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Construction Management Techniques in the Danish and Indian firms

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Preface

This thesis is part of the evaluation of the final semester of Master in Global Innovation Management course. The base of the report is the research made on the comparison between the Danish and Indian construction management techniques. This report progresses by understanding the various issues faced by the construction management industry, and the various steps that can be taken to overcome these problems. This also provides the steps taken by the Danish firms to overcome their construction management issues and it provides a brief comparison over the Danish and Indian construction management techniques in aspects such as cultural, organization and workforce, and the difference in practices. One of the main focus is ‘’how the industrialization took place in the Danish construction industry and what can the Indian construction industry learn from the Danish sector ‘’.

Abstract

This thesis addresses the arising questions of the practices between Denmark and India’s construction industry. The two countries cannot be easily compared since their political and historical background are different from each other. Denmark is considered a strong initiator when it comes to complying with new technologies, being an institutionalized country, defined by its development strategies. India, on the other hand, has always been oppressed by outdated methods, despite the drastic development in the education system. India can be characterized by the lack of technology and advancement in the construction industry sector, where the development strategies are missing.

Further on in the thesis, will be discussed how the technology can have an impact on the Indian construction industry and what can be learned by studying the Danish construction management techniques and how can it be used for the improvement of Indian construction management.

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Contents

1.Introduction

1.1 What are the general issues within the construction industry?

The speed with which the world is changing is faster than ever. The population in urban areas is increasing with 200,000 inhabitants per day, which means that the construction industry is shaken up, due to people's need for affordable housing, as well as transportation and infrastructure [World Economic Forum, 2016].

It is difficult to predict what will be the top issues which the construction industry will face yearly. At the same time, if we look back at the end of 2018, trends tend to continue, thus being extended for a longer period of time. Since the financial crisis, the world has been affected by a decline in productivity [Goldin, Koutroumpis, Lafond, Rochwics, Winkler, 2018]. One explanation could be the fact that, in risky times, firms are more rigid when it comes to employing new people, rather than investing in new and modern equipment. The construction industry has been affected by such problems for decades.

Things are particularly tough in rich countries. For example, In France and Italy, per hour productivity declined by about 6%. Germany and Japan have seen almost no growth, while in America, the situation is even worse: there, construction productivity has fallen by half since the late 1960s [economist.com, 2017].

A major source of productivity issue in the construction industry comes from its fragmented structure. For example, in America, less than 5% of builders, work for construction firms employing over 10.000 workers, compared with 23% in the services sector and 25% in the manufacturing industry. Profit margins are the lowest in any industry, except for the commerce [Nawi, Bahaudin, Baluch, 2014].

There are several problems facing the construction industry in 2019 such as workforce issues, the need to adapt to technology, the increase in prices for prime materials, as well as environmental and sustainability issues. Each of these issues is bringing sub-problems with them.

Globally, one of the most pressing topics with the construction industry is the labor shortage. This is a crucial issue in 2019 and is a continuation of an existing problem that started in 2018.

According to the Bureau of Labor Statistics, at the end of 2018, there were roughly 280.000 job openings within the construction industry sector, while finding skilled

workers has become more difficult, due to the unemployment rate being so low. The number of qualified workers available is dropping as the workforce is ageing. Between 2004-2005, the construction sector in India hired approximately 22.000 unskilled men per day for labor and 23.000 skilled or semiskilled men per day as workers. During the Engineering Congress on Human Capital Development from January 2002, it has been observed that *"in time to come, India will not have sufficient quality civil engineers even to undertake basic infrastructure work*." [Engineering Congress; 2002] [Nawi, Bahaudin; Baluch; 2014].

This is a crucial problem because unqualified workers are hired, leading to more defect claims and creating safety concerns. Another problem which the workforce shortage is bringing with is the fact that projects are taking longer to fulfil their deadlines or, in some cases, to even start. With the fact that there is a big age gap between the laborers, the generational differences are coming into play, causing conflicts as the younger workers are bringing different values and skills to a project. In order to combat this issue, certain industries are partnering up with universities, setting up programs which combine education with apprenticeship programs [Camm Construction, 2019].

Another problem is the need to adapt to technology. It is imperative for contractors to catch up with technology. Due to the increased number in the construction demand, they will need to use better cloud software as well as integrated collaboration tools. An improvement in their daily work life will be the use of building information modelling (BIM), laser scanning, virtual reality and so on, as these practices continue to grow in the industry. In spite of that, this technology has come later and unsystematic/irregular in the construction industry, as the contractors tend to use a variety of new software. This leads to an increase in cost, as well as delays, while the subcontractors and the architects are trying to learn each new software. Moreover, the construction projects are more defenceless against cyber-attacks because the sites are less secure, caused by the use of multiple systems at the same time [World Economic Forum, 2016].

The third problem is the fact that the prices for materials are constantly increasing, leading to unavailability of cement and aggregates. This is due to the impact which the 'trade war' has, increasing the project costs over the past few years. In some cases, material costs have increased with 10-12% over 2018 and are likely that this number will grow over the next few years. One way to reduce material costs will be to shop for

better and cheaper insurance policies. This can be easily done since the insurance market remains competitive [World Economic Forum, 2016].

Lastly, the environmental and sustainability issue is a hot topic nowadays. Given the fact that the construction industry is responsible for producing more than 25% of the world's carbon emissions, the industry must continue to take steps in reducing their footprint and to combat their impact on the environment [Abergel, Dean and Dulac, 2017]. With the employment of the younger workforce, there is more awareness among the laborers which are trying to build more sustainable and environmental - friendly projects. Also, the constant climate change will cause issues in the industry. For example, India's rapid urbanization has a great impact on the environment, which has led to a high level of land degradation such as desertification, floods, aridity and erosion.

There aren't just problems with the soil. The air is also suffering from too much pollution. Even though many industrialized countries, such as Denmark, are taking steps to reduce the amount of waste released into the air and soil, by introducing new practices and techniques [mfvm.dk, 2013], India is still falling behind in that sector [Irfan, 2018]. There are several measurements/methods which India can take in order to improve environmental quality. For example, the government could take action by releasing regulations regarding friendly environmental performances, assuring that all the companies are acting within environmentally safe legislation in order to protect the ecosystem.

Even though for the past five years the Indian construction sector has grown significantly, the lack of sophistication on the construction supply chain is one of the major issues with the industry [Hemanta, Doloi; Sawhey, Anil; Iyer, K.C; Rentala, Sameer; 2011].

Over the years, more and more companies all over the world started to accept the industrialization. With this increasing knowledge about industrialization, India has caught fast the pace, with its second fastest-growing sector being the construction industry with an annual growth rate of 10%, respectively 11.1% over the last eight years [Ahuja, Vanita; Kumari, Savita; 2013]. The prospects are showing that as of 2013, India was witnessing an unprecedented growth rate, hitting high levels of construction activity in all kinds of a residential project, infrastructure projects or even commercial projects. Most of these projects are facing differences in cost, having complex designs and strict timelines [Ahuja, Vanita; Kumari, Savita; 2013]. In order to

successfully complete them, the need to implement Construction Project Management methodologies and techniques was required. According to [Swarup ; Dawar, 2012] over a period of 10 years, India's construction output will continue to be among the fastest-growing countries.

If globally the construction market is expected to reach 5.1% and 4.7% growth during 2010-2015 and respectively 2015-2020, India's sector will supposedly reach staggering numbers of 9.9% and 7.6% during the same periods [Ahuja, Vanita; Kumari, Savita; 2013].

2.Indian construction industry and its main challenges

There are several important issues with which the construction industry is battling. But let's dig deeper on what is the most important issue in the construction industry in India.

According to [Auti, Atul; Skitmore, Martin; 2008], the construction industry in India is inefficient and highly resistant to change. Even though project management seems to hold all the answers in regard to raising the industry standards, by using the right techniques, little is known of how much the term 'project management' is extended as a discipline in India [Ahuja, Vanita; Kumari, Savita; 2013].

Regardless of the expertise on project management among the consultants within the Indian construction industry, a study which was conducted in early 2007, interviewing more than 150 participants and organizations, is showing that, when project management must be put in practice, many obstacles have to be passed [Auti, Atul; Skitmore, Martin; 2008]. A particular issue which was recognized by many companies is the lack of encouragement from the construction management. Another difference was observed between the private and public sector, claiming that project management is a feasible practice, but only within the private sector and under no circumstance in the public one. The major difference between these two sectors are the government policies such as project's poor execution, compromises on quality, personal interests and mostly, corruption. A large majority of respondents agreed over the fact that the construction industry lacks a pattern and project management can provide the needed structure [Auti, Atul; Skitmore, Martin; 2008].

When trying to implement project management during the development of a project, there are different challenges, while trying to balance all the involved elements such as people, money and scope. According to the [villanovau.com], the main challenges when implementing project management are the inadequate skills for the project development, as well as the lack of accountability. Project management training could be the solution for gaining the right competencies, when the staff and the available workers do not possess the required skills. All the involved parties must take responsibility in order to avoid unproductive project development. A good project manager could help their team to achieve the desired goals, in order for the project to succeed.

What is the most acute problem when it comes to India's construction industry? According to [Koehn; Ganapathiraju 1996: PRD31], the construction industry in India has been and still is, very labor-intensive. The Indian construction industry has experienced very few technological advancements.

According to [Ahuja, Vanita; 2007] project management methodologies must be adopted at an industry level, due to fast-growing competition within the construction sector, having a deep understanding of the customer needs.

While conducting their research, Koehn and Jagushte (2005) [Auti, Atul; Skitmore, Martin; 2008] were bringing into attention the different challenges which the industry is facing. They have discussed a technological upgrade for faster construction, as well as quality and cost reduction; the use of modern equipment was also brought into the discussion. Their findings are focused on modern management practices, increased technical skills as well as financial strengths. In order to be competitive in the international market, organizational competencies are needed to meet domestic and international standards. Every day, projects are reported as failing due to problems which are including high cost, over time and low-quality performance. According to Iyer and Jha, who conducted a research in 2005, to find out about the quality of the delivered end-product, they found out that more than 40% of the projects have been reported as being delivered in a low quality [Auti, Atul; Skitmore, Martin; 2008].

2.1 Problem statement

All over the world, the construction industry is blooming every day, and new construction techniques are constantly brought to the market. Companies must prepare their business to stand out in the pool of construction industry. Given the saturated market, competition has never been fiercer. Nowadays, companies must take difficult decisions in order to put themselves above the competition, regarding employment and their employee's safety, technology, investing in better and cheaper insurance policies, as well as taking into consideration their impact on the environment.

Different countries have their own approach when it comes to the construction industry and project management. This thesis will focus mainly on the Danish and Indian construction sector, thus other countries will be mentioned as well, in order to have a broader view of the different problems and techniques used.

In order to find out how different the thinking in Denmark and India is regarding the development of construction industry, an analysis will be made to find out how the Indian construction sector could learn from the danish one, and vice-versa.

With regard to the future analysis of the construction industry development, the following problem statement has been chosen: 'Could the Indian construction industry learn from the Danish construction industry and how these different approaches could help India's development?'

In order to find out what India could learn from Denmark; we have to take a look at the history within the Danish construction sector.

How did Denmark improve its construction sector? How was the shift from a labor type of construction to a technological one? And when did it take place?

The Danish construction industry faces the same problems as most countries, such as high accident rate, low productivity, going well over the cost as well as over the schedule. According to [Bertelsen; Nielsen; 1999], since the mid-1980's, the government and industry have taken many initiatives to improve the situation, coming up with different solutions [Bertelsen, Sven; 2002].

The earliest in which the Danish building sector has experienced the first wave of industrialization was in the mid-1950's going into the 1960s [kulturarv.dk]. Behind the industrialization wave, was a political measure to increase the housing opportunities, expanding their number and making them cheaper. According to ''The institutionalization of benchmarking in the Danish construction industry by Rasmussen, Grane Mikael Gregaard; Gottlieb, Stefan Christoffer '', in order to achieve a cheaper method of construction, it was believed that the building industry must be industrialized [orbit.dtu.dk]. Along with the establishment of the Danish Building Research Institute in 1947, the first steps in reducing skilled labor such as bricklayers, were taken. Between the 1950's and 1960s experiments with new ways of construction were put in place, as well as changing some traditional materials such as brick walls with concrete walls and prefabricated elements for bathrooms and kitchens. Due to this wave, the construction industry in the 1960s exploded to a mesmerizing number of 60.000 residential units per year [Brunoro, Silvia; Andeweg, Marie; Verhoef, Leo; 2007]. This had a huge impact on man-hours/sqm. The number fell from 24 hours for a traditionally built house to 8 hours on one of the large prefabricated buildings [Bertelsen, Sven; 2002]. After 10 years, the growth ended sharply. Housing production dropped to 20.000 units /year with a focus on design and variation, according to the

customers' needs/ wants. According to [Bertelsen, 1997] ‘*'concrete elements and prefabrication was established, but increased productivity ceased to form the agenda*''. However, in 1990 industrialization and productivity hits the news again, receiving dominant attention and starting to become known internationally [Kristiansen, Kristian; Emmitt, Stephen; Bonke, Sten; 2013].

