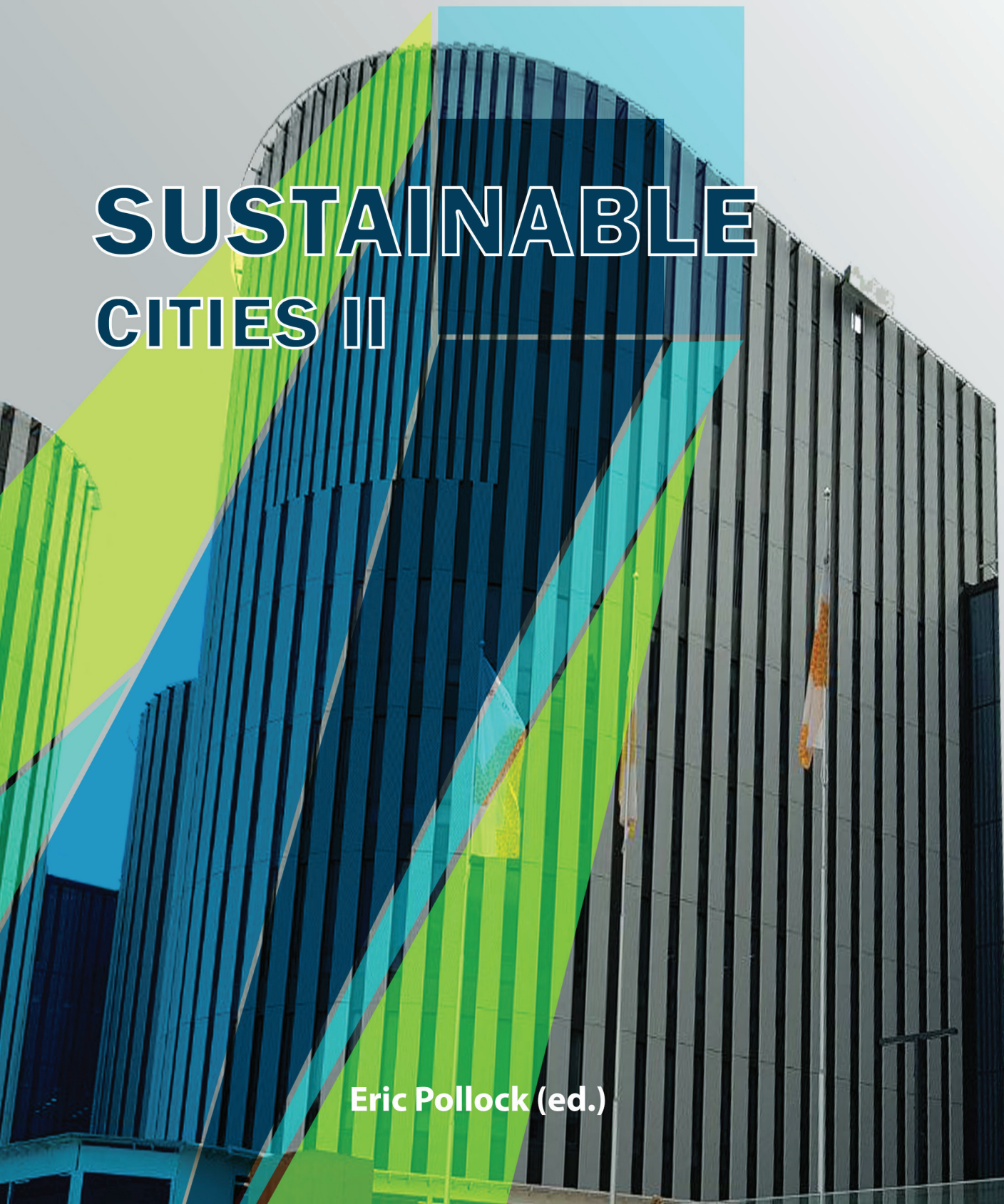
Metropolia
University of Applied Sciences

Master`s Programme in Construction
and Real Estate Management (ConREM)

SUSTAINABLE CITIES II



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Metropolia
University of Applied Sciences

Sustainable Cities II

Eric Pollock (ed.)

Preface

Dear Readers, welcome to an innovative journey towards sustainable cities. This book offers an intuitive understanding of our future cities. It is a collection of group works by the Case studies course of the Construction and Real Estate Management International Master's programme. This Master's degree is jointly run by Metropolia UAS and HTW-Berlin. The students are from around the world, some researching sustainable cities for the first time in their academic careers. The group works have case cities that are mostly from their own home country, giving their inside view of language, culture and engineering. This is boots-on-the-ground research. The graphic layout and cover are also by students.

The book has two sections. The first part contains professional articles by Metropolia experts in sustainablity and construction. The first article is the commitment of Metropolia to sustainable operations. The second article is by the course lecturer on how the pedagogic approach to the course was setup. The final article is a response by the student group chairpersons on the success of the pedagogical approach.

Part two is five case studies by international students concerning sustainability in cities, mostly from the viewpoint of the construction of the built environment. The students chose their own groups, engineering and architectural topics, and city cases. The students have lived, studied or worked in the case cities chosen, so silent knowledge is abundant.

The Construction and Real Estate Management programme (ConREM is a 4-semester Master's Degree. When undergraduates of architecture and civil engineering begin their Master of Science studies in Europe, their lives and their future careers undergo a major change. They have come from around the world to study in Europe, to start their professional lives in the design, construction and management of the built environment. They have come as individual students, but very quickly learn teamwork, to survive in academic works and student life. Their language and research skills vary, but they learn from each other.

