Professional MBA
Entrepreneurship & Innovation

Opportunities and challenges of AI technology applications in cement industry in Europe

A Master's Thesis submitted for the degree of
“Master of Business Administration”

supervised by
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Affidavit

I, **DUSAN PEICIC, DIPL.-ING.**, hereby declare

1. that I am the sole author of the present Master's Thesis, "OPPORTUNITIES AND CHALLENGES OF AI TECHNOLOGY APPLICATIONS IN CEMENT INDUSTRY IN EUROPE", 81 pages, bound, and that I have not used any source or tool other than those referenced or any other illicit aid or tool, and
2. that I have not prior to this date submitted the topic of this Master's Thesis or parts of it in any form for assessment as an examination paper, either in Austria or abroad.

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Abstract

Industry 4.0 is here and is driving the revolution of next generation manufacturing, customer service, logistics, supply chain, HR, comunication, etc. AI is set to power the fourth industrial revolution and companies that can incorporate and adapt to Industry 4.0 components are likely to thrive and set the bar of success very high.

Industrial units are constantly tending to increase efficiency, decrease the costs, optimize product time to market, upskilling of staff and others. AI is definitely recognized as one of the biggest breakthrough's in the industry, with great possibilities and advantages for early adopters. Industrial side of business has recognized great potential within next pillars: asset performance management, occupational health and safety of employees, production and quality optimization, energy consumption savings, as well as supply chain management improvement. Commercial side of the business has on the other side recognized better customer service, better logistic spread and planning and lower reclamation rate due to all above announced facts. The expansion of new technologies leads to intensification of business ventures with alternative value chains and business models. The ability to innovate by using functional business knowledge, technology and resources in accordance with changes in the market affect the company's business success by creating new value for customers and the company and improving one or more business segments. Today, vendors, consumers and partner companies actively and equally participate in the innovation process. Together they create new knowledge, ideas, new products, which is important to gain competitive advantage. This thesis has tried to find a foothold in the open innovation concept and business development, as well as innovative methodologies of project management to come up with adequate proposals for AI innovation model in cement industry.

Acknowledgement

To my children, my wife and my parents who were always having unselfish understanding for my professional ambitions and lack of time spent with them.

Dušan Peičić

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List of abbreviations

AI → Artificial intelligence

ML → Machine learning

OECD → Organization for Economic Co-operation and Development

CEMBUREAU → European Cement Association (based in Brussel)

SCM → Supply Chain Management

AF → Alternative Fuels

OH&S → Occupational Health & Safety

QMS → Quality Management System

MGI → McKinsey Global Institute

WEF → World Economic Forum

DIAI → Deloitte Institute for Artificial Intelligence

HR → Human Resources

(O)H&S → (Occupational) Health and Safety

VMI → Vendor Managed Inventory

API → Application Programming Interface

GUI → Graphical User Interface

KPI → Key Performance Indicator

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1. Industry 4.0 and AI

The expansion of new technologies leads to intensification of business ventures with alternative value chains and business models. Industry 4.0 is here and is driving the revolution of next generation manufacturing, customer service, logistics, supply chain, HR, communication, etc. Companies that can incorporate and adapt to Industry 4.0 components are likely to thrive and set the bar of success very high. Extraordinary big competition, high value assets and high mobilization of financial resources to keep the business running, are making cement industry highly inflexible and therefore the strategy and implementation speed are really, really crucial in this business. Industrial units are constantly tending to increase efficiency, decrease the costs, optimize product time to market, upskilling of staff, etc. AI is recognized as one of the biggest breakthroughs in the industry, with great possibilities and advantages for early adopters. The ability to innovate by using functional business knowledge, technology and resources in accordance with changes in the market affect the company's business success by creating new value for customers and the company and improving one or more business segments. Today, vendors, consumers and partner companies actively and equally participate in the innovation process. Together they create new knowledge, ideas, new products, which is important to gain competitive advantage.

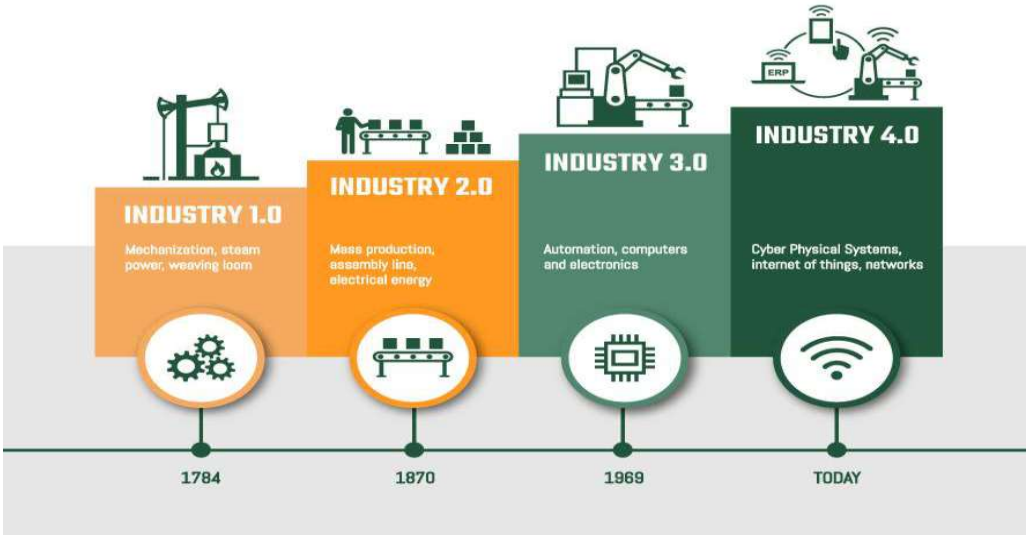

Figure 1. Industry development 1.0 – 4.0 (open source)

2. Uptake of AI in the cement industry today and potentials for the future

AI is positioned to disrupt our world. It is estimated that the way humans work and their productivity will be greatly influenced by automation and artificial intelligence. Experimenting and developing different technologies, opportunities and strategies requires significant investments from companies that want to capture value in this market. Deciding which opportunities, out of the thousands available, are worth pursuing can be a very difficult task for companies. Options can be narrowed using a structured approach. Choosing an industrial focus should be the initial step. Of course, decision will be greatly influenced by company's expertise and capabilities. However, characteristics of the industry, including the size of the chosen sector, should be considered. Potential for disruption within an industry is also a factor that can be examined. It includes estimations of start-up equity funding, total number of artificial intelligence use cases and estimated economic impact of AI use, which covers retrospective analysis of all benefits achieved by use of specific applications, such as cost reduction or productivity increase. Possibilities for economic benefit are what makes customers pay for an AI solution. Another factor that plays an important role is maturity. Not all sectors have the same willingness to accept AI solutions. For instance, automotive industry is much more eager to use AI comparing to the industrial sector, although it could gain a lot as well. This results in uneven value capture, meaning that some industries can initially produce higher returns comparing to others. Considering value at stake combined with maturity, AI has the greatest opportunities in following fields: automotive, banking, retail and public sector (Figure 2). The main reason why public sector invests in AI is that government officials see all the benefits that could be gained through the use of AI, especially when it comes to improving efficiency. The same goes for all customers; in the same manner as governments, they buy AI in order to solve specific problems that can save them assets or increase sales, resulting in generating a solid return on investment (ROI). It is therefore important for buyers to get offers that fit their needs so that the solution's ROI could justify its expense. Offering a horizontal solution that could be applied on different unrelated use cases but doesn't fully cover its primary purpose of cost reduces or performance improvement isn't satisfying for buyers. For instance, a manufacturing plant that tries to reduce machine downtime will look for a solution

with proven predictive-maintenance expertise and won't simply seek a company with a good reputation in the industrial sphere.

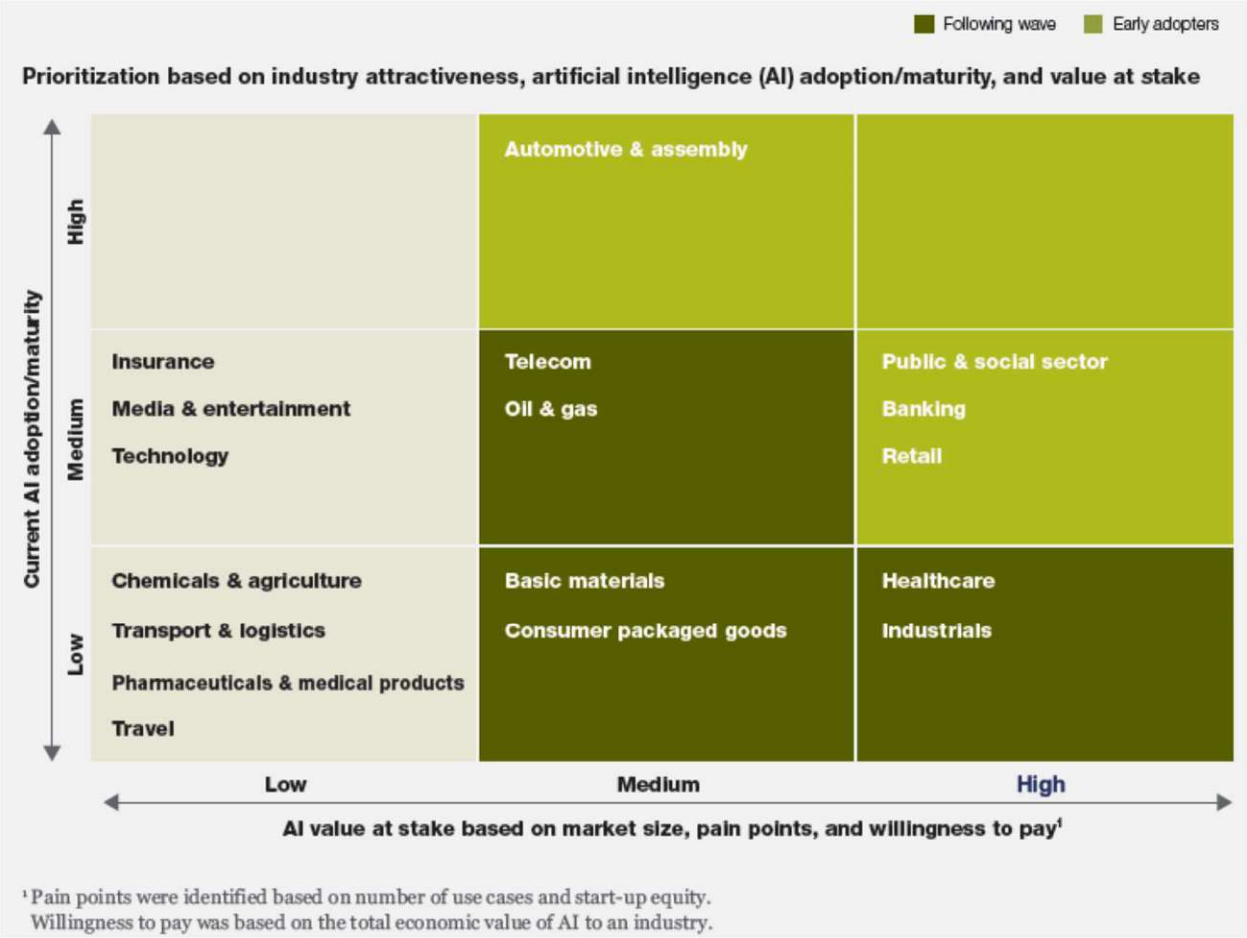

Figure 2. Readiness for adoption analysis (sources: Crunchbase, IDC, IHS)

2.1 Technology overview, assessment and opportunities

Very few cement producers have introduced artificial intelligence (AI) in their business processes, at least not in any systematic way, despite the fact that AI provides enormous opportunity to raise the efficiency of these processes and consequently, create added value. The producers who instantly realized the advantages of AI gained a powerful advantage over the competition. Industry 4.0 is exploring new ways to create connections between physical/analog and digital systems. In general, many industries have already implemented industry 4.0 solutions with promising outcomes. For example, mining companies are using

equipment status date (temperature, pressure, etc.) to predict potential failures. Aeronautics and automotive companies are applying digital twins to improve their production processes. First movers across industries have gained advantage over competition. There are many ways for cement production to benefit from applying AI. (Figure 3). AI solutions are able to manage more effectively energy consumption, cost challenges in general and different kinds of process complexities. Traditionally, in estimating end-product quality, cement companies rely on engineers' knowledge, traditional expert control systems (like PXP, Fuel Mng or Mill Master) and statistical data from prior production campaigns (one or two hours delay). On the other hand, AI solutions use real-time data, historical data to train the models first which are later used for managing and predicting outcomes.

Although major cement companies understand the benefits of AI, very few are aware of its full scope or advantages which could come. Those among them who are the first to react will create exceptional added value for business and higher competitiveness. Among the many AI solutions offered, five hold major potential for cement manufacturers: asset performance management, digitalization of occupational health & safety solutions, production & quality analytics, supply chain optimization and carbon footprint.

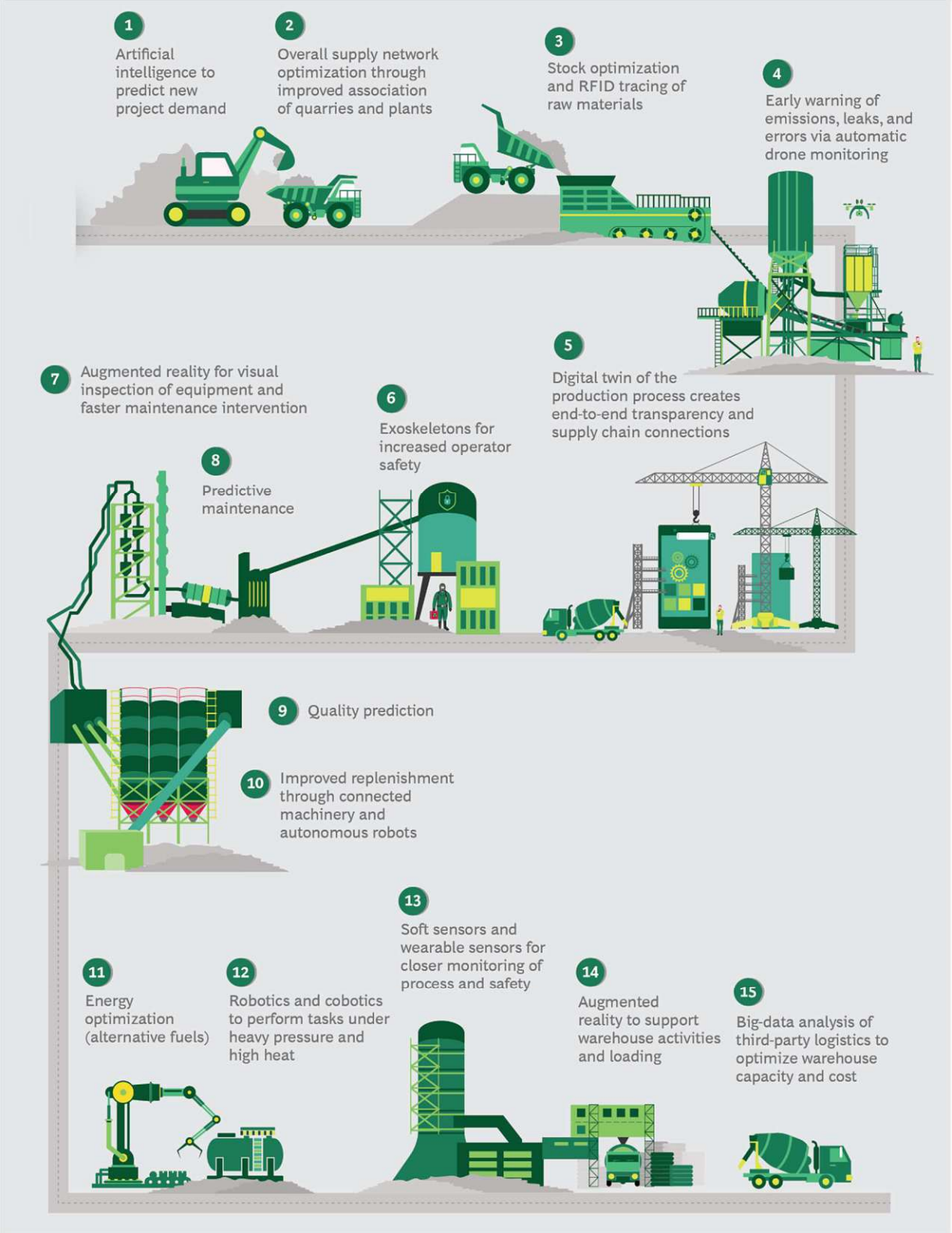

Figure 3. AI solutions that could enhance cement production (source: Cembureau – European Cement association based in Brussel)

2.1.1 Asset performance management

Asset performance management has three pillars: proactive / predictive maintenance concept as the strongest, faster decision-making process and refractory management (Figure 4).

