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## **World Class Manufacturing, strategic methodology toward future sustainability. CNH Industrial Case**



**Relatore**

prof. Settineri Luca

**Candidato**

De Luca Francesco

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## **Abstract:**

In the three months of working experience in the role of intern for FPT Industrial, brand owned by the group CNH Industrial, I decide to base the final part of my university studies highlighting and studying relationships and linkages between the methodology applied in each plant of the group, known as World Class Manufacturing (WCM), with the Sustainable Development Goals stated by the United Nations in the 2015 with the program called “Agenda 2030”. CNH industrial promote itself for the achievements obtained in the past years in concordance to these goals, and each two years make a sum up declaring objectives obtained and future prospective in the Sustainability Report, taking in consideration new worldwide challenges from both environmental and economic viewpoints.

In concordance with the company’s future targets aligned with the Agenda 2030 and, after having achieved a good knowledge about the methodology applied in the plant, I had the opportunity to be part in multiple projects aimed to develop more efficient solutions to be implemented directly in the production and assembly process. In this final thesis I evidenced the affinities between the way the World Class Manufacturing is applied in some projects and the six Sustainable Development Goals chosen by the top management, paying attention to objectives significant to CNH industrial and to all the stakeholders which will be affected by. I illustrate two projects I took actively part, highlighting at the end the common points between the WCM and the Agenda 2030 to evidence the feasibility toward a more sustainable and efficient production.

# 1. CNH Industrial:

## 1.1 Overview of what CNH industrial is today

CNH industrial is a worldwide group operating and producing capital goods whose main investor is the financial holding “Exor”, whose president is John Elkann. CNH Industrial was born in 2013 after the merge of two of the main players operating in the market of commercial and special vehicles and capital good that are CNH Global and FIAT Industrial.

## 1.2 Markets and segments

Today CNH Industrial compete at global level in the market of capital good, engaged in the engineer, production, financing and sales of trucks, commercial vehicles, busses, defense vehicles and firefighting vehicles, as well as, engines, transmission, axels for all of those vehicles mentioned above and for marine and power generation applications.

In 2018 the society was composed by 12 brands with 9.626 active patents owned. Company’s presence is strong all around the world with 54 Research and Development centers, 66 manufacturing plants, 64.625 employees of which 6.000 are dedicated to the innovation. In this way it compete with an efficient and effective financial and commercial presence in 180 national markets generating \$29.7 Billion revenues.



Figure 1: CNHi Key Figures end of 2018 [5]

### 1.2.1 Agricultural equipment

CNH Industrial is the second largest manufacturer of agricultural machinery sold under its brands CASE IH NEW HOLLAND AGRICULTURE globally, STEYR brand in Europe and Miller brand in North America and Australia.

Each of these brands mentioned above deals with designing, manufacturing and distributing of farm machineries and implements, both two- and four-wheels drive tractors, combines, cotton pickers, hay, forage, planting and seeding equipment.



Figure 2: Case IH brand [1]



Figure 3: New Holland brand [1]



Figure 4: Steyr brand [1]

### 1.2.2 Construction Equipment

CNH Industrial is the seventh largest player in the manufacturing of construction equipment sold under the CASE Construction Equipment and New Holland Construction brands.

It deals with designing, manufacturing and distributing a full line of construction equipment like excavators, compact track loaders, crawler, dozers, graders, backhoe loaders, wheel loaders, skid steer loaders and telehandlers.



Figure 5: Case construction brand [1]

### 1.2.3 Commercial Equipment

CNH Industrial is the fifth largest manufacturer of commercial vehicles in Europe and market leader in alternative fuels. It deals with the designing, manufacturing and distributing of full range of light, medium, and heavy vehicles dedicated for the transportation and distribution of goods under IVECO brand, commuter buses and touring coaches under IVECO BUS and

HEULIEZ BUS brands, quarry and mining equipment under IVECO ASTRA brand, firefighting vehicles under MAGIRUS brand, and finally vehicles for peace-keeping missions and civil defense under IVECO DEFENCE VEHICLE brand.



Figure 6: Iveco brand [1]



Figure 7: HeuliezBus brand [1]



Figure 8: Magirus brand [1]

### 1.2.4 Financial Services

CNH Industrial is present also in the market of financial services, supporting customers and dealers with tailor-made solutions.

Financial services administrate and provides retail financing to customers for the purchase or lease of new and second-hand industrial equipment, vehicles and other equipment sold under all of CNH industrial dealers. Furthermore, financial services provide wholesale financing to CNH industrial dealers, that consists primarily of floor plan financing and allows the dealers to purchase and maintain a representative inventory of products.

### 1.2.5 Powertrain

CNH Industrial is the global leader in regulated markets, producing more than half million industrial engines per year. It deals with designing, manufacturing and distributing a range of engine, axles for on-and off-road application, transmission systems. Also produces engines for marine and power generation systems under FPT Industrial brand.



Figure 9: FPT Industrial brand [1]

## 2. Agenda 2030



Figure 10: 17 Sustainable Development Goals [2]

### 2.1 Sustainable Development Goals

On the 25th - 27th of September 2015 the General Assembly of United Nations met with the aim of establishing new global goals for a sustainable development. From this meeting comes out what today is called all around the world “AGENDA 2030”, an action plan for people, planet and prosperity dealing with 17 Goals for a Sustainable Development and 169 Targets.

The Goals and Targets are going to stimulate actions over the next 15 years (from 2015), in areas of critical importance for humanity and for the nature underling that the actual development model is not sustainable anymore and, sustainability in not only an environmental matter, but sustainable goals are interconnected and indivisible taking into account each dimension of the development: economic, social and environmental dimensions.

Each dimension is integrated with the 5P approach:

- *PEOPLE*: main targets is to end poverty and hunger, to ensure that human being can fulfil their potential in dignity and equality and in healthy environment.
- *PLANET*: main targets is to protect the planet from degradation managing a sustainable use of its resources and taking timely actions against climate change.
- *PROSPERITY*: main target is to ensure all humans being can enjoy prosperous and safe life from both economic and social point of view and, technological progress occurs in harmony with nature.
- *PEACE*: the main target is to promote peaceful, in a world free from fear and violence.
- *PARTNERSHIP*: main target is to revitalize the partnership and collaboration between all member states, otherwise the implementation of the Sustainable Goals will be not possible because of the interlinkages and integrated nature of the Agenda itself.



**Figure 11: 5P dimensions [3]**

All of its points are shared and agreed by everyone, taking in consideration nationality, capabilities and status of development, different from each country.

The 17 Sustainable Development Goals are [1]:

- *GOAL 1: End of poverty in all of its forms everywhere*
- *GOAL 2: End Hunger, achieve food security and improved nutrition and promote sustainable agriculture*

- *GOAL 3: Ensure healthy lives and promote well-being for all at all ages*
- *GOAL 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all*
- *GOAL 5: Achieve gender equality and empower all woman and girls*
- *GOAL 6: Ensure availability and sustainable management of water and sanitation for all*
- *GOAL 7: Ensure access to affordable, reliable, sustainable and modern energy for all*
- *GOAL 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all*
- *GOAL 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation*
- *GOAL 10: Reduce inequalities between and among countries*
- *GOAL 11: Make cities and human settlements inclusive, safe, resilient, and sustainable*
- *GOAL 12: Ensure sustainable consumption and production patterns*
- *GOAL 13: Take urgent action to combat climate change and its impact*
- *GOAL 14: Conserve and Sustainably use the oceans, seas and marine resources for sustainable development*
- *GOAL 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss*
- *GOAL 16: Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels*
- *GOAL 17: Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development*

The agenda, with the Sustainable Development Goals, could be implemented at global level with the collaboration and coordination of all governments and political forces as delighted in the Addis Abeba's Action Plan, yet included in the Agenda 2030. This plan is useful to contextualize the implementation tools of the Agenda, underling the usage of internal public resources, national and international finance, cooperation for the development, debt and its support and international markets as growth engine.

Technology plays a key role as a support to the Agenda in order to fulfill all its objectives. This is based on the multilateral collaboration of united states, private sector, scientific community and all other actors interested.

Collaboration is organized with a workgroup, a forum and an online platform shared by United Nations about science, technology, and innovation for the Sustainable Development Goals promoting inside the united nations the coordination and cooperation about scientific, technological and innovation issues, increasing the synergy and efficiency, particularly in order to strengthen capacity building initiatives

The online platform facilitates the access to information, to the knowledge and to experiences, as best practices due to political incentives to innovation. In addition it is useful for the divulgation of scientific publications to all the world.

The forum about the science, technology and innovation to achieve the Sustainable Development Goals is convened once a year. It is physically a meeting place where there is an open debate about the cooperation for the implementation of the goals, grouping all the actors involved to contribute in own area. Moreover, there is a monitoring process of all of these goals placed in the High Level Political Forum (HLPF) which meets once a year under the Economic and Social Committee appointment, while every 4 years the forum meets under the General Assembly appointment. Its aim is to evaluate progresses, results and future challenges for each country, and to ensure that the agenda remains “considerable and ambitious”.

At September 2019 it has been published the “Sustainable Development Goals Report 2019” by the Sustainable Development Solution Network, a global study evaluating the improvements of each country according to SDGs. So, it shows strength and weaknesses of each country representing a good monitoring tool, fundamental to the release of the objectives of each country accordingly to each goal maximizing the efficacy.

Each Goal is monitored and verified with a multitude of indicators at global, regional and stately levels developed by member states.

## 2.2 Sustainable Development Goals' Indicators

*“To fully implement and monitor progress on the Sustainable Development Goals, decision makers everywhere need data and statistics that are accurate, timely, sufficiently disaggregated, relevant, accessible and easy to use. The Open SDG Data Hub promotes the exploration, analysis, and use of authoritative SDG data sources for evidence-based decision-making and advocacy. Its goal is to enable data providers, managers and users to discover, understand, and communicate patterns and interrelationships in the wealth of SDG data and statistics that are now available.”* is what is declared on the official site of SDG Data Hub [1].

The first Indicator framework was adopted by General Assembly on the 6<sup>th</sup> July 2017. It is contained in the resolution adopted by general assembly on Work of the Statistical Commission pertaining to the 2030 Agenda for Sustainable Development.

The complete list was developed by the Inter-Agency and Expert Group on SDG Indicators (IAEG-SDGs), updated and modified yearly to be in line with the evolution of the to-date situation and to the new challenges that comes out, containing 232 indicators on which general agreement has been reached, available on the official site of United Nations [1].

To make an easier implementation of global indicator framework, each single indicator is classified by the IAEG-SDGs into three tiers according to their level of methodological development and the availability of data at global level.

“Tier Classification Criteria/Definitions” [2]:

- *Tier 1: Indicator is conceptually clear, has an internationally established methodology and standards are available, and data are regularly produced by countries for at least 50 per cent of countries and of the population in every region where the indicator is relevant.*
- *Tier 2: Indicator is conceptually clear, has an internationally established methodology and standards are available, but data are not regularly produced by countries.*
- *Tier 3: No internationally established methodology or standards are yet available for the indicator, but methodology/standards are being (or will be) developed or tested.*

All indicators are equally important, and the adoption of the tiers classification is only intended to assist in the development of global implementation strategies.

At the 11<sup>th</sup> December 2019 there is the last classification containing exactly:

- 116 Tier 1 Indicators
- 92 Tier 2 Indicators
- 20 Tier 3 indicators

## **2.3 Most important goals targeted by CNH Industrial Worldwide**

The sustainability model represent the linkage between CNH Industrial and the external world that may have any sort of effect on the company's business. Global challenges of course are not intended to be pursued in the short-term, they represents long-term challenges affected by governments, economies, and societies.

CNH Industrial respond to these external inputs with a shared corporate purpose and individual initiatives of each brand, consistent across the Company and implementable over the medium-to-long term, as well as with a set of values that lie at the core of CNH industrial daily activities.