The Case studies course in the second semester follows up on the Sustainable development course of the first semester. The sustainable development research projects of the first semester were individual works. For the second semester, after they got to know each other, the students wanted to make a publication in groups on real sustainability questions in today's urban world. Many students need to participate in academic research publications for future doctoral studies. ConREM head Mika Lindholm encouraged us to go for a full publication again this year, as well as participate in the Finnish Engineers' sustainability conference SBE 19 in Helsinki in May, 2019.

This shift of academic responsibility to the student groups was both innovative and a great deal of work. Academic writing for some was a big challenge, some for the first time, but apparently better than a test. Our second lecturer, ConREM graduate Ana Reinbold checked the use of sources in the drafts. Thanks to the broad diversity of the authors, the book has been able to make justice to the title.

This publication shows how sustainable cities research in groups of international students from very different backgrounds can work together by teaching others about their cultures and history.

Eric Pollock

Lecturer of the course and editor of the book

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PART I - Viewpoints on learning how to develop sustainability

What is Metropolia itself doing about sustainability in its own operations? What can lecturers do in their teaching methods to get the sustainable message into students' brains? What can new visual technology bring to research methods for urban development? And finally, what do the students make of all this?

Part I contains professional articles by Metropolia experts in sustainability, construction and new technologies. The commitment of Metropolia to sustainable operations is given and the pedagogic approach is explained. The final article is a response by the students, how they organised their own group works, and what else they learned besides sustainability.

The students organised themselves into five research teams and their case studies are presented in Part II. The topics are Sustainable Construction, Project Management, Technological Developments in Construction and Real Estate Industry, Sustainable Transportation and Water Management in Egypt.

Metropolia Meets the Challenge

Mika Lindholm

Metropolia UAS is a higher education institution and our strategy is to be a bold reformer of expertise and an active builder of the future. We want to strengthen the development of high quality learning, increase competitiveness and societal impact, and promote Metropolia as a player in the development process of the greater metropolitan area. We have very strong ties with local industry.

Metropolia is going through some major campus unifications, and the new facilities allow us to renew our learning environments. The growth in the competence of our staff, students and partners can be seen clearly. In spite of our long winters, our international students learn to enjoy the sometimes chilly circumstances and study here. We set out our academic goals and then get the job done, the sunny springtime giving the students a boost for the final push to complete the studies. Studying takes place in English and prepares our students for working life anywhere in the world.

Metropolia offers a relaxed study environment for international students who get to develop their competence and together create something new. With an open and experimental operating culture we aim to make the society a better place for all.

Towards Sustainable and Functional Cities

Metropolia takes sustainability and functional cities seriously. We have recently founded five new innovation hubs for unique developments in cooperation with local industries. One of the hubs is the Clean and Sustainable Solutions Innovation hub and another one is the Functional City for People Innovation hub. The innovation hubs bring together actors from various fields and sectors – companies, research institutions, cities, organisations, local residents and Metropolia students, lecturers and other experts – to learn and investigate together and to test out and innovate various solutions for sustainable technology. The clean and sustainable solutions theme is founded on low emissions, resource-smart action and especially the circular economy, and the utilisation of various technologies, such as digitalisation and IoT.

In addition, there is an innovation hub called Data Driven Construction, which applies all suitable IT-technologies during the whole life cycle of a construction project or a building, to manage the building process better and add value for money.

Metropolia is International

Metropolia University of Applied Sciences is one of the most international Universities of Applied Sciences in Finland. Metropolia has 15 international degree programmes in English. Over 1300 international degree students, who represent more than 90 different nationalities, study at Metropolia every year. In addition to the international degree students, Metropolia welcomes over 325 exchange students every year from partner institutions of higher education from all over the world.

The Construction and Real Estate Management Master's degree programme (ConREM) in English is jointly offered by Metropolia UAS and the Berlin University of Applied Science HTW-Berlin since 2004. The two-year ConREM programme venue is both in Helsinki and Berlin. This international programme provides graduates with a combination of engineering, management and communication skills. Our graduates have found employment in Finland, Germany and in the home countries of the international students. Several ConREM graduates each year are accepted to doctorate programmes.

Working in the European construction industry usually requires language skills of the home country. However, the market is steadily growing, so investing in language skills is worth the effort. The commercial building and residential construction market in Europe has increased at a combined growth rate of over 3% for the past five years. Business opportunities for young Master's degree graduates are very good, because they possess skills in IT software, cutting edge research, management and communication that employers want.

This Sustainable Cities II publication is another example of the fine research work our students produce. Congratulations for this fine work! The next generation has set their goals, now the work begins.

Learning to Understand Sustainability in Cities
Lecturer's View to Pedagogic Methodology

Eric Pollock

Cities are the most complicated things humans have ever built. With climate change (the biggest threat our species is facing) the word sustainability has achieved more relevance than ever. As the majority of the world's population live in urban environments, the sustainable city is the most important thought of today.

European Universities have a direct responsibility for Sustainability studies in all faculties, why not globally as well. In Architecture and Civil Engineering works, this means mostly buildings and infrastructure works, both new construction and renovation projects. We need to educate young designers and managers to take the construction industry into the sustainable building era of energy plus, low CO2 emission structures. Buildings must have pleasant working environments with good indoor air quality. Cities must have sustainable transportation and good use of water resources. Cities must also respect and protect their heritage sites, as well as develop public services, housing and green areas.

Learning without Traditional Lectures and Tests

The students chose this pedagogic alternative research publication in place of the traditional lecture and test course without hesitation.