In 1999, under the governmental program '*Project House*', the Danish project sector became aware of the concept Lean Construction network. Lean Construction refers to a "*way to design production systems to minimize waste of materials, time, and effort in order to generate the maximum possible amount of value.*" [Koskela et al. 2002]. It is a combination of practical development and operational research. Lean Construction aims at faster project delivery, with lower costs during the building process. Lean Construction has a huge benefit for the working force. *"One can think of lean construction in a way similar to mesoeconomics. Lean construction draws upon the principles of project-level management and upon the principles that govern production-level management. Lean construction recognizes that any successful project undertaking will inevitably involve the interaction between project and production management."* [Abdelhamid; 2007]. Through this concept, the employment of young talents is acquired, as the concept provides a pleasant and healthy environment.

In 2001, through an initiative from the government, 'digital construction' group was established, as a form of strategy to develop the construction sector. The group's aim was to use information and communication technologies (ICT) in public construction projects, with high expectations that the private sector will acquire the same good experiences as in the public sector. Since 2001, Denmark has improved exponentially in the construction sector by developing and implementing the 'digital construction' strategy.

Considering that Denmark has grown exponentially and has improved in the aspects of the construction industry, India could follow the patterns to improvement. From the gathered data and research, it is clear, and moreover, fair to find these aspects that could direct India's focus on a more Danish oriented approach.

According to a later study conducted by Ahsan and Gunawan in 2010, comparing the development of project performance, at an international scale, they found out that, compared to China, Bangladesh and Thailand, India has the worst schedule performance, when comes about construction projects [Ahsan; Gunawan; 2010]. They

found out that India's average overrun is with 55% higher than the actual schedule, compared with the other three countries. A major reason for delays, according to Iyer and Jha (2005), is the fact that there is conflict among the project participants, ignorance and lack of knowledge [Ahsan; Gunawan; 2010].

In 1998, Kumaraswamy and Chan, examined eight factors which leads to delays and have identified them as being due to poor risk management and supervision, unprepared for different site conditions, lack of materials, laborers and equipment, slow decision making and unforeseen external factors [Kumaraswamy; Chan; 1998].

The use of ICT in the Indian construction industry is far lower than in Denmark. Globally, Denmark is one of the leading countries which uses ICT systems. According to the ICT development index, following a list of 30 countries, Denmark was ranked as number 1 in 2013, falling on the 4th spot in 2017. In comparison, India was never mentioned in the index.

According to the European Union data, 85% of the Danish population has some understanding skills when coming about computers and 42% of the population having high computer skills. Whereas, according to the NSS 575 report as shown in Table 1. [NSS 71, 2014], only 46% of Indian population with age over 14 years old can operate a computer (have some understanding skills).

Statement 6.2: Number (per 1000) of population (age 14 years and above) able to operate a computer

gender	rural				urban				rural + urban			
	age group (years)											
	14-29	30-45	46-60	60 and above	14-29	30-45	46-60	60 and above	14-29	30-45	46-60	60 and above
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
male	227	64	22	6	536	309	209	106	323	143	82	38
female	135	19	5	1	438	173	87	28	229	67	31	229
person	**183**	**41**	**14**	**3**	**489**	**243**	**148**	**68**	**278**	**105**	**56**	**24**

Table 1 Citizens able to operate a computer in India [NSS 71, 2014]

This shows the fact that Denmark is a small country, nevertheless is a technology-driven one, being quick to adapt to new technologies. The Danish government has a huge impact over this matter, as it perceives ICT as a major tool for economic development, growth as well as innovation. Moreover, comparing Denmark with India, Danish companies/people, are considered to have more access to expensive software solutions, as a result of the economic standards that are generally higher than in India.

In conclusion, we can easily see that the Danish government was more involved when it comes to industrialization and growth of the companies as well as their productivity. Unfortunately, the same cannot be said when it comes to India. The corrupt system doesn't allow for healthy growth, thus putting down / rejecting all the attempts for a better, faster, more efficient way of construction. This has a huge impact on the Indian construction industry since its development will affect most construction companies.

2.2 How does this problem affect the industry and growth?

The lack of technology in the Indian construction sector has pressing importance since is pausing the Indian industry, interrupting its evolution. Technology evolves at a fast pace and while some countries are able to keep up, unfortunately, others are suppressed from its progression, due to too much corruption and personal interests. However, evolution can be dramatic and sometimes even be disruptive. Technology is drastically changing in different areas. Globally, one area of particular importance is the solar power generation. Closely behind falls power storage, material sciences and robotics.

After the implementation of RERA (Real Estate - Regulation and Development Act 2016 on 26th March 2016) [moneycontrol.com], India's government has put an emphasis on the completion of the project in a shorter time, by adopting new technologies. From July 2017, it was mandatory that the companies were registering their projects such as commercial or residential units, under RERA. Due to the rising request for residential, commercial or even industrial projects, there is a demand for faster construction processes as well as an improvement in the quality of the end product. It is, therefore, necessary that the companies are starting to use newer technologies and materials, in order to meet the increasing demand [nbmcw.com].

The construction industry in India is at its peak of disruptive change, with more and more companies using new materials and technologies to digitize the construction process, in order to change the way of building [nbmcw.com].

By 2020, the Indian real estate market is expected to hit 120 billion Danish Kroner. The private sector is expected to contribute with about 11% to India's GDP. As previously stated, construction workers are an important contribution to the construction industry. Having an ad-hoc manner, the construction industry in India is

inefficient, lacking also the quality. Since the procurement of materials to the construction, the existing construction process is very ineffective, having a waste of materials and time of nearly 80% more than it is considered reasonable [irbnet.de]. Based on the Iyer, K. C., & Jha, K. N. (2005) "*Factors affecting cost performance: evidence from Indian construction projects*", over 40% of construction projects in India had time overrun between 1 to 252 months. By having this data, it becomes clear that one of the main issues is the lack of coordination and poor management.

The construction industry in India is booming, therefore it is a clear indicator that many investment opportunities are arising and the need for project management practices is highlighted. The fast-growing residential and commercial demand is requiring faster construction and world-class quality. Even so, the construction method is still ancient, using manpower/labor, instead of machine/technology. Even though a part of India is trying to adhere to new technologies, making the work easier, faster and more efficient in terms of time and budget, most parts, are still using enormous machines to move boulders and concrete pillars.

2.3 Problem Analysis

2.3.1 Cultural differences

This chapter has been written in order to dig deeper into the different approaches between the Danish construction system and Indian one, regarding technology and industrialization, as these issues are the most important when it comes to industrial development. Later on, this chapter will be used in making an analysis of how the situation could be avoided.

Since 2010, the construction industry in Denmark has been on the revitalization path, being aligned with the economy's overall improvement [Mortensen, Kristiansen, Kanstrup-Clausen, Jessen, Rohde, n.d]. Between 2010-2016, the housing market has improved considerably, having an increase of 15,5% in housing prices for dwellings. The number of residential constructions has also increased. The strategy 'Road to energy-efficient buildings in the Denmark of the future', finances renovations of buildings which have as a plan the better use of energy [ec.europa.eu, 2014]. However, due to a fragmented value chain and many restrictive regulations regarding the environment, there are still problems with the low productivity (which has been recognized by the Productivity Commission – Produktivitetskommision, as well as the European Commission), which affects the competitiveness in the industry.

On the other side of the globe, in India, the construction sector witnesses growth prospects for the past five decades [en.wikipedia.org], but there is a pressure on the efficient and effective building system. The construction industry in India is responsible for the majority of the national economic and social growth [irbnet.de]. Even so, the industry has many issues, which are slowing the efficient growth prospects. The major problems in the industry are due to lack of commitment, poor site management and coordination, unprofessional planning, lack of communication and others [Hemanta, Doloi; Sawhey, Anil; Iyer, K.C; Rentala, Sameer; 2011]. Every day, construction projects are facing delays. Due to the increased demands, India's construction sector must change its ways, and improve the system. There is a need for a systematic approach, in order to avoid the delays and develop a clear understanding of the project between all the parties involved in the project [Hemanta, Doloi; Sawhey, Anil; Iyer, K.C; Rentala, Sameer; 2011].

If we take a look at Denmark, the situation does not differ much from the Indian one. For example, within the Danish construction sector, many have heard about BIM (Building Information Modelling) but in reality, not many can fully comprehend its power and what BIM involves. Even though the BIM terminology is widely spread in Denmark and many talked about it, its full powers are rarely used during the project's execution phase. Despite the fact that the Danish construction industry is thought about as being in good communication with technology, that is not always the case. In most of the projects, BIM model dies before the execution of construction even begins. This happens because the industry doesn't have the right knowledge and education regarding the use of BIM in the construction process. By combining BIM with LIDAR technology (which creates a high-quality 3D image), the quality of the project is improved and is also less time-consuming.

According to industry reports, it is shown that construction companies are slow in adopting new technologies. Even in Denmark, many companies still rely on paper when it comes to completing a process and this, in most of the times, delays the project and increases its cost. According to [Agarwal and co. 2016 "The digital future of construction"], '*'The industry needs to change",* the report reveals the fact that R&D (Research and Development) departments choose to spend money on incremental innovation, rather than taking radical steps for shaping and improving the construction industry. This is done even though the industry lacks productivity growth and low financial returns. As a result of the construction projects getting larger and more

complex, incremental innovation will no longer do the trick. There is a growing demand for environmentally friendly constructions, which means that the traditional way of a building must change in the near future [Agarwal and co. 2016]. Denmark is facing the same problem as India's construction sector. Lack of skilled labor as well as supervisory staff, which will only get worse. Since these are issues which shouldn't get overlooked, the system requires new ways of thinking.

Due to the high project demands in India, the construction industry is trying to push harder for a new disruptive era. The technology is slowly integrated into India's construction industry along with all the latest demands. New materials, software and building technology are tried daily. Digitalization era and artificial intelligence are steadily infiltrating, changing the way India's construction sector conceptualizes and builds slowly. The changes are related mainly to the speed and efficiency of the construction process with the help of software and machinery.

Every day, private developers are exploring new technologies which are helping upgrading buildings strength, quality and safety. These technologies offer advantages such as more durability, increased productivity and lower maintenance.

This is obviously understandable, since the government is trying to reduce the unemployment rate as low as possible, maximizing the employment opportunities [Auti, Atul; Skitmore, Martin; 2008]. Every year, the construction industry in India employs over 41 million people [Swarup, 2012], which is 17% of the working population. The numbers are increasing with over 1 million every year. This working-class contributes with 5.7% of the total GDP [Chiang et al 2005]. The industry constitutes over 40% of the investment in India [Ranavive, Gaikward 2006].

Unfortunately, even though it is such a prosperous working branch, 25% of its workers received their training, mostly, from their parents. Moreover, the literacy level was low, which means that the workers needed retraining to have a well-rounded knowledge of the construction trade which they follow [Koehn et al. 2000]. This results in simple and easy to understand construction techniques, which have been present for many years already. According to [Koehn et al. 2000], most accidents in the Indian construction industry are occurring due to the poor education and training, as well as ignorance from the management staff and workers.

There are new technologically breakthrough solutions, which can be easily implemented during the working process [for more information read Appendix B] so that the process can be followed by every person involved in the project.

2.3.2 Differences in the organization and workforce

As it was mentioned earlier, the construction industry in India is booming. So, what is Denmark doing in its construction industry, that India could learn and maybe apply there?

In 2014, the EU gave a directive that the Building Information Modelling should be implemented by the companies, as a criterion for the award of public contracts. On 15th of December 2015, the Federal Ministry of Transport and Digital Infrastructure in Germany started implementing the directive, and makes BIM compulsory for public infrastructure projects, as of 2020. Already, as of 2019, similar rules are applying in Denmark.

During the Construction Technology India – 2019 Expo-cum-conference on the 2nd of March, the prime minister Narendra Modi mentioned that the year 2020, will be the year of construction technology. He announced that in June 2019, the project called 'live laboratories' will be implemented, meaning that almost 1000 houses in six cities across the country, will be built only with low-cost, sustainable, and disaster-resistant innovative technologies. The six cities are Lucknow, Chennai, Ranchi, Agartala, Rajkot and Indore. The project will be developed in close collaboration with ASHA -India (Affordable Sustainable Housing Accelerator), which will offer training, mentorship and acceleration guidance in order to make them ready for the market. During the same event, Mr Durga Shanker Mishra announced that 32 new technologies which were evaluated by the Technical Evaluation Committee (TEC) from 25 countries will be used. The plan is to extend the project outside those six cities.

After the survey from 2007, there is an indication that changes in terms of quality and standards are happening in the construction industry. This can be possible because there are knowledge and understanding regarding project management, its methods and benefits, and if used, how project management can improve standards. Even though the concept and design phases are receiving more attention than the actual construction phase and the termination of the project, this has a tendency to change with the new implementation of the technology. It is clearly understood that the clients, stakeholders, as well as the end-user, will appreciate if the project management as a tool will be more implemented / widespread.

Moreover, another reason why productivity is so low, according to the Danish Association of Building Experts, Managers and Surveyors [Konstruktor Foreningen], could be the fact that accessing financing it proved itself to be quite difficult, as well as

the unwillingness of companies to invest in new technologies such as BIM (Building Information Modelling). Due to this issue, the government launched the strategy 'Towards a stronger construction sector in Denmark', which aims to strengthen the productivity and increase the employment in the construction industry sector [European Construction Sector Observatory, 2018].