Purposes and values are implemented through:

- A strategic panning
- A system of principles, rules and procedures in which roles and responsibilities are clearly defined
- A process that anticipate and manages current and future economic, environmental, and social risk opportunities.

Shared value is the approach to business sustainability in which companies generate economic value in a way that also create value for society, meeting the needs of both. Particularly in the recent years the company has changed its approach to sustainability, from a reactive to a proactive approach, where CNH Industrial leverages sustainability to make decision for long term value creation. The main target of this approach is to make business and social aims meets.

To this end the Company took part in the pilot project to quantify shared value, in particular the shared value generated by farming solutions. The social needs identified as the starting point of the study were the United Nations Sustainable Development Goals (SDGs).

To this end, the best tool to start approaching to SDGs is the Materiality Matrix resulting from the Materiality Analysis that identify material topics and ensure their alignment with business decisions, integrating continuously sustainability principles into the company daily activities.

The materiality analysis represents a strategic business tool that [6.0]:

- *support the company aligning its purposes, targets, brand portfolio, regional presence with topics that are relevant with stakeholders*
- *identifies the material topics through which the company aims to respond to global challenges*
- *define targets, in accordance with Sustainable Development Goals, based on potential risk and opportunities arising from global challenges and material topic.*

The materiality analysis process involves the following steps [6.0]:

- *selection of global challenges*
- *establishing the relationship between material topics and global challenges*
- *stakeholders' evaluation of material topics to set priorities*
- *preparation of Materiality Matrix.*

## **2.4 Global Challenges Analysis:**

In 2016, CNH Industrial performed an analysis in order to identify the global challenges that affect its business or have potentiality to do so. This made the materiality analysis a strategic tool to identify intervention priorities. The most significant global challenges according to the company are selected by the GEC members from a list compiled after assessing many different sources; these included context and scenario analysis, including SDGs goals, sustainability report and websites of over 100 companies.

So the 3 main global challenges identified as most relevant to the business of CNH Industrial are:

- *Climate change*: which takes into account political, ethical, economic, judicial and scientific factors going far beyond the literal definition of natural climate variations
- *Food scarcity and food security*: taking into account individual efforts respect to agricultural world, processing, transport, manufacturing and consumption production chain
- *Innovative and digital world*: which is considered an excellent future growth opportunity because of the huge amount of data available on internet, and because of the current trend to make industry more and more digital (Industry 4.0).

After selecting the global challenges in 2016, a task force was organized by the Sustainability team to identify 12 material topics, each of them can be related to one or more global challenge.

The evaluation of them was two-fold: from one side there must be relevance according to CNH Industrial based on feedbacks from the GEC members, and on the other side, material topics must be important according to stakeholders, so they have been selected collecting feedbacks from a sample of about 1700 stakeholders, including employees, customers, dealers, public institutions, non-governmental organizations and journalists.

The result of the materiality analysis is summed in the Materiality Matrix [figure 12] that reflect how many times each material topic has been selected.

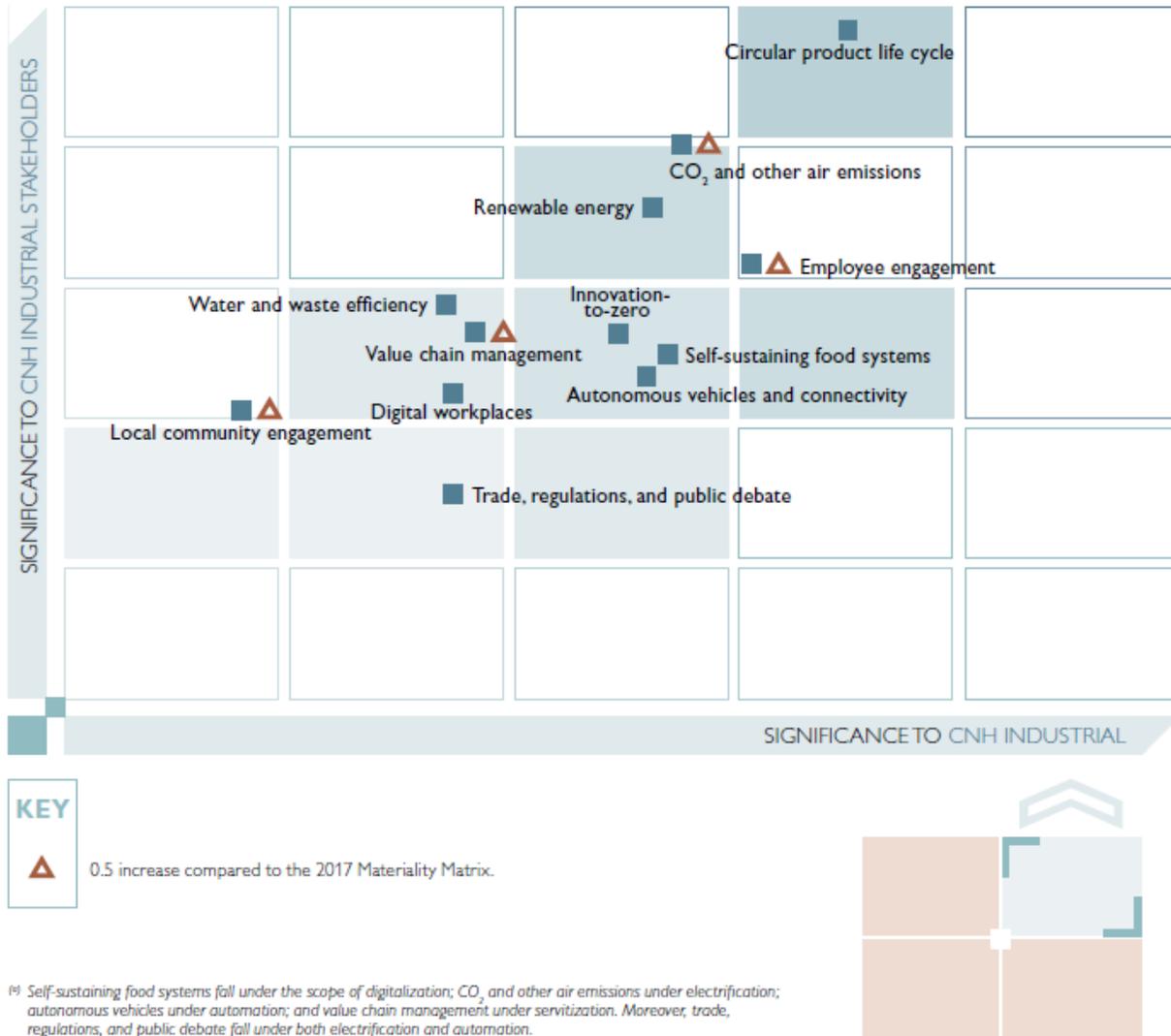


Figure 12: Materiality matrix [6.0]

Each one is positioned within the Material Matrix according to internal and external relevance, in this way the matrix can be read in two ways:

- The horizontal axis means the level of importance according to CNH Industrial, in ascending order
- The vertical axis means the level of significance according to stakeholders, in ascending order

The matrix is updated annually taking into account change in stakeholders' perceptions and incorporate any new topic that may become significant for the company.

## **2.5 2018 Materiality matrix**

The 2018 materiality matrix encompasses 3 year engagement process, involving a totality of about 1800 people.

Going into details the Global Reporting Initiative identified in the materiality analysis are the following [6.8]:

1. Local community engagement
2. Trade, regulation and public debate
3. Digital workshop
4. Value chain management
5. Water and waste efficiency
6. Autonomous vehicle and connectivity
7. Self-sustaining food system
8. Innovation-to-zero
9. Employee engagement
10. Renewable energy
11. CO<sub>2</sub> and other air emission
12. Circular product lifecycle

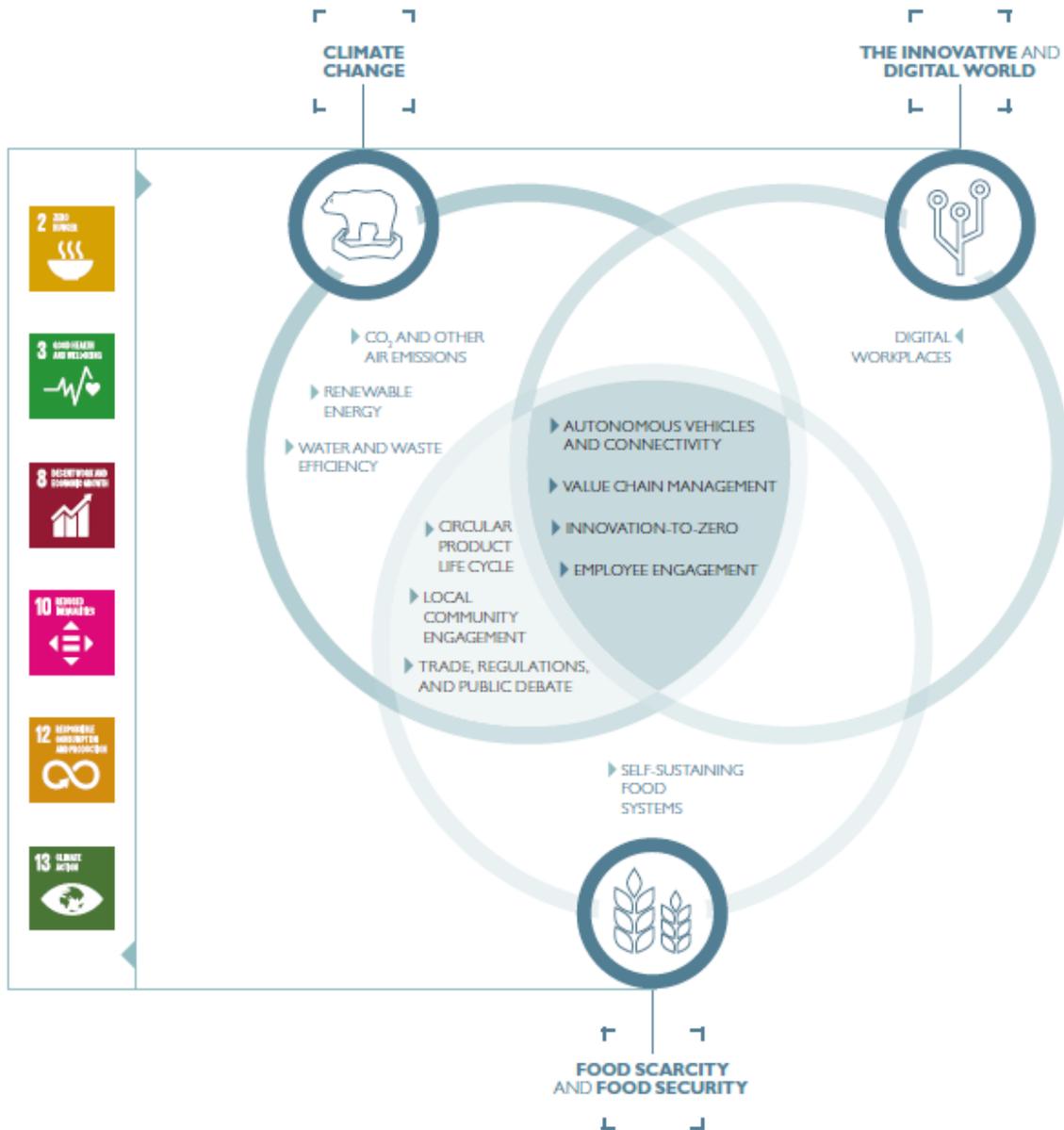


Figure 12.1: Material Topic linked with the three global challenges [6.0]

## 2.6 Key Targets

The company senior management set 24 key targets aligned with material topics consistent with United Nations SDGs. Progress toward their achievement is verified twice a year and new ones are added yearly.