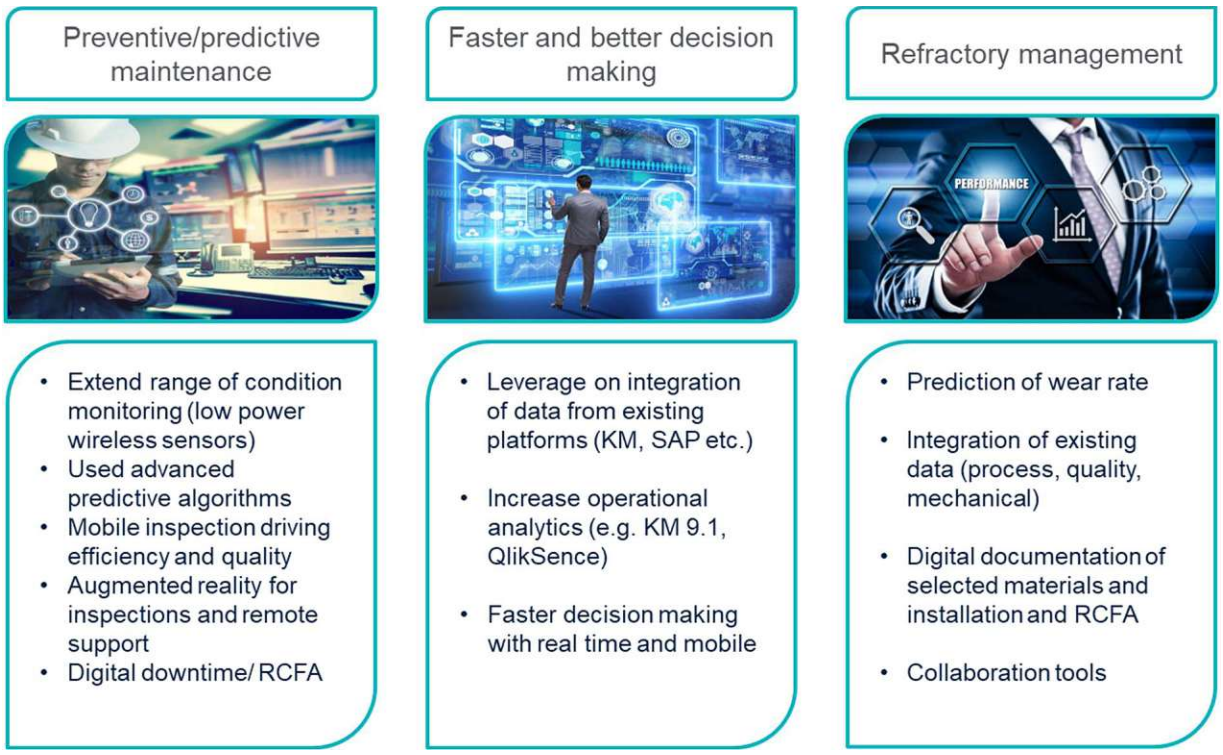

Figure 4. Main pillars of asset performance management (source: internal CRH co. file)

Since the predictive maintenance is having the strongest influence in asset performance management category, it will be more elaborated. Predictive maintenance allows cement producers to deal with maintenance issues before the actual breakdown of equipment, thereby increasing reliability of equipment, preventing equipment damages, improve production line efficiency and cutting costs for maintenance. Just as example, each month the operator can stop production for a couple of minutes to replace part of equipment that's about to have failure, instead of replacing that part every year, no matter if it is necessary or not.

For cement companies, implementing systematic AI predictive maintenance, means first equipping production lines with sensors for condition monitoring (vibration, temperature and pressure). Next step is collection and transfer of data from sensors into repositories, or so called "lakes". Furthermore, the performance thresholds must be established which will automatically activate

maintenance as soon as the value from a sensor exceeds the predetermined threshold. As a final point, machine-learning algorithms will explore historical data, train themselves according to them, find causes of previous malfunctions and predict the risk of failure. Many cement companies are imposing different AI projects to explore ways to benefit from usage. Traditionally, improvements in cement industry have been financed as capital expenditures. AI offers cost effective option by enabling companies to use already applied software to analyze collected data and interpret their results in order to achieve highest possible efficiency of the equipment. Applications of AI technologies are leading to improvements in administration and supply chain functions, but presence in production was very humble. This is particularly interesting, considering that cement plants are very eager in introducing of automation and expert control systems and are using different sensors and signals for a very long time.

Although this has brought considerable improvement in the field of visual control for operators, most companies with related to heavy industry are very slow in following latest trends and AI developments, fast analytics and other support solutions. Operators are still main link relying on their long experience and learned patterns during decision making process. Teams of control room operators are still working in traditional ways, monitoring a huge amount of signals and data in order to properly adjust the system. Apart from that, they are expected to simultaneously solve problems, perform different trials and are pushed to the limits. Understandingly, majority of control room operators are forced to cut corners by prioritizing activities that are urgent, but on the other side not adding value to a business. Due to a huge dependency on the operators, they are very hard to be replaced in case of retirement as example. Since inconsistencies in knowledge of operators have big impact on production performance and cost, the advantage of AI is to save, build and standardize knowledge applied. Very important to mention is that being able to make complex operational set-point decisions by itself, AI can deliver predictable and consistent output in markets that have difficulties to recruit the control room operators. Speaking about adaptability and retention, AI is far beyond conventional expert system technologies. AI is solving fully autonomously complex challenges, at the same time delivering while delivering high reliability and optimal performance in a real time. Workforce to maintain functionality is set on minimum and manufacturing strategy is very easy adjustable to revised manufacturing plans. Evidence obtained from European cement companies shows that algorithms created with sophisticated AI advanced software's for analytics result in significant improvement of energy consumption savings

and throughput performance of main industry equipment's (raw mills, cement mills, rotary kilns) by increasing profit dramatically. Only with clever usage of the information already given at disposal, AI can upgrade performance without capital intensive investments, but having quick gain as results. An additional appeal of AI is its ability to generate machine learning which acquired knowledge can be transferred to similar processes or operations. Based on gained knowledge and experience as well as the rapid development and growing presence of AI, it is reasonable to predict that AI optimizers will become irreplaceable in many plants while a growing number of companies will need to develop their own systems in order to fit their needs.

2.1.2 Digitalization of occupational health & safety solutions (SAFETY 4.0)

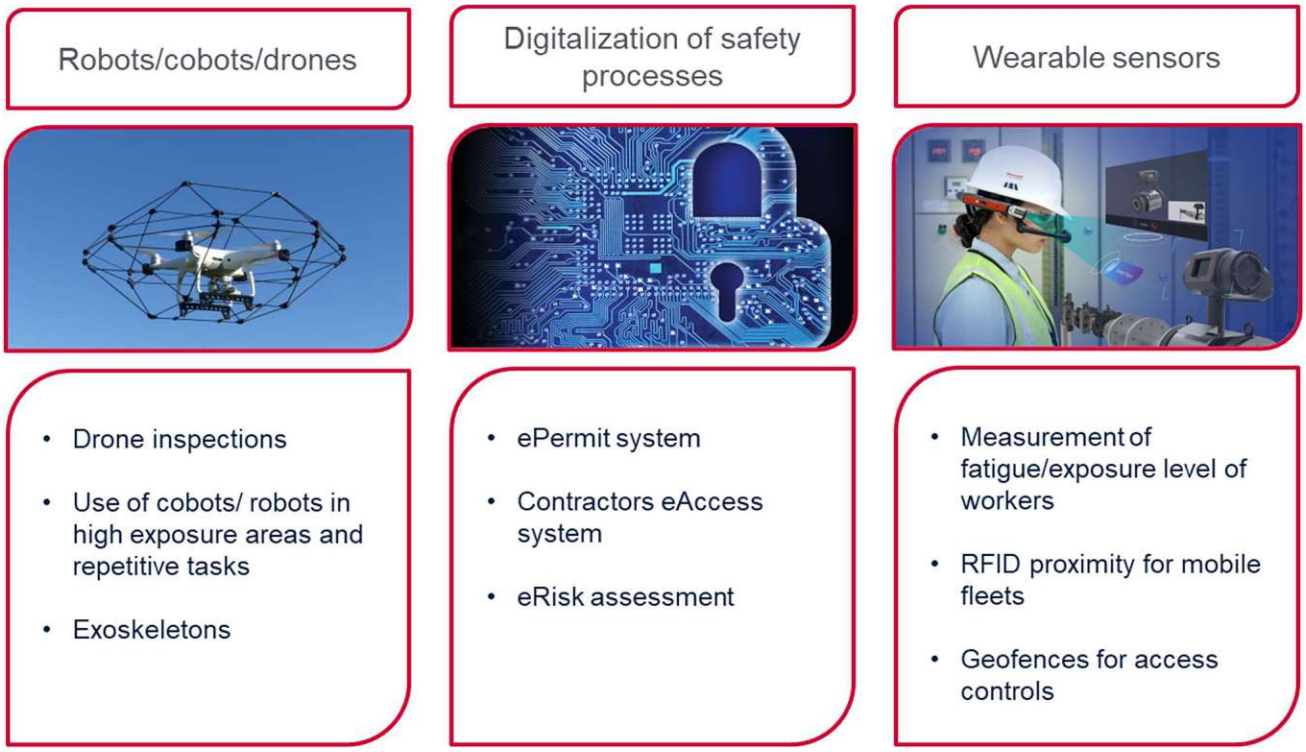

Figure 5. Main pillars for digitalization of OH&S solutions (source: internal CRH co. file)

Companies are aware that more must be done in terms of injuries prevention caused by operating heavy machinery and equipment, primarily because they have negative effect on the health and well-being of staff, while reducing the productivity and increasing the costs operations. A new standard for occupational health and safety ISO 45001 serves as a guide for business owners in mitigating the risks of workplace injuries. It is a framework helping business owners to control work related risks better and enhance employee's safety, which inevitably leads to better performance.

Advanced items in IoT (Internet of Things) technology improved the understanding of the staff safety by manufacturers. Emergent technologies serve both workers and employers in environmental risk management and in health monitoring. Industrial Internet of Things (IIoT) is connecting Personal Protective Equipment (PPE) with manufacturing equipment and systems in order to level up safety management to automatic level. An example of this technology are wearable sensors which can detect risky worker behavior (such as prohibited area entry) and alert supervisors and line management about potential threats. Smart Helmet is a product intended to

improve occupational health and safety within the industry by using augmented reality. The helmet equipped by cameras and sensors warns about any potential threats with collection of information's about workers behavior and his environment (pressure, temperature, etc.) Safety instructions can be displayed on the screen mantled on helmet, helping the worker to anticipate better accuracy during maintenance works and eliminate or mitigate mistakes. Apart from performing environment monitoring, mantled sensors in personal protective equipment can observe the workers' health indicators, by presenting current heart rate, breathing rate and even the blood pressure. According to reports HSE received in last two years for the Europe, 22 % of the lost time injuries were caused only by excessive load from lifting different objects. Tasks requiring physical actions with high repetition are best performed by robots, because they can be utilized whole day without breaks and are able to handle weights too heavy for humans, without getting injured. Another option are exoskeletons, more appropriate for doing more refined work. Exoskeletons will not only make work easier for plant workers but will also allow them to benefit from the improved skillset. Nowadays wearable robotics enables workers to perform tasks which used to be dangerous and difficult for a single employee to accomplish, such as lifting extremely heavy machinery. Exoskeletons which can help people walk again, can certainly offer innumerable benefits in terms of optimizing efficiency and capabilities of the workforce.

Speaking about robots for collaboration with humans (cobots), they should not have sharp edges, motors out of geometry or some other concave points because they were designed to work having health and safety in program. For the same reason, cobots are equipped with sensitive monitoring devices, controlling the speed of its movement and ensuring to be stopped if a worker is very close. Examinations and inspections can be performed more rapidly, safely and less costly by robots than by people or helicopters. Advantage is not just being much cheaper, but also they are capable to perform more frequently. New forms of analysis are being made possible by increasing the volume of collected data. Drones are already being used in this kind of industry transformation.

In order to have everything centralized from one place, cloud-based software's are developed for this purpose. Nowadays software manufacturers can integrate safety features into one common manageable and optimized platform. Connected worker concept is the best precondition for developing H&S software. The platform has incorporated headsets with possibility of voice instructions allowing employees to have free hands to perform other tasks. A wide range of information can be fed into software for health & safety management, such as recordings of PPE

from IoT, inspection results and H&S training files. This allows the producers to have excellent overview of H&S across the plants, which supports the understanding of what further steps should be taken to improve safety.

2.1.3 Advanced production & quality analytics

Figure 6. Main pillars for advanced production & quality analytics (source: internal CRH co. file)

2.1.3.1 Digital "twin" system for process optimization

Cement companies can use the digital twin system which allows simulation of all processes in a digital "twin" models of the plant by implementing different AI modules. When applied to the cement production process, one can think of a billion of variables, from the material quality in quarries, across fuels chemical properties, considering all fuels in pyro processing, quality of cement as final product with optimized costs. Cement producers usually tent to balance all these variables through whole production process. Not only that this is a very strenuous process, but it does not actually result in true optimization. The digital twin technology is making simulation of all processes, at the same time allowing the cement plant to generate different options for each important variables affecting optimal equipment running. This digital twin technology can propose the most efficient settings of equipment for accomplishing given targets and KPI's, e.g. balanced

cost structure vs wanted level of quality or some other specified targets. And most importantly, these systems are capable of learning from experience and improving their performance accordingly. Since it is able to learn, the machine does not need to be reprogrammed to make data-driven predictions or decisions. The early adopters of the digital twin technology were aerospace and defense industries, which used it to test component quality through many iterations, thus eliminating or mitigating unwanted high cost for prototyping. Since then, digital twining technology is implemented with success in other industries as well, e.g., mining and construction. When it comes to cement producers, they are building digital twin system one step at a time, from one subprocess to the other, until all process lines are covered. As the simulation is learning and making iterations, prediction model starts to be built achieving the wanted level of digital replication. The digital twin simulation should produce results predictions in a real-time since it is not having hourly spot samples as in cement industry but is even capable to have 3 or 6 digital samples per minute, where based on that adjustments in process application across the entire production line are done.

2.1.3.2 Predictive Analysis for Quality

Predictive quality models are important in order forecast quality development of finished product in real time during production process. This should improve quality of cement and improve cost structure in terms over-quality avoidance. In the usual cement plants is not possible to estimate cement strengths until its 1-day, 2-day, 7-day and 28-day strengths are achieved and measured through physical and mechanical tests. Cement producers tend are using some other additions, high grade limestone, slag and additives to ensure a high performance of cement. As alternative, in order to improve strengths, they could perform finer grinding to increase strengths, which on the other side impacts capacity loss, meaning increasing the costs. Models used for quality prediction are using ML algorithms to connect the quality of each production campaign for certain cement type with necessary process parameters. Due to strong interdependency of parameters, it is difficult to determine immediate impact of every single parameter. AI lets the system train himself and learn, to connect all input parameters in order to have as output a high quality results. As a result, every cement plant can build unique predictive model, tailor made for needs of the plant. Also, cement producers will have more comprehensive system to detect root causes of production and process issues, being able to make difficult decisions about potential investments,

choosing most cost efficient ones which will improve product performance in terms of quality and quantity.

2.1.3.3 Alternative Fuel Optimization

Another feature of analytics is optimization of alternative fuel consumption, resulting in cost reduction and improvement of cement business's environmental impact. It is estimated that energy expenditures, which represent approx. 50-60% of total cement production costs, could be cut by 50% by using alternative fuels sources. The use of alternative fuels is increasing every year, but still can be improved. An analysis of three leading global cement producers, shows that alternative fuels usage is only 20% of the industry's fuel usage globally and it is considered to be even lower in developing countries. Some of the reasons for the low consumption of alternative fuels are providing constant supply chain with proper quality of fuel to maintain burning process by that avoiding disturbances with clinker quality, which is main ingredient for cement production. The precondition for a greater use of alternative fuels, is a better control of variables in the process, considering amount dosed, heat values, points of dosing, etc. This can be controlled better by more accurate predictions of fuel heat values and other characteristics, with following steps:

1) Data collection about chemical composition of fuels and rotary kiln performance with different fuel type usage, taking temperatures, pressures and other process parameters onto account

2) Creation of total heat value per hour prediction model, performing after that industrial trials to access cost vs performance ratio for every combination of fuels, dosing points, calciner vs main burner ratio, etc. This models could be used afterwards on other fuel types as well.

3) Include ML algorithm using to predict the split of fuels, amounts based on heat values and type of fuels per dosing points to achieve wanted outcome.

4) As the final step, define the model dynamics by using artificial neural networks, which are supporting self-adjustment of process parameters giving an optimal cost vs performance outcome.

2.1.4 Supply chain optimization

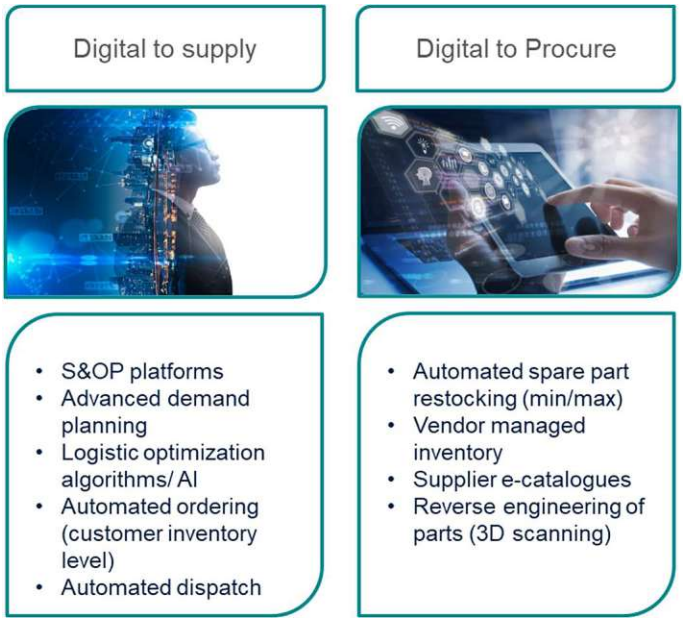

Figure 7. Main pillars for supply chain optimization (source: internal CRH co. file)

This sub-chapter includes a brief description of certain opportunities and challenges of supply chain optimization via AI. It will be discussed later in depth. Supply chain design used by companies for a long time faces the need to be reconfigured due to disruption created by industry 4.0 and AI. Traditional ways of working and thinking about supply chains are altered by modern technology. Companies have to adjust themselves to this newly created settings and trends. Customer expectations have changed and that fact shapes the business models. Besides being a challenge in terms of adaptation, the newly established business environment can also be seized as an opportunity for companies to improve their operational effectiveness, by further improving their supply chain models with digitalization and to substitute the traditional supply chain model by a digital one.

There are several global trends that greatly influence supply chain management: the wealth relocates to regions that were excluded before as rural areas incessantly expand on a global level. Another considerably significant factor is the pressure to reduce carbon emissions and to change traffic regulations for socio-economic reasons. Demographic changes reflected in workforce age increase result in reduced labor availability and increasing ergonomic requirements. One of the most influential aspects of business is customer expectations, which are constantly growing.