- 34 Initiatives - *Towards a stronger construction sector in Denmark*

A. Quality in the regulation of construction

1. Simplification of regulation on the construction site (simplifying construction regulations - The Minister for Climate, Energy and Building ensures that inter-ministerial work will be initiated to look at possibilities for regulatory simplifications in the regulation of construction, including other legislation that affects the construction of construction and to present a comprehensive simplification package).
2. Simplified fire control (The Minister for Climate, Energy and Building initiates a thorough review of the regulation in the field of fire in order to clarify uncertainties, made the fire requirements more accessible and easier to manage and on the whole make the regulation more intelligent).
3. Service goals for construction case management (The government will reduce the processing time on construction cases by 1/3 in 2016. This must be done by setting maximum processing times for construction cases).
4. Professionalization of the technical construction case management (The Minister for Climate, Energy and Building Minister, in collaboration with the Minister of Finance and the Interior in the spring of 2015, will present an idea catalog for the professionalization of the technical construction case, based on analyzes of models for the collection of the technical construction case agreement under the agreement on a growth package 2014. models for assembling the technical construction case processing into one or more larger units).
5. Modernization of the building damage insurance scheme (The Minister for Climate, Energy and Building will, in collaboration with the construction parties, look at the possibilities of simplifying and lowering the mandatory building damage insurance, which typically the professional builder must take out for the benefit of the consumer who wants to build a new home).

6. Better indoor mobile coverage by information on the influence of building materials on mobile signals (The Minister for Business and Growth, together with the Minister for Climate and Energy, will ensure that a working group is set up to identify various possible solutions to remedy poor or lack of mobile coverage in buildings).

B. Strengthened competition in the construction

7. Action against social dumping in construction (The Government is continuously implementing ambitious efforts to help prevent social dumping in Danish construction)
8. Increased harmonization of Danish standards and removal of national requirements in legislation (The Minister for Climate and Energy will ensure that a review of building legislation is carried out with a view to ensuring the greatest possible harmonization with regulations in our neighbouring countries as well as removing unnecessary Danish standards and regulatory requirements)
9. 9. Modernization for Approval of Drinking Water Scheme (The Minister for Climate and Energy will ensure that the approved scheme for construction products in contact with drinking water in 2015 is modernized in order that the scheme can as far as possible be coordinated with similar schemes in other EU countries)
10. Competitive analysis of the building materials market (The Minister for Business and Growth ensures that the potential for more direct trade and barriers to direct trade between producers and exporting companies is investigated and that voluntary labelling schemes can contribute to costly construction. Based on the studies, a number of recommendations are made for the industry)
11. Revision of the Danish agreement system (The Minister for Climate and Energy is initiating a committee work that will result in a revision of the Danish contract system in the field of construction. In the audit work, among others, the Danish agreement system can be made more internationally recognizable)
12. Overview of major construction tasks (In collaboration with the Builders' Association and Realdania, the Government will prepare an overall ongoing overview of major planned construction projects. In this context, the Government will take the initiative to improve coordination of larger buildings across the public sector, so that as far as possible, many large public construction projects are being offered at the same time. A dialogue is initiated

with KL and the Danish Regions with a view to including larger regional and municipal construction tasks in the overview).

13. Dialogue forum between public developers and the industry, regarding large projects (The Minister for Climate and Energy has ensured that a temporary and informal dialogue forum has been set up in which the public developers, together with the actors, can discuss the market situation in the construction industry with a view of preparing the public builders to meet the market requirements during the tender).
14. Guidance to municipalities on effective competition (The Minister for Business and Growth ensures that guidance is carried out to increase the municipalities' focus on the financial gains that can be achieved by ensuring effective competition in the procurement of public buildings, including avoiding being cheated by a cartel).
15. Analysis of the Offering Act (The Minister for Business and Growth ensures that an analysis of the competitive effects of the provisions of the Tendering Act is made in section 1 of the Act on works contracts. The analysis will, among other things, focus on the anti-competitive rules on restrictions on the number of bidders, as stipulated in section 1 of the Act)

C. Effective public construction

16. Increased use of flexible tendering in the public sector (The Minister for Climate, Energy and Building will select and run a series of test projects which will be tendered according to flexible tendering in order to gain experience with this and to contribute to a cheaper and more innovative construction. Based on the experience of the test projects, the possibilities to prepare guidance and information material for use by other government builders as well as municipalities and regions are assessed in their future use of the flexible tender law forms)
17. Guidance on the extension of the procurement law (The Minister for Business and Growth will, following the adoption of the Procurement Act, carry out a guidance effort on the new rules. In this connection, a sector-specific guidance effort will be launched in collaboration with the Minister for Climate, Energy and Building, aimed at the construction of early dialogue and flexible tendering)
18. Reduction of tender costs for tenders in construction (The Minister for Climate, Energy and Building, together with the Minister for Business and Growth, will

ensure that guidelines are developed in collaboration with the industry, which will help to reduce the cost of procurement in the construction industry)

19. Evaluation of Public Construction Law (The Minister for Climate, Energy and Building will carry out an evaluation of the Public Works Act to assess whether all parts of the special regulation on public construction should continue to apply, or whether there are any rules that can be advantageously simplified or repealed)
20. Follow-up on evaluation of key figures for state and general construction (The Minister for Climate, Energy and Building, together with the Minister for City, Housing and Rural Affairs, will ensure that, as a follow-up to the evaluation of the key figures system, it is assessed whether the system meets the main objective of promoting quality and efficiency in construction by using key figures)
21. Analysis of OPP's financial advantage (The Government will ensure that an analysis is carried out focusing on when PPP - public-private partnership, can be economically advantageous. The analysis should focus on total economic benefits, including financing, efficiency gains, risk sharing, project sizes and distribution between plant and operation, technology, complexity and innovation, and competitive conditions)
22. Analysis and presentation of models for coordination and streamlining of municipal construction tasks (From autumn 2014, the Government will carry out an analysis of the economic potential by coordinating public tenders and professionalizing the municipality as a public building with a view to presenting possible models in spring 2015 for common solutions across municipalities, taking into account local self-determination)
23. Efficient property management in the municipalities (The Minister of Finance and the Interior, together with the Minister of Finance and KL, have initiated a benchmarking analysis of the municipalities' property administration. The purpose of the analysis is to provide knowledge on the most appropriate organization of the municipality's property administration)
24. Analysis of the potential of a further compilation of the builder task? (The Minister for Climate, Energy and Building initiates an analysis of the potential of a further gathering of the building task of the Danish Building Authority)

D. Growth across the value chain

25. Construction Growth Summit (The Minister for Climate, Energy and Building will take initiative to meet authorities and the construction industry at an annual summit, which jointly discusses the building's challenges and solutions)
26. Support for export of Danish building solutions to China (In 2012, the Ministry of Climate, Energy and Building signed a cooperation agreement with the Chinese Ministry of Housing on energy efficiency in buildings. The agreement is one of several agreements with the Chinese authorities, where the long-term goal of the cooperation is to promote CO2 reductions in China by focusing on renewable energy and energy efficiency, including energy efficiency in buildings through the exchange of knowledge between Denmark and China)
27. The better working environment in construction (The Minister of Employment is making extensive efforts to ensure a better working environment in the construction industry. The effort contributes to increased efficiency and productivity in the construction industry)
28. More knowledge regarding the working environment in higher education and civil engineering (The Minister of Employment will establish a dialogue forum to discuss opportunities for higher education in construction and civil engineering to increase knowledge of how construction projects are planned so that serious work accidents and attrition during the construction process are prevented)
29. Visibility of architecture's value creation (The Minister of Culture is undertaking a project to uncover the value creation of architecture and to search for value chains in the construction industry from various points of view)

E. Sustainable construction

30. Voluntary Sustainability Class (The Minister for Climate, Energy and Building ensures that a voluntary sustainability class is developed, which will act as a unified "official" sustainability tool. The class must provide the builders who want to build sustainable construction, the tools to do so)
31. Guidance efforts in the field of sustainability (The Minister for Climate, Energy and Building is launching a Sustainability Package with a number of guidelines and instructions on how to build sustainable construction, including the development of widely recognized tools for calculating total economy (LCC) and the environmental impact of building products and buildings (LCA). prepared in collaboration with relevant authorities to ensure consistency across regulation and efforts)

32. Taskforce for sustainable building materials (The Minister for Climate, Energy and Building sets up a task force by implementing the Building Products Regulation's requirements for sustainable building products and ensuring the greatest possible Danish influence on the process)
33. Coordinated efforts for the recycling of bricks and other building materials (The Minister for Climate, Energy and Building, the Minister for the Environment and the Minister for City, Housing and Rural Affairs will set up a team to work on promoting the recycling of construction products. A pilot project will be carried out looking at the possibility of recycling bricks. The experience is then intended to be disseminated to other building materials. The work is coordinated with the Sustainable Building Materials Task Force)
34. Catalogue of inspiration for recycling and transformation of cultural heritage in the municipalities (The Minister of Culture initiates the preparation of a sample catalogue that will inspire the municipalities in their work to recycle and transform existing cultural heritage.)

- Measures by Indian Government

In contrast to the Danish initiatives, the Indian government has also started different strategies, such as smart cities and housing for all, these are mainly focused on developing the Indian infrastructure from the current 31% to 50% by the year 2050 [Indian service sector, 2019]. However, the key focus isn't on the people and their issues faced in the construction industry as in Denmark. On top of that, India is the positioned 2nd in the overall foreign direct investment, which is mainly focusing on the development of the infrastructure.

The Indian government had come up with a plan of building around 50 million houses- both urban homes and rural homes by the year 2022, which would lead to an increase in job opportunities and infrastructure of India. But with respect towards construction management, Indian infrastructure and service department should learn from the Danish initiatives on how their strategy is placed by collaborating with 20 ministries in order to assist construction management in every aspect and should start focusing more on aiding the construction industry through initiatives which might increase their performance.

If in Denmark, in 2008 there were 16,227 building permits issued, in 2018, there were 24,386 [Elmeskov, 2017]. The growth of the Danish construction industry is rising due to the large-scale infrastructure investments and is expected to continue growing for

the upcoming years. Being a leader in eco-innovation and sustainable construction, Denmark has a variety of funding schemes for development of new, eco-friendly and sustainable construction projects, which are using the energy in an efficient way [Mortensen, Kristiansen, Kanstrup-Clausen, Jessen, Rohde, n.d].

Even though in 2009, due to the economic crisis, Denmark has also faced a decline in the demand for new buildings, its economy has recovered [Economic Forecast, 2009]. Since then, the government has taken many initiatives, creating different campaigns in order to help the construction industry sector. A very important strategy is 'Denmark without waste II', in which the government is dedicated to making it easier for companies to recycle and reuse building components such as walls or floor segments. Due to this initiative, Denmark has reached a recycling rate of 87%, positively contributing to the environment [eng.mst.dk].

2.3.3 Difference in practices

After learning about the best tools which, if used, will help tremendously the construction industry, let us dig deeper and check if Denmark or India are using some of them, and if so, what could the Indian sector learn from the Danish one and vice

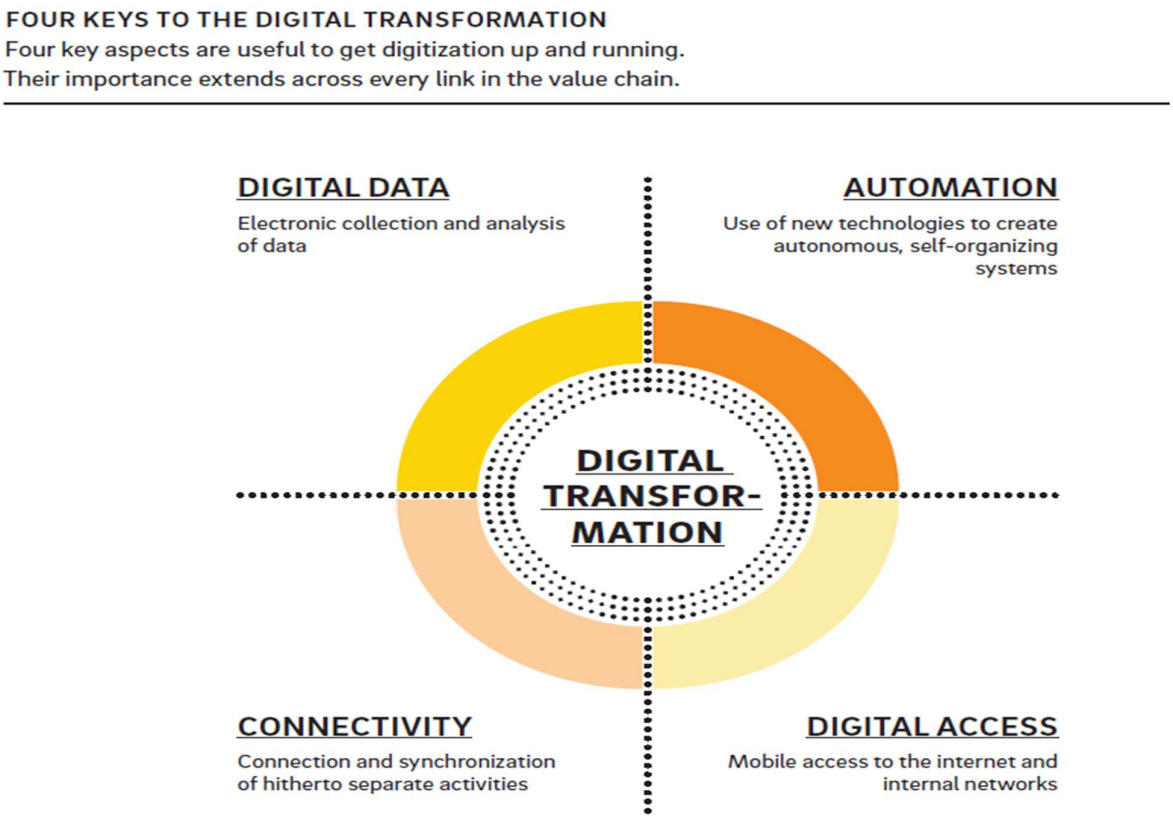

Figure 1 Digital Transformation [Berger, 2016]

versa. It is not a hidden secret that innovation plays an important role when comes about evolving.