How the course was built? First, we started with a lecture series. It began with *Polluted cities*: air, land and water pollution in urban areas. Next was *Traffic planning:* road networks, railways, waterways and bicycle/pedestrian paths. In *Aging Infrastructure,* developed nations like the USA and Britain have a tremendous repair deficit for bridges, tunnels and highways, and nations depending on railways like India have failures far too often. In the *High-rise housing lecture,* Western nations have almost a century of experience, but fast-growing nations in the Middle East and South America and China have a different middle and high-rise housing crisis of their own. Finally, in the *Off-Grid Housing* lecture, rural areas are obliged to find their power locally, use their fresh water wisely and recycle their wastewater.

After the lecture series, the students chose their own topics, formed their own groups and selected chairpersons as well as fixed their deadline for completion. They worked independently, and since some had more academic writing experience, teamwork in the groups produced five very good case studies on sustainability with research from cities around the world.

Some Thoughts about Learning

The research works presented here went through classic cycles of lack of information, then an overload of information and finally an understanding of what is important for the reader and what is not. ConREM graduate students needed only some feedback to keep the schedule as agreed. Deadlines are important in sustainable research too.

Working in groups, all with mixed backgrounds, has led to some really good discussions, and has brought them together as authors and researchers. The students are from all corners of the world, so it was easy to get comparisons of sustainable development from major cities on many continents. Climates around the world are different; some regions suffer from both drought and flooding, others have abundant solar energy, but no real solar energy industry. By sharing their local climate challenges, global solutions become clearer.

Lecturers often see the statistics, the past, but students have a look more towards the future. They interpret their present situation with the future job market in the construction and real estate industry. They see the opportunities for renewable energies, for saving energy and for purifying wastewater.

What are the global sustainable concepts students have developed? This book offers an intuitive understanding of our future cities to the reader. The book can also be used as sustainable coursework related to cities in an undergraduate curriculum. The authors were encouraged to back up their views with evidence and reasoning. Nevertheless, the issues covered in the book are of timeless value and would undoubtedly appear relevant for our future cities.

The basic goal of the whole publication is to look at the 17 Sustainable Development Goals (SDGs) of the 2030 Agenda for Sustainable Development that became official in 2016. With these new goals that apply to everyone, nations can mobilize efforts to end all forms of poverty, fight inequalities and tackle climate change.

In particular, goal 11 states "Make cities inclusive, safe, resilient and sustainable. Cities are hubs for ideas, commerce, culture, science, productivity, social development and much more. At their best, cities have enabled people to advance socially and economically. However, many challenges exist to maintaining cities in a way that continues to create jobs and prosperity while not straining land and resources. Common urban challenges include congestion, lack of funds to provide basic services, a shortage of adequate housing and declining infrastructure. (http://www.un.org/sustainabledevelopment/cities/)

Sustainable Construction is defined in the first case study. Sustainability is meeting the requirements of a project or process by less impact on the environment, economy, social life and their well-being. Decreasing consumption, producing less waste and using environmentally sound materials are required for a sustainable construction site. The research questions are: what methods and technologies make construction sites more sustainable, are there international differences or similarities in sustainable guidelines and goals and how to deal with the renovation of existing properties.

The **Sustainable Project Management** case study describes projects in four contrasting countries. Questionnaires were used to collect data from project managers whose projects are situated in Iran, Guatemala, Albania and Nigeria. They have differences in geography, scale and form of contract, but the goal is to understand how project management works in these countries, concentrating on sustainability. Data concerning technology, communication, waste management, site safety and human resources are given, and recommended improvements are presented.

Case study 3 is titled **Technology Developments in the Construction and Real Estate Industry.** The integration of Artificial Intelligence, the Internet of Things, Building Management Systems and Zero Energy Buildings promise low cost and high value structures with a longer life cycle. These technologies provide project managers and facility managers with real-time advanced tools for managing schedules, quality and CO_2 emissions. An insight is given to the design, operation and maintenance phases and development related to sustainable cities.

Sustainable Transportation, case study 4, presents the influence transportation can have on city development all over the globe while highlighting the challenges and techniques used to tackle them. Although eastern and western transport infrastructure varies depending on local economies, similar solutions for sustainable transportation are given. Modern transportation in Istanbul, Turkey, Wuhan, China and Jakarta, Indonesia show how cities with innovative ideas and methodologies can grow.

Water Management, case study 5, deals with the Nile basin countries and their water scarcity challenge. The population growth is high, and agricultural expansion is necessary. Egypt has developed the Vision 2030 strategy to solve the crisis. The Jordan tertiary treatment plant is presented as an ideal example for a sustainable and eco-friendly plant, producing its own hydroelectric power. By following the recommendations, good results and progress can be made by 2030.

The experienced team of professionals combining architects and engineers brought their expertise into this book. I am confident we will hear from them in the future as sustainable developers.

Reflections about Learning
Students' Response to Pedagogic Methodology

Eric Liebe, Sherif Otman, Gjergj Zhebo, Abdelrahman Md Alhato, Sanjay Joshi

The topics for the research groups for this Sustainable Cities II publication were chosen by the students as academic research works. This opportunity was given by the class lecturer, where students were given the chance to choose between the classic lecture and exam for the class or academic research in the sustainability field as part of a book for publication. The importance of sustainability nowadays and the opportunity to be part of a published academic work inspired the students immensely making the choice of producing a book easy.

The main reason for choosing the academic research was that we felt that increasing awareness of sustainability of the built environment is a social and professional obligation of the new construction and real estate professionals graduating soon. This opportunity made it possible to improve our research skills and derive meaningful conclusions in many related fields of sustainability.

The whole process of creating groups was based on the free choice and interest of the students related to sustainable development in the built environment based upon the United Nations Sustainable Devel-opment Goals.

We formed five groups, with each group considering sustainability in cities from different points of view. Here we present the group themes and observe and reflect, from the student point of view, what it was like to learn in this pedagogic way.