As specified in the Sustainability report [6.1]: “Since CNH industrial embraces all 17 United Nations SDGs, efforts were made to ensure commitments stated in the Sustainability Plan are

aligned with said SDGs, not only to substantiate the company contribution to achieving global objectives, but also to ensure transparency in its communication with stakeholders by providing details on its responsibility to build a sustainable future”.

From the 17 SDGs a total of 6 were identified as most relevant [6.1]:

- Sustainable Goal 2: End hunger, achieve food security and improved nutrition, promoting sustainable agriculture
- Sustainable Goal 3: Ensure healthy lives and promoting wellbeing for all at all ages
- Sustainable Goal 8: promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
- Sustainable Goal 10: Reduce inequality within and among countries
- Sustainable Goal 12: Ensure sustainable consumption and production patterns
- Sustainable Goal 13: Take urgent action to combat climate change and impact

### 2.6.1 Sustainable Goal 2: Zero Hunger

As stated in the official document written by United Nations “*The 2030 Agenda for sustainable development*” [10.1]: Goal 2 focuses on ending hunger and ensuring access by all people to safe nutrition and sufficient food all year round; on ending all form of malnutrition by 2025, paying particular attention on children’s nutrition under 5 years old; on doubling agricultural productivity and incomes for small-scale food producers through equal and secure access to land and other productive inputs; on ensuring sustainable food production system and implement resilient agricultural practices the increase productivity and production, helping to maintain ecosystem unaltered and that strength capacity for adaptation to climate change; by 2020, focuses on maintaining genetic diversity of seeds; on increasing investments in rural infrastructures, on ensuring proper functioning of food commodity markets.



Figure 13: Sustainable goal 2 [2]

### 2.6.2 Sustainable Goal 3: Good Health and Well-Being

As stated in the official document written by United Nations “*The 2030 Agenda for sustainable development*”[10.2]: Goal 3 focuses on reducing the global maternal mortality ration to less than 70 per 100,000 live births; on ending preventable death of under-5 children to at least as low as 25 per 1,000 and neonatal mortality to at least as low as 12 per 1,000; on reducing by one third premature mortality from non-communicable diseases through prevention and treatment and



Figure 14: Sustainable goal 3 [2]

promoting mental health and well-being; on preventing and limiting substance abuse; by 2020 on halving the number of global deaths and injuries from road traffic accident; on ensuring universal access to sexual and reproductive health-care services; on achieving universal health coverage ensuring essential medicine and vaccines for all; on reducing considerably the number of death and illnesses from hazardous chemical and air, water and soil pollution and contamination; on going further in the research of vaccines and medicines.

### 2.6.3 Sustainable Goal 8: Decent Work and Economic Growth

As stated in the official document written by United Nations “*The 2030 Agenda for sustainable development*”[10.3]: Goal 8 focuses on sustaining pro capita economic growth particularly at least 7% of GDP per annum in the least developed countries; on achieving high level of economic productivity through diversification, technological upgrading and innovation; on promoting development-oriented policies that support productive activities and growth of micro- ,

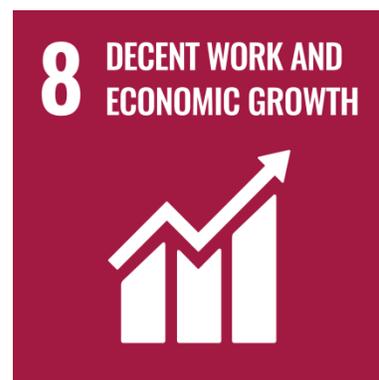


Figure 15: Sustainable goal 8 [2]

small- and medium-sized enterprises; on improving progressively global resources efficiency; on achieving full and productive employment and decent work for all women and man, including people with disabilities, and equal pay for work and equal value; on reducing by 2020 the proportion of youth not in employment, education or training; on taking immediate and effective measures to eradicate forced labour; on protecting labour rights and promoting

safe and secure working environments for all workers; on promoting sustainable tourism that create jobs opportunities and local culture and products; on strengthening the capacity of domestic financial institution to encourage and expand access to banking, insurance and financial services for all; on developing, by 2020, a global strategy for youth employment.

#### 2.6.4 Sustainable Goal 10: Reduced Inequalities

As stated in the official document written by United Nations “*The 2030 Agenda for sustainable development*”[10.4]: Goal 10 focuses on achieving and sustaining income growth of the bottom 40% of the population at a rate higher than the national average; on promoting social, economic e political inclusion of all; on ensuring equal opportunity and reduce inequalities of outcome, by eliminating discriminatory laws, policies and practices and promoting appropriate legislations;

on improving the regulation and monitoring of global financial markets and institutions; on ensuring enhanced representation and voice for developing countries in decision-making in global international economic and financial institution in order to deliver more effective, credible, accountable and legitimate institutions; on facilitating a responsible migration and mobility of people through the implementation of planned and well-managed migration policies; on encouraging official development assistance and financial flows, including foreign direct investment, in particular to least developed countries; on reducing to less than 3% the transaction cost of migrant remittances and eliminate remittance corridors with cost higher than 5%.



Figure 16: Sustainable goal 10 [2]

### 2.6.5 Sustainable Goal 12: Responsible Consumption and Production

As stated in the official document written by United Nations “*The 2030 Agenda for sustainable development*”[10.5]: Goal 12 focuses on implementing the 10-Year Framework of Programmes of Sustainable Consumption and Production Patterns taking into account the development and capabilities of developing countries; on achieving the sustainable management and efficient usage of natural resource; on reducing food losses along production and supply chains; on

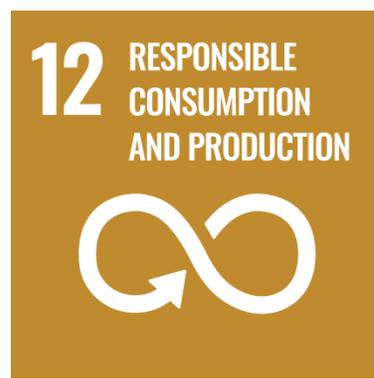


Figure 17: Sustainable goal 12 [2]

achieving environmentally management of chemicals and wastes through their life cycle; on reducing substantially waste generation through preventive action plans; on encouraging companies, particularly large ones, to adopt sustainable practices and to integrate sustainability information into their reporting cycle; on ensuring that people everywhere have the relevant information about sustainable development and lifestyles in harmony with nature; on supporting developed countries to move toward more sustainable patterns; on developing the implementation of tools to monitor sustainable development impacts for sustainable tourism that creates jobs and promotes local culture and products; on rationalizing inefficient fossil-fuel subsidies that encourage wasteful consumption caused by market distortion.

### 2.6.6 Sustainable Goal 13: Climate Change

As stated in the official document written by United Nations “*The 2030 Agenda for sustainable development*”[10.6]: Goal 13 focuses on taking preventive and opportune reactive action plan against climate-related hazards and natural disaster in all countries; on integrating climate change measures into national policies, strategies and planning; on improving education, awareness-raising and human and institutional capacity on climate change mitigation; on implementing the



Figure 18: Sustainable goal 13 [2]

commitment undertaken by the developed-country parties to the United Nations Framework Convention on Climate Change to a goal of mobilizing jointly \$100 billion annually by 2020; on promoting mechanism for rising capacity for effective climate change-related planning and

management in least developed countries and small islands, focusing on woman, youth and local and marginalized communities.

### **3. World Class Manufacturing: way to be more efficient in accordance with Agenda 2030**

Target of the chapter is understanding what is the World Class Manufacturing, the production methodology adopted by CNH Industrial for the management and administration of daily and long term production and corporate objectives. Secondly, methods and instruments used will be described more into details and to follow the target of this thesis it will be evidenced the direct linkage between the implementation of the WCM methodology and the persecution of the main Agenda 2030's target according to CNH industrial.

#### **3.1 World Class Manufacturing – history**

After the Industrial Revolution the industries started to focus their attention on the production system, improving and optimizing it from multiple points of view. Actually it is unthinkable to compete only on efficiency, but customer preferences and flexibility are important variables to take into account for the competition in the global markets [7]. So, for companies and firms it is indispensable to have a lean production, with a high degree of efficiency and efficacy, able to compete transversely on costs and quality.

In this environment the acronym WCM identify some of the most important global goods manufacturers, and for the first time in 80's the American researcher Richard Schonberger defined the whole set of optimization methodologies utilized by the best Japanese companies.

WCM is a manufacturing methodology coming from different way of thinking the production:

- *Lean manufacturing*, methodology that aims to delete or minimize each activity without value added, minimizing buffers and trying to have a low level of stocks, reduction work-in-progress pieces and reducing set-up times adopting an optimal production mix.

- *Just in Time* it's a methodology for the management of stocks. It can be intended as a way of managing stocks trying to minimize them because each single piece of stock in the warehouse is considered a waste of resources.
- *Total productive Maintenance* for the proactive management of maintenance programs of machineries and plants. Proactive maintenance means to act to the root cause of the problems before this happen.
- *Total Industrial Engineering* is a methodology that takes into account the improvement of production system introduced by Hajime Yamashina, aimed to the problem resolution and the optimization of each single division involving the whole factory stuff. Issues are resolved with the principles of lean manufacturing.
- *Six Sigma* is a methodology aimed to the reduction of inefficiencies in each industrial process, starting from data and analyzing the process from a statistical point of view.
- *Total Quality Control* has be defined from Feigenbaum as an efficient system to integrate and coordinate the quality development, its support and all the effort for its improvement in order to have a production able to satisfy all the customer requirements at the minimum cost. So quality principles must be applied to all industrial levels making quality a responsibility of everyone.

The set of these methodologies have the target to reduce to zero losses and wastes, solving problems at its root cause, not only inside the production process but along all the value chain.

In details the objective is to have in the production line minimal (or ideally have zero): breakdowns, accidents, stocks, complaints, defects. This objective is followed with a continuous improvement process operated by the implementation of numerous projects of variable duration, called *KAIZEN* that in Japanese mean: continuous improvement in little steps.

### 3.2 World Class Manufacturing - methods and objectives

The World Class Manufacturing is completely driven by Cost Deployment, an analytical tool based on the study of the production costs, in fact it is one of the most important technical pillar on which the whole methodology is based.

Despite all the methodology and ways of thinking WCM comes from, it differentiates from them in multiple aspects.

Firstly, WCM approach is organized in “pillars” that represents all the company aspects, managerial and technical, following a process aimed to a continuous improvement toward the operational maximum efficiency divided in 7 steps.

Secondary, another important difference is the strong attention paid to the measurability, in fact the WCM is based on multiple systems of control of performances that can be distinguished in 2 main categories: *KEY PERFORMANCE INDICATORS (KPI)*, that takes into account productive performances, and *KEY ACTIVITY INDICATORS (KAI)*, that takes into account actions and required efforts to reach an improvements objective. A KPI is the evident result of an improvement project, for example an increase in the labour productivity. A KAI is the result of a process implemented to achieve an improvement in a project, for example, the number of training courses for employees or the number of Best Practices put in place in the plant.

Finally, a strong attention is addressed to the competences development of the whole plant staff, continuously tested in order to increase the capacity, knowledge, and right *modus operandi*. WCM is also founded on the concept of continuous improvement, on the maximization of valued added, the elimination of any sort of wastes taking in consideration each single person of the whole supply chain.

This 3 key concepts, can be summed into; *valued added*, so everything that have a concrete value for the final customer; *loss*, so the usage of a resource that represent a cost without generating any value; *waste*, so the loss resulting from the number of resources utilized exceeds the number of resources necessary for the same action.