It has a great impact on business development and on lives. In 2016, Roland Berger (a leading global consulting company founded in 1967) conducted a survey with 250 companies, in order to find out the degree of digital implementation in different companies. As shown in Figure 1. [Berger, 2016], they split the potential of digitalization into four key areas: digital data, automation, digital access and connectivity. Digital data combines all the electronic collection and analysis of data and automation is all about the use of new technology in order to create an autonomous, self-organizing system.

Digital access includes all the mobile access to the internet, internal network and connectivity resume at the connection and synchronization of separate activities.

Globally, in the 21st century, the construction industry is still struggling to be effective and that is not a secret. Even Denmark, which is considered as being one of the leading countries when comes about construction automatization, has some areas which are dealing with problems. Even though Denmark is making huge efforts in investing for its people's everyday life improvement by paying the extensive amount of money for the construction of kindergartens, nursing homes, schools and even

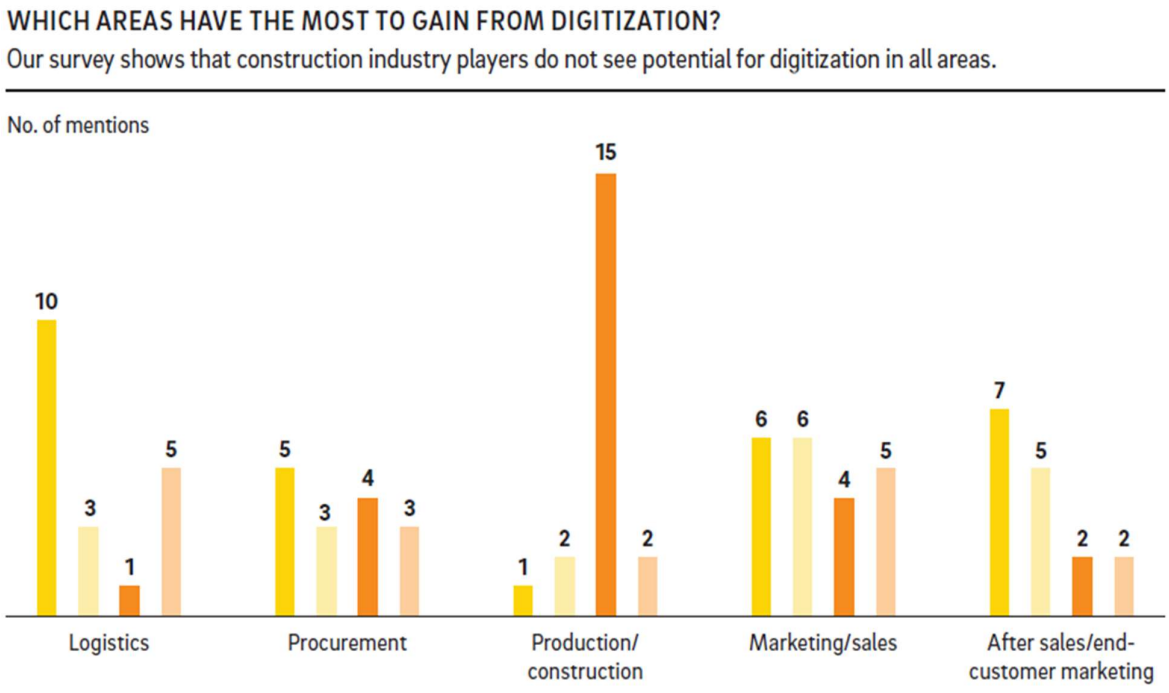

Figure 2 Which areas have the most to gain from digitization? [Berger, 2016]

roads, it can be a difficult process to track down and control what is happening on every construction site.

Figure 2. [Berger, 2016] above shows the results of the survey conducted in 2016 by Roland Berger, trying to find out more about digitalization in different construction companies. The result is that most companies feel the need for digitization within the production/construction sector having a total score of 15 points. Close behind is the logistics sector, with a total of 10 points.

There are major struggles which the construction industry is confronting, Denmark and India are no exceptions. One of the most important problems is broken communication. Miscommunication is a considerable problem during the construction project, which leads to many delays (which is an outcome of bad communication and data inefficiency) and mistakes. Since crucial updates and information are reaching the project managers late, the entire project is sometimes stopped or even mistaken.

When the project is facing delays, automatically more resources are required for a project to get done in time. This uncontrollable situation harms dramatically the whole construction process because they are limiting the project's quality.

Even though Denmark, like the rest of the world, is facing the same problems mentioned anterior, it tries to rise above them. Slagelse Municipality has adopted a

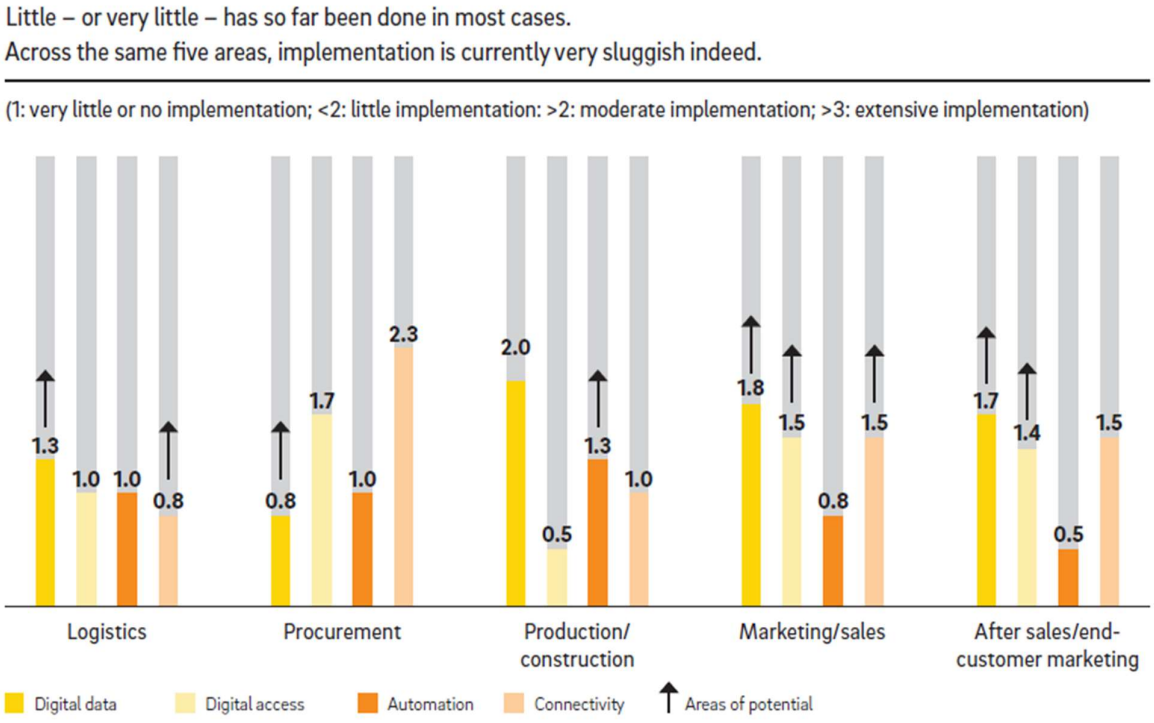

Figure 3 Level of implementation of digitization [Berger, 2016]

digital tool named Geniebelt, which improved the communication among team members, shared their responsibilities, streamlined the workforce and gave fact-based decisions. According to Henrik Sørensen, department manager of the contractor consulting services at DanskeKommuner, it appears that the users are pleased with the choice: “The digital tool, GenieBelt, has been a huge success." Using this software, allowed everyone involved in the project to easily monitor the entire construction process, in real-life. ‘‘We can sit and track what is actually going on out there. It provides transparency, and you can’t – as in a regular construction project – hide and blame someone else, if anything goes wrong. From what the workers have reported, we can immediately see if, or what problems there are. And if they have been handled’’. - Henrik Sørensen Using this software, Slagelse Municipality has not only seen an improvement in the dynamics between workers and contractors, but also an improvement in the construction process which has been considerably accelerated.

In the same survey mentioned above, conducted by Roland Berger, Figure 3. [Berger, 2016] illustrates the degree to which digitalization has already been implemented in the same five areas: Logistics, Procurement, Production / Construction, Marketing/sales and after-sales / end-customer marketing. It is clearly visible that in the production/construction sector, the digital implementation is very little or is not implemented with a score of 0.5 for the digital access and 1.0 for connectivity, with an area for the potential within the automation of the construction processes.

India could take an example from Denmark and try to extend its population knowledge regarding project management tools, as well as implementing more software to facilitate the construction phase and communication among the people involved in the project. As Denmark is taking measures by legally implementing BIM in their infrastructure projects, India should do the same. It is very clear that the industry is aware of the importance towards digitalization, now, is just a matter of implementation. It is very surprising that implementation takes so long, taking into consideration that the productivity in the construction industry is low.

Denmark is already using some of the planning techniques which will be mentioned further on and is just a matter of time until India should start doing the same if they are planning to keep up with all the demanding upcoming projects. Further on, these are some of the most known planning techniques for construction projects:

a. Gantt Chart was developed in 1917, but it wasn’t so complex as it is today. Nowadays, is a popular tool used by project managers because it tracks both time and

independent tasks, showing the phases of a project, milestones and resources needed. It was used for the first time in 1931 during America's Hoover Dam project. Nowadays, the overall look is represented by horizontal bar charts, with each bar representing a phase and its duration.

b. Logic Network, as the name implies, shows a logical sequence of the activities which are following or precedes another one. It is usually used to identify the problems on the path of a project. It helps project managers to understand the workflow and the timescale of their project. The information which sometimes may be overlooked can be revealed using this tool.

c. PERT Chart also is known as The Program Evaluation and Review Technique was first developed in 1958 by the United States Department of Defense's US Navy Special Project Office. This tool is used to analyze the time each task takes in a given project and to identify the minimum amount of time for the completion of the project.

d. Product Breakdown Structure (PBS) helps breakdown the work structure of a project and to clarify what the outcome of the project should be.

e. Work Breakdown Structure (WBS) unlike Product Breakdown Structure, besides breaking down the structure of the project, WBS allows assigning people for each task, making a total cost of the project and schedule each task involved in the project.

If we are taking a look at how India's construction industry could improve, and taking into consideration that technology such as augmented reality; 3D scanning, modelling and printing; Building Information Modelling; all have reached the maturity phase, it is safe to assume that, if the industry will adhere to a more technological way of construction, by adopting these innovations, companies will enhance the quality and safety of the project, as well as boosting their productivity.

Compared to India, a big part of the Danish research was financed by the government, as well as other organizations and associations, which collaborated in their research projects. Whereas in India, most of the research has been conducted by enthusiasts, learning through their own initiative, lacking governmental support.

2.4 Sub-conclusion

The Danish and the Indian firms are unique and diverse in their own ways, having their own advantages and disadvantages. It is clearly visible how a developed country is perceiving a problem and how it tackles it, in regards to construction management.

Compared to India, in Denmark, not only do the construction firms take initiatives for solving a problem, but the government also focuses on the roots of different issues, to further reduce the occurrence of the problem. In India, the government focuses mostly on taking initiatives based on the problems, but not on the cause of the problem.

The study above also provides a good understanding that the Danish firms are digitally mature in terms of their construction management techniques, while India on the other hand, has been facing a lot of issues to cross over its traditional boundaries and move towards the current technologies. Despite their fundamental differences between the two countries, the issues faced regarding the construction management are similar. However, the Danish firm's approach towards the problems, can be adopted by the Indian firms to gain better results. Especially within the area of project management, the Indian construction industry can learn to be more willing to adopt new technologies. So, let’s see how digital project management tools can impact construction management practices in India.

3. Design Statement: How can the Indian construction industry become more digitally mature with their use of project management technology?

3.1 What is project management?

According to The Project Management Institute (PMI) (2000), project management is the *"application of knowledge, skills, tools and techniques to project activities to meet project requirements"*. Because each project is unique, there is no one fits all type of project management approach. When applying project management to a certain company, it must be customized based on the company's needs, culture and projects type. Project management started to emerge as a profession in the mid-20th century when the guide ''PMI's *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)*'' has been released and project management processes were broken down into its five distinct phases: initiating, planning, executing, monitoring and controlling, and lastly, closing. As a result of nobody having a clear definition of what project management truly means, each organization tried to adjust their own approach based on the company's needs. Therefore, nowadays there are seven most commonly used project management approaches.