Technology Developments in the Construction and Real Estate Industry

The Technology research group was created as a unification of different topics, which all had in common the contribution to sustainable development. Six different team members coming from different profes-sional and cultural backgrounds worked together during the whole process.

In the beginning, there was slight confusion due to the different subtopics chosen. Nevertheless, through some long hours of brainstorming and discussion, we could see that all our topics were related to technol-ogy development and its contribution to sustainable development. The process started to gain momentum and all the subtopics were plotted in a network diagram converging to the main topic of technology. All this was achieved through extensive group work where each member made their contribution with respect to other members' work. The opportunity of working in a multicultural environment made us discover different working cultures and respect them by eliminating stereotypes and appreciating different points of view about work.

Moreover, specifically in the research group due to six different subtopics, we had the opportunity to also learn from each other by widening our horizons on the contribution of technology to sustainable development. All this thanks to the open discussions and communication between group members where feedback and cooperation was a key point. The outcome of the research is a chapter where technology developments in the field of construction and real estate industry are analyzed to give the reader a spe-cific overview of the role of technology in sustainable development encompassing six different areas of application. Several conclusions were derived at the end of each subchapter, which can be converted into useful applications and also give an opportunity for further research.

Project Management (PM)

It takes a great deal of courage to pick an unconventional path. When we were presented with an idea to select between the traditional method of textbook learning versus working towards a publication, my colleagues and I were excited to pick this new method of learning. The class was divided into many different groups, with individual topics according to the groups' research interest. Soon a team under the topic of Project Management was formed. This team had 11 members. A WhatsApp group was formed for all kinds of dialogue. All members decided to meet later in person and decide how we intend to move forward. During the first formal in-person meeting the team members started to discuss what they have to offer. It took two to three face-to-face meetings to decide how our publication would look like. After these meetings, we came to the conclusion that we would be speaking to project managers from four different parts of the world and thus learn about their project management styles.

Our basic objective was to understand how PM works in different parts of the world and how project managers and current students can learn from their positive and negative experiences. A chairperson was appointed to coordinate and streamline the process. The rest of the members were divided into 4 groups (one group per country) which had their own group leaders. The group conducted an interview with four project managers by telephone and email. Working in a group where most of the team members come from a different background is tough. It is a difficult job with regards to communication since some people like to be monitored while others like to work without much supervision.

These issues were often resolved through open and direct communication. All members were instructed to communicate with the leaders in case of a roadblock during their work. In the end, everyone learned about effective communication within a group and how to get things done even though all members work at a different pace and have a different outlook towards time management and project deadline. In addition to learning about sustainability and project management, this group work also helped us understand how to organize and manage people and also gave us the confidence to manage people from a different cultural background in our future professional life.

Sustainable Transportation

In a Master's program where a written thesis is a requirement, our group found itself outside of its comfort zone regarding this academic setting. The group consisted of an architect and two engineers in need of academic writing skills to complete our Master's thesis. A good idea was proposed by Mr. Pollock to write a book with different case studies highlighting the course subject and objectives. This method was to prepare us for writing the final Master's thesis and making the thesis presentation. Sustainable Transportation is the subject we picked due to its influence scale and how interesting it can be to present. By using *DropBox* for file sharing and *WhatsApp* group to communicate we managed to stay in sync every step of the way.

The challenge with every update was how to edit the submitted document from each of us at the same time, but that worked well with the mixture of WhatsApp and *DropBox.* We decided on a strategy for working on two case studies of major influence on cities and supporting the idea by presenting recent sus-tainable technologies and methods in transportation with a summary to every section stating our overall conclusions. The conclusions are to answer the questions in the introduction and their relation to sustain-able development goals published by the UN.

It was a very good opportunity to learn what academic work means and skills such as good referencing and organization of papers and reports along with the ability to manage group work with different opinions and backgrounds.

Water Management

The working progress of the water management group was separated into two different parts by individual members of the group. The communication channel we used was WhatsApp for progress and questions for exchanging files and discussions, in case any changes were required. In the face-to-face meetings, we brainstormed and determined the layout of the text from a general point of view.

For discussing water management, we picked the critical places located along the Nile river that are facing water scarcity. This led us to propose wastewater treatment as a solution to solve the problem in Egypt, which is considered the end point of the Nile river. We presented a wastewater treatment plant case study located in Jordan, which is considered as the best example for sustainability. Dealing with such a sensi-tive topic is not easy as you have to consider all the challenges and the directions of the UN sustainable development goals.

It was a very good opportunity to learn the meaning of academic work and the significance of good refer-encing and organization of papers and reports. Also, the ability to agree on certain topics and a common vision was a big success.

Sustainable Construction

The working progress of sustainable construction was separated into 11 different parts by individual mem-bers of the group. Communication took place through team meetings and WhatsApp was used for pro-gress and questions, along with e-mail for exchanging the written parts. The meetings were irregular due to the daily opportunity of talking to each other during the lectures at the university.

In the beginning of this work, we started to develop the content of this topic and ways of organizing the whole project. Starting to evaluate sustainable construction on different continents and countries led us to the decision to cover three different case studies on sustainable construction. To understand the topic of sustainable construction and the overall concept of sustainability, notes on the development, content and differences to Green Building had to be ensured. In addition, alternative approaches and technologies are mentioned to achieve different goals.

An overview of the whole topic, materials and examples are given for the reader to understand the back-ground. Dealing with a large amount of team members from different countries with different subtopics under a general topic was a learning process for everyone. Communication among people with different levels of language skills increased the team spirit to help each other and is bound to bring advantages in future professions for everyone. Different cultures and levels of knowledge regarding the topic made the project challenging but interesting for every member of the group.