Organization adopting the World Class Manufacturing have to implement it in the all company areas, starting from the production plant (Gemba), continuing through the product quality, the better efficiency of logistic processes and finally to the management. In this way it is possible the target of “Optimal Zero”:

- ZERO Incidents
- ZERO defects
- ZERO delays
- ZERO stock
- ZERO breakages
- ZERO changeovers
- ZERO wastes

To better represent characteristics and structures of the WCM, it is easy to compare it to a temple, in which each columns represent a technical pillar at which the base in a managerial pillar.

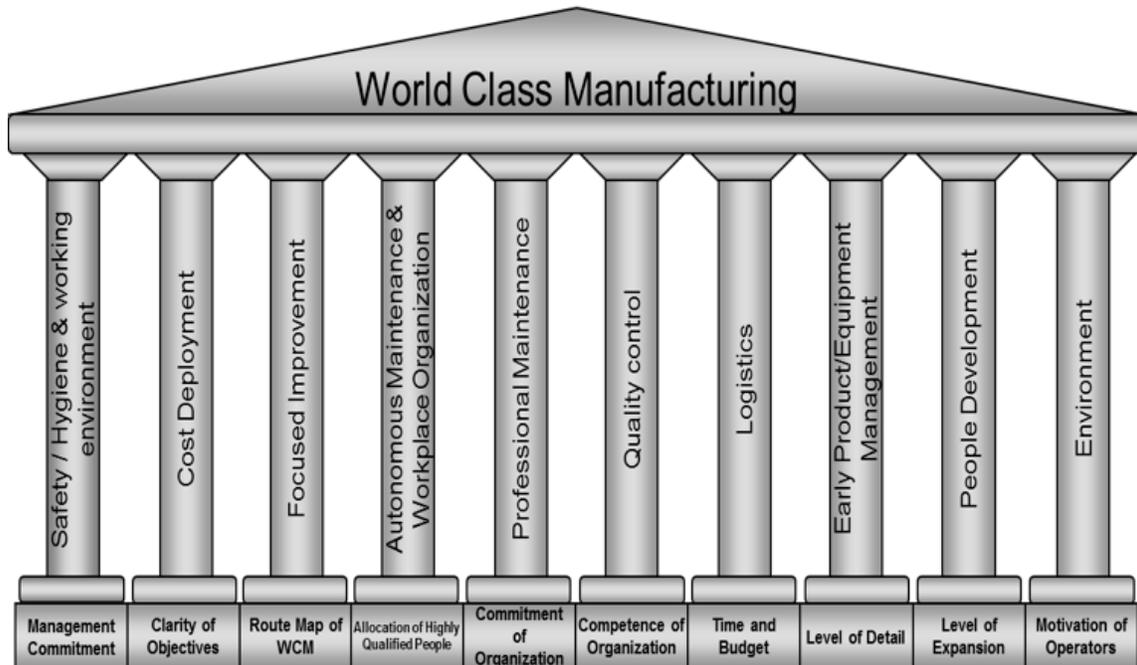


Figure 19: WCM Temple [9]

Steps to reach the excellence through the WCM is divide in 2 dimensions:

Profundity: the continuous improvement process of each technical pillar is structured in 7 steps, and these steps can be grouped in 3 macro phases:

- **REACTIVE:** the problem is identified and consequently reactive actions are put in place to solve it and to reduce negative effects
- **PREVENTIVE:** processes and possible problems are analyzed in order to identify causes, so preventive actions are put in place in order to minimize the probability to make them happen and also to minimize losses in case they happen.
- **PROACTIVE:** process and its possible dynamics are analyzed to prevent them and improve working standards.



Figure 20: WCM Phases and Steps

Extension: toward the “Optimal Zero” each activity starts always from a model area, a part of the plant or a specific productive area where there is the largest and most expensive loss in terms of costs and that must be attacked as soon as possible. Improvement projects put in action in the model area are then extended in a second moment in other areas of the same plant but also in other plants where is applicable.

Taking in consideration the attention paid to the measurability, there is an audit program aimed to verify the achievement of each performance levels of plants and to value the WCM

implementation toward standard World Class. Audits can be managed internally, as a self-evaluation by pillar leaders, or externally conducted by the World Class Manufacturing Association and can be each 6 or 12 months. During the last ones, each pillar, both managerial and technical, is put under operational analysis and at the end it has been assigned a score from 0 to 5 corresponding to:

- Score 0: no activity in place
- Score 1: reactive approach
- Score 2: preventive approach in the model area
- Score 3: preventive approach in the most important areas of the production plant
- Score 4: proactive approach in the model area
- Score 5: proactive approach in the most important areas of the production plant

The overall sum coming from each single pillar gives the Methodology Implementation Index (MII), with a minimum of 0 to a maximum of 100. The World Class Manufacturing Association fixes the following goals:

- 50 points: Bronze Medal
- 60 points: Silver Medal
- 70 points: Gold Medal
- 85 points: World Class

In this way it is guaranteed a continuous benchmarking within the multiple companies which decide to adopt the WCM. In conclusion it can be affirmed that the WCM is the answer to the companies which aims to the continuous improvements and a sustainable success in what is today a highly competitive global markets. It has the target of reaching and sustain a World-Class competitiveness through the Manufacturing Excellence, in this way the company is able to spread best practices and know-how, and at the same time is able to develop employee capabilities and the culture of continuous improvement.



Figure 21: WCM plants [6.2]

### 3.3 WCM – Agenda 2030: tool to support sustainable development

According to the culture promoted by the World Class Manufacturing described above there are not few linkages with the promotion of the goals described in the Agenda 2030. In this paragraph in fact I am going to analyze how CNH Industrial have decided to face what are the main goal after analyzing the results of the materiality matrix.

In fact the WCM methodology can be applied at 360 degrees in the company and globally without distinction of culture and production process, and it would result not correct to think it is implementable only in the production phase.

### **3.4 GOAL 2: End Hunger, achieve food security and improved nutrition, and promote sustainable agriculture**

According to the materiality analysis goal 2 has been identified as a material topic through which CNH Industrial aims to respond global challenges. The choice is based on potential risks and opportunities linked to the company's activities. As a company operating in the Agricultural markets Goal 2 is so important in order to promote the company in the world of food against one of the most important problem of the 21th century.

Dealing this problem goes in the same direction of one of the three global challenges CNH Industrial identified, it is *Food Scarcity and food security*: accessibility and usage of food resources show important and uneven distribution worldwide, and these aspects have been amplified by the joint effect of population increase and the growth of the middle class. Both the increase in demand and quality and safety of food is directly dependent from the effort of all the actors involved in the agricultural, transport, manufacturing, and consumption production chains. Scarcity of water, food, and natural resources has been associated with the intrinsic socio-economic instability. Adequate food availability for social harmony, at the same time within the country and between different countries.

In this direction CNH Industrial in 2018 established key targets in concordance to Goal 2 [6.3]:

- within 2022: up to 25% respect to 2015 in field productivity by expanding data management and control systems
- within 2022: distribution of new alternative fuel tractors (methane and propane)
- within 2022: up to 50% respect to 2017 in number of people involved in CNH Industrial's local communities' initiatives.

To follow those targets there have been put in place lots of initiatives all around the world. The principal ones are:

- CNH Industrial's employees who took place in the program Social Team Building, under the initiative organized with the Rise Against Hunger organization, packed 1.000 meals distributed to people in need in Zimbabwe and other countries. To have an idea of numbers,

in 2018, 339 employees dedicated 1.077 volunteer hours through Social Team Building events.

- In Ghana, the brand Case IH in collaboration with local third parties launched a training project in 2018 at the Damongo Agricultural College, offering courses on smart and modern farming projects practices and on machine operation and maintenance as stated in CNH Industrial Sustainability report 2018 [6.4]. This project has the objective of farming hundreds of hectares of land, turning students into future farm manager with the technological capabilities of transferring their fields experience into new future job opportunities all around the globe.
- The brand FPT Industrial have decided to donate an irrigation system powered by its engine F32 to the University of Nairobi, in collaboration with the Milan Center for Food Law and Policy and the E4Impact Foundation in order to encourage the practices of modern farming across the country.
- In USA, the Hunger Task Force Farm in 2004 started to grow fresh foods to create a reliable source of healthy food for its network of food banks. the farms since its beginning has shipped about 340 tons of fresh food per year.
- In 2018, in occasion of the event called Food Security Week in North America, CNH Industrial promoted awareness campaign against food scarcity and waste among employees and other stakeholders. Employees and students put together over 400 snack packs and 200 hygiene kits then distributed to charitable organizations
- One of the most important project CNH Industrial has decide to face up is “Zero Hunger”. In this field Precision Agriculture management system gives an important contribute to contribute to food security and safety as it involves high technology solutions able to produce more with less. In this way there is a less resource consumption in terms of water and land, with an improved output from lots point of view.

As the stated in the Sustainability Report of CNH Industrial [6.5]: “*World cardinal principle the World Class Manufacturing seeks to eliminate all types of waste and loss*” and today the loss of waste of food is one of the most important loss to debate.

All the projects described above, where the company has decided to invest resources are in concordance with the cardinal principle of the WCM: improve efficiency targeting to

“Optimal Zero”, in fact achieving zero waste of food is one of the main to-date challenges against world hunger and malnutrition.

In addition all those initiatives are real evidence of sponsored activities by the technical pillar “People Development” and the managerial pillar “Motivation of operators”, where it is encouraged a high degree of collaboration toward a common goal recognizing to each actor who took part in the project results achieved, improving on one side motivation and the well-being and on the other side tackle an global issue evidenced by the United Nations.

### **3.5 GOAL 3: ensure healthy lives and promote wellbeing for all at all ages.**

CNH Industrial is involved in the promotion of its employees’ good health and wellbeing with dedicated programs, aiming at balancing personal commitment trough time and money saving initiatives and flexible working. The overall goal is to promote motivation, pride, and sense of integration at work. In addition the company promote at global level number of plans targeted to local communities in order to safeguard and improve health.

Key targets reported in the Sustainability Report to face up to Goal 3 are the following [6.3]:

- within 2022: reduction of 33% versus 2014 in employee accident frequency rate
- within 2022: involvement of 100% of employees in wellbeing activities promoting healthy lifestyle
- within 2022: participation of 40% of employees in flexible work location scheme
- within 2022: involvement of 100% of employee worldwide in training activities
- within 2022: reduction of 20% respect to 2014 in Volatile Organic Compound (VOC) emission per square meter painted
- within 2022: increase of 40% in number of people involved in CNH Industrial’s local community initiatives

To follow those targets there have been put in place the following initiatives:

- Flexible working time (also called Smart working), according to the company, is one the most effective answer to improve employees’ wellbeing and healthcare. Results ends up in a wide quantity of information, in order to choose best actions for the right balance between work and life. The majority of the surveyed employees decide to take advantage of the new way of

working spending time for family care, other results are study leave, personal care and sabbatical.

- Safety and health in the workplace are a fundamental right according to the company policy, so in 2018 started the plan of introducing defibrillators across all the plants and offices departments in EMEA in order to ensure a right intervention in case of illness. the electronic device chosen is an Automated External Defibrillator, which automatically recognize abnormal changes in the heart's frequency and deliver an electric impulse to re-establish normal frequency heartrate.

CNH industrial here applies concepts of the World Class Manufacturing recognizing that people play a key role, in fact there is a dedicated technical pillar, "People Development", aiming at offering the grow of employees' competencies, offering at same time good future job opportunities to grow simultaneously with a good balance between work and life.

Another important pillar called in place to reach the objectives and give continuation to project jet in place is "Safety". In this direction this pillar plays a fundamental role aiming at a continuous improvement of workplace, detecting, isolating and eliminating sources of danger. In addition safety pillar leader must take in consideration all the reference standards put in place in each country. Safety is not just a prerogative for the company it allows to empower its performances, in fact managers are enrolled in the continuous promotion of the safety culture. The overall goal is to have zero accidents.

### **3.6 GOAL 8: Promote sustained, inclusive, and sustainable economic growth, full of productive employment and decent work for all.**

CNH Industrial would like to ensure optimal condition at work, adopting preventive and protective measures with the target of minimizing the risk of injury in the workplace.