Further on I will dive on what are the benefits of owning a project management software.

1. *Task and project creation.* Most of the times, the construction project differs in size and needs. This means that the software should be able to create unique tasks and phases for each project. Some other times, software will be asked to create a cyclical project but also templated ones. The flexibility of juggling between the two ensures that a project manager will be able to work on different types of projects.
2. *Simple and efficient reporting.* Most of the available software on the market can make accurate reports when the budget for a project has blown up. Good software will be able to pinpoint where most of the spending went and what has caused the problem.
3. *File sharing options.* The option for storing all the files which were shared for the whole length of a project is usually looked for. It is a plus point if the software offers

the option to share the files on a third-party storage solution like Dropbox (cloud-based file hosting service).

4. *Intuitive and clean user interface.* Having a clean user interface sometimes is a make or break decision for the management. This feature is sometimes more important than what the tool can actually do.

5. *Reliable support.* Customer support is an important benefit to have when buying a project management software.

[For more information regarding project management and the processes involved, see appendix B]

The project management skill is a vast one, because it allows you to predict the cash flow requirements, profitability, as well as the maturity level. All these techniques need to be used in a project, because without the project management model, one is not able to define what are the risks, which ones should be covered first, the method to tackle those, and what would be the damage caused to the project, if those risks are not understood. The work breakdown structure (WBS) gives a complete list of the required materials when they should be purchased, and their cost, as well as giving an insight whether the purchase is aligned with the project scope, or if there is any deviation. This is a powerful insight because any kind of deviation will affect the final cost and using the project management skills will help control the cost. With the help of the tools mentioned below, the outcome of the project is a more systematic one, giving a systematic result, making all the stakeholders happy.

In order to have a clear working schedule that includes the whole process from the design to construction and finally to handing in the building, it is essential that the Project Manager keeps track of the entire process. This thing could be better attained by dividing the process and using management tools.

When talking about project management in construction, this process is divided into five subcategories.

a. Site selection and landscaping

Considered as being the most important step in a construction project, site selection and landscaping (if chosen and investigated properly), may solve many issues. It is not only determined for the cost and completion time but also affects the quality of the overall project. Location site dictates the material and human resources, the availability of raw material sources, availability of roads, airports, the impact which the

new building has on the environment as well as the availability of distribution electricity lines.

b. Basic Infrastructure

When developing basic infrastructure, points as *''water supply, power supply, roads and hospitals, entertainment and shopping facilities"* [Natarajan; 2003], must be kept in mind.

c. Contract Management

Contract management holds a major part in the construction project management, as everything depends on a good contract. In most cases, the main contractor is accountable for the sub-contractors and this results in delays and in a low-quality project.

d. Consultancy Services

Good advice and proper guidance must be given by consultants during the execution of the project, as they are capable of assessing the financial resources, the legal aspect and the environmental impact of the project.

e. Project Control

When developing a plan, project control must occupy an important role in the process. By developing a good project control, parameters can be measured and reported back frequently. In this way, correct decisions can be taken.

These steps, accompanied by good technical and technological tools and knowledge, could help India go on the path of digital maturity. An extensive analysis of the new developments in the project management technology has been made.

There are many ways in which the industry could improve/transform. In this section, five techniques which can improve the industry will be emphasized as shown in figure 4. [Mckinsey & company]

1. Geolocation

One of the biggest reasons for which the projects are getting delayed is the fact that geological surprises are constantly arising. This makes for a project not only to be delayed but also go over the initial budget. This will be a situation in which technology may come in handy. New techniques which are integrating 3D laser scanning with high definition photography, maybe a way to avoid this issue.

2. 5D building information modelling

The construction industry lacks a platform which extends over the full project timeline. Additionally, nowadays, project owners and contractors are using different platforms which usually don't sync with each other. Next level technology (5D building information modelling), allows all involved parties to dive into a five-dimensional representation of the physical project as well as its functional characteristics.

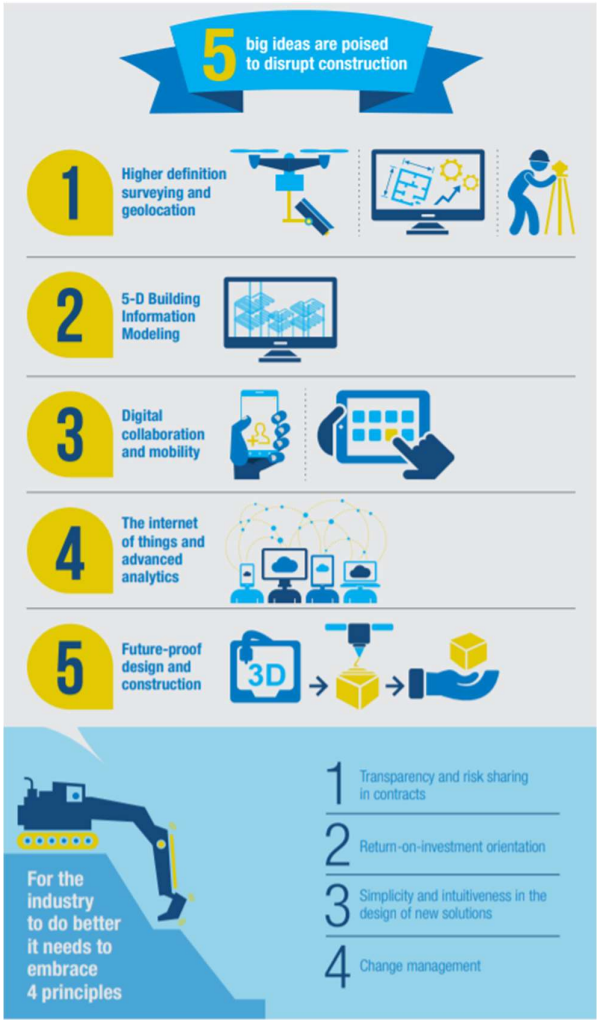

Figure 4 five techniques which can improve the industry [Mckinsey & ompany,]

3. Mobility and digitization

Another reason for poor productivity in the construction industry is the fact that people are still relying on paper for delivering blueprints, design drawings, daily progress reports and so on. Luckily, we live in an era where technology surrounds us and is easier than ever to have low-cost mobile connectivity, allowing us to share things on cloud faster than ever.

4. The internet of things

With help from the internet of things, a larger amount of data can be captured and processed. By connecting equipment with one another, through sensors and wireless technologies, data transfer and protection is faster and more secure than ever, improving efficiency and risk management.

5. Future proof design and construction

Newer ways of approaching the construction process as well as new building materials can lower the cost and speed up construction. At the same time, they are improving the project's safety and quality. Building materials are accounted for more than half of the total project cost.

6. New materials

Being still in the proof-of-concept stage, *Self-healing Concrete* has a high expectation rate. This new material is closing the cracks in concrete, using bacteria as a self-healing agent.

A cement-based material is called *Topmix Permeable* and it is in its early adoption phase. This alternative for cement can absorb up to 4.000 litres of water in just a minute.

A technologically breakthrough material which is a super-insulator and is consistent of 99,98% air, is called *Aerogel*. This product is commercially available.

Being still in the research stage, *Nanomaterials* are super-strong and ultralight materials, with the capability to replace steel reinforcement in foundation and structures. [For more information see Appendix D]

3.2 Tools, software and activities

There are several standard tools which are usually used in project management and planning. These tools are helping a project manager to divide the work properly and easier and to improve the efficiency within the production team. After a case study of the Du Telecom company (Emirates Integrated Telecommunications Company, a telecommunication company based in Dubai), the Project Management Institute concluded that the company achieved a 32% growth rate from its first four years. This growth was achieved by having very secure project management practices.

However, what are the advantages and scope of using project management software? These tools are used to keep an eye on the performance of the project, making sure that everything goes according to plan and on time. Each project must be properly and efficiently completed. Following, some of the key features a good project management software must have will be enumerated in order to help the project development in the right direction.

1. *Real-time collaboration*. On-site communication/collaboration is a major problem. Sometimes, the entire information/changes don't reach the right person. This leads to major delays with the construction process.

[For more information see appendix C]

2. *Sharing documents*. A part of real-time collaboration is the ability to share and edit documents in real-time, along with other team members, allowing for cloud storage. This means that teams and managers can upload and edit documents from remote places.

3. *Cost management*. As a project manager, one of the biggest issues in the construction industry and not only is the ability to create a clear and accurate price for the entire project. Good software should have the ability to predict cost in real-time, depending on changes in the project, as well as price changes of materials.
[For more information see appendix C]

4. *Reporting*. Having a good cost management software, won't be possible without a good reporting system, where users can change their report formats. This means it can be included just the needed information for any stage of the project.

5. *Ease of use*. Since the whole objective for having a project management software is to ease the job and make it faster, a good software means that it should be easy to use/understand and learn for all the users involved.

6. *Easier Documentation*. This feature is in connection with real-time collaboration. This means that the software must have the ability to easily document all the steps followed during a certain project. This allows for future use or re-implementation of the solutions used during a past project.

Considering the most important features a project management software must-have, it is essential to learn about some different types of project management software and how they are functioning. Mostly, the difference between them are the prices, the installation location and what is the purpose needed for the software.

1. *On-premise*. Also known as the locally-hosted project management software. These types of software are typically the ones installed in the company's servers. This means that the access is restricted only to the devices connected to that server. Two examples of this kind of software are Microsoft Project and JIRA.

2. *Cloud*-based. These types of project management software are usually hosted by cloud servers. This makes it possible for users to access the documents from everywhere, through a web browser or app (if the software has one). Two examples of cloud-based software are Asana and Wrike.

3. *Individual*. These kinds of software are for the ones in need for a light project management solution, or for those who want to learn before trying a heavier / more complex alternative. An example of individual software is Trello.

4. *Open API*. The last type of project management software is the Open Application Programming Interface which allows the users to change the interface of the software, according to the user/project needs. It is a great tool for the ones that

have found a software they like, but they want to switch the interface to fit perfectly their particular needs. Two examples of this kind of software are Trello and Clarizen.

[For more information regarding software, see Appendix A.]

On the other hand, what are the key / crucial features a software must have in order to help a project manager keep track of her/his entire project? What it should do?

1. *Project tracking.* It is self-understandable that every project management software should have as a basic function, project timeline tracking. This feature allows to check who was responsible for which task, as well as identifying their performance.
2. *Easier collaboration.* Reliable software must have this feature in order to ease the continuation of a process. Each user involved in the project must be able to check on the latest changes as well as continue where the other person has left off.
3. *Better communication*. This feature makes it easier for all the parties involved to collaborate with each other. As we saw from the previous chapter, communication is key when working on a project. A developed software must be able to allow for easier and more efficient communication between the users.
4. *Documentation*. As previously mentioned, documentation is a key part of every process. This means that the app should be capable of storing information like documentation changes and project updates.
5. *Accurate dashboards for reporting*. This is probably one of the most important features a project management software should have. The ability to accurately send reports, because this is the key component when identifying the key performance indicator. A good software should have the ability to show the state of the project in real-time.

3.3 Research and Analysis

After carefully observing the differences in the Danish and Indian industry, a questionnaire was made to understand what the difficulties are which Indian firms are facing in order to attain digital maturity. Along with a questionnaire, a few more firms were contacted to get a better understanding of their response and to learn their reason behind each response. The survey [see appendix E] was carried out digitally, in order to gather information on different types of firms and the mindset of various individuals from different companies and their techniques. This combination of data was gathered from three Indian based firms, which were targeted based on their type (f.ex. contractors - medium size firm, engineers – small-size firm, project managers of large-scale firms). The employees shared it through their network of people who they knew from various different companies.

As the term of construction management is a vast one, the query was narrowed down to a few topics which are relevant to this thesis, such as the type of the firm, the issues which the companies are facing, the size of the firm and the performance of it. In order to get a better response and honest replies, the query was carried out in an anonymous way as the first attempt was too diplomatic as everyone stated that their firm excelled in all aspects and it was hard for the study. It seemed like most of their answers were biased, maybe they were afraid to disclose how they felt regarding the performance of the firm.

The main idea behind the survey [see appendix E] was to analyze how the various companies were functioning, either traditionally or digitized or if they are aware of the current trends in the industry. The entire questionnaire was prepared in an orderly manner, directing the people from the size of the firm to more details such as the problems faced and how adaptive the people in the company are, or through asking them to rate their performance objectives. However, the survey only gave a brief structure on how different firms perform, so, the data which was collected was cross verified with experienced individuals on a general basis on why a certain person might have opted an answer along with taking into account the individuality and difference in peoples choices and opinions.

The questionnaire was shared through the network of contractors, civil engineers and interns. The contractors are working in medium-scale firms, whereas the engineers are working in either micro-scale or small-scale firms. A group of interns which are

working in large scale firms were contacted as well. The questionnaire was sent to over 100 people, out of which 59 people replied. For better understanding, all the responses collected were put into a graphical representation which was added below as figure 5. and into the [appendix E.]