PART II - Case studies, Sustainable Cities research by students

Academic guidelines for group research works were agreed upon early on. The previous sustainable development research works were individual, so this change over to group works was logical. It was imperative for the responsibility of guidelines for time and quality shift to the student groups, i.e. their chairpersons. The lecturers had to relinquish this responsibility, which was difficult at first, when results were slow in coming. After the shift had fermented for some time, draft versions showed real progress in scholarly research.

The students organised themselves into five research teams and their case studies are presented here. The topics are Sustainable Construction, Project Management, Technological Developments in Construction and Real Estate Industry, Sustainable Transportation and Water Management in Egypt. The students were asked to send their group research works to the city governments that they had studied, but those results are not available here. They will certainly show up in later research literature.

Sustainable Construction

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Case Studies 1: Building and Refurbishment
Construction and Real Estate Management
Supervisors: Eric Pollock and Ana Reinbold
April 2019

Authors: Nawrin Layla, Eric Liebe, Ehsan Bodaghi, Tejas Prajapati, Md Tohami Md Hisham Abdelaziz, Mikko Borg, Olabanji Amos Fayemi, Adarsh Gangadharan, Alejandro Gomez Zaldivar, Ahmed Hussein, Gonzalo Ruiz-Liard Moyano

Abstract

Sustainability is meeting the requirements of a project or process by less impact on the environment, economy, social life and their well-being. Decreasing consumption, producing less waste and using environmentally sound materials are required for a sustainable construction site. Green building impacts the lowest possible pollution and decreases the energy consumption for the lifecycle of a building. Other benefits are positive social, ecological and economic impacts in construction.

Efficient use of energy, renewable resources, methods to reduce waste and pollution, use of non-toxic materials and good indoor quality are reviewed. Three case studies are given showing first a sustainable building, secondly a renewable energy production case. The third case study shows good reconstruction and renovation techniques of a bridge project, with new solutions for facilities and services in a heritage site.

Research questions are what methods and technologies make construction sites more sustainable, are there international differences or similarities in sustainable guidelines and goals, and how to deal with existing properties.

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Abbreviation Directory

EU	Europe Union
CO2	Carbon dioxide emissions
SDG	Sustainable Development Goals
U.S.	United States
UK	United Kingdom
U.N.	United Nations
WCED	World Commission on Environment and Development
BIM	Building Information Modeling/Management
LED	Light-Emitting Diodes
ROI	Return of Investment
UNEP	United Nations Environmental Program
EBPD	Energy of Building Performance Directive
BREEAM	Building Research Establishment Energy Assessment Methodology
LEED	Leadership in Environmental and Energy Design
HK BEAM	Hong-Kong Building Environmental Assessment Method
EEA	European Environmental Agency
ISO	International Standard Organization
EPBD	Energy Performance of Buildings Directive
EST	Energy Saving Trust
NBC	National Building Council
LECA	Light Expanded Clay Aggregate
IPCC	Intergovernmental Panel on Climate Change
UAE	United Arab Emirates
DBT	dry-bulb temperature
WBT	wet-bulb temperature
RHM	relative humidity
PV	Photovoltaic
MW	Mega watt
LECA	Light Expanded Clay Aggregate
DGNB	Deutsche Gesellschaft für Nachhaltiges Bauen

Introduction

Research Method

To understand the topic of “Sustainable Construction” and the industry, an overview about the topic, the development and the methods are given. The research method is qualitative, using studies, articles, blogs and statistics from institutions, government or private persons from all over the related industry.

Report’s structure

The layout of this academic report is structured in ten sections by separate authors. Starting with an overview about sustainability and its goals followed by their connection to the construction sector, written by Mikko Borg and Olabanji Amos Fayemi, followed by the section of Green Building by Eric Liebe. The next section will clarify the importance of the topic, facing the impact on the pillars of sustainability in construction by Nawrin Layla. Section five, written by Alejandro Gomez Zaldivar and Gonzalo Ruiz-Liard Moyano, elucidates common materials and techniques related to sustainable. The sixth and seventh sections contain the understanding of the construction sector, by Tejas Prajapati, and the renovation of existing buildings, by Adarsh Gangadharan, for sustainable construction. These sections will bring the reader knowledge about the importance of construction in different positions of a properties life-cycle. Chapter eight to ten will contain different case studies of different sustainable aspects in varied countries, starting with Tehran, Iran – by Ehsan Bodaghi, Egypt – by Ahmed Hussein and Istanbul, Turkey – by Md Tohami Md Hisham Abdelaziz. The last section contains the conclusion and recommendations.

Keywords: sustainability, renewable resources, material management, development

Summary

Sustainable Construction is more than just Green Building and new innovations all around a facility. Infrastructure, transport and human living are just a small amount of the things this topic needs to cover. All those things are listed in the meaning of sustainability and its global goals. The following figure (1) visualizes the meaning of sustainability, how to reach it and the different fields of impact. Sustainability is the ability to meet the requirements of a project or process by less impact on the environment, economy, social life and their well-being. Decreasing the consumption, using environmental materials, techniques and ensuring mobility are some points given to face the construction site with sustainability.

To achieve the sustainable goals and health to the three pillars of sustainability it is important to know what kind of technology is used and how it is being used in the construction lifecycle. Also, the continuous reorganization of economy and society is bringing changes in consumption patterns and development of new and necessary technologies. The definition to make the construction sector sustainable is not clearly defined, but well known and necessary for the industry. In Europe, buildings consume over 40% of the total energy, which is more than the whole transportation sector combined making energy efficiency actions the real target to meet.