Technology development and online trend caused higher service expectations. The competitiveness of supply chains grows due to transparency enabled by internet and user's possibility to choose between various company and product or service options. Orders are becoming more and more individualized and customized, which encourages different planning in the stock keeping unit (SKU) per plants. Conclusion that can be drawn from all stated is that supply chains needs to be more agile, efficient and accurate. Exactly this vision of the future environment for supply chain will be separately elaborated in one of the following chapters.

2.1.5 Carbon footprint

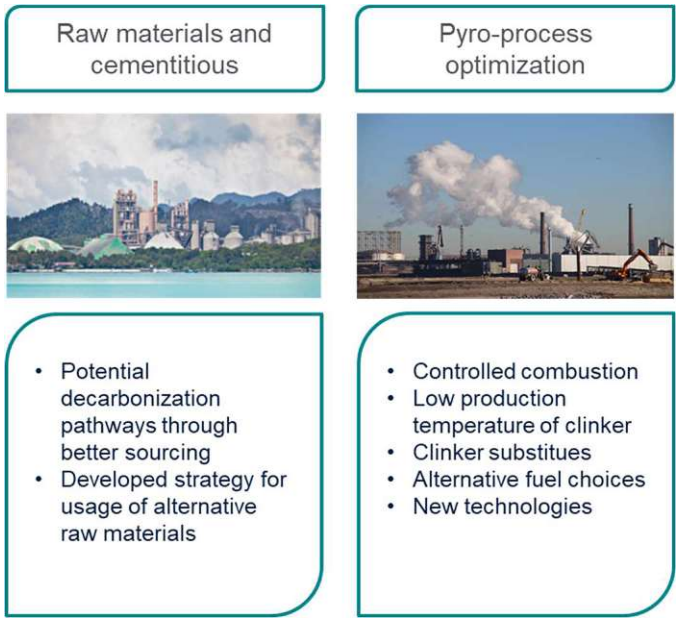

Figure 8. Main pillars for carbon footprint (source: internal CRH co. file)

Two major strategic challenges must be addressed for the purpose of decarbonizing the cement industry. Cement plants will need to develop own roadmaps for decarbonization targets taking into consideration own potentials (e.g. biomass in fuels, decarbonized additions in cement) and technological innovation such as carbon capturing facilities. Second, they will have to develop a new projects that are providing opportunities across the "zero carbon" value chain. During the second path, AI will play decision making role.

2.1.5.1 Operational advances

In line with continuous advances in improving efficiency in the last decades, traditional strategies could decrease emissions by about 25% by year 2050 (CRH internal strategy reporting). This reduction can be achieved by having more additions in cement, higher biomass in alternative fuels and reducing electrical energy intensity through better plant performance. Carbon-free electricity could be produced by waste heat recovery (energy recuperation model from preheater tower), as it is the case in Rohoznik plant. Advanced analytics is another efficiency booster. CRH managed to save 6% of fuel by creating basic algorithm models of a heat profiles in the system and optimizing the main burner potentials. In the future, cement plants which will combine digital technologies with operational performance's will be more competitive. It is estimated that the already established trend in industry combining alternative fuels with fossil fuels could reduce emissions by nearly10 percent by 2050, depends on biomass geogenic index in the alternative fuels. Biomass supply differs from one region to another and other industries are using them as well due to lower CO2 footprint and good heat values.

Clinker substitutes in cement production are having certain limitations in terms of usage. Large scale and comprehensive assessments of natural pozzolans (such as volcanic rock and ash) still have to be carried out. Decarbonization and the consequent reduced waste materials production of the power and steel industries may lead to shortages in supply. Last but not least, additions such as fly ash from coal-fired power plants and slag from steel-blast furnaces are having clear tendency to be turned off due to high CO2 footprint which will additionally decrease options.

2.1.5.2 Technological innovation

Key factor for achieving sustainability in cement industry is innovation, and its role is already emerging. An example of this is one of start-ups using a lower amount of limestone in cement production, which results in CO2 decrease immediately due to lower usage. Also, there is an opportunity for additional saving of CO2, which is added before the concrete start to cure. This process is improving concrete strengths and decreasing amount of cement needed. Thanks to existing methods, the CO2 generated during the production process can be lowered by 5 percent, but latest technologies could reduce it even by 25 to 30 percent (internal CRH estimation). If the industry is adequately supported by the government in covering additional costs, this carbon decreased products if positioned differently, could open new market opportunity among

environmentally conscious companies and their customers. General tendency in the industry in total is to reduce CO2 emissions until 2050 approx. by 50%. Cement industry on the other side has declared full carbon neutrality until 2050, which will be impossible without capturing technologies. Obviously, higher investments are crucial for capitalizing on technology and innovation, but a shift in mindset of producers who are used to traditional ways is just as important. Majority of cement producers are still reluctant to rely on partnerships or to operate in types of ecosystems, but there are good examples as well such as Mannersdorf plant near by Vienna and OMV corporation (project of over 100 Mio. Euros).

2.1.5.3 Prospects for Growth

It is assumed that the sustainability in terms of carbon neutrality will push the industry to seek growth via new business models, partnerships and construction approaches. Concrete will definitely remain preferred construction material, but sustainable constructions with zero carbon guideline will emerge on regional and local levels, demanding direction changes in many of corporate strategies. In most of EU28 countries (later referred to as EU countries with cement producers), for example, recycled material from construction and demolition waste is replacing aggregates in concrete. Most of cement producers have so far failed to embrace this opportunity or intentionally rejected it, giving away the construction waste recycling business and having external supplier. At the same time, in non-EU markets, traditional cement may compete with new and improved material, like energy modified cement which releases less carbon and is less energy demanding for production. This type of cement in combination with traditional cement has already been used globally for different projects. However, there are other options as well such as alternative building materials combined with different approaches in the business. This strategy will play a major role in the decarbonization strategy of the cement industry, although their efficiency in reducing emissions remains to be seen. Additional value in construction sector includes prefabricated and modular housing. This transparent way of planning and leading business in general should decrease waste, thus reduce amount of cement or concrete required. Actually, digitalization and AI are simultaneously supporting decarbonization efforts of the cement industry and contributes to its growth.

Companies planning to be front-runners of the decarbonization must identify the best roadmaps, followed by proper technological progress, redefinition of product portfolios and building right

business collaborations. When it comes to that, AI companies could have a very significant role in reshaping the whole picture of cement industry.

Cement industry will always remain a local led business due to high transport costs, which makes it necessary to build this perspective from one micro-market to another. Starting from that level, the findings should be raised to next stages, prioritizing the appearing opportunities, low carbon or zero neutral concrete. This strategy, however, can only be successful if the leaders are able to achieve complete mindset change within the organization as a precondition for changing the current way of working. So, the main role of the management is to find the best ways to empower and encourage all levels of the organization to be open to decarbonization process. At this point of time, cement producers are coming to the crossroad. Points as carbon neutrality, value-chain interceptions and competition are keep growing. AI mindset can play a crucial role in closing all patching points by reshaping the industry and ensuring a profitable and greener future.

3. Benchmark with other industries in terms of AI application

Results of OECD AI policy observatory survey indicate that the number of companies in Europe that have started with AI projects is not big. Most of companies in which exists some kind of AI technologies awareness are not fully established but are in experimental or pilot stages. When asked if they have implemented AI technology at a significant degree or as a core part of their business, only 20 percent out of the 3,073 respondents answered affirmatively. Two or more technologies have been adopted by 10 percent of companies, while only 9 percent have adopted machine learning.

Such a low percentage of use among companies still overstates the current commercial demand for AI technologies. In a review OECD made across different industries it is shown that on a sample of more than 160 use cases only 12 percent have completed the experimental stage and progressed. Commercial concerns have been observed as the main reason for hesitance to adopt. Small firms in particular have to consider the risk for poor or uncertain returns and that fact is seen as one of the greatest obstacles for implementing AI-based technology. Potential buyers also have significant regulatory concerns. It is normal with every new development of technology, to have either leaders or followers across companies. In other words, those who are early adopters in current wave of digitalization are usually leaders in the waves coming after.

The essential finding concerning early AI adopters is that their backgrounds are sectors that are at the leading edge of digitalization and already invest at scale in related or similar technologies, for instance big data or cloud services. Based on this finding, it can be concluded that catching up in digitization is limited among sectors and firms, which is a result of the inherent nature of technology – the previous generation is always the basis for the next one.

Second thing that should be noted is that large companies are investing faster in AI, regardless of the sector they come from. Small and midsized firms are typically not that eager to invest in new technologies, as stated for digital adoption.

Third, companies that decided to early adopt don't narrow their choice on just one type of technology. They are interested in broader range of AI tools and variety of different use cases.

Fourth, businesses that invest at scale choose to do so in relation to their core business. They are not interested to go out of the box, since it would be completely new playground for them and therefore are playing safe.

Fifth, companies find their motivation to be early adopters of AI both in the upside growth potential as well as in cutting costs. What companies get with early adoption of digital technologies is not bare process automation, but also product and service innovation with endless potential to discover new sources of productivity and enhance and widen those existing ones, thus making a visible distinction between companies with high levels of performance and those who struggle.

Sixth, there is a notable connection between strong executive leadership and stronger AI adoption. C-level support was rated almost twice as high from respondents coming from companies that have implemented AI-based technology on high level comparing to respondents from companies that had not deployed any of it. Adoption of AI is not even among companies across the industry, which is a fact that indicates many characteristics of digital adoption. There is a certain pattern in adoption new technology that exists for a while. It was similar as with adoption of enterprise social technologies. Larger companies that already have adopted digital technologies see AI as the next wave of digitization that represents a natural upgrade, so these companies are more likely to adopt AI in the future. Furthermore, it is likely that in the near future deployment of AI-based technology will accelerate at the digital frontier, which will cause increase of the existing gap between adopters and strugglers, and it will be noticeable between companies and industries as well as between geographic regions and countries. Industries that are leaders are high technology and telecommunication as well financial services. Those sectors are seen at the digital frontier by MGI's Industry Digitization Index and have already invested in development of digital technologies. Although digital tools were developed and used by these sectors for optimizing their performance as well as for their core product offerings, even their adoption of AI is slow compared with overall digitization (see Figure 9.)

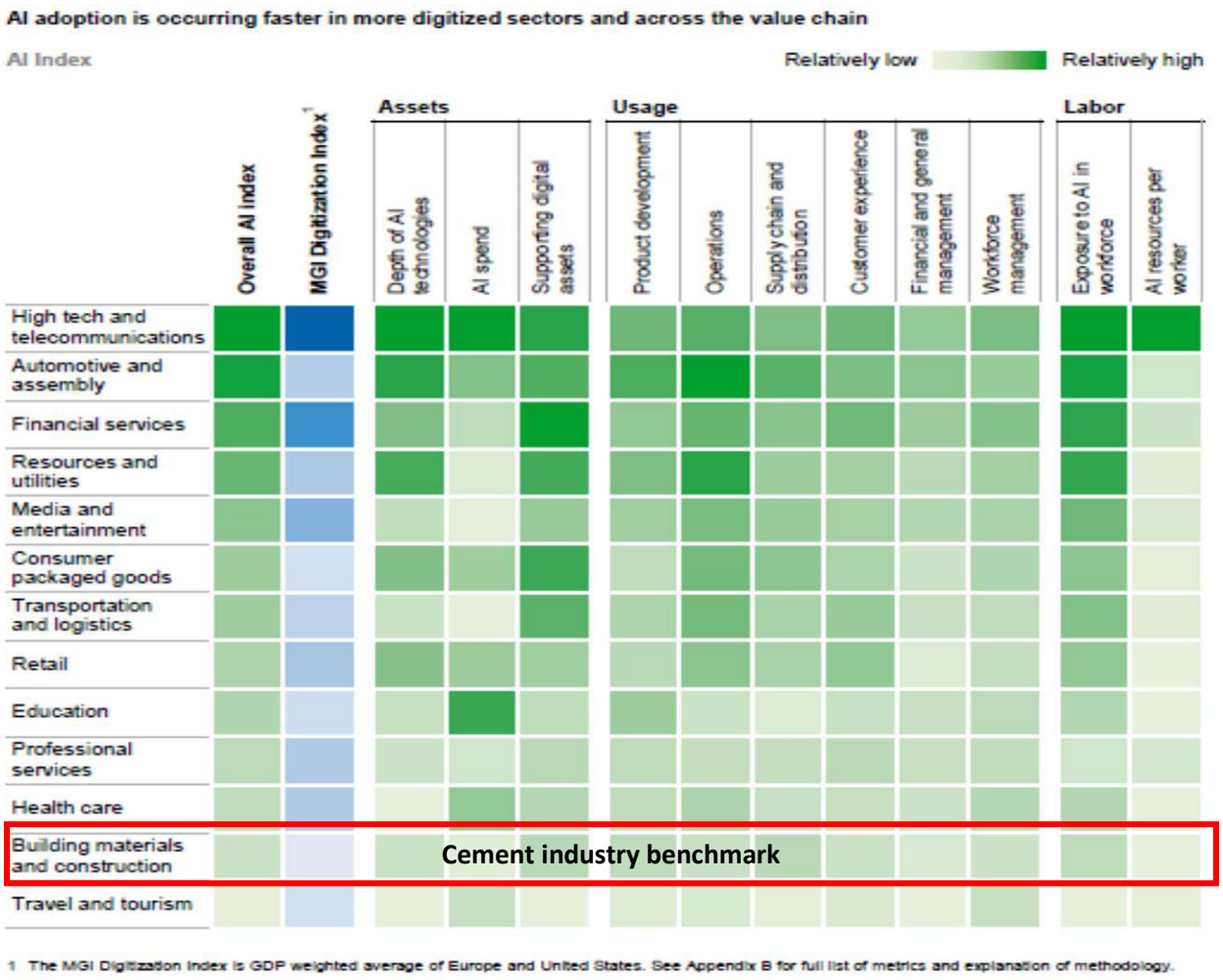

Figure 9. Industry comparison in terms of AI adoption (source: OECD AI and McKinsey institute)

Advanced robotics at scale was used in manufacturing in automotive and assembly, being among the first sectors to do so. AI technologies are still being used there today for self-driving cars development.

Sectors like services of any nature, resources and utilities, than construction busine belong to the middle or less digitized industries. Reasons for that can be seen in combination of various factors. With the exception of some parts of large construction firms and professional service industry, these industries are generally slow when it comes to employing digital tools. Being primarily focused on domestic markets, those sectors lag behind in innovation and productivity growth.

Education and health care, traditionally less inclined towards digitalization, are currently close to the bottom of the pack. Although there is a tendency to create publicity given to cutting edge AI applications, uptake in these industries appears to actually be quite low. Reasons for weaker adoption can be found in challenges that are specific for these fields. For instance, despite the health care practitioners and administrators recognizing the potential of AI in reducing costs, the main impediment to its implementation are the regulatory concerns and customer acceptance. There is, again, more willingness for adoption of innovative technologies among large firms than among smaller ones, which are, commonly, more hesitant to be early adopters.

Definition states that a larger company is the one that has over 500 employees. Considering all sectors, the likelihood of larger firms to adopt AI at high level or as nucleus of their businesses is at least 10 percent more likely in comparison to smaller ones. Furthermore, sectors that have lower AI uptake rates note the difference in adoption rates up to 300 percent in favor of larger companies.

Advantages of larger companies can be found in their access to more and better structured data, in being in position to have technically skilled stuff that is able to perceive the importance of AI investments, as well as in the fact that fixed-cost investment necessary for AI generates higher returns on a larger base.

All of the stated does not mean that there are no success stories among smaller companies. Some of the aspects from which a smaller firm could benefit include: fewer issues with legacy IT systems, weaker organizational resistance to change and AI tools provided as a service. Rather than choosing only one technology to focus on, early adopters tend to look across multiple AI tools.

The adoption patterns in other digital technologies are similar. Sectors willing in general to adopt new techs have open mindset and will do it faster. For instance, high tech and telecom are most open sectors by now of all technology groups, while the construction business or cement industry has the lowest one. Health care and education are perceived as slow when it comes to AI technology adoption. Two thirds of the companies belonging to the frontier sectors are those which have already some of AI technologies implemented.

AI applications are applicable across the industry, but with different levels of attention. For instance, customer service related sectors (like sales and marketing, operations and product

development) usually employ often cited AI-based applications, while general and financial management drop behind in that aspect. Big data have a similar pattern. Sales and marketing functions use the majority of big data applications. A survey among firms showed that they usually adopt AI technologies closest to the core of their business. For financial services the most important areas are customer service and operations. It was initially intended for new digital technologies to remain marginal and away from the core. However, sectors and companies expand their deployment of AI technologies and go deeper and broader in implementation. Leading industries have incorporated AI in the core parts and specific parts of business. More use of AI by companies results in changed perception about its potential gains and benefits. Advantages of early adoption could be: revenue and market share growth, as well as cost reduction potential. Research showed that among companies considered to be advanced AI users there was much higher probability approx. 27 percent to use AI for market growth than those who were partially adopting or in an experimental phase of adopting AI, and a 52 percent higher probability to use it to increase market share. Focus of companies in experimental phase was, however, on costs. In these companies there was a 23 percent higher probability than among advanced adopters to emphasize decrease of employee costs and 38 percent higher probability led to other cost reductions, not related to labor (PwC figures from AI study). The conclusion indicates that the deeper knowing of artificial intelligence companies have, the bigger the chance for their acknowledging its potential. Companies that are not closely familiar with AI are more likely to focus on cost reduce. In order to achieve success with AI adoption, executives need to generate necessary impetus to overcome initial organizational resistance. It means that a strong management leadership support for technology implementation is of crucial importance. Companies that have successfully deployed AI technologies stated that they have had solid support from the CEO and IT executives, as well as from all the high-ranking executives and the board of directors. The pivotal point for growth will be the adaptability of companies to overcome challenges. Those sectors currently have the highest degree of digital adoption, which is crucial for AI (see Figure 10).