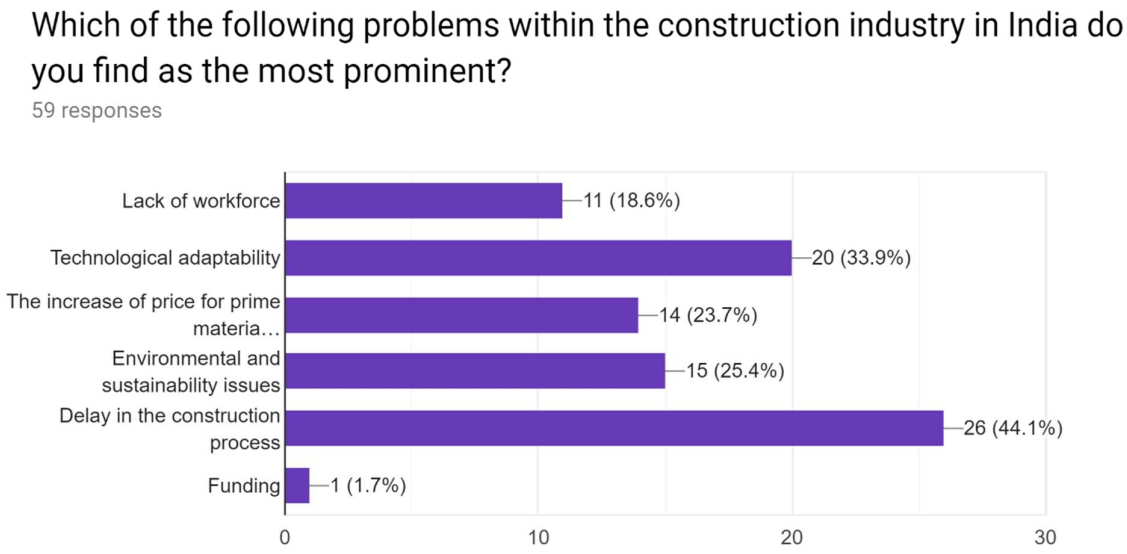

Figure 5 Problems faced in the construction industry

The group of individuals who had taken up the survey [see appendix E] was so diversified, that only 20% of them were working into large-scale firms, whereas the rest were working in small-scale, medium-scale and micro-scale industry. Moreover, the study made it clear that each type of firm had their own issues in their performance, due to resistance from both parties, either from the people in charge or from the workforce. For instance, both a large-scale firm and a newly started firm, had stated that their main barrier towards bringing new and innovative technologies inside the firm is its size. If we carefully analyze the companies, usually the large-scale firms tend to have a traditional approach, due to the fact that they worked in this way for over 25 years and they don't want to disrupt their work process, whereas a micro-scale firm is one which is taking up smaller projects where the tracking and accountability is convenient in a traditional way.

Some firms have been using a traditional process for the past few centuries, meaning that shifting their view to a more digitized way of handling the construction process, will have a disruptive impact on everyone working in the company. Based on the theory written above and with the help from the survey [see appendix E], it was found that

the adaptability of the firm and its innovation towards technology, is mainly depending on the number of employees, the size of the firm and the nature of its employees. This conclusion was based on the responses gathered from different people involved in the survey, as well as from elaborate explanation, giving a clearer picture over why different firms are deciding to opt for a traditional way of handling the construction process over a more digitized one.

According to the survey [see appendix E], 44% of the problem within the construction industry in India is due to project delay and this is caused because of either the lack of skilled labour, accountability of work, mobility or the cost. Based on the survey, the next most pressing issue is that 33.9% of the people believe that the lack of technological adaptability is one amongst the most prominent issues faced in the construction industry, and the irony is that the same people had picked ‘’NO’’ as an answer for the question ‘’Would you like to digitize your firm if it is beneficial?’’. However, this raised a lot of questions regarding the emotions of people and why they tend not to change, surprisingly an engineer stated [Duraiswamy; 2019]. According to [Duraiswamy; 2019], construction companies are the ones which constantly have difficulties to tackle the price hike, labor shortage, etc. so, as a firm, to sustain in this competition, it seeks the most familiar way to solve these issues.

The next question which had the most importance, was whether the people find the traditional methodology familiar and risk-free due to the lack of awareness in technology. Yet again, out of 59 people who had placed their responses, 30.5% of the people are working with BIM on a regular basis and 47.5% of the people knew Business Information Modelling and they have just not utilized it so far. As shown in figure 6., 44.6% of the firms have a mixed approach toward their working process in terms of traditional and software.

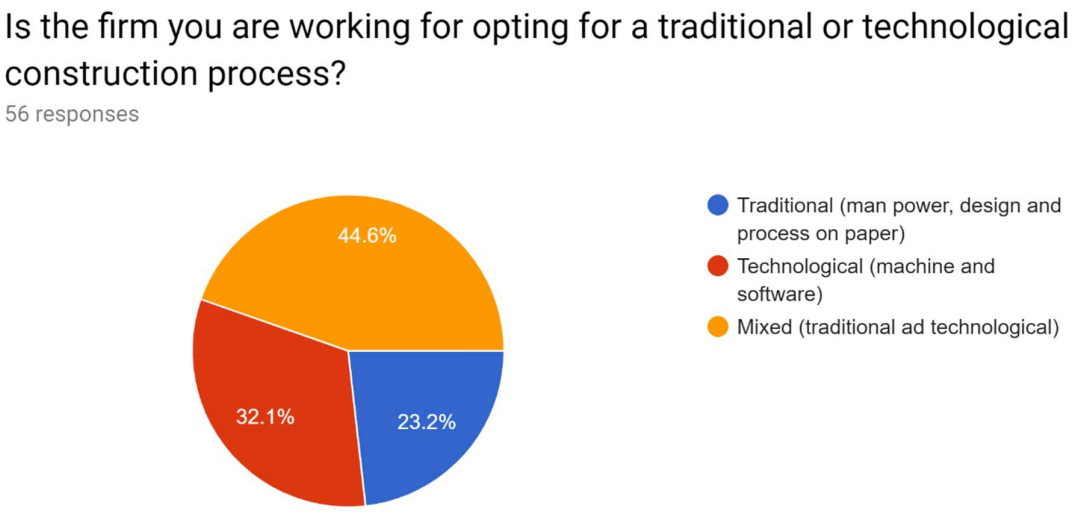

Figure 6 Choice of construction practices by firms

This data was narrowed down to the conclusion that people used technology as minimal as possible to cut down extra cost, but also considered themselves as being initiated in terms of technological development. More than 50% of the firms in India are inclined towards the traditional methodologies while they have all faced issues in cost, delays of work, accountability and tracking of the work process. Although inflation of construction materials is an unavoidable factor, the other issues can be solved through hiring more people for inspection [Senthil Kumar; 2019]. On top of that, firms which emphasize on speed, tend to have flexibility or cost as a trade-off, while companies who tend to emphasize on flexibility have speed as a tradeoff, making it hard to figure out what efficiency can be defined as.

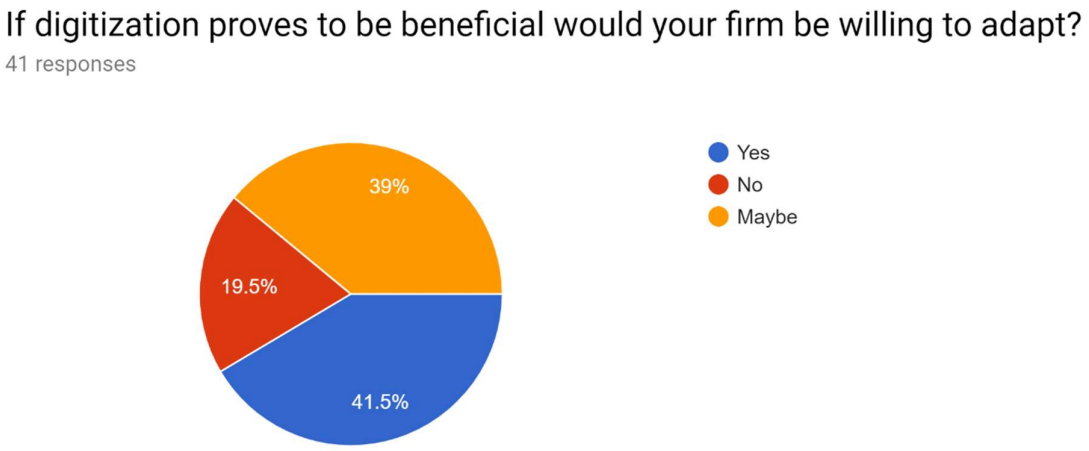

Figure 7 Obstacles in digitization for construction firms

With respect to different individuals, the term efficiency has varied. For some of the respondents, it turned out that the customer satisfaction was the most important aspect, while for others, the fast delivery of the project as well as the use of the resources was more important.

By now, it was clear that people weren't fully aware of the technological advancements and were pretty confident they have taken initiatives towards digitizing. After going through the survey as shown in figure 7. it was overwhelming to learn from people that their response as "haven't thought about it, less aware and not interested" are mainly due to the lack of knowledge on why and how digitization can be achieved and people aren't quite aware of the benefits of transparency and the other objectives.

The firms who have initiated digital project management tools were only successful in the level of off-site workers and haven't fully implemented the new technologies. Currently, in order to sustain themselves in the competition, the firms are trying to learn newer techniques. As shown in figure 8. if it proved to be beneficial, 35.6% of the respondents were willing to adopt digital construction management tools. These observations made me conclude that people would adapt to new technology, once the digitization process turns out to be a part of construction i.e. like a mandatory step or as part of the construction culture.

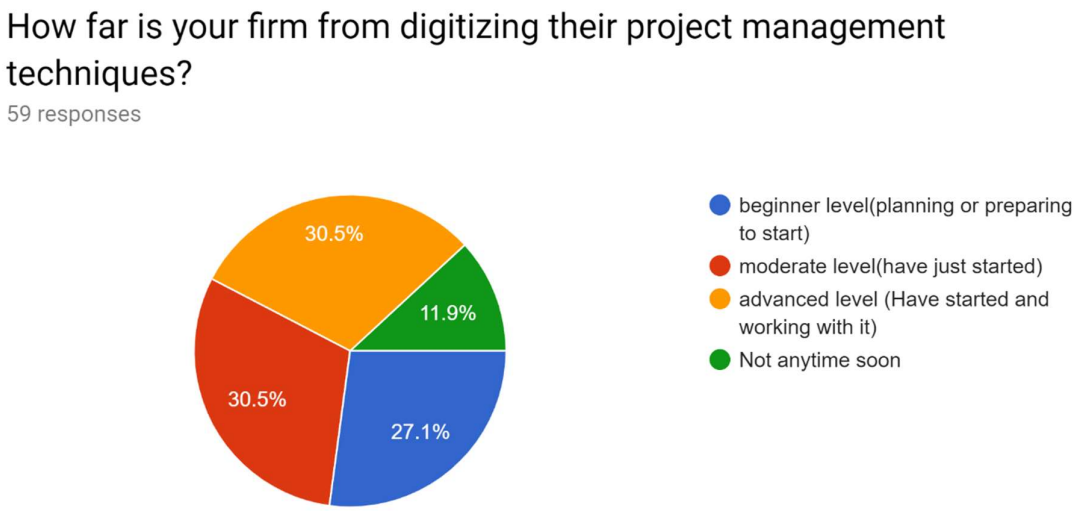

Figure 8 Level of digitization achieved by the firm

In contrast, as shown in figure 8., only 30.5% of the firms have started utilizing digital project management software and the rest have either started or planning on starting to utilize digital project management tools. Still, there are few firms (11.9%) who are not planning to turn their attention towards digitalization anytime soon, due to the firm's size or employee's resistance to change or due to the cost to set up a digitized environment. The firm size is one of the major factors that are influencing the need of change, as in the survey [see appendix E], nearly 50% of the firms are too small to start requiring a project management tool. On the other hand, firms with employees less than 50 members would be able to adapt to digitization as the transformation wouldn't be as disruptive as in very big firms. Accordingly, people who represented small-scale and medium-scale firms, have all quoted that ''*it might not be necessary but if needed, we are open-minded towards change*''. Transparency is another huge initiative, as the whole process can be tracked and monitored by everyone involved in the project. With transparency, the accountability is greater, hence, restraining people from not missing out their tasks on time. Additionally, this enables the consumer to also keep track of how the work is done and the whole cost of the process is constantly monitored and updated to reduce errors. This reduces the strain on the supervisors and the contractors, enabling them to plan accordingly, by giving them time to strategize for their current ongoing projects. According to the survey [see appendix E], 35.6% of the people are believing that the members of their firm, would be able to

adapt to current technology without having any resistance as they have already been given the basic awareness over digital management concepts.

On the other hand, 16% of the respondents are sure that their firms are too inclined towards traditional methods and decision making, so they wouldn't be able to change , while the rest of the respondents were not sure on how their colleagues might react.

Overall, the people's opinion on digital project management techniques is really optimistic, as the survey [see appendix E] states that more than 50% of the responses believe that digitizing a firm would be beneficial for all the performance objectives, such as faster response rate of the customer or speed of the provided service, project flexibility, dependability of the project deadline, cost-effectiveness which can be monitored from the start, and finally, the time to manage the whole project.