Key targets reported in the Sustainability Report to face up to Goal 8 are the following [6.3]:

- within 2022: reduction of 33% respect to 2014 in employee accident frequency rate
- within 2022: Involvement of 100% of employee all around the globe in training activities
- within 2022: sustainability self-evaluation of 100% of Tier 1 suppliers

- within 2022: up to 50% respect to 2017 in number of people involved in CNH Industrial’s local community initiatives

Company’s targets for occupational and health are considered so ambitious for the industry it operates, because of the work and product typology, to certificate its involvement managers of 70 plants, around 45000 employees, all around the world applied to the certification for occupational health and safety “OHSAS18001”, standing for “Occupational Health and Safety Assessment Series”.



Figure 22: CNH OHSAS 18001 certified plants [6.6]

Taking care about the safeguard of employee health and offering good work environment are essential topics, in this direction the following projects have been put in place:

- Because of safety is always a priority, more or less about 270,000 hours of occupational health and safety training was issued in 2018. One of the most effective way of put in place good practices for safety is according to the top management is the on-the-job training activities which involved about 42,000 employees.

- CNH Industrial consider the value of health and safety important in all the value chain of its products and components. In the identification phase of suppliers, the prevention and minimization of risks concerning environment and society are factors put in first place. Managers developed a process based on sustainability issues useful to have a final choice about suppliers to work with. Sustainability reports specify: “suppliers assessment process is managed yearly by the Purchasing function and is overseen by Suppliers Sustainability Committee. It involves 3 consecutive steps in a time horizon of one-year.

- Industry 4.0 is another important paradigm change that ensures a better quality of work and economic growth involving continuously innovative technology in all its manufacturing process.

Example of improvement thanks to modern new technologies is the Virtual Reality forklift simulator which integrates full immersive virtual reality firm environment, like a warehouse for example, with the physical commands of a forklift. Simulations are useful to train new and old employees about new logistics paths and maneuvers.

In addition, virtual reality in combination with augmented reality provides a competitive advantage in the assembling phase to train employees with specific components at specific workstations.

- In 2017, in collaboration with the Education Ministry of Córdoba, in Argentina, CNH Industrial started the project called “WCM at schools” providing knowledge about the World Class Manufacturing program to students and teachers, including a large number of employees to explain and promote what really is the WCM applied in a manufacturing plant. In addition, the program has been extended at University inviting students interested in to train on sites.

As evidenced in the last project described above, here the WCM acquires more and more importance in order to reach the SDGs sets and the study evidenced here there is the participation of both technical and managerial Pillars.

Pillar “People Development” plays a key role, because of it is focused on people and, especially, employees. So reaching a good score in this pillar means granting for sure a good “decent work condition” [10.3], from multiple points of view, like safety on work and good

environmental work condition in order to having a continuous decrease of employee accident frequency rate.

Pillar “Environment and Energy” represent another fundamental technical pillar to SDG 8. According to what is evidenced in the period of the internship, having a good score about this pillar means at the same time minimizing environmental impact of the production and granting good work condition to employees. The linkage with the global challenge “*climate change*” undertaken by the management is direct and thanks to the implementation of Industry 4.0 solutions, as the Virtual Reality, targets appear more and more near.

Pillar “Autonomous activities” represent an important milestone for WCM respect to the goal and objectives under analysis. It is divided in 2 main branches: Autonomous Maintenance and Workplace Organization. The former push for preventive maintenance activities and focus on prevent the plant breaks and its micro stops, this grants for sure a decent work condition and most important safer workplace condition due to continuous checking, in this way the any risk linked to dangerous accident are minimized. The latter put under the investigation each work station in which the employee operate. This pillar grants to each employee at each level ergonomic condition of work, without putting any part of its body under strain with movements not safe. In this way the absence rate due to body-health problems is reduced substantially, also on the long-term better condition for the employee are granted.

“Safety” pillar has the overall goal to improve workplace condition, so as consequence there is a decent work and economic growth. it acts in three directions: for people, acting to prevents some behaviors that can generate problems and errors; for machines, acting to prevents incidents linked to them; for organizational management to grants the right involvement of the overall measures. To classify abnormalities related to safety condition it is widely used the Pyramid of Heinrich [Figure 23] as shown below. In details:

- Fatal (F): accidents which causes the death
- Severe Lost Time Accident (SLTA): accidents with permanent damages
- Lost Time Accident (LTA): accidents with a prognosis less than 30 days
- First Aid (FA): accident causing in medical treatment
- Near Misses (NA): accident without any injury

- Unsafe Condition (UC): unsafe condition of work
- Unsafe Acts (UA): actions potentially dangerous



Figure 23: Pyramid of Heinrich

“Level of Expansion” is a managerial pillar also important for SDG 8, because of CNH Industrial focalized on global challenges so it means that all the action to reach decent work and economic growth are to intend globally. in this way WCM is adopted in all the offices and plants to establish a standard for each standard and also as evaluating tool of the activity of each plant and offices. Any model area and any Kaizen identified is in fact firstly implemented in the plant and in a second moment is divulgated on online platform to evaluate the implementation of the same in other plants all around the world.

### 3.7 GOAL 10: Reduced inequalities within and among countries.

CNH Industrial constantly aims to support project and activities encouraging social, cultural and economic development of local communities. It behaves in socially responsible way, paying particular attention and respect for the culture and tradition of each country.

Furthermore, supporting socially and environmental responsible behavior across the entire supply chain is the company's first responsibility.

Key targets reported in the Sustainability Report to face up to Goal 10 are the following [6.3]:

- within 2022: increase of 10% respect to 2018 in number of employees involved in volunteering activities during paid working hours
- within 2022: sustainability self-evaluation of 100% of Tier 1 suppliers
- within 2022: increase of 50% respect to 2017 in number of people involved in local community activities

To move forward SDG 10 and the targets linked to, the company recognize that today's business world is more and more global, so communication and collaboration in a harmonious behavior represent a key ingredient to across cultural and geographic boundaries.

It is promoted the project called "Managing Multicultural Teams", that represent the bodywork and the tool indispensable for a good collaboration within multicultural professional environment. The program proposes three courses: Recognizing Differences; Managing Differences; Sustaining energy at a distance. Generally, they enable employee to recognize and manage cultural differences, understand in different contexts behavioral expectations, and finally, promote trust and motivation in multicultural teams despite the geographical distance.

Number of initiatives took place in order to promote and build consciousness of the importance of a multicultural and inclusive workplace. Example of this initiative to promote gender diversity, the company's most brilliant female employees takes part in workshops in schools and universities, in these occasions there is a sharing of experiences with students encouraging girls to pursue their ambitions without any sort of limits and stereotypes. In addition there are multiple initiatives aimed to promote volunteering and social team building initiatives for employees, for example over 300 employees in Italy took part in the CNH INDUSTRIAL OLYMPIC GAMES and over 200 employees from Spain joined people with disabilities in a SPECIAL OLYMPICS.

As evidenced during the internship period, CNH Industrial is continuously promoting motivation campaigns on the World Class Manufacturing with big posters. To reach results prefixed above the WCM here is present with key pillar “People Development”, which has the core goal about improving the competencies of each employee and put them in the condition of share them with other who has the will of learning and improving the work with new knowledge. Sharing competencies and past experiences means also try to develop activities where each person is in condition of meeting others, so project and initiatives mentioned above are the key to go further in direction of Agenda 2030’s SGD 10.

### **3.8 GOAL 12: Ensure sustainable consumption and production patterns.**

CNH Industrial is engaged in the creation of added value for the company itself and for communities in which it operates with solution environmentally virtuous and economically practicable, granting a efficient and responsible use of resources with the final aim of reducing the environmental impact.

This is one of the most important goal the company take care, so objectives are so ambitious.

Key targets reported in the Sustainability Report to face up to Goal 12 are the following [6.3]:

- within 2022: involvement of 100% employees worldwide in training activities
- within 2022: sustainability self-evaluation of 100% Tier 1 Suppliers
- within 2022: reduction of 20% respect to 2014 in VOC emissions per square meter painted
- within 2022: reduction of 23% respect to 2014 in water withdrawal per production unit
- within 2022: 93% of waste recovered
- within 2022: reduction of 23% respect 2014 in waste generated per production units
- within 2022: reduction of 35% respect 2014 in hazardous waste generated per production unit
- within 2022: reduction of 30% respect 2014 in energy consumption per production unit
- within 2030: reduction of 60% respect 2014 in CO2 emission per production unit
- within 2030: 90% of total electricity consumption derived from renewable sources
- within 2022: reduction of 18% respect 2014 in kg of CO2 emission per ton of goods transported
- within 2022: development of next-generation alternative fuel engines
- within 2022: focus on natural gas engine technologies

- within 2022: distribution of new alternative-fuel tractors (methane and propane)
- within 2024: distribution of new alternative-fuel wheel loaders (methane)
- within 2022: increase up to 25% respect to 2015 in field productivity by expanding data management and control systems
- within 2020: autonomous technology development on self-propelled vehicles

The company decide to choose SDG 12 as one the most important for its business because it recognize the usage of resources as a material topic for its business, having big impacts on risk related to climate change all around the world.

*“As evidenced in materiality analysis, renewable energies and CO<sub>2</sub> and other air emissions are considered priority material topics by both CNH industrial and its stakeholders...”* is reported in the Sustainability Report, so each project assumes a continuous increasing importance day-by-day.

CNH Industrial intend to fight environmental issues, not with projects which are affective only for their duration, but it wants to start a change of the paradigm. The best way to do so, is the promotion of culture and knowledge about what are those problems and how we can change something little in our life to avoid a overutilization of natural resources. For this purpose, the company put in place some project aimed to the promotion of waste regeneration and recycling, to name a few there are:

- Recycling in the family: environmental workshops and event about how to recycle in a creative ways paper, wood and plastic in order to create useful object such keychains and pallets.
- Farmers for a day: employees and their family take part in typical farm activities such making preserves, handcraft and natural soap.

Other than promoting social and environment models of behaving CNH Industrial stars new project to mitigate the environmental footprint of its plants and activities.

Environmental Management has become in last years a key topic for both political actors around the world, but most important also for industrial actors, like capital goods companies. CNH industrial in one of the most active company in this field, in fact its effort is certified

and confirmed from the wonderful results obtained performing as a leader in the DOW JONES SUSTAINABILITY EUROPE AND WORLD IDEXEX with a score of 88/100. Another important socially responsible recognition is the grade of A- in the Carbon Disclosure Project (CDP) Climate change program, which has the overall objective of reducing greenhouse emissions and mitigate climate change risk.

All of those recognitions are due to a high engagement of the management and employees in what is denoted “Environmental Management”. It is a program performing with projects and activities on the short, medium and long term focusing on the 2 main global challenges the company decide to face to: climate change and food scarcity and food security.

Key role in this program, with a direct linkage to SDG 12, is water management as the company recognize the economic and environmental importance of responsible water management. Each plant is engaged at local level in the water reduction requirements paying attention especially on wastewater volumes without a decrease of quality standards. The impact of water resources is a constitutive part of plant’s environmental assessment required by ISO 14001 standard. Going into details CNH Industrial in 2012 issued the “Water management Guidelines” [6.9] which states:

- *Analyze the management of water withdrawal and distribution system and the consumption of water, identifying and eliminating leaks and waste*
- *Identify specific performance indicators and benchmarking for the different manufacturing processes*
- *Identify the manufacturing processes with the highest impact of water resources, and prioritize the necessary interventions*
- *Adopt changes and technological innovations to boost water use efficiency, reduce consumption and improve the quality of effluents*
- *Promote water recirculation within individual manufacturing processes and its reuse in multiple processes*
- *Raise staff awareness of responsible water use, both at work and at home*

In this way since 2016, the water withdrawal per product unit has decreased of 20.2% thanks to the promotion of multiple project aiming at the reduction and reutilization of water.