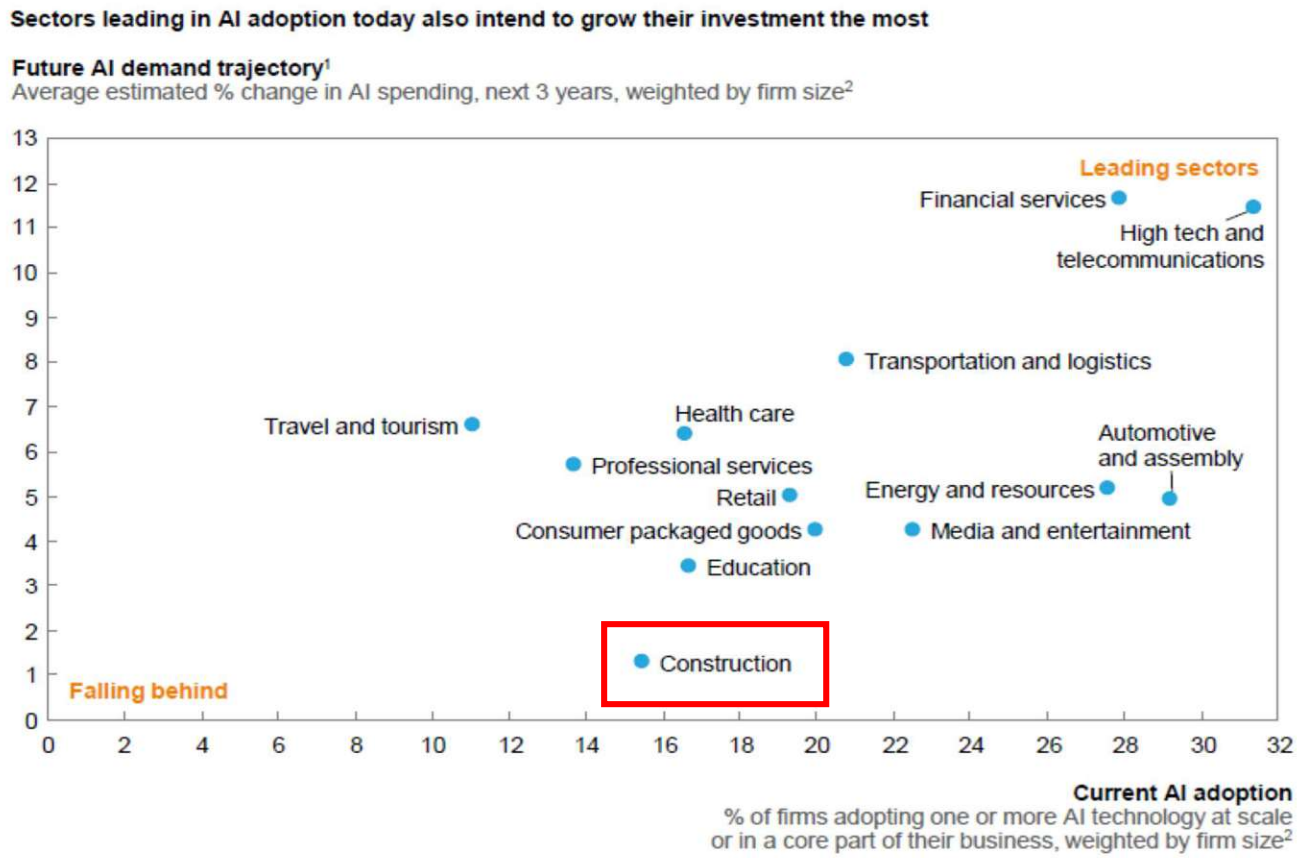

Figure 10. Dependency between current AI adoption and future demand throughout the industry

Industries can be differentiated based on technical challenges. Big tech companies highlight the performance of the used technology, while engineering solutions require data as well as talent, since they have to be elaborated for each specific case. Industries like construction and travel do not generate and store great amount of structured data, unlike for instance, financial sector, IT and telecom. Different industries are having different commercial motivation as well. Sectors with complex businesses, operationally and geographically, with performance intertwined with forecasting, quick and precise decision making, or personalized relationship with customers, are those who will most likely be leaders in adoption of AI technologies at scale. Financial services could clearly gain from improved AI optimized fraud-detection systems that are far more accurate and faster. Forecasts state that the market value in 2020 will be $3 billion (PwC study, e).

Features such as inventory prediction, automated operations for customers and marketing promotions which are highly personally oriantated improved by AI could get a lot of benefit to, for instance, retail. Health care could benefit by both reducing costs and enable better outcome for

patients and it could be achieved by AI-powered diagnosis and treatment systems. Regulatory and social obstacles can interfere and slow adoption even in those cases where companies calculated potential commercial leverage and therefore want to implement new technology. All of announced has certain effect on profit margins of the company within respectful industry (see Figure 11).

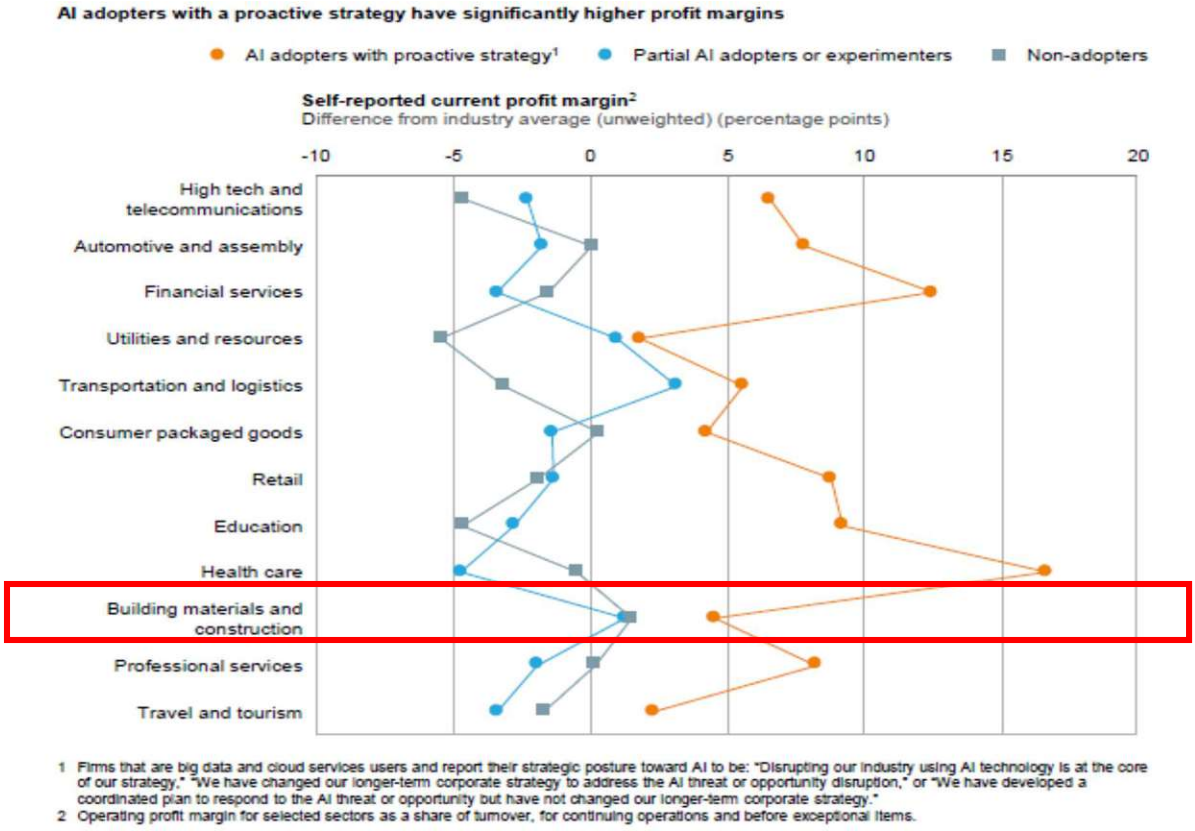

Figure 11. Profit margins movement estimation – overview (source: OECD)

4. Competitors analysis in terms of AI implementation development in cement industry in Europe

4.1 Overview of cement business activities and main producers in Europe

Since assignment of master thesis is to explore opportunities for AI implementation among cement producers in Europe, competitor analysis will concern European cement producers, current implementation level and their readiness for further AI adoption. Main resources for this chapter part are related to CEMBUREAU (European Cement Association based in Brussels). Cement and concrete have long been used to build durable structures. Cement's exceptional binding properties make concrete a very robust, durable material that can bear heavy loads and and is very resistant to extreme environmental conditions.

4.1.1 Key facts in brief

Capital intensity: Annual capacity dictates the cost of cement plant. Common price is higher than €150M per million produced tons. Modifications have correspondent costs. Cement industry belongs to industries with highest capital intensity, with costs of new plants equivalent to approximately three decades of turnover.

Transport: Land transportation costs are significant and earlier it was considered not to be economically viable for cement to be transported more than 300 km. This was changed with introduction of bulk shipping, and nowadays it is more affordable to have ocean transport with 35 000 tons than to use financial equivalent for truck if it is 300 km or more.

Energy intensity: Depending on the manufacturing process of cement (dry or wet based production lines), up to 0.15 tons of fuel with certain heat value is needed to manufacture one ton of cement, as well as about 110 kWh (kilowatt-hours) of electricity.

4.1.2 Key figures in brief

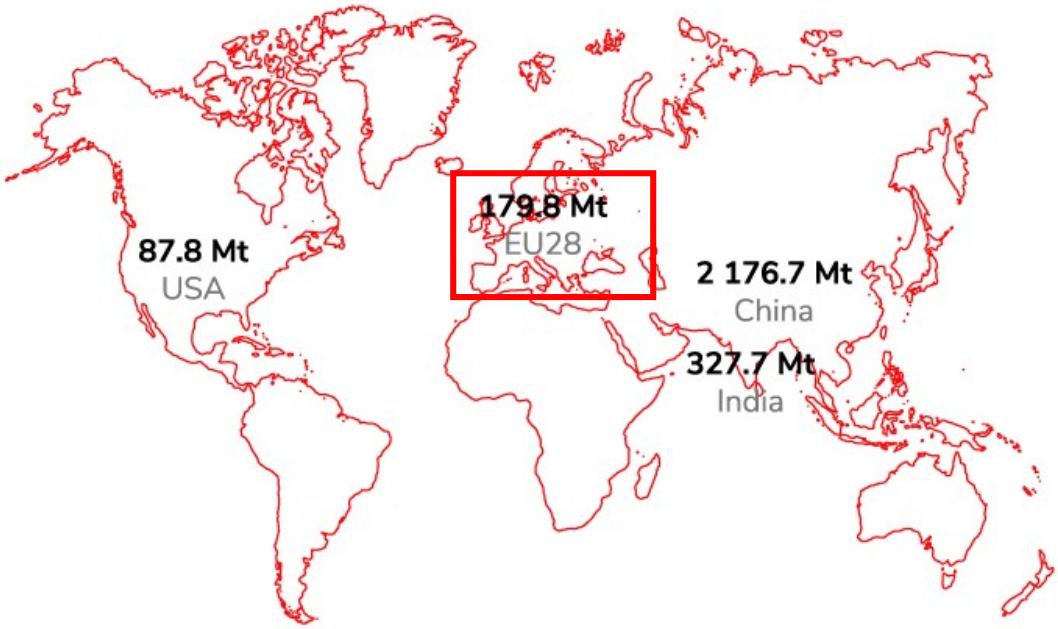

Figure 12. Main world cement producers in 2019. – overview (source: CEMBUREAU)

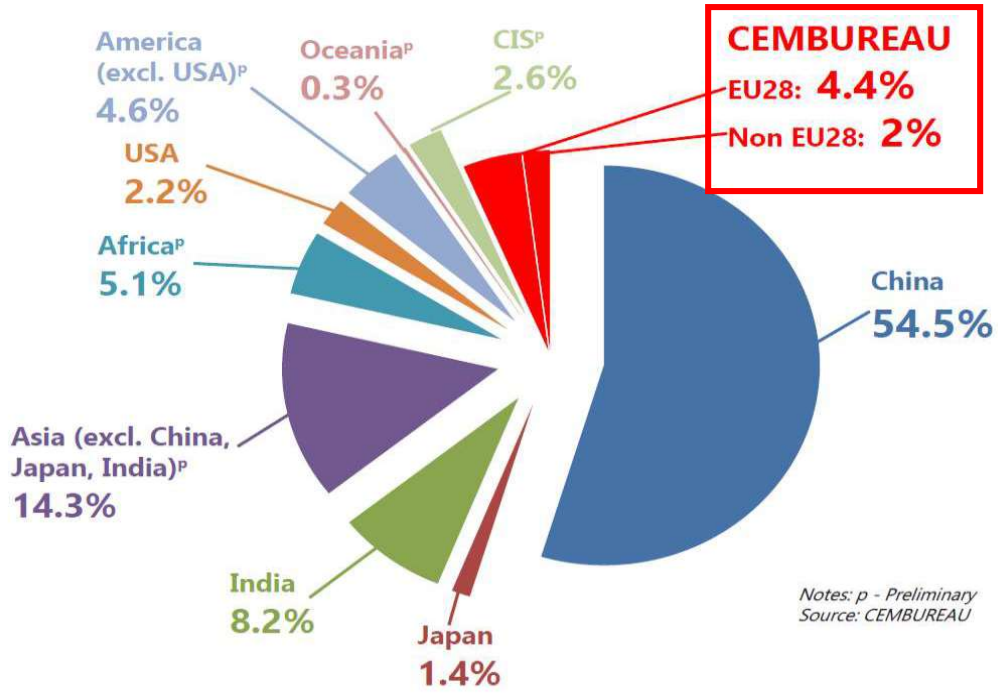

Figure 13. Overview and comparison in percentages in 2019. (source: CEMBUREAU)

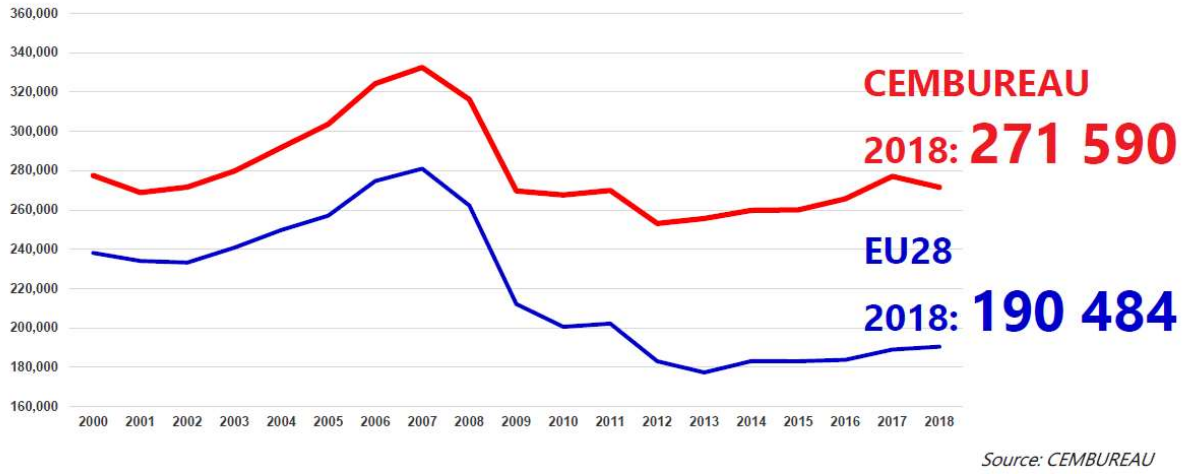

Figure 14. Cement production: EU28 & CEMBUREAU 2000 -2018

Main difference between CEMBUREAU and EU28 is amount of cement produced in the countries, which are geographically in Europe but still not part of the EU. Difference is definitely not insignificant, but since those countries are mainly strategy followers.

4.1.3 Main cement producers in Europe

Main cement producers in Europe are also big players in the market worldwide. When we take out China as the ultimate producer, we will recognize 5 biggest cement companies which are operating in Europe, among 10 biggest in the world (China is exception as mentioned). This 5 companies will be introduced briefly, since they will be the subject of our further analysis. After the introduction, competitor analysis will be performed based on the Porter's Five Forces analytical model.

1. LafargeHolcim *(whole section source: www.globalcement.com)*

The youngest cement producer in the Top 10 is also the largest producer in the world by installed capacity – LafargeHolcim. It was created in 2015 by merging the bulk of the assets owned by the former multinational producers Lafarge and Holcim, both with a strong experience in cement production. According to the Beta version of the Global Cement Directory 2018, LafargeHolcim has 149 integrated cement plants with a total capacity of 287.3Mt/yr, as well as 57.9Mt/yr of grinding capacity across 71 plants. This gives it a total of 220 plants and 345.2Mt/yr of cement capacity.

Rank	Producer (Origin)	Total		Integrated Total		Grinding Total	
		Capacity (Mt/yr)	Number of plants	Capacity (Mt/yr)	Number of plants	Capacity (Mt/yr)	Number of plants
1	**LafargeHolcim** (Switzerland)	345.2	220	287.3	149	57.9	71
2	**HeidelbergCement** (Germany)	185.4	141	159.3	102	26.1	39
3	**Cemex** (Mexico)	91.6	61	85	52	6.6	9
4	**UltraTech Cement** (India)	91.4	39	52.2	18	21.6	21
5	**Votorantim** (Brazil)	70.8	59	60.2	43	10.6	16
6	**InterCement** (Brazil)	53.5	42	42.8	28	10.7	14
7	**CRH** (Ireland)	50.5	54	41.9	39	8.6	15
8	**Buzzi Unicem** (Italy)	49.2	37	46.2	31	3	6
9	**Eurocement** (Russia)	47.2	19	47.2	19	0	0
10	**Dangote Cement** (Nigeria)	43.8	12	42.3	10	1.5	2

* Company CEMEX is significant player in European market

Table 1. Comparison between 10 biggest cement producers with exception of China

(source: globalcement.com)

2. HeidelbergCement *(whole section source: www.globalcement.com)*

After the major acquisition of Italcementi in 2016, Germany's HeidelbergCement continued with developing further capacities in 2017.It now claims 159.3Mt/yr of cement capacity across 102

active integrated facilities and another 26.1Mt/yr from 39 active grinding plants. This presents a total of 185.4Mt/yr of installed active cement capacity across 141 sites. The Italcementi acquisition was a turning point for HeidelbergCement which from then started to build its sales revenue, with growth both in Europe and North America. Its sales rose by 19% on a year-to-year basis to Euro13bn in the first nine months of 2017 from Euro10.9bn in the same period of 2016. On a like-for-like basis they increased by 1.1%. Its cement and clinker sales volumes increased by 29.2% to 94.4Mt from 73Mt or by 0.3% on a like-for-like basis.

