

Problem Description	
What?	
When?	
Where?	
Who?	
Which?	
How?	

Sketch of the problem if applicable

Start time | Time of intervention | Duration to repair or fix | Finish time

Loss (T, m², h…)	Loss (k€)

Defect Mode/ Failure Mode/ Type of losses

Other impact (customer, wellness…)

Containment and Immediate Intervention

Description	Who	When	Done

Prior Signs Seen (no root cause)

Turn page to proceed 5Whys analysis 2

3

Branch #	Root Causes for Event	7M*	Preventive actions (to avoid event)	Owner	Deadline	Real Date

Branch #	Root Causes for Duration of event / excess of impact	7M*	Preventive actions (to minimize Duration/ Impact of event)	Owner	Deadline	Real Date

* 1. Mother nature, 2. Man-Operator, 3. Man-Management, 4. Machine, 5. Method, 6. Material, 7. Measure

4 Standardisation / Sustainability

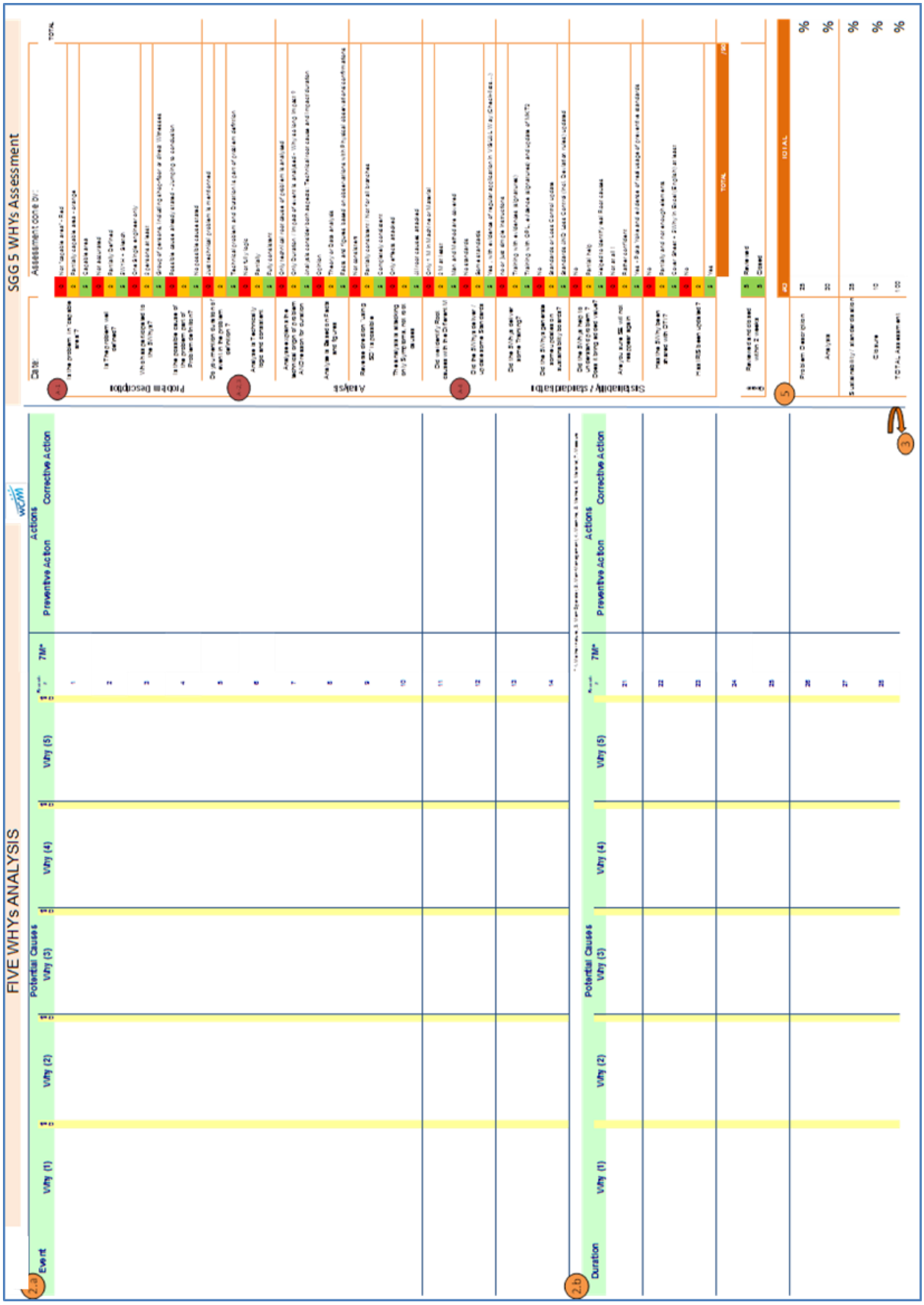
Loss Prevention	Applied	In DCS
OPI + Loss Control + Deviation rules	Y / N / NA	
CILs + Checklist + Planning	Y / N / NA	
Area operators trained and skill matrix updated	Y / N / NA	
Preventive Maintenance updated in IT system	Y / N / NA	
Operating Procedures updated in IMS	Y / N / NA	
Quality Control Plan updated in IMS	Y / N / NA	
MKT2 to be updated	Y / N / NA	
QxQM Matrix Updated	Y / N / NA	
Sustainability Board implemented (DCS)	Y / N / NA	-
Team skill matrix updated	Y / N / NA	-
Shared with DTI + Central WCM	Y / N / NA	-

Team Action Plan

Description	Who	When	Done

5WK Team | Reviewed by and Date | Final Score

5


SGG 5 WHYs Assessment
FIVE WHYs ANALYSIS
Problem description
Analysis
Sustainability / standardisation
Event
Duration
Potential Causes
Why (1)
Why (2)
Why (3)
Why (4)
Why (5)
7M*
Actions
Preventive Action
Corrective Action
TOTAL