The second very important section of the “Environmental Management” is the waste management. In fact, the overall aim of CNH Industrial is not only to improve the quality of the end product, but also eliminate waste and enhance management of waste produced. To this end each plant is called to analyze their supply chain in order to identify potential waste improvements at different levels, limiting the quantitative of waste produced and risks associated. Waste management acts on three levels: waste recovery, waste to energy conversion and waste treatment.

Waste management at each level has been put in practices with lots of projects and initiative around the globe, for example in Suzzara (Italy) it has been installed a new system for paint recovery and for the washing of recirculating pipes, resulting in a reduction of almost 14% in hazardous waste. In addition, in collaboration with suppliers and final customers plants is implementing packaging solutions to reduce wood waste associated to logistic, as empty returnable solution, replacing disposable packaging with reusable materials as plastic or materials.

Any sort of losses, in terms of energy or resources are expressly indicated in the World Class Manufacturing Methodology, which directly classify and clearly identify energy inefficiencies. Environment and Energy pillar in fact takes care about optimizing energy use in manufacturing processes. In particular, this pillar, analyze, monitor and reduce energy consumption and the impact of CO<sub>2</sub> generated during manufacturing processes, and translate its optimization in monetary and environment benefits.

In terms of project implemented there are have be multiple action field and the main results are about: compressed air efficiency, building, lighting and heating/process heat and cooling.

### **3.9 GOAL 13: Take urgent action to combat climate change and its impacts.**

CNH Industrial is actively involved it action plans to reduce CO<sub>2</sub> and other air emissions, and at the same time it pays close attention to monitoring emission associated with its manufacturing processes, logistics, and the use phase of its vehicles.

Key targets reported in the Sustainability Report to face up to Goal 13 are the following [6.3]:

- within 2022: involvement of 100% of employees worldwide in training activities
- within 2022: achieve the monitoring of CO<sub>2</sub> emissions of 100% of key suppliers
- within 2022: reduction of 20% respect to 2014 in VOC emission per square meter painted
- within 2030: reduction of 30% respect to 2014 in energy consumption per production unit
- within 2030: reduction of 60% respect to 2014 in CO<sub>2</sub> emission per production unit
- within 2030: 90% of total electricity consumption derived from renewable sources
- within 2022: reduction of 18% respect 2014 in kg of CO<sub>2</sub> emission per ton of goods transported
- within 2022: development of next-generation alternative fuel engines
- within 2022: focus on natural gas engine technologies
- within 2022: distribution of new alternative-fuel tractor (methane and propane)
- within 2024: distribution of new alternative-fuel wheel loader (methane)
- within 2022: up to 25% respect 2015 in field productivity by expanding data management and control systems
- within 2020: autonomous technology development on self-propelled vehicles
- within 2022: increase of 50% respect to 2017 in number of people involved in CNH Industrial's local community initiatives.

“Climate Change” has been evidenced by the Global Executive Committee as broad, general concept, that goes far beyond the literal definition of natural climate variations. So SDG 13, probably represents for high level management one of the most important key objective to reach and to approach in a very urgent manner. They decide to fight this global problem from three perspectives: with a decrease of CO<sub>2</sub>, and other gas emission in the atmosphere, with the adoption of renewable energy systems and finally with a smart and more efficient management of water and waste.

Firstly, CNH Industrial decides to approach to the first perspective mentioned above developing project with the double action of decrease CO<sub>2</sub> emission coming from its products and working on logistic processes to reduce and optimize transports nets. So one of the most inclusive project which took place in Europe by Iveco is called “ECOCHAMPS” standing for *European Competitiveness in Commercial Hybrid and AutoMotive PowertrainS*, which has the overall objective of making hybrid vehicles more attractive for customers by extending

their functionalities and minimizing costs. In particular it has been developed a new efficient, compact, robust and cost-affordable hybrid powertrain for cars, light-commercial and heavy-duty vehicles resulting in a decrease of CO<sub>2</sub> emission thanks to the electrification of the powertrain which gives lower and lower emission in the acceleration from a standstill phase.

Secondly, to approach adoption of renewable energy systems, it has been addressed project to increase the production of energy coming from non-fossil fuel source. One of the most relevant projects in this field is the installation of Solar-Power systems at 3 of its plants, Annoy (France), Vallaloid (Spain) and Madrid (Spain). In details in the first 2 plants mentioned above, it has been installed the SmartFlower, a new photovoltaic energy generator which optimize automatically its inclination respect to the sun generating so up to 40% more energy respect to a normal



Figure 24: SmartFlower [11]

static solar panel, in addition it guarantees a self-clean and self-ventilation functions minimizing the maintenance.

Meanwhile in the last location mentioned above it has been installed a SolarWall solar heating system, a particular technology installed onto the exteriors walls that heats and ventilates interiors spaces using solar energy.

Those are just two virtuous examples of project aimed at improving the production of renewable energy, but there are overall 200 efficiency projects which generates about \$3.3 million in savings.

For what concern making more efficient and smart water and waste management, company's efforts is described in the paragraph before, talking about SDG 12.

To have good results for achieving of targets set in correspondence of SDG 13, the World Class Manufacturing represent a direct solution, in fact it pushes toward the "Ideal Zero", and this can be translated in lower emission of gasses in the atmosphere. In addition, attacking

wasteful usage of energy with the adoption of new technologies and the implementation of “Industry 4.0”’s solution the outcome is dual, because there is a savings in terms of money, but also in terms of environment, because the demand of energy coming from non-renewable energies is lower and lower. There have been put in place a real “decarbonization strategy”, including both emissions correlated to manufacturing processes and logistic. For the former it has been implemented renewable energy solutions as mentioned above, instead for the second one suppliers are involved in project and initiatives adopting intermodal solutions, optimizing transport capacity working on the EOQ (Economic Order Quantity), minimizing non-reusable packaging and protective materials and, lastly, investing in the adoption of innovative fuels like biodiesel, biomethane and electronic propulsion.

#### **4. Personal experience linking WCM and Agenda 2030**

According to my role during the period spent working for CNH Industrial, I had to work on project aiming at improving the efficiency and the effectiveness of logistic and production solutions. Each project has to follow the World Class Manufacturing guidelines, starting from the cost analysis and, after reaching a Pareto diagram of the main voices of costs, then project must attack what are the principal cost columns. This phase is followed from the study of To-Be solution, with the part-number that will be affected by, the relative cost to sustain to buy and implement the solution, and the relative savings it will generate, estimating in details the benefit to cost ratio that must be bigger than 1 or if not, must evidence a big improvement in safety condition, otherwise the solution is not convenient and will not be adopted. At this point, if there is an evidence that the solution is going to generate benefits, the project takes place and the solution is implemented. During all the phases there is a constant monitoring, also after the solution starts working, it must be demonstrated the real effectiveness translated in costs. After the conclusive phase of monitoring real benefits, there is an expansion of it in other areas of the plant and in other plants too.

Meanwhile the study of the World Class Manufacturing methodology, I decided to focalize my attention to the sustainability aspects of the company, giving evidence that it can be a key instrument to pursue at same time sustainable targets not essentially correlated to the production volumes or the revenues of the year.

In this sense I decided to be part of teams for the study of solution of 2 projects giving evidence on one side to strong impact that would have on the production costs and, on the other side, to the impact they have on the environment.

#### **4.1 3D Printer**

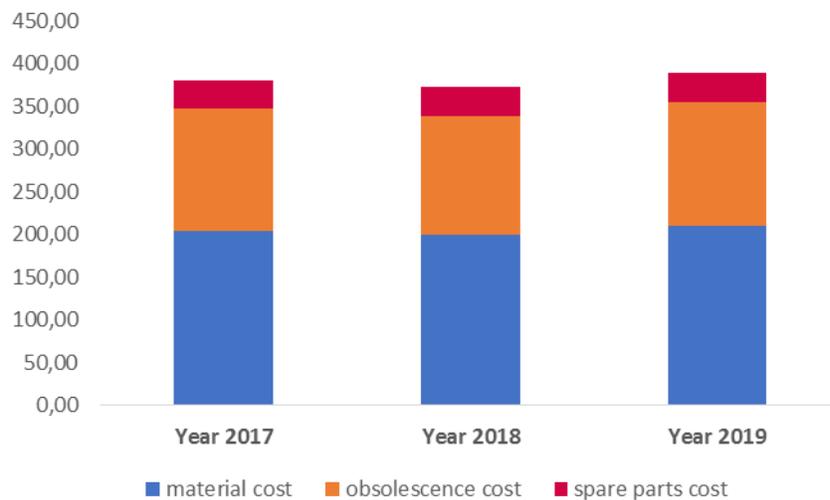
At the beginning of my period of internship at CNH industrial I have been assigned to the study of acquiring a 3D printer in order to produce maintenance spare parts and prototypes, implementing WCM methodology.

The printer was supposed to represent the solution to have savings from multiple aspects. Firstly, producing spare parts with the additive manufacturing technology can cut lead time, and in addition, it is possible to “print” only the necessary quantity, avoiding the minimum order quantity imposed from suppliers and so saving on warehouse spaces and cost of capital inside the plants.

Secondly, it represents a very good technology for producing prototypes to be implemented on the plant. Those ones usually must be built in a soft material with specific geometries to be fitted with delicate components of engines and are supplied from external companies who usually cannot apply large volumes at the beginnings, so costs are usually high.

For those purposes it has been started the study according to the World Class Manufacturing, identifying the principal losses and quantifying them. After the analysis conducted for last

three years it comes out that the principal costs are due to: material cost, obsolescence costs and spare parts cost, as shown in the figure below.



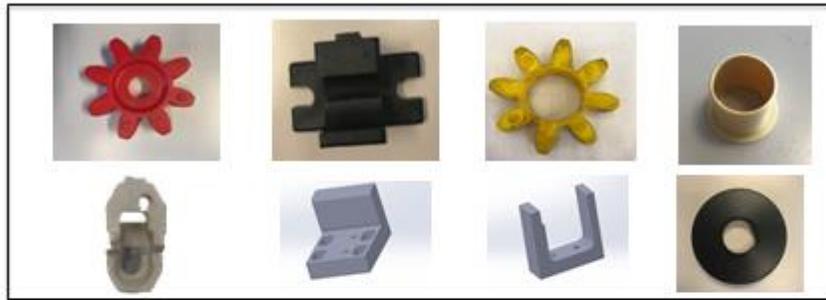
**Figure 25: Cost analysis**

Going deeper into the analysis there have been a separation of costs in 2 main categories: attackable costs, which are the ones who the project is going to reduce; and no attackable costs, the ones who are not affected by the solution to be implemented. The former are essentially plastic material and the minimum order quantity of small and medium size components, instead, the latter are specific manufacturing features with such dimensions to be not produced with a 3D printer.

Evidenced the attackable costs, the World Class Manufacturing states that, in order to evaluate the implementation on large scale of the solution, a model area must be identified, and, after the complete application of the project in this area, are evaluated the solution will be implemented in other plants.

In this case the model area is represented by 11 components, associated to an singular part-number, which are the most expensive ones in terms of difference yearly costs from making and buying them, and are reassumed in the imagine below.

### Maintenance Spare Parts



### Prototype

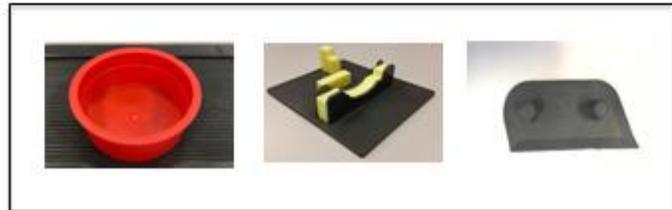


Figure 26: Components representing the model area

On average it is expected a saving per part of almost 38.5% as it can be seen in the table 1. Meanwhile, the choice of the printer is crucial, because of it should respect some technical features to make all the solution reasonable in terms of production requirements and costs. Going into details, the future 3D printer must be able to produce components of specific dimensions and geometries, with a good layer resolution, able to print in different material according to the usage of the components in the plants. All the technical characteristics of the printer chosen are reported below.