3. Cemex * *(whole section source: www.globalcement.com)*

Cemex held on to its third place position in this year's Top 100 analysis, despite the growth of UltraTech Cement. At the end of 2017 Cemex had a total of 91.6Mt/yr of cement capacity across 52 active integrated plants and nine active grinding plants. It has a total of 61 plants. Cemex's profit increased in the third quarter of 2017 thanks to growing sales and low costs. Its net profit rose by 1% year-on-year to US$289m in the third quarter of 2017 from US$286m in the same period in 2016. Sales increased by 2% to US$3.5bn due to higher cement sales volumes in European markets and growing prices in Mexico and the US.

4. CRH as my current employer *(whole section source: www.globalcement.com)*

CRH grew rapidly between 2015 and 2016 due to its acquisition of a range of assets from the merging Lafarge and Holcim. It has 50.5Mt/yr of cement production capacity across 39 integrated and 15 grinding plants. CRH became even larger in early 2018 following the US$3.5bn acquisition of Ash Grove Cement in the United States. This ensured an additional eight integrated plants with 7.5Mt/yr of cement capacity. It has also submitted a formal offer for the cement assets of South Africa's PPC.

5. Buzzi Unicem *(whole section source: www.globalcement.com)*

As the only family-owned cement producer on the list, Italy's Buzzi Unicem is the only family-owned cement producer with 49.2Mt/yr of cement capacity, and having production interests in nine countries across Europe and North America.

4.2. Porter's Five Forces analysis among major cement producers in Europe

Company's relationship with its environment is defined through competitive strategy. Environment that is relevant for a specific business stretches to a broad range of circumstances and settings, including social and economic situation. That aspect is important indirectly; it implies company's ability to survive in given conditions and it affects all companies within a sector. However, crucial is the industry to which the company belongs because it establishes competitive rules that are to be followed and sets the authorized strategies available to the company. Competition transgresses the behavior of present competitors and is driven from underlying economic structure. There are five fundamental competitive forces that shape the state of competition and determine the ultimate potential for profit. Potential is always observed through invested capital and long run return. Five competitive forces and their role in AI strategy must be better comprehended in order to be able to analyze different available frameworks for assessment of solutions for the increasing impact of AI technology in the cement business followed by different regulations in different markets. Understanding their mutual connection is crucial because they form a competitive framework that gives insight into the way market functions. By definition Porter's five forces are: rivalry, threat of substitutes, buyer bargaining power, supplier bargaining power and barriers to entry and exit.

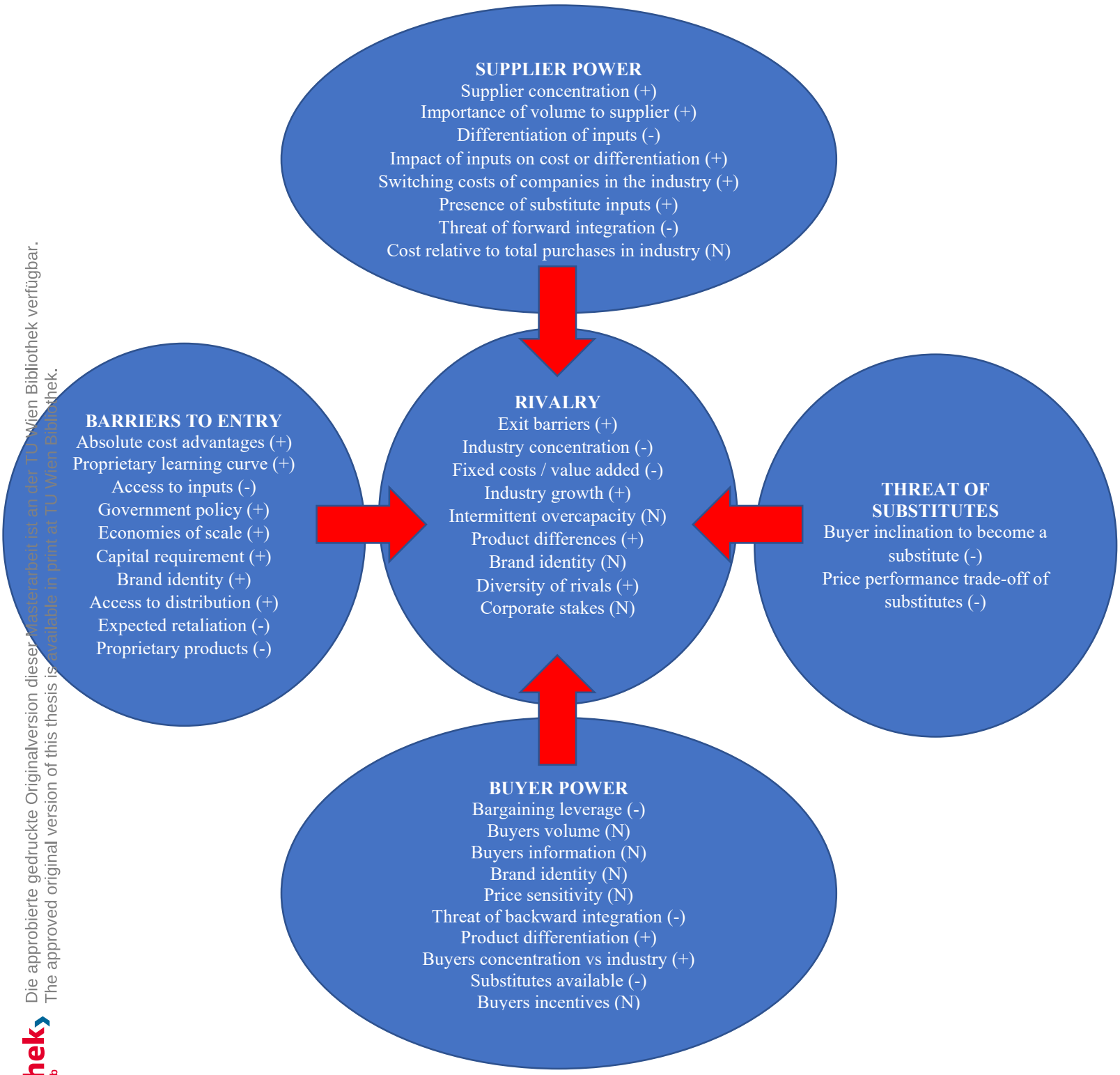

Table 2. Porter's Five Forces Analysis considering CRH progress in terms of AI implementation

State of European cement industry and relation of Porter's Five Competitive Forces to AI adoption is shown in the above diagram. The sign (+) indicates existing effect of the force on the cement industry in increasing rivalry. The sign (-) indicates the opposite effect. An (N) indicates that the effect of the force is neutral or that it has no relevance to the industry.

Summary: Table 2 portrays the five competitive forces among considering major European cement producers in terms of AI adoption and development. General conclusion is following, but afterwards impact will be described: high effect was noted for supplier power and entry/exit barriers; moderate effect has rivalry; weak effect is noted for substitutes while buyer power has minimal effect. Essentially, pricing power over final consumers has the vertical supply chain because of low level of AI adoption and big benefits. Horizontal dimension of competition is missing without differentiated advantages in production. There will not be any difference in advantages once the technology is adopted, which indicates the importance of quick adoption in order to gain benefits. Industry that adopts AI technology will have all advantages; the sooner it does so, the more leverage it will gain. Detailed summary will follow in the text.

Cement industry notes moderate rivalry regarding AI adoption. Market is mostly oligopolistic in Europe's different regions, which indicates dominance of only a few companies (which is five, in this case) on the whole European market, including different regions. Reasons for such situation can be found in high fixed costs. In average, a plant costs approximately 10 million euros, and that results in limited rivalry due to uneven possibilities, and highly concentrated companies' environment. Besides, cement products lack proper differentiation, which together with consumers' low switching costs in some circumstances intensifies rivalry. All above factors combined cause moderate rivalry in the cement industry on a global level.

Threat of substitutes is recognized as the second force. A credible threat of competition does not exist if there is a lack of substitutes, meaning that there is a lack of other products, from other industries that could be used instead of a certain product. Simply put, replacement for cement still does not exist in the world; there is no material that could be an effective substitute for cement, which is a fact that shapes the reality and position of the cement industry. Construction companies can choose to replace cement with other materials that have similar, cementitious characteristics, but the effect of such a substitution does not affect the market price of cement in a significant manner. The threat exists exclusively if another industry creates a product with similar features

that could persuade consumers to switch (minimal partial substitution) and decrease their usage of the product. When it comes to cement industry, both of these possibilities are practically non-existent, so the threat of substitute is very low and the cement industry is not endangered in that sense.

Buyer bargaining power is the third force of competition. This force indicates to which extent the customers can affect a specific industry. Pure buyer power can exist exclusively if the market consists of only one buyer, which gives him the complete power and control over conditions. Cement industry notes minimal effect of buyer bargaining power. Some circumstances, such as lack of substitutes, not many existing cement companies and the consumers' demand keep consumers limited in their power. Situation as it is makes it easier for company to have control over setting prices, while buyers have to be just price takers. Buyers can have the power depending on their concentration, of purchase amount and of product standardization. Although the last effect does exist, shortages in the cement market make its impact weak. Overall, buyer in the cement market does not have necessary characteristics to have power, so the competitive level observed through this force is very low.

The fourth Porter's force is supplier bargaining power. When suppliers have the power over producing firms, they can extract part of the profit from those firms by raising the raw material prices. Cement industry has both concentrated suppliers and concentrated buyers, which makes the initial bargaining balanced. There are two categories of cement industry suppliers: transportation suppliers and raw material suppliers (clinkers). Price surges in the cement industry are reported by the manufacturers to be due to price increases both in transportation and raw materials, which implies that suppliers have sufficient power to affect prices on the cement market. However, lack of power related to consumers implies that the weight has transferred to the final product price. The power of suppliers could come in several cases: if a credible forward integration threat exists, which means that suppliers can buy producing company; if there is no switching option, meaning the suppliers are concentrated; if switching suppliers is prohibited or if a supplier can gather final consumers. None of this is case in the cement industry since suppliers come from different fields. In this particular case, suppliers drive their power from their regional concentration and high costs of switching between suppliers. Distance is a factor that must be considered, as it determines prices, which implies that AI would not generate significant leverage. That being said,

the bargaining power in this case is in hands of local or regional suppliers. Barriers to entry and exit are the fifth and final Porter's force that helps measure competition within an industry. If a barrier to entry is high, it means that companies already doing business in a specific industry are not worried by the outside competition and that the rivalry among companies is not intense. Actually, there are incentives for cooperation inside the industry, as well as collusions like cartels. On the other hand, barriers to exit refer to companies being stuck or locked in the market, and it usually implies company's inability to sell its assets when wanting to leave the industry. There are four different ways of looking at barriers to entry and exit. First is the government limitation of licenses sold for production. Due to cement being energy intensive and highly polluting, governments have to strictly regulate entry to the market. Second, barriers are created by patents. Although cement industry is not highly dependent on patents, like, for instance, pharmaceutical, patents on new methods of production or new machines form certain difficulties for new companies to enter the industry. Third aspect refers to usability of assets needed for cement production in other industries, which is not high, as cement industry is particularly asset specific. This implies very high costs of potential cease in production, once the company enters the industry. In the end, AI could be prevented from entering by economies of scale, but there is no interest. Overall conclusion is that high barriers to both entry or exit the industry are existing. Porter's five forces create the framework which takes market forces perspective when observing rivalry and relations between consumer, company and industry. Regarding cement industry, the final consumer does not have bargaining potential, and he does not have much power or say when it comes to prices due to the high inelastic demand which limits AI development. Rivalry is moderate because of high production costs and strict regulations in most areas. The burden of price hikes is shifted to the end user, because raw material suppliers and cement firms have the power over prices. All said must be carefully considered in terms of AI applications to enable creating an effective framework allowing the analysis of policies related to cement industry in general.

5. State of the art and future development potentials in the industry

In the chapter 2, it was already discussed about main opportunities and challenges in cement industry. Cement business is financially overloaded due to the huge assets and capital needed to keep the business running. Therefore, any competitive advantage created can be capitalized fast at the beginning and can increase brand equity as company value. Exactly because of that, the companies in cement industry are ready to invest in the innovation which will bring benefits on these levers. As previously mentioned, there is no replacement for cement even on horizon, so that added value will not come from this side. Cost savings on one side and increase of brand equity on the other side are values which AI, if properly implemented, could bring at the end. Main question is how AI approach should be implemented properly? Main problem that cement industry has is that all innovation loops are closed and need to be kept in secret due to high investment values and market advantage afterwards. In cement industry, the innovations can hardly be protected as intellectual property, but in case of AI, why it should be? AI is by default an open innovation concept which should bring benefits to broader population, which is significantly different from current implementation strategy regarding innovations in cement industry. Implementation of innovation concepts in cement companies' portfolio is mainly based on project management guidelines, and as previously mentioned like closed innovation process.

5.1 Theoretical background

The term "open innovations" (OI) was launched by Professor H. Chesbrough, director of the faculty of the Center for Open Innovation at the University of California. Given term open innovation refers to the use of knowledge inflows and outflows to improve in-house innovation and expand markets for external exploitation of innovation (Chesbrough, 2003). Open innovation concept per definition allows and supports that firms should use external and internal ideas to advance their technology.

Alternatively, it is an innovation with partner firms through risk sharing and revenue sharing, so that the boundaries between partner firms become permeable to the environment and easy transfer of innovations to the inside and outside is enabled. Many companies in the world cannot fully rely on their own development and they do business with other companies. In that sense, it implies

systematically encouraging and researching a wide scope of sources for innovation, opportunities, integration of research according to opportunities and resources, as well as their exploitation through multiple channels. In the past, R&D centers were a valuable strategic resource for companies. Lately the former leading industrial companies face strong competition from the new ones. Those new companies alone are not at all undertake, or undertake very little, basic research, but instead obtain new market ideas through different processes. Namely, there was a fundamental change in the way companies produce new ideas and applying them afterwards to the market. Closed innovation model has the prevailing approach where successful innovation requires control such as applied in cement companies, i.e. that companies must base their development on their own generated ideas, and to produce, sell, distribute and service on their basis. This approach requires reliance on their own. Logic of closed innovation has been considered the only correct way to gain competitive advantage. On the other side, more open companies have invested more in R&D from its competitors, hiring the best and most capable resources. Because of this investment approach, they were able to create high value for their business. Of course, this has also meant higher profits for those companies that defended by aggressive control of the intellectual property, protecting itself from competitors. Such companies could reinvest profits, strengthen R&D and thus achieve further development of new ideas (Altmann & Kämpe, 2010).

At the end of previous century, a combination of different indicators led to the disruption of the Foundations and closed-end innovation models. Maybe the crucial factor was a drastic increase in the number and mobility of human resources with proper knowledge, making difficult to fully control the ownership of ideas and expertise. Other important fact was growth of private capital available for investment in new firms. This capital helped to support financially new companies and gather new great ideas that have spread beyond corporate research laboratories working in silo mode. The characteristics of this new approach of open innovation, is that companies are commercializing both external and internal ideas, making their way to the market. In specific situations, firms can commercialize internal initiatives through external opportunities and routes to market, generating the value for the organization. Some of the ways to achieve this are startup companies and license agreements. Innovations are happening globally these days and are introducing inevitable changes in the industry and society as a whole, and their speed of introduction represents a new challenge in the necessary models and accompanying project management methodology. Project management can be taken for a tool to promote the

development of innovation, and the corresponding application of project methodology must be supported through the development of information technology, in a way that provides a framework for rapid decision making. The complexity of innovating projects forces organizations to improve identification, selection, selection of methodology and performance indicators of innovative projects, as just managing it requires more flexibility, precisely because of frequent changes of stakeholder demands. Simultaneously with an increase in the complexity of projects, the scope of possible changes within them also grows, and this particularly applies to the field of information technology.

These changes can occur in every phase of the project life cycle, and the revision of the initial plan and the ability to adapt to new circumstances as well as having available mechanisms for rapid decision making is the ultimate condition for the success of future projects. On the more complex projects increase the number of key participants, and thus communication with them the project becomes more complex. The circumstances under which it occurs are possible misunderstanding of requirements, poor communication between managers and other stakeholders in terms of not understanding their expectations, unnecessary change in functionalities, market pressure, regulatory requirements, execution delays and poor control over the changes to the project itself. The main differences of the applied project methodologies in relation to traditional project management are related to to the degree of risk, number of stakeholders in the management model and project duration. The aim of the thesis is to show that traditional ways of project management currently prevailing are not supportive of introducing innovation in the company's portfolio and that it is necessary to change the project management model in order to increase flexibility and ensure swift adaptation to market fluctuations when introducing innovations. When talking about project management, a new approach to project management, unlike the traditional one, is arose as a pursuit of constant innovation and the need to reduce costs. Wheelwright & Clark (1992) and Chesbrough (2003) distinguish three models of open innovations:

- **Inbound model of open innovation** related to the use of external sourcesinnovation within the company. As an example of this, the company decides to use licenses for technologies that have already been developed outside the company and do not seek to develop equivalent in-house technologies;
- **Outbound model of open innovation** for external development and commercialization pathways innovation (Chesbrough & Crowther, Beyond high-tech, 2006). In this regard,

the companies can offer licenses of its products to another company in order for this other company to develop them providing at the same time the necessary regulatory approvals or further distribution;

- **Coupled innovation model** that combines the previously mentioned two models, i.e. joints work of companies in order to develop new solutions (Gassmann & Enkel, Implementing the open innovation approach: three core process archetypes, 2004). This model may include either close integration, for example joint venture, or looser affiliation through engagement through innovation competition.