The figure 9. below shows that 67% of the respondents believe that implementation of digital project management, would be beneficial not only for the company but for the customer as well, due to having constant updates on the construction process. Project managers would be able to manage the project easier, having greater accountability, thus finishing the project faster and cheaper.

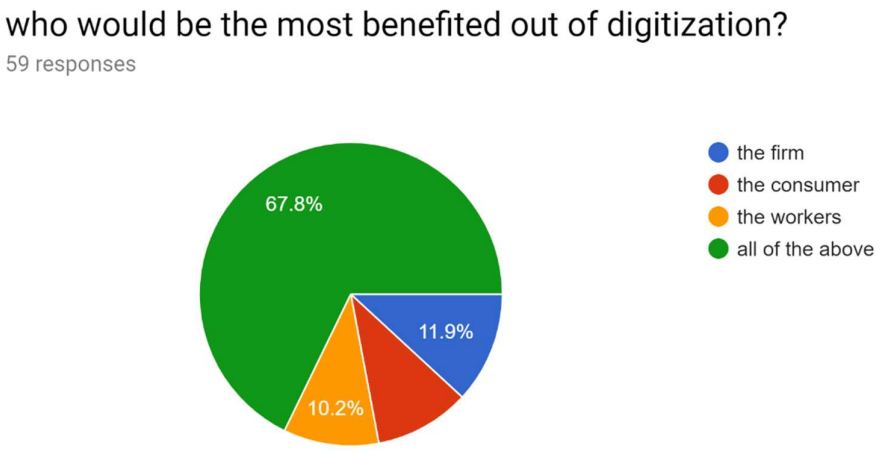

Figure 9 Benefit of digitization in terms of service

4. Epilogue

4.1 Conclusion

As we have seen earlier, the construction management is a vast topic and it's issues, if elaborated, can be written as a book, whereas we had to narrow down to our focused problems such as cost, flexibility, time, dependability, speed and quality.

The study on what the construction management techniques are and what the issues are and how the Danish industries have dealt with these issues, have provided a better understanding on how to differentiate the construction management techniques of the two different countries. Moreover, we now have an idea on how the construction management process in India can be developed, if they would like to take as an example the 34 danish initiatives regarding the development of the construction industry.

Let's go around all the factors that have been focused in this thesis and what has been derived through this study regarding the different factors. The most common answer stated by various individuals in many of their research work, was that cost was one of the major factors that affects the construction management practices in India. When it comes to cost, it is mainly due to the inflation and based on the economy of the country.

When thinking about what could India's government / indian construction firms do in order to further develop the construction industry, the initiatives taken by the danish firms, were an eye opener. The fact that the government mainly focuses on the cause of the problem, can be a fitting solution for Indian construction industry as well. The key to solving the issue, is by diverting the focus on the cause, through construction friendly initiatives for materials, mobility and authorization etc. Though the cost factor might not be solved, but it wouldn't be an obstacle to the construction sector as it used to be.

There should be an awareness program on all the current innovative construction management techniques, which would help the people to be more open minded towards innovation and change. The awareness on digital project management techniques can be taught to all the firms as their people would increase their adaptability and the resistance in a firm for digitizing would be reduced. As the Danish firms have adopted proper project management tools and practices, India's firms should follow the example, only then can better outcomes be achieved, and their firms

can slowly progress. There is no one stop all, solution for all the problems, but these are few initiatives that can enable a relentless growth in the construction industry in India despite all the other difficulties.

4.2 Reflection

Although the project has covered different aspects, there is still space for improvement. As the research work was carried out on Indian and Danish firms, the distance has been an impediment, due to the fact that there were many unanswered emails and questions. At some point, it felt like if the project was carried out from India, I could have gotten more information regarding the lack of digital maturity in India.

As hard as it was to unravel data from Indian construction industry, it was also hard to retrieve data from the Danish construction industry, due to the cultural differences all the data gathered online were in Danish and I had to collaborate with Danish speaking construction management students for getting as much information as possible. Nevertheless, in this process, I learned the art of collaborating with people from different areas of expertise and also learned the various behavioral aspects of an industry.

However, there are few places where the research could have unraveled details such as, how the change from traditional to a digital way of handling the construction process took place in different firms and all the obstacles they had to overcome. This would have added as an illustration for the Indian firms to look up to, if they would have stumbled upon some of the same problems which the Danish firms have encountered.

Another possible improvement was that a comparison on the theoretical aspect and the practical setup could have been shown for a better understanding on how this thesis could be used to implement for the development of Indian construction industry. For instance, the report concludes that, if the Indian government takes supportive initiatives for the construction industry, it would highly benefit the construction sector, but in practical setup the procedure and time taken for such decisions cannot be predicted.

In my opinion, despite certain limitations, this report has the potential to act as a guideline for developing the Indian construction industry.

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(www.trafikstyrelsen.dk)

APPENDIX

A. Software options

By having a shortage of suitable qualified professionals within the sustainability and energy efficiency sector in the industry, the project faces some issues since the shortage constitutes a barrier for achieving the planned target. The European Construction Sector Observatory, predicted in March 2018, a growth of 3.5% in 2019 and 2.4% in 2020 for the Danish construction sector [European Construction Sector Observatory, 2018].

Further on, let's take a look at the different software which were described anterior and make a comparison / analysis between them based on key differences such as their price and needed features.

a. Wrike vs. Asana

Wrike is a more expensive choice than Asana. Wrike starts at 66dkk per month and increases its price until 231dkk, depending on the features you want. Comparable, Asana starts at 70dkk per month, but it doesn't increase its price based on the features needed. Another disadvantage which Wrike has, is the fact that is built for small teams (only 5 users can use it), whereas Asana doesn't limit the user numbers. Both software's are offering free versions to get to know the tool. Another difference between the two is the fact that Wrike provides only annual subscription, whereas Asana provides both monthly and annual subscription.

b. Trello

Trello is on the opposite spectrum as Wrike or Asana, providing free service for small and medium businesses. Trello offers also Business Class for a price of 70dkk per month, giving additional features which can change the way Trello adapts on the project. As Asana, Trello provides monthly and annual subscription.

B. Theory: Newer developments in the project management technology

Tools, techniques, apps

The work of a construction project manager is multifaceted, which means that s/he has to be in control of every architect, contractor and supplier and to make sure that everyone is on schedule and on project's budget. A project manager has many duties to fulfill for the entire span of a project. Starting from project planning, going further with cost management, time management (because the project must be delivered in the time agreed with the customer), construction management professional practice, quality management, administration of contracts and lastly, safety management.

Nowadays, many software are available in order to facilitate the work of a construction project manager. But having a software is not always enough. The PM (project manager) must figure out how to implement and work around those tools. There are strategies which combined with the tools, might lead to a successfully delivered project.

First of all, communication is very important. Is one of the most essential parts of every construction phase. By keeping a constant communication flow with stakeholders and suppliers, the number of misunderstood issues reduces, thus decreasing the number of phone-calls every time a new problem arises. A transparent communication can be done with the help from different applications / software (f.ex. WhatsApp) by syncing documents, photos, budgets or any schedule changes which might occur. Different platforms can send automated alerts in case of changes, so everyone is up to date with all the news.

Second, a construction project manager must make a habit of continuous planning. S/He has to start planning before the actual construction begins and continue to make plans until the end of the project (usually failure arise, and a project manager must always be prepared with new plans in case of project delays).

Third, the skill of observing and asking questions is a crucial one. Sometimes, a project manager must see an issue in person in order for her/him to be able to solve it. By being familiarized with the working environment / site, a project manager can overcome most of the upcoming issues. S/he must be in a constant learning state, because the construction industry is constantly evolving, which means that s/he has to always be up to date with the latest technology releases.

Fourth, a construction project manager has to be good with numbers, because s/he has to keep track of the entire budget, being aware of all the spending. This is another part of a construction project manager life where technology comes in handy.

Lastly, embracing automated reporting systems, is another asset which a construction project manager must have. By implementing an automated reporting system, a project manager will have time to take care of other tasks and focus on communication. The use of smartsheets eases the job of a project manager, since the workflow is shared in real time, and everyone (PM team, subcontractors, partners and stakeholders) can see it and participate with comments and updates.

C. Software and activities

Real-time collaboration. A good project management software must have real-time collaboration as a feature, because it allows the users to work in close collaboration with each other without sacrificing the user's focus. This means that the teams can focus on their tasks, team leaders can keep an eye on multiple projects at once and managers can watch everything as it happens, without interfering with other's work.

3. *Cost management*. As a project manager, one of the biggest issues in the construction industry and not only, is the ability to create a clear and accurate price for the entire project. A good software should have the ability to predict cost in real time, depending on changes in the project, as well as price changes of materials.

D. Techniques

1. Geolocation

Geographic information system combined with drones can improve the accuracy and speed dramatically. This kind of combination can be used especially on historical project sites or environmentally sensitive ones, since the disturbance level must be minimized. Since the technology is relatively old, the price shouldn't be a problem since it dropped considerably over the past years.

2. 5D building information modeling

In addition to the 3D BIM, the 5D BIM allows for a live peak over the project cost and schedule, including also thermal and acoustic properties. 5D BIM could easily be implemented in addition to the augmented reality, giving the user an enhanced experience.

3. Mobility and digitization

The progress can be shared in real time, thus minimizing the time spent on hand - drawing and waiting. With cloud help, information can be accessed even from remote places (construction sites) and could change the way in which the industry deals with productivity and performance.

4. The internet of things

With help from the internet of things, a larger amount of data can be captured and processed. By connecting equipment with one another, through sensors and wireless technologies, data transfer and protection is faster and more secure than ever, improving the efficiency and risk management.

5. Future proof design and construction

The most demanded materials are concrete, cement and asphalt. Due to this demand, there has been a wave of innovation based on these materials, developing the base of the material, making it stronger, having more qualities. Some of the newly developed materials are worth being mentioned.

Being still in the proof-of-concept stage, *Self-healing Concrete* has a high expectation rate. This new material is closing the cracks in concrete, using bacteria as a self healing agent.

A cement-based material is called *Topmix Permeable* and it is in its early adoption phase. This alternative for cement can absorb up to 4.000 liters of water in just a minute.

A technologically breakthrough material which is a super-insulator and is consistent of 99,98% air, is called *Aerogel*. This product is commercially available.

Being still in the research stage, *Nanomaterials* are super-strong and ultralight materials, with the capability to replace steel reinforcement in foundation and structures.

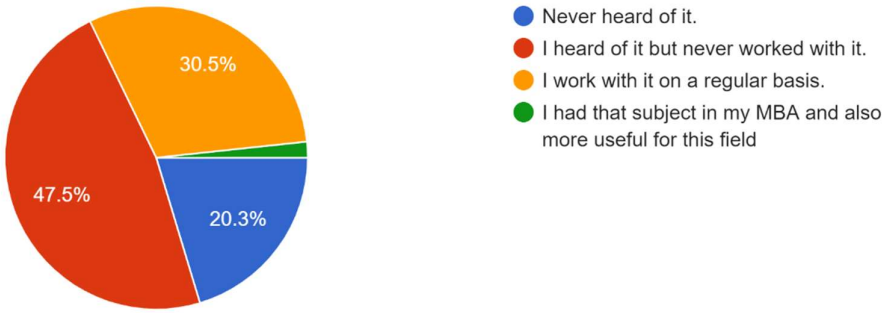
E. Questionnaire / survey

What do you find to be the major productivity issue within the construction industry in India?

45 responses

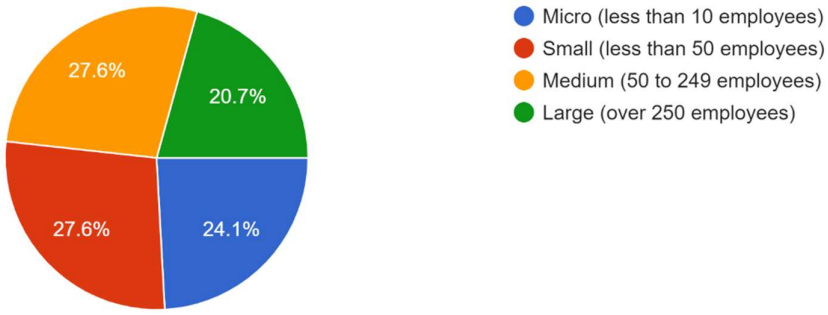
Are you familiar with BIM (Building Information Moddelling)?

59 responses



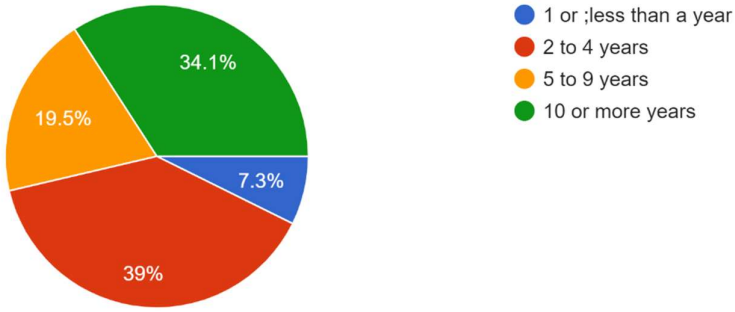
What's the size of the company you are working for?