Characteristics	Technical Data
Precise and reliable	Endurance lower than $\pm 0,05$ mm
Print materials	ABS, PA, TPU, PET-G
Autonomous Printing	Internal memory
Layer Resolution	Fast 250 $\mu$ m – HD 150 $\mu$ m – Ultra 50 $\mu$ m



Figure 27: 3D printer and its technical features

	PN	Quantity [units]		Costs in 1 Year [k€]		Delta
		Bought	Real Need	Before: Bought	After: Printed	
	5801857902	600	240	28,5	20,0	30%
	60800870	1500	580	20,0	13,3	34%
	60138528	1500	600	17,2	10,3	40%
	5802044215	1200	620	10,7	7,0	36%
	5801567834	1000	450	10,4	7,1	32%
	5801791348	200	80	9,5	5,7	40%
	17318611	1500	800	8,3	4,7	44%
	5802084588	1200	500	7,9	5,3	34%
	M677473	1500	60	7,7	4,3	44%
	M615517	1500	60	6,2	3,2	48%

Table 1: Sum-up components

In the end the evaluation of results, after a testing period are a key milestone, in fact it has been highlighted that for each part-number there is an overall material cost saving [Figure 28] and a cost per unit saving [Figure 29], as displayed below and reaching globally a Benefit to Cost ration of 2,8. With a payback period reached in almost 5 months taking in consideration the real quantity needed.

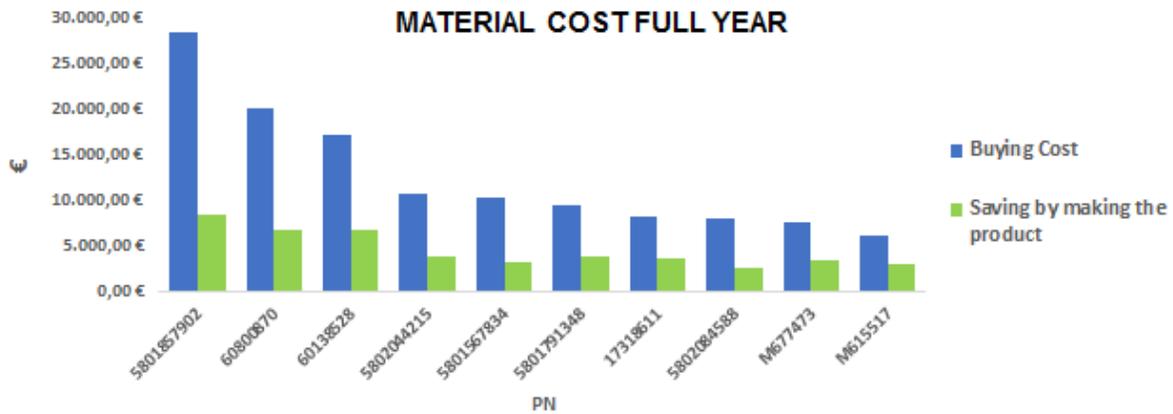


Figure 28: Yearly material cost

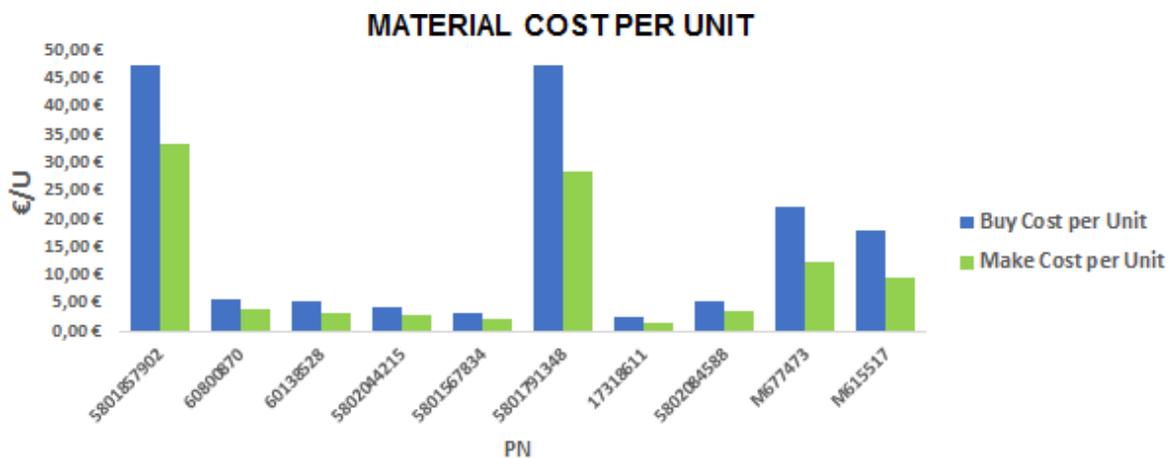


Figure 29: Unit material cost

Accordinging results obtained with the “model area” the project of course represent a good investment for the future and it could be useful to implement it in other part of the plant and in other plants. In fact, it can be implemented easily with other technological solution proposed by the Industry 4.0 and contribute in a more incisive on the daily production.

## 4.2 Extruder Sludge Coating

According to the final object of the thesis I decided to take part in a project outside the logistic area, so to better understand the links between the World Class Manufacturing and the environmental purposes of the company, work in collaboration with the environment pillar represents a good opportunity to explore how CNH Industrial takes care, at the same time, of production and environment targets.

The second project I decide to take part and to base my thesis is the study of the implementation, in the painting department of the plant, of a wall veil. Exactly is a slight water veil running on a wall with the aim of capturing the overspray of paint coming from automatic and manual guns, and then is conveyed to water treatment.

The study starts from the Pareto diagram of costs and identify what are the attackable environmental losses. From this analysis it is evidenced that there are three categories: chemical losses, waste losses and water losses. The project is going to “attack” waste losses, because the final aim is to reuse paint present in the air that does not go to the engine.

This type of waste can be spitted in two macro areas: non-hazardous and hazardous waste. The former is represented by aqueous suspensions containing not dangerous paint or varnish, instead the latter are formed by aqueous sludges containing paint or varnish containing organic solvents. Together they represent the 31% of the overall waste losses of the environment Pillar.

At this point the problem must be identified and clearly described in order to evaluate all the possible solution which better fit the plant and all the requirement of each stakeholder. It is exactly represented by an excessive presence of water in the sludge during the normal condition of work, so during the normal work cycle. The phenomena is easily verifiable in the tanks used for water relaunch of painting and in the tanks of automatic cabins. This problem, because of its relationship with the normal work cycle has a steady trend.

The engines in the painting room are automatically processed by robots, then after the completion of this phase, engines move to manual cabins for final possible adjustments. The overspray of paint, from both automatic and manual guns are collected by a water veil and conveyed to the water treatment.

In the polluted water treatment phase the water coming from automatic and manual cabins are conveyed to the flotations system in which are added chemical products for chemical treatment. Here there is a system of blades which partially collect sludge on the top of the tanks and everything is finally discharged to the big bag of waste (water and wet sludge).

From a chemical point of view two particles of overspray paint present in the cabin, have charge negative. This charge causes the particles tend to repel each other. So, it can be found ourselves in the presence of a dispersion in water. The target is to coagulate these particles in order to make sure that these congregate, assembling flocks. So, the addition of an electropositive coagulant solution with positive charge cancels the negative charge of the paint particles and so these tend to aggregate.

At this point the particles are aggregated, and then the sludge is produced and ready to be quickly removed from the coating bath. To remove it as quickly as possible it necessary to use a flocculant product in order to pick up flakes on surface. In this way the wet sludge on the surface of the bath can be remove mechanically.

In this way the plant is going to dispose only dry sludge with only a minimal part of water, it can be translated in terms of costs in a decrease of hazardous waste process disposal. Graphically the AS-IS and the TO-BE results are represented in Figure 30 -31.

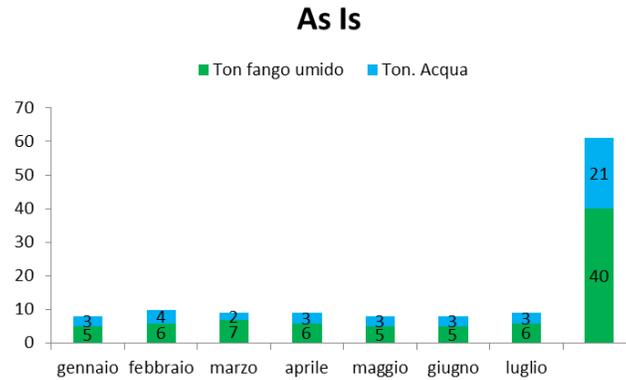


Figure 30: AS-IS analysis

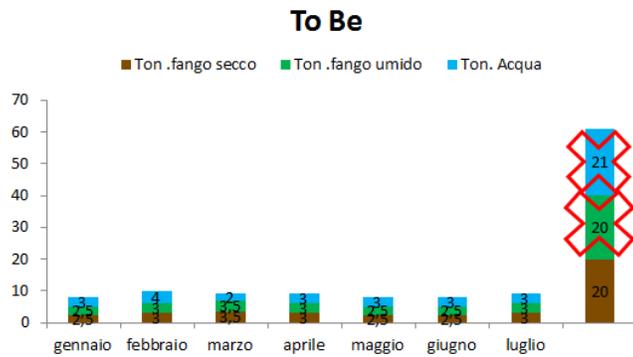
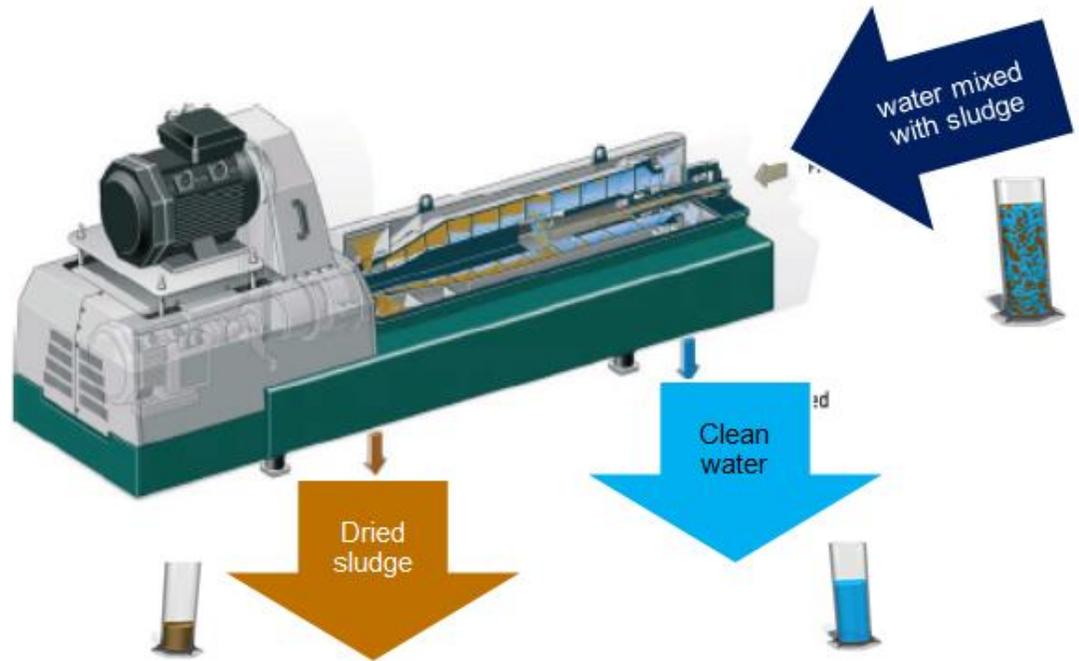


Figure 31: TO-BE analysis

After some market research of a top performing products, following the” green procurement” logic with the lower environmental impact possible, it has been decided to implement Aldec pump which separates the liquid components from a stream of sludge in a horizontal rotating cylinder (auger) provided with a screw conveyor inside. The feed enters the bowl through a stationary inlet tube and is accelerated smoothly by an inlet rotor. This gives rise to a centrifugal force which separates the solids from the water by acting on different specific weight. The overall working of this pump is represented in the scheme below [Figure 32].