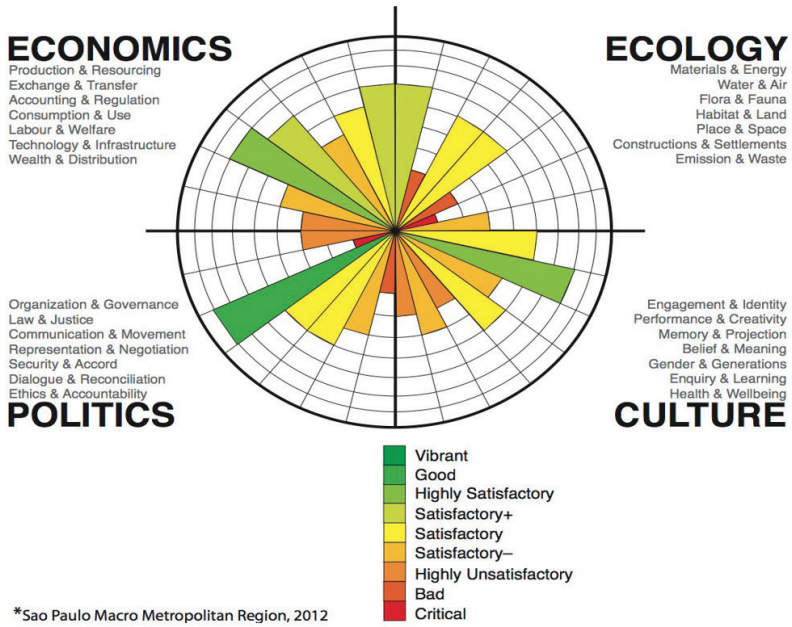

Figure 1: Circle of Sustainability (Paul, 2015)

The construction industry has changed over the last years and so have the buildings and the environment of it, but not only new properties to be built to regulations and specifications, also existing buildings become a big player when it

comes to sustainable construction. Changing an existing element can bring more issues in a building than expected, therefore the actions have to be considered and clear to avoid poor performance. (Bishop, 2017)

To ensure sustainable construction it is also important not to face only the building, furthermore the whole aspects of sustainability and their impact on the project. Separating sustainable construction and Green Building is always a challenge. To clarify the difference, chapter three has been added to visualize the meaning of Green Building. However, this work is analysing three different case studies. The first case study considers the building as a main target. On the other hand, the second case study will review the renewable energy production for achieving sustainability. The third case study provides an example of the advantages in an old project, not only with good reconstruction and renovation techniques, but also by creating new solutions for facilities and services without affecting the transportation capacity. The reader will be guided through the several parts of the topic and a recommendation and conclusion part at the end, where examples dealing this topic will be summarized.

1- The focus of this study is to define the following research questions and find suitable solutions for them.
2- What is the impact on the construction site by sustainability?
3- Which methods and technologies support sustainable construction?
4- Are there international differences or similarities in sustainable guidelines and goals?
5- How to deal with existing properties?
6- International Sustainability, Development and Goals

Sustainability

Today, it is obvious that our everyday modern way of life is quite unsustainable. As natural resources are used in an un-recoverable manner, causing air, land and water pollution which we all depend on for survival. The frequency at which we burn fossil fuels increases the “global temperature of the earth” at same time causing natural disaster and making the world uninhabitable. An unreasonable amount of non-organic waste is been generated with little or no plan for the management or modification in forms of production and utilization. Yet, the international economy is based on the idea of limitless growth though resources and the planet are subject to limitation. (1903)

Alan (1998) opined that sustainability is a specified situation, “It is a lofty goal whose perfect realization eludes us”. Basically, there are diverse descriptions and conflicting definitions for sustainability, but factually all these definitions will entail the nature, livelihood, social organization and our global economy, collaborating essentially for a long period of time. Clough et al. (2006) therefore stated that sustainability is “a process that helps create a vibrant economy and a high quality of life, while respecting the need to sustain natural resources and protect the environment. It expresses the principle that future generations should live in a world that the present generation has enjoyed but not diminished.” The practice of sustainability then becomes an innovation for everyone in which the present-day humans and future humans exist in a sensible standard, there are opportunities for everyone economically, land and landfill are made safe and the strength of our planet is reinstated and sustained at a necessary degree in achieving these goals. In achieving this vision, attention must be paid to all sustainable features.

DuBose and Pearce (1997) stated that “sustainability offers a way of interacting with our world which reconciles the ubiquitous human desire for a high quality of life with the realities of our global context. It calls for unique solutions for improving our welfare that do not come at the cost of degrading the environment or impinging on the wellbeing of other people”.

Sustainability “can encompass an interaction and relationship between social, ecological, as well as economic systems” (Zuofa et al., 2016). The definition of sustainability according to Brundtland (1987) is “the developments that meet the needs of present without compromising the ability of future generations to meet their own needs”.

Thus, this vision of sustainability is achieved only when inhabitants of this planet live well in respect to securing a more desirable living standards of living for generations to come (Jucker, 2003).