58 responses



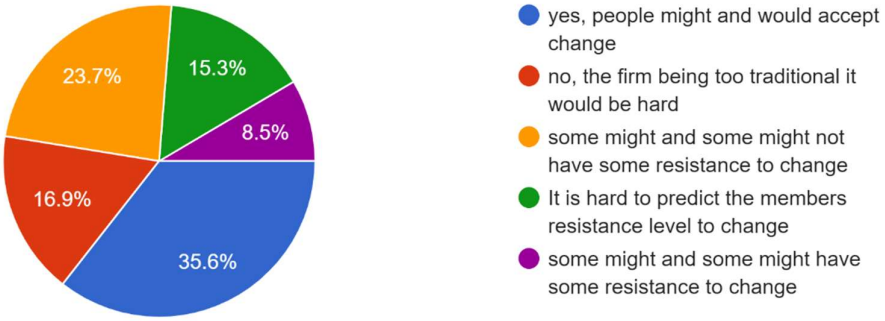
How long has your firm been operating in a traditional methodology with respect to project management?

41 responses



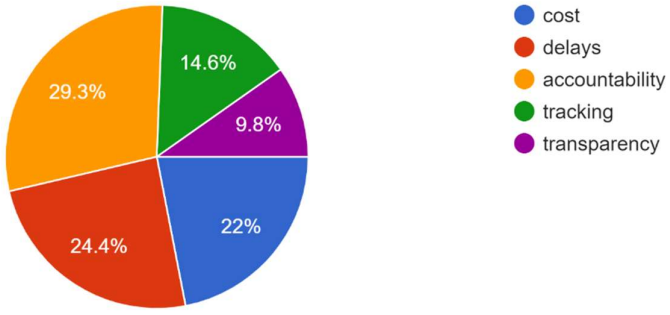
Would the people in the organization be able to accept the change or disruption in their traditional methodology?

59 responses



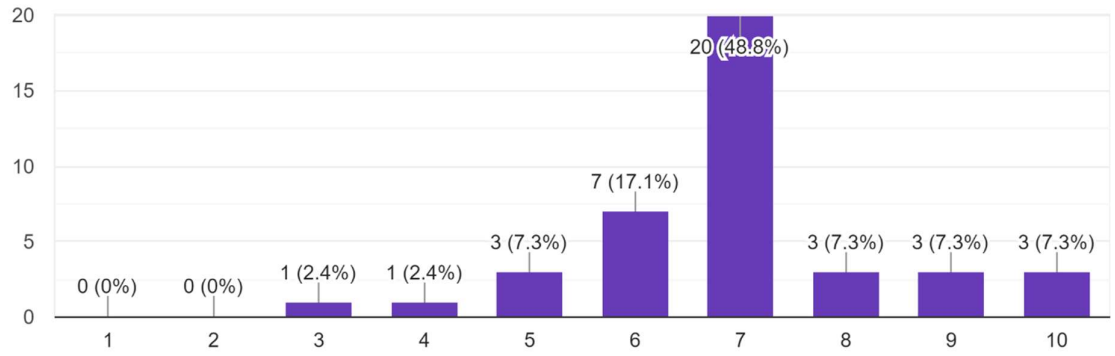
In your opinion what are difficulties to operate a firm traditionally?

41 responses



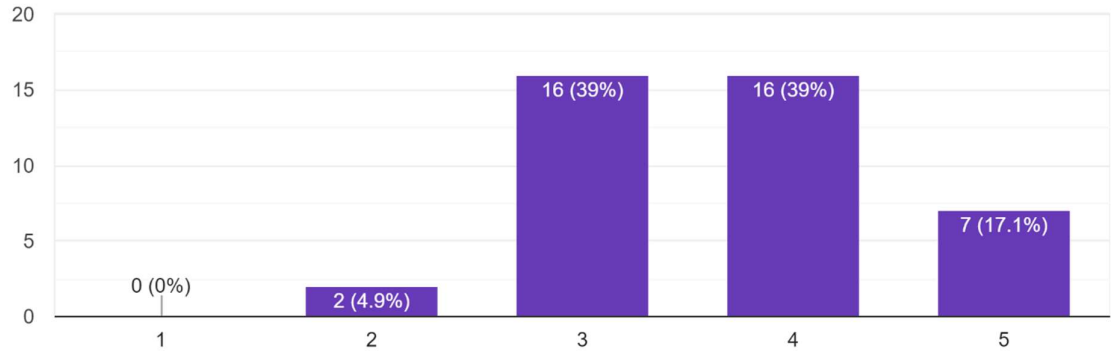
How would you rate your firm with respect to efficiency in project management?

41 responses



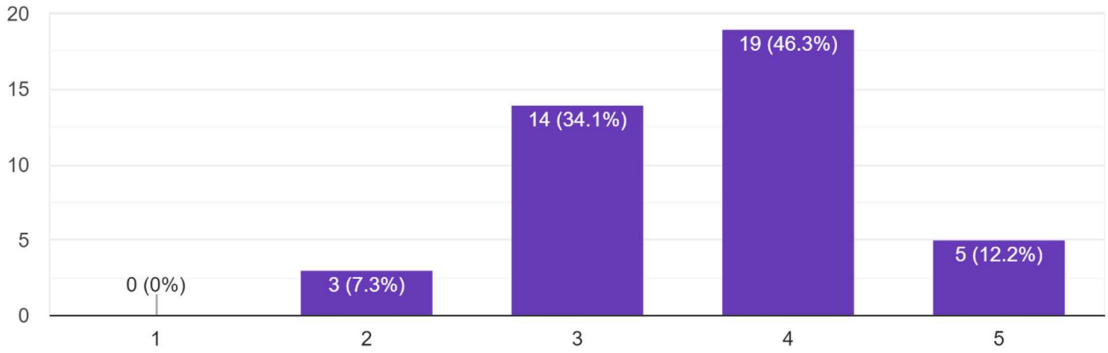
How would you rate your firm with respect to speed of delivery of project?

41 responses



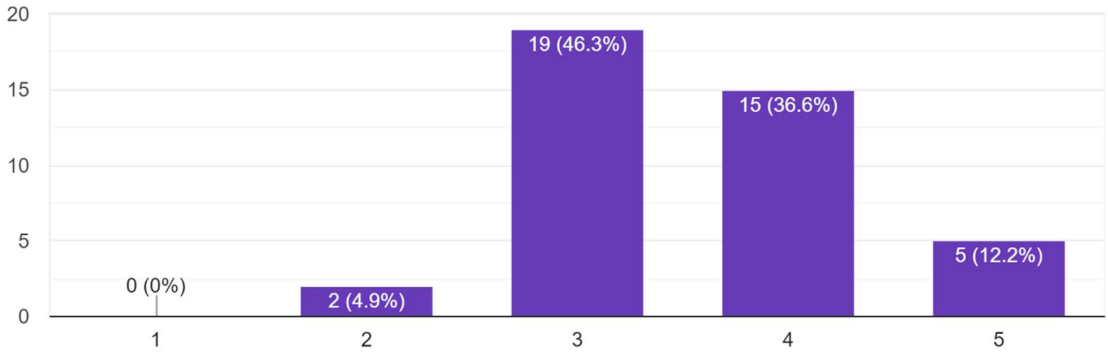
How would you rate your firm with respect to flexibility of project?

41 responses



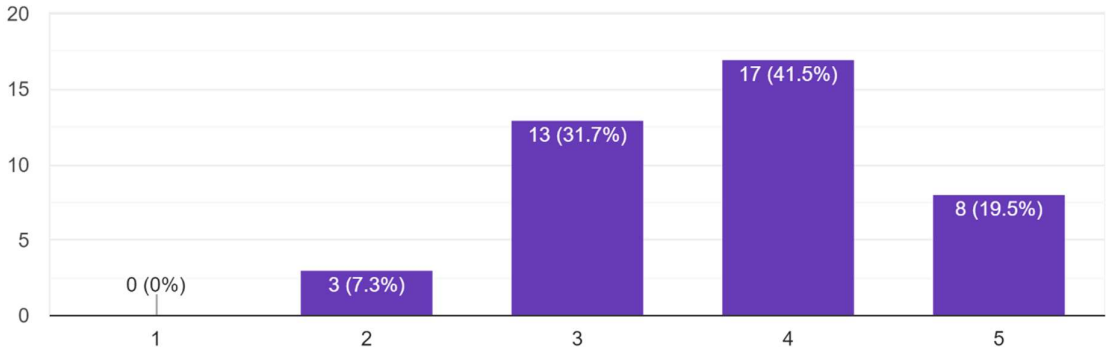
How would you rate your firm with respect to time of delivery of project?

41 responses



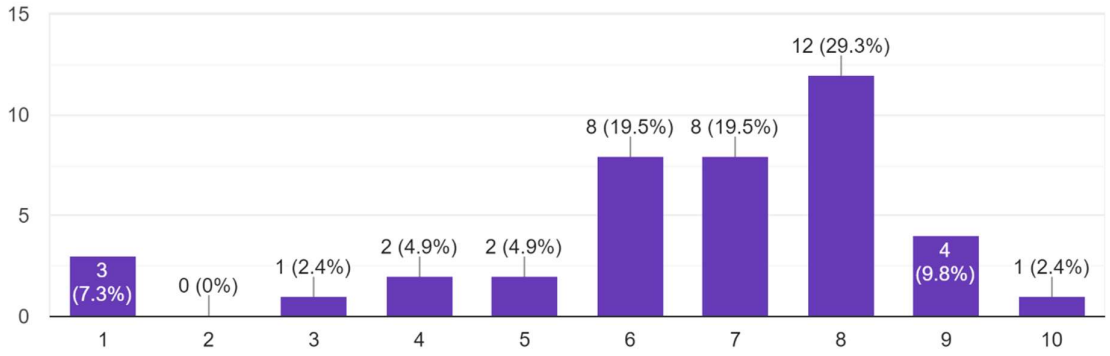
How would you rate your firm with respect to dependability of project?

41 responses



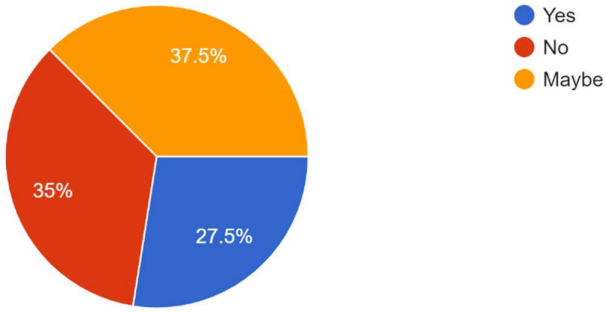
How would you rate your employees acceptance towards digitization?

41 responses



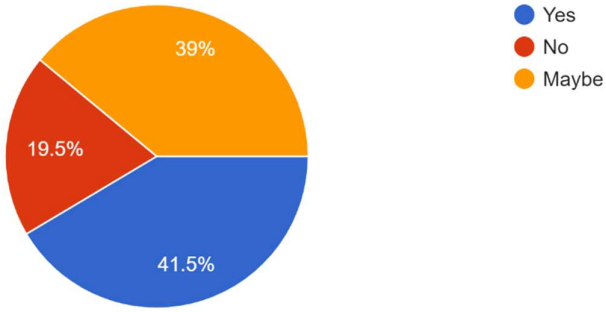
Has your firm ever utilized digital project management tools?

40 responses



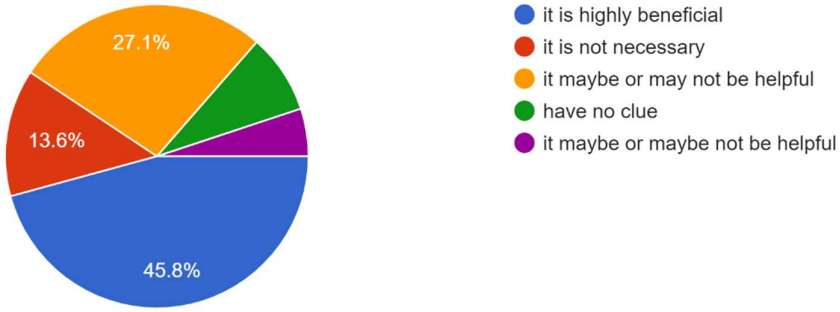
If digitization proves to be beneficial would your firm be willing to adapt?

41 responses



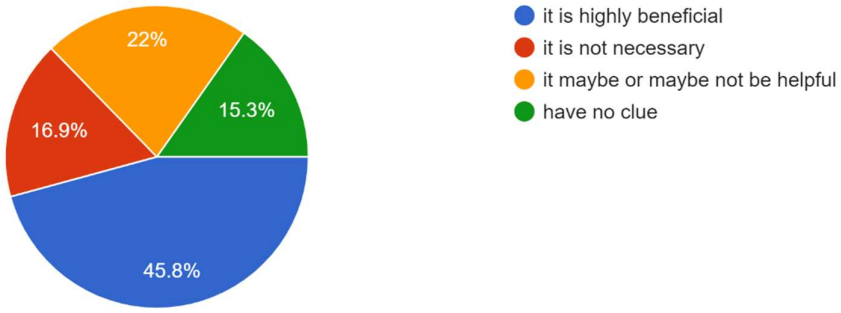
what is your opinion if your firm is enabling the project management in a digitized manner?

59 responses



What is your idea on the transparency attained due to digitization of processes?

59 responses



In what ways do you think that digitization would help?

59 responses