**Figure 32: Pump representation**

So after having decided and implemented the solution, here there is a checking phase where there is a direct match between the process and data before and now. Before there was no automatic separation of di sludge on the surface, now there is a new system with centrifugal separation and sludge deposited on the bottom. In addition before there were a rejection of only hazardous waste to be dispose of, instead now there are only non-dangerous chemicals sold on secondary markets as chromogenic products.

In this phase, also the evaluation of KPI is fundamental. The ones analyzed to evaluate the effectiveness of the project are essentially four KPIs:

- Kg/engine of coagulant used
- Kg/engine of defoamers used
- Kg/engine of flocculant used
- Kg/engine of corrector Ph used

Numerically the following graphs summarize the results before and after:

### KPI Chemicals Consumption/Engine – Before

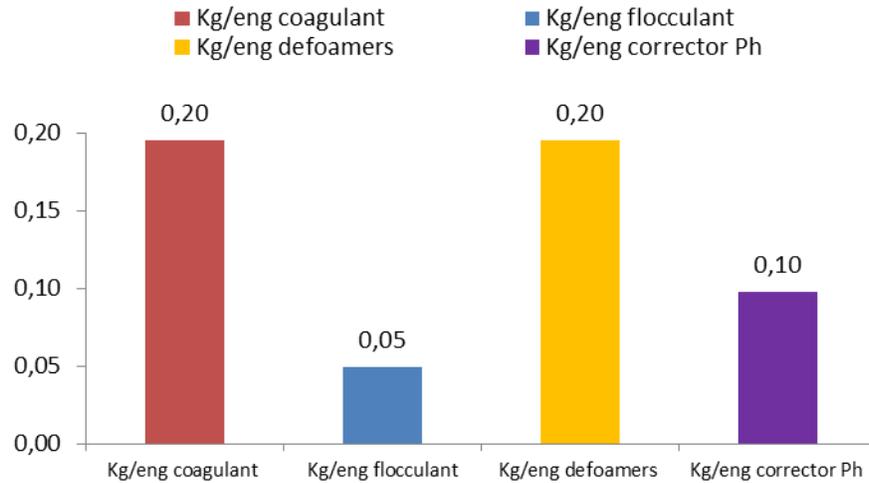


Figure 33: KPI results - Before

### KPI Chemicals Consumption/Engine – After

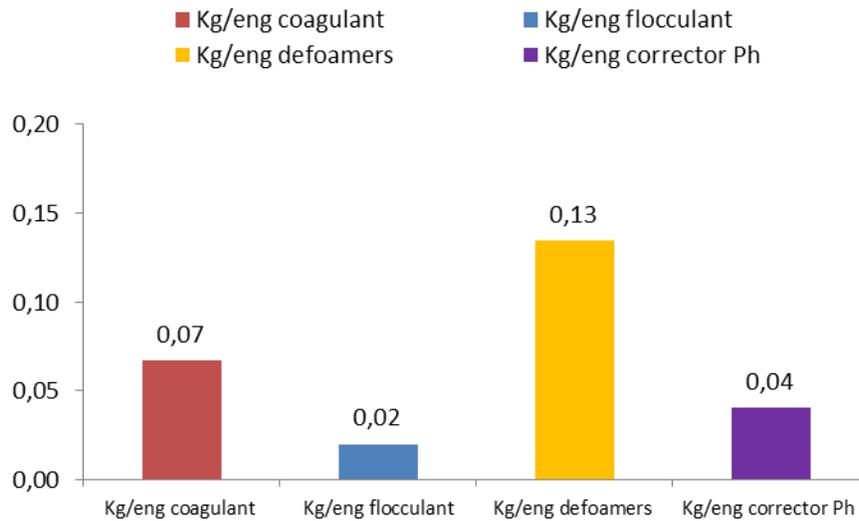


Figure 34: KPI results - After

The overall benefits are comes from three directions: firstly there is a saving of about €12.500 in terms of cubic meters of aqueous suspension disposal coming from painting, in fact before it happen monthly, now only four times per year; secondly now it is possible to save about €23.500 with a reset to zero of the disposal of tons of aqueous sludge coming from painting

units; and lastly there is the biggest piece of about €63.000 of savings coming from the consumption of chemicals per engine. in the table 3 are summarized before-after-delta amounts.

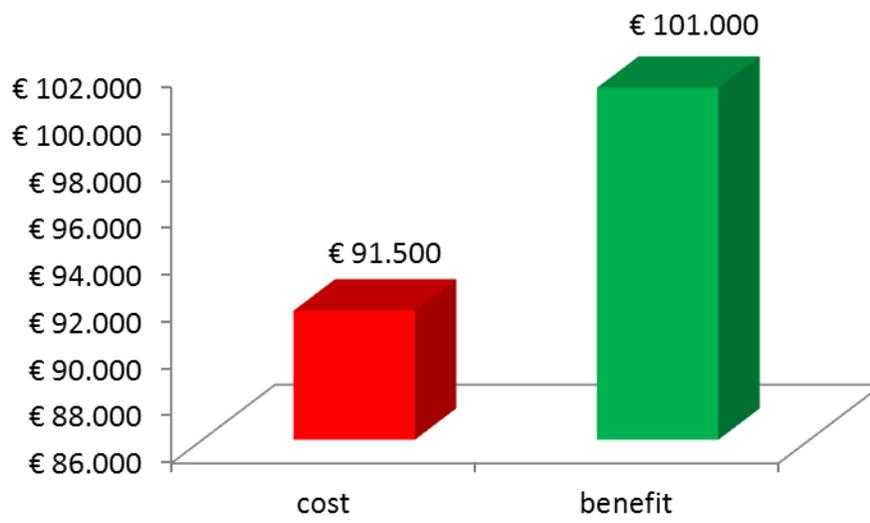
At the end there must be the final balance which evaluates costs and benefits. in details costs and benefits are summed up in the table blow with a final B/C ratio of 1.10 which states the project is provides advantages and benefits, so it can be implemented in other plants.

<b>Cost details</b>	
Analysis	€ 1.500
System & Equipment Purchase + Buffer	€ 90.000

**Table 2: Costa details**

<b>Benefit details</b>			
	<b>PRIMA</b>	<b>DOPO</b>	<b>Δ</b>
Aqueous suspensions disposal	€ 21.500	€ 10.000	€ 12.500
Aqueous sludge disposal	€ 64.500	€ 41.000	€ 23.500
Chemicals	€190.000	€125.000	€ 65.000

**Table 3: Benefit details**



**Figure 35: Graphic representation B/C**

## 5. Final conclusions and future prospective

Projects in which I took part, described above, are the good examples of the hypothesis that adopting the World Class Manufacturing in any kind of production process, here is a capital good company manufacturing and assembling diesel engines for multiple purposes, can have a really strong impact on the environment and society, in this case represented by Sustainable Development Goals set by United Nations in the program named “Agenda 2030”.

Starting from the project about the 3D printer, it goes perfectly with what is called “Optimal Zero”. According to this thought every production process should go toward zero waste, scraps and defects, and the 3D printer in fact aims exactly to reduce at the minimum wastes applying the “Just in time” methodology. When there is the necessity of a maintenance components or a prototype part, it is printed, so it will not reduce warehouse storage and, moreover, it can be exactly printed according to the necessity and features required by the plant’s specifics. There is no dispersion of information because few people can manage the entire process, and, in addition, risks linked to any sort of delay are minimized. Another important advantage is that the material with which components are printed can come from recycled process, because the most used material is the plastic, so if there are no particular requirement about the material to use, it is easy to change and switch for a recycled plastic, in this way there are multiple linkages SDG 12, “Responsible consumption and production”, and with SDG 9, “Industry, innovation and sustainability”.

Taking in consideration the project about the extruder sludge coating, here it is a perfect example of a perfect conjunction of objectives. From the World Class Manufacturing side the overall goal achieved is an general improved efficiency and a substantial cost decrease in determined processes. In this case savings are in the areas of aqueous suspensions disposal, aqueous sludge disposal and chemicals used in the painting process. Analysis of savings are reported in the description of the project above. Focusing the attention on the Sustainability side, the project is an important milestone for environment pillar because of it is impacting the painting process, usually considered one of the most unsafe and delicate from environmental point of view because of its nature and chemical material used. Here the direct link is with SDG 3, “Good health and well-being”, reducing substantially the emission and the possible contact of the work of Volatile Organic Compound (VOC). Moreover, this

project is easily conducive for the reduction of chemicals used and for a second life given to the waste of the painting process to SDG 12, “Responsible consumption and production”, and to SDG 13, “Climate action” thanks to a decrease of emission of gasses in the atmosphere.

In conclusion, as the WCM starts everything from a cost prospective, in indirect way it takes in consideration also environmental and social issues, not always easy to quantify in monetary terms, but easily conducive to sustainability goals which represent future challenges to take in consideration. In this way CNH Industrial have a clear intent for its future: it is increasing constantly its effort toward a “greener future” and it is doing this right here in Turin. In fact under the brand of FPT Industrial it has been developed a new engine named Cursor X, it represent a multi-power engine working with natural gas, hydrogen fuel cell electricity generation or battery-stored electric power; it represent a modular solution thanks to its architecture that simplify assembly process, vehicle integration and servicing. It is multi-application because is designed for power traction, but also for auxiliary systems, tools, an power take-offs for all types of industrial vehicles and machines. Most important the CursorX is designed to feature self-learning capabilities and provide large number of data to continue the development of both hardware and software. It is equipped with sensors and processors to identify anomalies and so guarantee prompt maintenance. From an environmental point of view thanks to natural gas configuration and to the electric mode option is ideal for accessing in the city centers with a reduction of CO<sub>2</sub> of 30% with a range 200 KM in electric mode. Finally, the hydrogen cell fuel configuration has the potentiality to become the first fully electric technology appropriate for heavy-duty transports with a range of about 800 KM. In this way the company is going to produce an innovative product able to compete for performances but also in sustainability aspects making its plants more and more efficient from all perspective implementing the world class manufacturing methodology, increasing continuously its effort in innovative project in order to pursue goals and objectives coming from stakeholders and CNH management evidenced in the materiality matrix.

	End poverty in all its forms everywhere
	End hunger, achieve food security and improved nutrition, and promote sustainable agriculture
	Ensure healthy lives and promote well-being for all at all ages
	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
	Achieve gender equality and empower all women and girls
	Ensure availability and sustainable management of water and sanitation for all
	Ensure access to affordable, reliable, sustainable, and modern energy for all
	Promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all
	Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation
	Reduce inequality within and among countries
	Make cities and human settlements inclusive, safe, resilient, and sustainable
	Ensure sustainable consumption and production patterns
	Take urgent action to combat climate change and its impacts
	Conserve and sustainably use the oceans, seas, and marine resources for sustainable development
	Protect, restore, and promote sustainable use of terrestrial ecosystems; sustainably manage forests; combat desertification and halt and reverse land degradation; and halt biodiversity loss
	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all, and build effective, accountable, and inclusive institutions at all levels
	Strengthen the means of implementation and revitalize the global partnership for sustainable development

Figure 36: Sustainable Development Goals

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