Development Goals

Regarding sustainability and development related to it, perhaps globally the most widely recognized initiative towards a more sustainable planet is the Sustainable Development Goals agenda set by the United Nations. The United Nations, an international, intergovernmental organization of 193 member states was founded in 1945 after the 2nd World War. United Nations as an organization is quite remarkable as almost all recognised countries in the world are members of it. This gives the organization a spectacular mandate to carry out international operations. The Sustainable Development Goals agenda set by the UN consists of 17 individual goals to be achieved by 2030. The goal headlines, also visible in figure 2 are the following: (United Nations Sustainable Development, n.d.):

Goal 1 - No Poverty
Goal 2 - Zero Hunger
Goal 3 - Good Health and Well-Being
Goal 4 - Quality education
Goal 5 - Gender equality
Goal 6 - Clean Water and Sanitation
Goal 7 - Affordable and Clean Energy
Goal 8 - Decent Work and Economic Growth
Goal 9 - Industry, innovation and Infrastruture
Goal 10 - Reduced Inequalities
Goal 11 - Sustainable Cities and Communities
Goal 12 - Responsible Production and Consumption
Goal 13 - Climate Action
Goal 14 - Life Below Water
Goal 15 - Life on Land
Goal 16 - Peace, Justice and Strong Institutions
Goal 17 - Partnerships for the Goals

Figure 2: The UN Sustainable Development Goals (United Nations Sustainable Development, n.d.)

It could be argued that the construction industry has to develop in every single one of the United Nations Sustainable Development Goals (SDGs), and it would be probably true. To further examine the role of built environment and construction industry in achieving the Sustainable Development Goals, it is worth taking a look at World Green Building Council, a global network of councils from 70 nations on a mission for greener buildings. The World Green Building Council has selected nine goals where the role of construction industry is crucial – the goal numbers are 3, 7, 8, 9, 11, 12, 13, 15 and 17. Their consideration behind selecting these exact goals go beyond just preserving the nature by building ecologically as can be seen in figure 3 (World Green Building Council, n.d.): a big difference in sustainability could be made in terms of general health, wealth division, cohesion in society and resource consumption always linked to environment and emissions critical in fighting the climate change. (World Green Building Council, n.d.)

Figure 3: World Green Building Council: SDGs (World Green Building Council, n.d.)

The Intergovernmental Panel on Climate Change (IPCC) published in October 2018 its report "Global Warming of 1.5 °C" and went on to set another goal the planet cannot afford to miss – to limit the global warming to 1.5 °C compared to the age before industrialization. The report extensively goes through the consequences warming would mean for the globe and the measures that should be taken to limit the global warming from developing further. The World Green Building Council is also committed to these limitations and actions towards fighting global warming. The IPCC climate report also links its recommendations to the UN sustainable development goals to find the synergies and trade-offs in between the climate actions and the sustainable development goals. The comparison reveals both synergies and trade-offs, yet mostly synergies (figure 26) (Intergovernmental panel on climate change, 2018).

Out of the 17 UN Sustainable Development Goals, probably the most obvious one affecting construction industry ecology-wise, therefore the main scope of this report, is the goal 12, "Responsible Consumption and Production": "Sustainable consumption and production is about promoting resource and energy efficiency, sustainable infrastructure, and providing access to basic services, green and decent jobs and a better quality of life for all. Its implementation helps to achieve overall development plans, reduce future economic, environmental and social costs, strengthen economic competitiveness and reduce poverty." (United Nations Sustainable Development, n.d.). As can be seen from the figure 26 about the linkages between the UN sustainable development goals and the climate change actions defined by the IPCC, the goal number 12 has high synergies and almost no trade-offs in between the interests of climate and sustainability, therefore making it a rewarding goal to pursue for the construction industry. Decisions linked to the built environment have to be far-sighted: the whole life cycle from design to construction and from use phase to disposal and demolition have a considerable effect on sustainability. The environmental impact of construction and built environment is further discussed in case study 4 and the concept of green building is described in case study 3.

International differences

Still some countries and members of the UN have differences in the view of sustainability and climate issues. The Paris agreement, where UN member states in 2015 have agreed to limit global warming to 1.5 °C, the IPCC later providing its previously mentioned report on the means to achieve this goal, has been heavily criticised by the President of the United States, Donald Trump. Trump went as far as announcing the United States will withdraw from the agreement (Fox News, 2017). The earliest possibility for actual withdrawal is in November 2020, just within the presidential term of Mr. Trump. However, actions and policy changes that are in conflict with the Paris agreement have already been taken in the United States (New York Times, 2018).

The European Union, on the other hand, has repeatedly declared its commitment to the Paris Agreement and the UN's Sustainable Development Goals. The European Commission has published its own implementation plan of the SDGs. (International Cooperation and Development).

With regard to construction, the European Commission in August 2017 has published a common framework for sustainability in built environment called "Level(s) – A common EU framework of core sustainability indicators for office and residential buildings". The introduction states that "Level(s) provides a set of indicators and common metrics for measuring the environmental performance of buildings along their life cycle. As well as environmental performance, which is the main focus, it also enables other important related aspects of the performance of buildings to be assessed using indicators for health and comfort, life cycle cost and potential future risks to performance. Level(s) aims to provide a general language of sustainability for buildings. This common language should enable actions to be taken at the building level that can make a clear contribution to broader European environmental policy objectives". The framework has separate sections and instructions for different target groups, for example designers, constructors, managers, nvestors, promoters, end-users and public authorities, therefore giving clarification to the question of what do all these different measures and goals mean in practice. (Dodd, Cordella, Traverso, & Donatello, 2017)

In areas and countries considered developing, priorities are typically slightly different, as Karim Elgendy, a sustainability oriented architect states in his article in 2011: "In the developing world, however, sustainable development takes on a rather different meaning. With the agendas of developing nations focused on addressing basic developmental challenges such as economic growth, water scarcity, food security, and health, other environmental and social aspects are considered secondary at best and, for the most part, a luxury that a developing nation cannot afford." (Elgendy, 2012) This is the case for example, in the Middle East where a lack of regulatory environment, energy efficiency requirements and financial incentives has stalled sustainable development by and large. Meanwhile lately some regional governments, for example United Arab Emirates (UAE), Egypt and Jordan have introduced their standards of energy efficiency and green building. (Elgendy, 2012)

Sustainability in construction

Sustainability is vital in construction business as construction industry consumes approximately 40% of the global resources, these resources include sand, water and gravel which are the world's most used raw materials, not only the construction industries but also other industries rely solely on their availability. There is an enormous ecological footprint in the construction industry as large amounts of raw materials are needed to deliver a construction project. Recently as these raw materials are becoming unavailable, leading to change in the process of construction, as the concept of sustainability in construction is to ensure these resources are efficiently used in a construction project. Sustainability is now an essential requirement for the industry, as it means considering the impact of the way we source for materials and the process in which construction project are delivered has on the environment. Sustainable construction

then means understanding a construction project not just about the benefit to the business but also in respect to the society, environment and the world in general (Tyler, 2016).