Companies can adopt open innovations for defensive reasons, that is, to manage costs, reduce them as well as to reduce the risks associated with product development. More often, they cooperate for offensive reasons, and that is to proactively use innovation and knowledge outside companies in order to improve their offer and to be ahead of competitors (Chesbrough & Crowther, 2006; Van de Vrande, De Jong, Vanhaverbeke, & De Rochemont, 2009).

Open management innovations in large companies have primarily dealt with this issue from an aspect of large organization as well as process management, and later began to emerge papers on open innovation project management (Chesbrough & Brunswicker, 2013). The way to overcome the challenges were recognized arising from the introduction of the concept of open innovation in large companies, by connecting with the project management tool and thus, coming to a solution through creating models for introducing innovations in the cement company's portfolio.

5.2 AI as coupled open innovation concept in cement plants

It is foreseen that in future, AI will take over repetitive and data-heavy tasks in cement production. In terms of open innovation concept this means that the robots can assume the scanning, searching and matching part of the work. However, the second part of OI is to cooperate with the matching external innovators with the purpose of integrating ideas into large enterprises, which will require inter-human interactions, discussions, and negotiations. Identifying the right idea is essential and OI approach should focus more on the integration part because of it, leaving the hunting and matching to the machines. It is very important to prepare a industry population for AI implementation and to define a right step for introduction of open innovation concept. On the next figure, a clear roadmap for implementation in cement industry is illustrated.

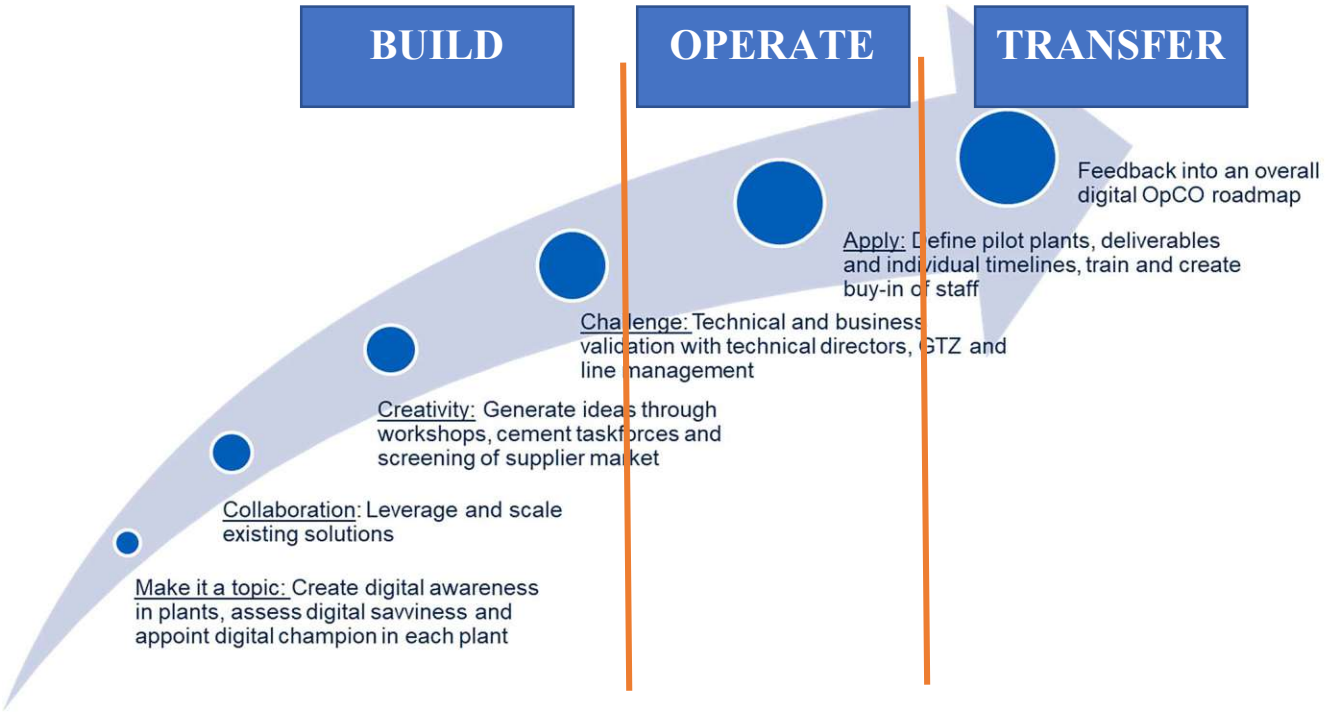

Figure 15. Roadmap for AI implementation concept developed for cement industry (source: CRH internal)

This is a clear roadmap which has defined actions for every feature mentioned above, but due to the possible breach of company rules it will not be given in detail for CRH. Undoubtedly, there is no singular, standardized course that could be able to empower all AI-driven performance improvements within organizations in the industry. Aspiring companies should adopt a number of existing perspectives that are recommended within the cement industry. Still, general steps for roadmap implementation follows:

1. Understand possibilities and potential of AI, prioritize use cases, and take care of the available assets because they are the foundation of innovations. Innovations in the AI sectors are developing in an overwhelming speed; nevertheless, it is crucial to avoid impulsive investments in recently developed technology without previous research of the ways it could bring benefits to one's business. An important thing for creating a solid AI business case is understanding of actual features of AI in a specific context and honestly perceiving its limitations. A precondition is systematic understanding of AI performance and its difference from conventional technology, as well as necessary conditions for AI deployment. All of that still does not make an actual business easy. The adopter will get

imperfect information, unclear and misleading returns and there are often some who do not want new ideas enter the commercialization process. What could be useful is a pragmatic prioritization of potential use cases for AI-improved processes and products, which should consist of two dimensions, specifically of the financial baseline and optimization potential.

2. Develop core analytical capabilities in-house while at the same time making use of third-party resources. The performance-boosting value of AI technology could be fully comprehended by creating strong internal capabilities and by cooperation with eminent companies in AI sector. A great example in cement industry is cooperation between company Petuum (AI solution provider) and Cemex or FLS (AI solution provider) and CRH. It is relevant that companies have so-called "quants" whose task is to develop necessary algorithms, and "translators" who serve as the mediator between data scientists and management. The main translator's task is to point out to the management the actual advantages of AI and to help create values correspondent to a specific business. Developing AI engine is the task of quants. It is currently difficult to find talent for these roles, in particular in late adopter industries like cement industry. The best way of implementing and running AI technology, considering lack of talent and other difficulties related to AI-based projects, is to combine developing as an internal asset and recruiting as an external asset, i.e. obtaining skills and partnering. Process has to follow the phases "build, operate, transfer", whose success is proven. In every phase tasks of quants and translators are different. Translators have knowledge to assess, from technical and business perspective, what is feasible, so during the build phase, their task is to help prioritize use cases. Quants, both internal and those of external partners, integrate systems, data and algorithms, thus laying the foundation of an AI application. Operate phase consists of testing of prioritized cases in order to assess the value creation potential of specific applications. Translators provide support for the acceptance of the solution in the entire organization. Operate phase results in a fully functioning and scaled AI-based engine. Transfer phase shifts all necessary skills for running the system on internal personnel. That transfer of skills from external partner to internal stuff is managed by translators. A certain number of internal quants is required in order to successfully run systems, perform updates and determine needs for improvement. Considering specific challenges of each phase of the build-operate-transfer process, it is suggested to hire first-class analytics to supervise the whole process,

as a complement to internal up-skilling. Establishing an attractive AI-centric environment could help overcome the talent scarcity issue, thus becoming an alluring place for the skilled employees. AI resources could also be improved by recruiting pure data scientists.

3. Store structured and consistent data and if possible transform unstructured or flat data into usable, which is a process that creates value. If provided data are having over 95% of consistency (2σ distribution fulfilled), probability to have successful project is over 90%. Role of data has been recognized in disruptions that occur in the economies, so data makes critical corporate asset. AI engine cannot be launched without data. Therefore, it is crucial to understand value of company's data and information and treat it as relevant for the company's future business success. It requires a significant skill to make usable data which at the moment is not in a proper format for common understanding or is not detected as part of any traditional analysis, for instance pictures and videos, voice transcripts and data collected by machines and sensors. The latter is structured data in its essence, but its format and size are difficult for analyzing using traditional methods and relational databases, which are in business context being used for three decades. It is estimated that 90% of all data created in manufacturing context is flat data, which does not have relational structure. This data has to be made usable by applying new approaches that could work with given data volume and types. New approaches have specific aim, which is storing and processing data in its original fidelity and are mostly NoSQL databases, which are faster and more flexible compared to conventional databases. One of frameworks for new technology is Apache Hadoop, a framework that uses mainly commodity hardware while storing and computing large data sets, so its obvious advantages compared to conventional approaches are speed and more efficient processing, but also higher scalability. Format of data should be such that it enables easy adjustment to a specific approach to AI and machine learning, for instance labeled data for supervised learning techniques. Some data can be usable only in combination with other data sources in a larger system, using cross-organizational data utilities, enriching data and making it available for participants in the closed data ecosystem. Data outputs from sensors, machines and social networks are rapidly increasing, so one of organizational challenges that occur is how to handle so extensive stream of data. Data created in different use cases can vary in quality and volume, and every situation needs a proper thoughtful approach on different ways of storing different

data. In some use cases data can be concrete and clear, but that is not always the case, as in some situations data can be fuzzy, not fully or not well defined, so approaches should make decision when the data is to be stored in its original granularity, and when it should be pre-analyzed. Flexibility is rapidly optimized by increasing data storage capacities using clouds, but also by more powerful computing facilities close to the sensor.

4. Use domain knowledge to AI strategy enhancement and use also specialized knowledge and skills to exploit the full potential of AI. Specialized know-hows in specific areas, such as parameters for certain type of manufacturing, is always a leverage that industry wants to keep and not lose to start-ups or service providers. There are two ways in which domain knowledge can help companies.First, companies understand their industry and technological environment, and typically perceive relations between systems, technologies and participants, and thus can precisely describe issues to be solved using AI. Second, AI-based applications can integrate domain knowledge in the system, for instance, codifying domain knowledge and boosting performance of an AI algorithm before the start of self-learning. To ensure the optimum use of AI's full potential, the suggestion is to perceive AI as a tool that could be used for solving many problems and improving current state, but only with a proper amount of deep understanding of the specific context.
5. Go forward making small and quick steps using pilots, testing, and simulations. Big up-front investments are not necessary for AI transformation, but speed and experience are important preconditions for success. Those preconditions are important for effective gaining advantage by using AI within the company. As already mentioned, companies can obtain basic programming interfaces for free or at a low cost, and if necessary, computational resources at a larger scale could be used through cloud-based solutions. Third parties can help build up initial process know-how, but companies maintain ownership of the data and domain knowledge. Agile management and an open mind about real power and limitations of AI is the best practice for implementation of AI-based applications. Doing the opposite is a typical trap and thwarts successful implementation. Simulation base pilots other types of small steps will insure the right focus, and will also enable companies to quickly make impact estimations. Companies that had the best cases of implementation set up cross-functional taskforces, which can design the solution in period of one to three weeks if the data is available for use, then test it and based on that

define the next steps. In order to ensure optimal use of resources, the approach needs to be agile. Ultimately, the best practice is to foster organizational culture that instigates the cooperation between humans and machines, based on trust. It is necessary for humans to adjust to the paradigm shift, as the algorithm's predetermined steps are changing and the outcome depends on data. So, companies should tend to establish AI-ready culture within organization already in build phase.

6. Recommendations for competitiveness in the industry

Artificial intelligence uses innovative approach to connect physical and digital systems as highly functional unit. Different production industries have already implemented AI solutions with positive outcomes. They incorporated robotics and digital twining technologies into their manufacturing process with great success. Early adopters in different industries have thus earned advantage as more competitive. Cement industry can be improved as well by implementing AI in many different ways. Primarily, AI solutions could prove to be invaluable in better managing the electrical energy consumption, cost increase coming from different sources (inflation, market position, etc.) and process problems related to the industry. For example, traditionally, in cement production, the estimation of end-product quality relies basically on engineers' intuition and data set from previous production series (sometimes with a several hours delay). Compared to this, AI is using real-time data, historical data to train operation model and predicting models.

Many cement producers realize the benefits of AI, but no any has seen full potential of it. The first among the competitors in the industry who will adopt it in full, will generate substantial value and build a strong competitive lead. Evidence based on early adopters experience demonstrates AI's ability to redesign processes, rethink sectors within the industry, increase operational margins by having better costs and create added value.

Many specific use cases in industry are available which can be used by companies for defining a focused strategy. Also, while ML and DML reinforcing many chances, industries should first identify the AI opportunities from which they will benefit the most. Next steps are start with infrastructure development, talent acquisition and knowledge gathering asap in order to find yourself on learning and adoption curves. Most successful outcomes are having companies which are incorporating AI in whole value chain and using it to enhance the productiveness of their employees.

Competitive advantage industry pillars	AI recommendations
Cost optimization	Digital twinning (electrical and thermal energy consumption decrease), alternative fuels usage mastering
Quality improvements	Quality prediction system (based on real time data assessment without delays)
Supply chain efficiency	Fast forecasting (inventory optimization, CF improvement)
People development	Upskilling and reskilling process (better workforce), culture development
Customer centricity	Fast analytics (adaptability to the market trends, faster response)

Table 3. AI recommendations for competitive advantage improvement

However, AI application is highly dependent on the existing infrastructure and digital pillars due to the fact that it often must be adapted to the company's unique data and requirements. This means no shortcuts for adopters. Companies regardless their growth should not delay their digital development. Early adopters are always creating competitive advantage and the gap with the companies falling behind will increase with time. A successful program implies major digital and analytics transformation within the company comprising: identification of the proper AI model, data setup of wanted ecosystem, adaptation of workflow processes and culture. Study in the company CRH revealed that crucial factors are top-down leadership approach, readiness and endurance of management to implement it and technical skills in the organization. The workforce needs to be trained to be able to exploit AI rather than compete with it and therefore talent acquisition should be among highest priorities.

AI related breakthrough in cement industry will need to take into consideration the ethical, legal and regulatory challenges which may pose a threat to AI adoption. The primary area in which AI can create value is outcome prediction. Organizations aiming at gaining competitive advantage need to be able to constantly anticipate the future. AI helps businesses in making prediction models

for their supply chain. Reliable forecasting coming from demand is an example of using AI's ability to process diverse and unrelated data and automatically adjust to new information.

One of the many ways businesses are using this tool is predicting demand to stock with specific quantities of specific products which will be sold. On this way they are improving cash flow, minimizing waste and having good sales overview (JIT models). Forecasting itself is an old idea. An efficient supply chain is the main pillar of every industry in terms of cash flow optimization. Predictions are serving to ensure proper amount of inventory and if handling that good the companies are already having competitive advantage. Forecasting accuracy increase and replenishment optimization are leverage that could be gained using machine learning based methods, and supply chain functions start to accept that fact. The aim is to increase flexibility and reduce oscillations in inventory. The advantage of machine learning approach is that it integrates history with near-real-time data, so it combines historical sales data and supply chains setup with current data like advertising campaigns, prices and more specific variables like weather forecasts, which is a matter of importance as cement industry is related to building and infrastructure outdoor activities. Some data can be usable only in combination with other data sources in a larger system, using cross-organizational data utilities, enriching data and making it available for participants in the closed data ecosystem. Data outputs from sensors, machines and social networks are rapidly increasing, so one of organizational challenges that occur is how to handle so extensive stream of data. Data creates in different use cases can vary in quality and volume. In some use cases data can be concrete and clear, but also fuzzy, not fully or not well defined. Rapid increase in flexibility is the result of the proper increasing of data storing and restoring in the cloud, as well as computing capabilities coming from tracking sensors.

Crucial quality of the future cement manufacturing in Europe will be collaboration, flexibility and fast adaptation to new circumstances. From HR point of view, manufacturing must be more collaborative, due to more complex challenges which are arising. A global digital network will enable increased interconnectedness and collaboration between plants worldwide.

7. Ethical issues associated with AI technology implementation in cement industry

Ethics of artificial intelligence is very important topic and in case it will not be taken seriously from the beginning, companies could have a lot of troubles. Cement companies in general are having a lot of troubles within local communities, employees and on governmental levels, since they are among pollution industries. Today, when the whole world is fighting against enviro issues, cement companies are not among welcome ones. Again, to repeat, since there is no material with same properties worldwide, it cannot be simply abandoned while population is increasing and people need to have place to live. CO2, NOx, Sox, dust emissions, even with values in controlled boundaries are still making big ethical dilemma. There are some new questions raised: for, instance, is it ethical to use AI for technology that enables sensitive issues, such as mass surveillance or autonomous process running? What will be done in the industry? On the other hand, is it possible to use AI for good causes, to address critical community challenges? How can companies, in everyday business, implement AI with guarantees for fairness, transparency and safety? Concerns about ethical implications of AI are legitimate and justified. From the other perspective, the question that should be asked as a high-level question among companies is how to maintain balance between benefits and risks of implementing AI technology. Benefits are easy to perceive, as it is already possible to see hundreds of millions people using AI and having benefit from it. There are numerous examples of use in everyday life, integrated into things like map, health technology, and mobile assistants like Siri on iPhones, that bring a lot of convenience and alleviation. But still there are a lot of legitimate concerns around jobs that are caused by automation of roles, enabled by AI. Concerns go from issues such as autonomous jobs, the potential impact on democratic process that could be produced by AI equipped spaces and forums to even more disturbing things emerging, such as deep fake, which represents a video, created using AI technology that can show anybody, any kind of public figure saying things that have never been said or showing things that never happened. This is not connected with cement industry, but still is pointing out following message: if AI is used in a wrong way, it can be a big ethical problem. All of those are risks we need to manage in our societies and industries. But it is necessary to think at the same time about some way to enable benefits to shine. AI is an incredibly powerful tool. It's

a general-purpose technology and main question is, for what purposes we want to use it? Good or bad?

According to World Economic Forum, there is a big number of ethical issues detected in connection with AI. In regard to cement industry, eight of them could be considered as most important ones.

Automation has primarily concerned the hierarchy of labor. As automated jobs means less work for people, a room could be created for people that will have more complex roles, indicating a shift from physical work, which still prevails among the blue collars in the cement industry, to strategic and administrative work. It is enough just to compare number of cement plants and number of workers. Only LafargeHolcim and CRH are having 200000 employees, from which 80% are still blue collars. What will happen to them if machines will start to work autonomously? But if observed from different perspective, let's say from perspective of lowering risks of accidents, it is ethically justifiable to employ self-operating equipment. The same scenario could happen to office workers in other departments, sales, marketing, HR, etc. Here it is fitting to ask the question what people are going to do with their time. The case of most people includes selling their time in order to be able to provide for themselves and their families. Hope remains that this opportunity will change mindsets of people and enable them to find meaning in non-labor activities, such as caring for their families, becoming more engaged in issues of their local communities, as well as learning how they could contribute to the global community and human society in general.

The way economic systems work is compensating people for their contribution to economy, and the contribution is often assessed through hourly wage. Hourly work is still the foundation of the majority of companies that provide products and services. Artificial intelligence could drastically change the situation by cutting down on the necessity for human workforce in companies, which would cause revenues to go to a smaller number of persons. All of that means that all the money would go to few individuals owning AI-driven companies. It will have therefore a widening wealth gap. Also, cement industries are situated mainly out of the big cities, and they are representing engines of local communities there. A good model needs to be found, since they are also excavating limestone, marl, sand in those areas. Local communities will need to be much better subsidized from cement companies to balance inequalities in the community.

There is a significant improvement in the way artificially intelligent bots are modelling human conversation and interaction, and it becomes better and better as the time goes by. There was a survey where human raters where asked to use text input for chatting with an unknown entity and then they were asked to guess if they had been interacting with a human or a bot. The given situation is just the beginning of a new era which will be marked by frequent interaction with machines in the same way as with humans, maybe in customer service or sales in cement industry. Also, every order for certain amount of concrete can be used like this. An advantage of an artificial bot is that it has unlimited resources when it comes to attention, patience and kindness, while humans can lack it, be triggered or distracted. People are already witnessing, although perhaps not being aware of it, to how the reward centers in the human brain can be triggered by bots. On the flip side, the capability of software to effectively trigger certain human behavior and aim human attention could perhaps find a different purpose. In right hands this asset could be used as a way of directing and shaping more beneficial human behavior, which could do a lot of good for society, but if used for bad purpose, it could become extremely damaging.

Learning is what develops intelligence, both for humans and machines. The same way people learn, systems as well have a period that serves them to "learn" to detect and adopt correct patterns and to behave accordingly. That learning phase during which the system is being fully trained precedes test phase, which is a chance to show what has been learned and to demonstrate how it functions, simulating real world situations with new examples that could not fit into the training phase. There are some situations where these systems could be fooled, unlike humans. For instance, machine could misunderstand random dot pattern and mistake it for something that it is not. It is therefore crucial to ensure highly accurate and safe machine performance, to prevent misuse by humans, if people rely on AI to bring them new labor settings. Also, regarding data collection, consistency of them need to be checked and proven. If consistency of data is poor, result will be poor as well.

Great damage could be caused if robots intended for replacing human workforce, or autonomous equipment in the plants, as well as any kind of AI systems are being used nefariously. Power and potential of certain technology is what determines how harmful it could be if used maliciously. Given that circumstance, the importance of cybersecurity cannot be emphasized enough. AI

systems are way more superior to humans regarding speed and capability, so it is crucial for those systems to be safe in order to prevent any kind of unpredicted situations and possible misuse.

What would happen if artificial intelligence turned against humans? Of course, this does not mean that they could become "evil" and voluntarily destructive toward mankind, or any of implications from disaster movies. AI systems are highly unlikely capable of being malicious, but there is a possibility of misunderstanding the context of a command that has been received by the system, which can cause horrible unforeseen consequences. For instance, task for a system is to eradicate cancer on a global level. Computer does a lot of calculation, and after considering all the factors, it decides that the most efficient way to successfully finish the task is by killing every human being on the planet. From its point of view the aim "no more cancer" is achieved, but not in the way humans wanted.

In cement industry, it could be interpreted as achieve zero carbon target which is impossible as long as we are having pyro-processing as the part of production phase. In this case, computer would shut down the plant and made very expensive damage. Concept should be clearly defined and orders given should be based on SMART principle. If we leave many unpredicted free grades to the machines to think about, sometimes the results could be deteriorating.

The secret that explains why humans are the most dominant beings is not in force and strength. It entirely has to do with intelligence and creativity. It is possible for humans to control animals that are bigger, stronger or faster not because of physical superiority, but the capability to invent and use means and tools that enable control, physical instruments like cages, traps or weapons as well as cognitive tools such as conditioning and training. The same analogy could be used when considering relations between humans and artificial intelligence: is there a possibility it could gain the same leverage over humans? Disabling machines just by "pulling the plug" is not reliable enough, because there is a possibility of anticipation of such human move by sufficiently advanced software, which could then defend itself. Described situation explains "singularity", which implies the point in time when a more intelligent entity than human may appear on earth. This should not be a problem, if singularity is not applied on all levels and there are no threats for the human kind.

Development of neuroscience gives much more insight into the basic mechanisms of reward and aversion, which are the same in humans as in other, much simpler animals. Although full conscious experience still remains mostly a mystery, mechanisms of reward and aversion can help predict

some aspects of human behavior. In a similar manner, human is integrating these mechanisms into AI systems.

At the moment, these mechanisms are pretty superficial, but they are growing and developing into much more complex, detailed and realistic. So, is it possible for a system to be suffering if it gets a negative input for a reward function? Furthermore, genetic algorithms create many instances of a system at once, and what happens next something like "natural selection" where only the most successful continue to exist in order to create the next generation of instances, while the less successful instances are being deleted. This process is a way of improving the system and is repeated through multiple generations. If machines are observed like perceiving, feeling and acting entities, could genetic algorithms be perceived as a form of mass murder, and should the legal status of machines be debated? Is there space to treat them like animals that have comparable intelligence? Will the suffering of machines that can "feel" be considered?

Ethical questions concern both suffering mitigation and risks of negative outcomes. With all potential risks aside, it is necessary to keep in mind that every technological progress enables better quality of life for humans. Great potential of artificial intelligence is undeniable, but the burden of responsible implementation is on humans.

Main conclusion regarding ethical approach is to maximize fairness and minimize biases in connection with AI. First, biased decision making no matter by humans or machines, results in bad mindset of discriminated people which are against and secondly, harms to the other part of population which would like to develop themselves, economy in their country and society in general.

Another importance of minimizing bias in AI is that it contributes to encouraging people to trust these systems. This is of major importance for reaching full AI potential in driving benefits for businesses, for the economy through productivity growth, and for society through contributions to dealing with vital collective issues.

8. Talent acquisition, upskilling and reskilling processes in terms of AI

AI expansion is one of the crucial business challenges and opportunities today that managers should recognize. A major challenge associated with is to tailor an organization that can respond to such challenges and take full advantage of its potential. This requires preparing the management, staff, analytic core in the organization and to change way of thinking and working for end users. This is a humongous challenge for organization, but also great opportunity for interdisciplinary teamwork on new trends in the industry.

Mainly companies have an improvised style in recruiting and capacity building of staff. When in need of new workers who have necessary skills, they hire them on an ad-hoc basis while relying on online-learning options and C-level programs for training of employees. Companies must be aware that these quick fix tactics will not result into a transformed modern AI supportive organization capable to follow trends in both technology and the growing competitive market within the industry which make today's business environments. Acquiring potential talents can be done due to immediate needs to build up the organization's AI practice at the start, but it cannot be a substitution for what is a crucial requirement, and that is the overall capability building across the organization. The best way to achieve this is training existing staff. For this purpose, companies should know that educational offerings from external parties are not the best solution because they are not tailored for the specific needs of different companies nor do they have the consistent protocols, vital for creation of cultural changes, active collaboration between teams and sectors, and rapid scaling. The answer to this challenge is creating of own HR framework assessment, identify the gaps and build own training centers. Building internal training centers is not welcome as trend and is quite new, but it will accelerate knowledge acquiring process a lot. This system should also be applied in cement industry, where AI will be adopted as a part of a core business and insourced. Before such internal AI academy is established, its overall benefits should be explained to employees. AI implementation will take majority of blue collars jobs, but on the other hand it will create a majority of new ones as well. Every company need to have complete AI implementation strategy developed, otherwise the whole process can be really slow. Although it of great importance to build AI strategy, it is increasingly important to empower employees across the organization to take active roles in shaping the AI map of their company. With full engagement

of all employees and not only high technical staff as engineers in AI development, ensures that AI projects will serve to strengthen workers in performing their work, while stimulating their confidence which will help them to adapt to continuously changing working environment. It enables them to develop skills giving them tool to respond to demands of the future way of working shaped by AI.

8.1 Demystify artificial intelligence

The media often presents AI effects and new technological trends as spectacular or even unrealistic, so it is understandable that many workers respond negatively or with doubts to introducing technology in their workplace. The best way to solve this problem is to speak about AI approach by explaining in the simplest possible way to the employees. They should benefit from it by recognizing how use the technology to improve their daily performance. There are five main benefits for employees coming from AI:

Foresight. Forecasting abilities help workers in predicting more accurately potential equipment failures which will improve their efficiency.

Assistance. Quick access to all necessary data needed to respond to queries and automatization of time demanding activities (e.g. claims processing, basic customer protocols and inventory optimization).

Expertise. Using provided expertise from AI to identify the root cause of equipment malfunction and deal with critical operational stoppages when no experienced engineers are on site.

Explanation. Better understanding of production or customer preferences.

Simulation. Testing of all potential scenarios before making a decision, but far beyond human capabilities (e.g. prediction of the price reduction on profitability only in markets with uncertain degrees of competitiveness).

8.2. Build trusted AI sources

Management at all levels must have the skills to encourage extensive support of AI among working population. Training through own formalized analytics academy is the best solution as previously

explained, because it provides tailored learning enabling executives to identify different opportunities, there are other educational activities which can serve as initiatory steps in building knowledge. It is of crucial importance to identify AI champions among blue collars as well, not only in managerial layers. These employees will be crucial asset in the AI promotion and implementation process.

8.3. Develop business-intelligence sources

Apart from building AI champions, it is also beneficial to foster a culture of challenge acceptance, essential for AI implementation in organizations. Employees should be encouraged to use the AI tools in place with its simple features at the beginning and after gradually start to feel confident, they should be left to dig in and explore alone a bit. They will start to trust the data in time and will also become more data driven. This change of mindset paves the way employees becoming accustomed to using AI systems.

8.4. Highlight common ground

Companies are investing a considerable effort in providing openness towards AI solutions. It is done not only to meet regulatory requirements but also to facilitate trust in AI perceptions, considering how often they conflict with deep-rooted beliefs. Apart from tackling the extensive explanations about AI outputs, sometimes giving proper examples where AI will lift up employee knowledge and expertise is very supportive to gain trust in the technology. Open discussion and common ground presents an crucial first step in the implementation strategy.

8.5. Personalize the benefits

Managers are often aware of the need to establish the processes to appraise AI value for the organization, but this should also be vice versa towards employees. This can be communicated through townhall meetings, newsletters, company blogs and intranet activities. AI transformation journey in cement industry, in terms of people AI acceptance, upskilling or reskilling, will need to encompass following:

• Strategy and culture. This implies focus towards value, organization framework and creation of culture driven by data.

• Protocols usage in order to have knowledge sharing. Everyone should learn standard protocols about usage in order to comprehend technology better and be able to implement good cases, lessons learned and information sharing.

• Soft skills. Technical experts focused on soft skills, because of better communications with employees (a skill often lacking in technical team members).

• Agile processes and teamwork. Properly chosen members of technical teams trained in applying agile tools in AI area and instructions on promoting cooperation between departments while creating new features.

• Change management skills. Translators and leaders should primarily focus on the ways how the certain changes will be used and implemented into imposed AI agenda over time.

Number of necessary different skills that need development, use and upgrade is dictated by existing variations in products and services, which is constantly increasing. On the other hand, skills and knowledge required to fulfill needs of any particular customer are becoming more specific, variable and narrow. It is no longer lucrative to develop set of few generalized skills in a large number of workers, because those skills do not have broad use anymore, so they will not be able to make products as intended. A better approach that is becoming more and more accepted among companies is training their employees to master various specific skills, which will make them capable of creating countless variations of designed product or service. Training programs for a large group of employees that develops only generalized skills are not profitable nor economically justifiable.

The skills being mastered are mostly deficient for the type of challenges they are meant to deal with, if they are being learned without context. With changed roles and paradigm of business, customers have gained more power and are becoming active participant in designing products and services, which is a situation that requires more personalized approach. Information about companies and their products and services is easily accessible due to advancements in digital technology, which cause decreased brand loyalty thanks to greater transparency and lower switching costs. Part of consumers' power lies in chance to compare, identify inconsistencies and react if their expectations are not met. Described situation resulted in markets being more fragmented, but less consistent, less predictable and less lasting. Development of technology

allowed automation of more skills that could be much quicker learned and performed by machines than by humans. In that sense, humans are much inferior compared to machines. Digital technology, including artificial intelligence and robots, turned out to be continuously more able to adopt certain types of technical and scientific skills, although it once seemed that those are exclusively in human domain, such as lab diagnostics, eye surgery, selecting and packing grocery deliveries. Some tasks became outdated due to processes being redesigned by new technology, so tasks that were once required become redundant. Considering all this, standardization and scale are no longer the basis of competition. Many big manufacturing companies lose their battle on the market because they cannot adjust to the modern concept of customer's expectations. Such a new setting does not allow companies to fulfill customers' needs using outdated type of offering that maximizes efficiency for the company, but taking very little care about customers' wishes. If companies want to survive, they will have to find a way to adjust and to teach their employees specialized skills required to participate in today's fragmented market.

9. Integration of AI with Supply chain organization in cement industry

As mentioned in the chapter 2.1.4, AI is empowering supply chain to enable companies to address the new customer requirements, respond effectively to supply related challenges and to remaining expectations in efficiency improvement. AI applications for Supply chain will bring many benefits and the most important ones are:

- SPEED. Delivery time has been reduced to few hours due to changes in product distribution. New approach is based on advanced forecasting methods (predictive analytics) of both internal and external data which ensures increased accuracy in predicting customer demand. Frequency of forecast performing is on a weekly basis to every day, if it is a fast-moving product. Predictive shipping, which is Amazon's patent, implying that provider ships the product before the order is placed, will be the future of every industry. It is carried out so that the product is transported to the customer area when the order is placed and the order is subsequently matched with a shipment that finally gets it exact destination.
- FLEXIBILITY. Changing demand or supply situations does not cause too much hassle if planning is being done in real time. Providers are able to react energetically and fairly flexible to fluctuating demands or capacity feedback because the process is continuous and planning cycles and frozen periods are minimized. Customers are able to redirect shipments to the closest location when the provider sends the products. This flexibility in the supply chain is increased through new business models, e.g. one which can be acquired as a service without having the resources and capacities within the company. Service providers are able to "create both economies" (scope and scale), as well as providing outsourcing services. Transport will in the future be "uberized", which implies higher flexibility of transport by more competitive costs.
- GRANULARITY. Micro-segmentation is what leads to mass customization, as the customers' demand for more personalized products increases. Customers became grouped into more granular clusters and the offers they will get will be much more fitting. They will be able to choose between various "logistics menus" that seem designed exactly for every customer. Regarding cement industry, it is not possible to implement due to heavy load,

but it will be possible for some retails to improve their transport immeasurably using drone delivery, for instance.

- ACCURACY. Latest development of performance management systems enables process that is transparent from end to end, which is a precondition for accuracy. Information that the new generation of those systems use, stretch from top-level KPIs, like general service level, to very particular data. Combination of such data gives a very broad insight into supply chain and its specific stages and functions. Data from suppliers or service providers etc. are all gathered in one place in a cloud and all of them have access to the same data. Potential risks and exceptions are being identified by performance management systems, and supply chain parameters changed accordingly, through a closed-loop learning approach. Automation of that process enables handling exceptions and system functioning without human intervention, as well as a constant development towards its efficient frontier.
- EFFICIENCY. Automation of physical tasks as well as of planning enabled greater efficiency. Warehouse work is being entrusted to robots, which are in charge of handling the material (pallets as well as individual bags), so they receive and unload the material, as well as select, pack and ship. The products are being transported within the network by autonomous trucks. There is collaboration between companies in order to optimize transport and truck utilization, so capacities are shared and transport flexibility is increased. Setup of network is constantly being optimized as well, which ensures optimal fit to requirements. The supply chain is being secured from overloading by using different transparency and dynamic planning approaches with optimally shaped demands.

An aspect that thwarts the full potential of artificial intelligence for supply chains management to show is digital waste. It is very important for companies to comprehend both the sources of waste, as well as potential solutions that could help reduce or prevent it in the future. On top of existing waste, sources of digital waste are many, and there are 3 different types:

a. Trapping and managing data. For instance, if data is being handled manually and if updates are not being performed regularly it can cause problems. For instance, if target data for lead time of supplier is not changed since it was first entered, sometimes even for years. In warehousing it happens that notifications for shipping are received in advance, but not

optimized properly. What typically happens is that it becomes unclear which additional data should be used for process improvement. For instance, if a supply disruption is noticed, let's say the supplier lead time is constantly increasing; planners should be made aware of it and they should have assistance helping them to diminish disruptions at an early stage. New systems do not recognize this signal and that results in a lower supplier service level.

b. Optimization of integrated planning process. There is an increased interest among companies in integrated planning process, but the planning is often being performed without all necessary information for achieving the most successful result. Furthermore, it happens sometimes that planners manually overwrite automatically determined planning or statistical forecast data, which then negatively impacts the forecasting accuracy, in particular for medium or high-speed moving parts. The process optimization between collaborating companies is not fully achieved, do the full potential for improvement that increased transparency has is still not being materialized. In order to get the best of integrated process optimization, it is crucial not to be working in silos, to align setup, management, processes and incentives within organization, as well as between partner companies.

c. Physical processes done by machines and humans. Companies often perform same key functions, such as warehousing, assembly line utilization or transport management based on previous experience and without using existing data for pick paths improvement within the storage. Allocation of new orders in a real-time model is going to be disabled as long as warehouse work is being done in one or two hour batches.

9.1 Impact of AI on - and transformation of supply chain

Operational effectiveness of supply chains could be optimized by using new technologies and by eliminating today's digital waste. Estimated impact that artificial intelligence can have in the industry worldwide in the next two or three years is enormous – it could lower operational costs up to 30 percent (source: Deloitte AI institute). Performance indicators highly correlated with notable cost advantage are:

9.1.1. Lost sales connected with supply chain. Service for customers that is described as low usually has to do with unrealistic lead times (meaning that customer got a wrong

promise), a wrong inventory data (products are not available although it wasn't stated so) or delivery problems. Besides, lost sales are sometimes driven by unavailability of the required products in the system, which often cause customer loss due to switch to another more reliable brand. Mainly it happens for B2C and B2B. Cement industry is B2B environment and therefore the impact is even more significant. The level of service and overall customer satisfaction is possible to enhance dramatically by adjusting the way of communicating by relying more on available facts came out as result of market intelligence, improved forecasting, and combining demand shaping with demand sensing methods, which will consequently result in lost sales decrease.

9.1.2. Supply chain costs. These costs can be reduced up to one third, of which approximately the half could be achieved by optimizing the network and applying advanced methods of calculation for clean sheet costs for transport and warehousing (clean sheet costs are bottom-up calculated "true" costs of the service). The best practice is to strive to minimize as much aspects as possible, without lowering the quality of the service. Saving potential can be increased by combining that practice with features like smart automation and warehousing management improvements etc. Some of other approaches that could help reduce costs are dynamic routing, optimizing autonomous vehicles, Uberization of transport, etc.

9.1.3. Accurate planning in the SCM. Automation of planning like planning to demand, process analysis, granulated production with cost centers and supportive supply planning, which are now conducted mostly manually, could ensure higher speed and better quality of service. System support would allow majority of tasks to be automated. Artificial intelligence would adjust the planning process to a weekly basis and organize it in a manner that allows updates in real time. Service, costs and inventory in a way depend on accuracy, granularity and speed. AI systems would enable exception detection in time, so that a planner can get involved if and when necessary for decision-making.

9.1.4. Inventory. Demand and supply are separated by inventory. Safety stock would be redundant if new planning algorithms would be implemented. Another leverage it could achieve is notably reducing the uncertainty in terms of forecast error or the standard deviation of the demand/supply. The replenishment lead time is another variable that

is important for inventory management. It could be significantly reduced by more production batches and quicker changeovers. Level of digital experience of the current supply chain is what shapes the process of capturing the value. The first thing to do in order to increase digital capacities of the organization and leverage available data is to establish the transformation process into a digital SCM. It demands two crucial topics - capacity and working environment. Digitalization capacities must be found or built within the organizational structure, but they also require additional recruiting of specialists. Fast development cycles, fast trials through many iterations and implementation of selected options are possible if company tends to establish a very high empowerment and freedom in the organization with further nurture of IT environment. Immediate feedbacks on suitability and effects of the solutions are possible to get by fast pilots realization. IT also creates excitement within the organization, trust in innovative technology and enthusiasm for next cycles.

10. Brief legal requirements in terms of AI

At this point I would like to use the opportunity to point out the importance of information and communications channels, provided from organizations such as Organization for Economic Cooperation and Development (OECD). Plenty of information's per industry, per region, per many other parameters could be found. For the policy makers and industries which are going towards AI development it is an extraordinary place to gather necessary information's.

Organizations that develop AI systems have a great responsibility to understand how the system will be used and that its implementation will not be harmful to society. AI system developers should require that the purpose of the software implementation be identified in reasonable detail. They must ensure that the purposes of the new AI systems are ethical and not intentionally harmful. As the full potential of AI for both good and harm is recognized by national governments, some regulatory statutes or rules will follow. Laws that regulate AI should promote ethical uses that do not cause harm, avoid unreasonable disruptions and do not promote the distribution of false information. AI is already being used in the workplace to support automation and speed or eliminate routine administrative tasks. Organizations that develop or deploy AI systems should consider the net effects of any implementation on its employees and their work. In some instances, workers will be displaced by automated systems. To gain greater understanding and acceptance of AI systems on their employees, businesses should allow the affected workers to participate in the decision-making process. AI systems and automation usually boost efficiency and, as a result, workers are replaced by these systems. To promote efficiency and productivity, governments should consider creating programs for any displaced workers to learn new useful skills. Similarly, governments should promote educational policies to prepare children with the skills they will need for the emerging new economy, including life-long learning. The implementation of AI systems may have an adverse impact on the environment. When developing AI systems, organizations should assess the environmental impact of these new systems. Government should put into effect statutes or rules that ensure complete and transparent investigations of any adverse or unanticipated environmental impacts of AI systems.

The recent very public policy disputes relating to posts on Twitter and Facebook reveal how AI may be used to weaponize false or misleading information. Companies that develop or deploy AI systems to promote or filter information on Internet platforms, including social media, should take

measures to minimize the spread of false or misleading information. It is recommended that these systems should prove a means for users to flag potentially false or harmful content. Government agencies should provide clear guidelines to identify prohibited content that respects the rights and equality of individuals. Ethical and legal framework are always overlapping and main message for the companies which are implementing AI should be analyzed through following three categories:

Transparency and ability to explain

Transparency refers to the duty of every business and government entity to inform customers and citizens that they are interacting with AI systems. At a minimum, users should be provided with information about what the systems does, how it performs its tasks and the specifications and data used in training the system. The goal of transparency is to avoid creating an AI system that functions as an "black box." Explainability refers to the duty of organizations using an AI decision-making process to provide accurate information in human understandable terms as to how the decisions and outcomes were reached. For example, if an AI system is used to process a customer postponed 45 days payment for cement application the loan applicant should be able to find out the factors supporting a trade payables decision including credit ratings, quality and recent comparable prices in neighboring areas or regions. Transparency tends to preserve the public trust in AI systems and to demonstrate fairness of decisions made by an AI system. Transparency and readiness to explain become increasingly important as the AI system deals with important decisions involving sensitive personal or financial data. In designing the AI system, transparency should meet the reasonable expectation of the average user. For this reason, transparency and explainability should be built into the design of any AI system.

Fairness and Non-Discrimination

The design of AI systems is a human endeavor and necessarily incorporates the knowledge, life experiences and prejudices of the designers. Companies that develop or deploy AI systems should make users aware that these systems reflect the goals and potential biases of the developers. As has been studied in other contexts, implicit bias is part of the human condition and AI system developers may incorporate these values into the methods and goals of a new AI system. AI systems are often "trained" by reviewing large data sets. For example, an AI system assisting in postponed payment decisions for cement customer might have used a data set that indicated certain

racial or ethnic minority has a higher than average loan default rate. Screening for such a bias is necessary for a fair system. The decisions made by AI systems must be fair and non-discriminatory as compared to non-discriminatory decisions made by humans. As such, in the design of AI systems fairness should be prioritized in the system's algorithms and training data used. Without attention to fairness, AI systems have the potential of perpetuating and increasing bias and this could have a broad social impact. To minimize these issues, AI systems with a significant social impact should be independently reviewed and tested periodically.

Safety and Reliability

AI systems currently control a wide variety of automated equipment and will have a broader impact when autonomous vehicles are in common use. Whether in the factory or traveling on the highway, AI systems will have a potential danger to individuals. As to the issue of safety, AI system developers must ensure that AI systems will perform correctly, without harming users, resources or the environment. It is essential to minimize unintentional consequences and errors in any system's operation. These AI controlled systems must also operate reliably. Reliability refers to the consistency of performance, i.e., the probability of performing a function without a failure and within the system's parameters over an extended period of time. Organizations that develop or deploy AI systems in conjunction with a piece of equipment must clearly define the principles underlying its operation and the boundaries of its decision-making powers. When safety is a priority, which in the cement operations is certainly nr.1, the appropriate government agency should require the testing of AI systems to ensure reliability. The systems should be trained on data sets that are as "error-free" as possible. When an AI system is involved in an incident of an unanticipated or adverse/fatal outcome it should be subject to a transparent investigation. The possibility of personal injury and the potential liability raises a host of legal concerns. Legislators should consider whether the current legal framework, including product liability law, requires adjustments to meet the unique characteristics of AI systems.

11. Summary

AI is positioned to disrupt our world. It is estimated that the way humans work and their productivity will be greatly influenced by automation and artificial intelligence. Experimenting and developing different technologies, opportunities and strategies requires significant investments from companies that want to capture value in this market. Making a decision which opportunities, out of the thousands available, are worth pursuing can be a very difficult task for companies. Options can be narrowed using a structured approach. Many cement companies recognize the benefits of AI, but few are aware of full capability scope and potential. The first movers in cement industry will generate and build a strong competitive position towards all others producers. Among the many AI solutions on offer, cement manufacturers should focus on the following five as they hold the greatest potential for this industry: asset performance management, digitalization of occupational health & safety solutions, production & quality analytics, supply chain optimization and carbon footprint.

In terms of benchmarking with other industries, industries that are leaders are finances, high tech such as IT and space industry, than telecom as well. Those sectors are seen to be at the digital leaders by MGI's Industry Digitization Index and have already invested in development of digital technologies. Digital tools were developed and used by these sectors for optimizing their performance as well as for their core product offerings. Advanced robotics at scale was used in manufacturing in automotive and assembly, being among the first sectors to do so. AI technologies are still being used there today for self-driving cars development. Other sectors like utilities, services, resources and construction belong to the middle or less digitized industries. Reasons for that can be seen in combination of various factors. With the exception of some parts of large construction firms and professional service industry, these industries are generally slow when it comes to employing digital tools. Being primarily focused on domestic markets, those sectors lag behind in innovation and productivity growth. Education and health care are at the moment near the bottom of the pack and are known as traditionally less digital fields.

Cement industry notes moderate rivalry regarding AI adoption. Market is mostly oligopolistic in Europe's different regions, which indicates dominance of only a few companies (which is five, in this case) on the whole European market, including different regions. Reasons for such situation can be found in high fixed costs. In average, a plant costs approximately 10 million euros, and that

results in limited rivalry due to uneven possibilities, and highly concentrated companies' environment. Besides, cement products lack proper differentiation, which together with consumers' low switching costs in some circumstances intensifies rivalry. All above factors combined cause moderate rivalry in the cement industry on a global level.

Threat of substitutes is recognized as the second force. A credible threat of competition does not exist if there is a lack of substitutes, meaning that there is a lack of other products, from other industries that could be used instead of a certain product. Simply put, replacement for cement still does not exist in the world; there is no material that could be an effective substitute for cement, which is a fact that shapes the reality and position of the cement industry. Construction companies can choose to replace cement with other materials that have similar, cementitious characteristics, but the effect of such a substitution does not affect the market price of cement in a significant manner. The threat exists exclusively if another industry creates a product with similar features that could persuade consumers to switch (minimal partial substitution) and lower the ratio of their use of the product. When it comes to cement industry, both of these possibilities are practically non-existent, so the threat of substitute is very low and the cement industry is not endangered in that sense.

Buyer bargaining power is the third force of competition. This force indicates influence until what extent in this area the customers can have on the business. Exclusive 100% buyer power can exists if the market consists of only one buyer, which gives him the complete power and control over conditions. Cement industry notes minimal effect of buyer bargaining power. Some circumstances, such as lack of substitutes, not many existing cement companies and the consumers' demand keep consumers limited in their power. Situation as it is makes it easier for company to have control over setting prices, while buyers have to be just price takers.

The fourth Porter's force is supplier bargaining power. When suppliers have the power over producing firms, they can extract part of the profit from those firms by raising the raw material prices. Cement industry has both concentrated suppliers and concentrated buyers, which makes the initial bargaining balanced. There are two categories of cement industry suppliers: transportation suppliers and raw material suppliers (clinkers). Price surges in the cement industry are reported by the manufacturers to be due to price increases in transportation and conventional raw materials since both are unavoidable. This implies that suppliers have enough power to affect

cement business. The power of suppliers could come in several cases: if a credible forward integration threat exists, which means that suppliers can buy producing company; if there is no switching option, meaning the suppliers are concentrated; if switching suppliers is prohibited or if a supplier can gather final consumers. None of this is case in the cement industry, since suppliers come from different fields. In this particular case, suppliers drive their power from their regional concentration and high costs of switching between suppliers. Distance is a factor that must be considered, as it determines prices, which implies that AI would not generate significant leverage. That being said, the bargaining power in this case is in hands of local or regional suppliers.

Barriers to entry and exit are the fifth and final Porter's force that helps to be aware of potential competition within an industry and to measure effect of the existing one. If a barrier to entry is high, it means no threat from outside competition and that the competitiveness among companies is not intense. Actually, there are incentives for cooperation inside the industry, as well as collusions like cartels. On the other hand, barriers to exit refer to companies being stuck or locked in the market, and it usually implies company's inability to sell its assets when wanting to leave the industry. There are four different ways of looking at barriers to entry and exit. First is the government limitation of licenses sold for production. Due to cement being energy intensive and highly polluting, governments have to strictly regulate entry to the market. Second, barriers are created by patents. Although cement industry is not highly dependent on patents, like, for instance, pharmaceutical, patents on new methods of production or new machines form certain difficulties for new companies to enter the industry. Third aspect refers to usability of assets needed for cement production in other industries, which is not high, as cement industry is particularly asset specific. This implies very high costs of potential cease in production, once the company enters the industry. In the end, AI could be prevented from entering by economies of scale, but there is no interest. Overall, it can be stated that there are high barriers both to entry and and to exit the industry. Regarding implementation and state of the art path, cement industries are generally closed and this time change of a course is necessary. In the master thesis completely other approach has been recommended, that AI should be implemented as coupled open innovation strategy with agile approach, means with highly controlled iterations during every process implementation.

Five steps have been defined:

1. Understand possibilities and potential of AI, prioritize use cases, and take care of the available assets
2. Build strong analytical strengths within the company but also utilize and follow up third-party resources
3. Store structured and consistent data and if possible transform unstructured or flat data into usable
4. Leverage domain knowledge to boost the AI strategy
5. Make small but swift steps using pilots, testing, and simulations.

Speaking about recommendations for the industry regarding AI, main attributes considering cement manufacturing in Europe will be agility, collaboration, understanding as the ability to perform within the shortest possible time frame regardless to changes and external effects which are disturbing industry environment. From a HR viewpoint, manufacturing will become increasingly collaborative, due to progressively more complex activities and interdependent workers. Interconnectedness and collaboration between plants around the world, their interconnected value chains will be enabled by a global digital network. The major challenge will be organizational, in order to build working society that can embrace opportunity and make maximum use of the AI given potentials. Being able to deal with these challenges implies preparing the all organizational layers to work and think differently, not only to be supportive and helpful during AI adoption and adaptation period, but also by teaching them to respond positively to data investigation and interpretation in general. More often than not, management has an improvised approach to hiring and capacity building of the staff. They are hiring new workers with necessary skills ad hoc and for the purpose of training of existing employees using some existing approaches and platforms. However, these quick-fix tactics will not pave the way to creating a fully AI supportive organization able to keep up the pace with changing trends in technology and competitiveness faced with nowadays. To distinguish, hiring new skilled staff serves the purpose of addressing immediate needs towards AI supportive environment, but it is not nearly sufficient to provide what is crucial in this context: overall capacity building across all levels of the organization. This is most efficiently achieved by training current employees. Speaking about supply chain business advancement, it should be “installed” separately in the

cement business as an incubator. It is external based part of the operations towards customers and they need to be active part of that. Five main characteristics which will be improved, as described in chapter 9, are speed, flexibility, granularity, accuracy and efficiency. In terms of legal framework and ethical issues, it is important to take both prospective, human and machines, onto consideration. At the end, transparency, fairness, approach to biases, reliability and safety will determine the legal framework.

It takes more than just implementing AI technology in order to change the concept of business process. Possibly the key factor is commitment and enthusiasm to invest in employees and mastering their fusion skills, which are crucial for effective interaction between humans and machines. The first step is to learn to assign and distribute tasks to the new technology. For better outcomes, it is also necessary for employees to be able to collaborate and combine their skills that are specifically human with skills of smart machines, for instance, in robot-assisted surgery, and to attend trainings that will enhance their handling of AI-improved processes. Employees have to be capable of teaching intelligent machines new skills as well. AI systems must be used responsibly and without any unethical or illegal goals. Near future could bring completely different concept of company roles, which could be fully redesigned around reimagined business processes, so company organization could be arranged not around rigid job titles like before, but around various types of skills.

The best optimization of collaborative intelligence comes if companies re-conceptualize their processes, which only a few companies have done so far. Adjusting to the new relations between humans and machines will require doing things differently as well as doing different things than usually.

There is one thing which is crucial to remember: using automation for bare replacement of people by machines is not the right way for implementing such systems and will not develop the full potential of artificial intelligence. Companies that will have leverage are those that will nurture collaborative intelligence and adjust every aspect of their business to proper implementation of artificial intelligence.

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