Hibert (2012) then describes sustainability in construction as "creating and operating a healthy built environment which is based on resource efficiency and ecological design". Sustainability in construction "is a set of processes by which a profitable and competitive industry delivers assets which enhance the quality of life, offer customer satisfaction", are flexible and have "potential to cater for changes in the future and provide support for natural and social environments. It should permit increased investment in people as well as structures and equipment, achieve higher growth while reducing pollution, and improve the conditions of urban and rural areas for the benefit of society" (Yin and Cheng, 2005). The built environment is the centre of national economies, through the provision of infrastructure to reinforce and improve productivity, but considering the rate of natural resources consumption, it is then responsible for most global environmental changes (Diana et al., 2016).

Guidelines in sustainable construction

One main purpose of sustainable construction is the preference made in building materials and construction technology needed in construction works with less or zero waste, "promoting conscious and sustainable changes in all the building life cycle" while one main advantage of delivering sustainable construction is "improvement of energy efficiency with the reduction of CO_2 emissions". (Santos, Soares and Teixeira, n.d.)

Santos et al. (ibid) pointed out that in order to answer to the call of sustainable challenges and in tendering of worthy solutions corresponding to the activities in the life cycle of a building, some guidelines which are the basis for a good practice of sustainable construction are listed here.

1. Planning
2. Energy and gas emissions
3. Water and waste water
4. Materials, waste and quality
5. Indoor air
6. Social aspects

Planning

It's quite essential to plan for all construction activities in order to understand the features of the job and to establish a target and measures for sustainability. The planning phase is most important and a basis for other sustainable guiding principle. Santos and Teixeira (n.d.) identified two characteristic groups in the planning phase which can influence environmental behaviour, which are project and construction local characteristics. Project characteristics involve the functionality of the building and the user's needs, while the local characteristics include the solar exposure, type of soil, the climate condition, rain water affluence and the interests of future occupants.

Energy and gas emission

One of the major concerns about sustainable construction is the consumption of energy in our buildings, therefor it becomes vital to make an unresisting evaluation of energy in order to minimize energy needs in usage through construction strategies. The use of renewable of energy (solar and wind) and minimizing effective need of energy should be reckoned with both in new buildings and restoring an old facility. Santos and Teixeira also describe that the use of solar energy can reduce energy consumption by 40%.

Water and waste water

The need for establishing a measure to minimize the consumption of water and upgrade its usage is resulting from contamination of water resources and the yield of polluted waste water from buildings. The consideration of using waste water by providing waste water treatment plant for reuse, rain water usage should be adhered to in managing the use of water.

Materials, waste and quality

(Braganca and Mateus, 2006) provided that the construction sector consumes an approximate of 25% wood and 40% aggregate which has contributed to the depletion of natural resources, the excessive use of these resources has a high impact on the level of waste generation. To minimize this excessive use of materials and in avoidance of resources wastage, embracing the use of recyclable, non-toxic, materials, environmentally friendly and ecological materials then becomes an obligation in achieving sustainability in the construction sector.

Indoor air

More than 80% of our time is spent inside buildings, inhaling circulating contaminated air, also or inadequate airflow leads to discomfort and sometimes, diseases. In order to avoid contaminated indoor air to guarantee good quality of life for building occupants, more importance should be placed on the selection of building materials with non-harmful component, construction technique, and a proper planning for the erection of a sustainable facility.

Social aspects

The user's needs and comfortability are germane in constructing sustainable buildings. To achieve the potentials of a building constructed to sustainable prospects, the user of these facilities should possess a sustainable performance. This level of performance can be accomplished by providing adaptable space for interaction in buildings. Their interchangeable activity in the building will promote environmental affairs that deals with the good practice of sustainability in a functioning building.

Green Building

As a part of sustainable construction, less impact on the environment, resource consumption and health, Green Building emerged as a tool. A building that ensures a minimized impact on pollution and decreases the consumption of the life-cycle is referred to this method. Green Building suffers several benefits for socialized, ecology and economy in construction. (RICS, 2018).

The reduction of energy, heat and water consumption is also a big part of the Green Building mythology. To make a building "green" the *world green building council* defines several features to achieve this goal, part of those are not only the efficient use of energy, the use of renewable resources, methods to reduce the waste and pollution, consider aspects of sustainability to operations, the use of non-toxic materials and good indoor quality (n.a., 2019). Facing these points, it is possible to make a house to a green house, but essentially it doesn't mean it is sustainable. Sustainability involves a lot more than just a building, like mentioned in the previous chapters. The importance of sustainability is in the factor of the future and the biological system of humanity and environment. (n.a., 2017)

Green Building contains more than just resources and energy saving, furthermore over the years four guidelines were released to ensure the authenticity of the building. In the 1990s the first rating system for new construction Building Research Establishments Environmental Assessment Method (BREEAM) were established, followed by Leadership in Energy and Environmental Design (LEED). After the continuous grow of these programs, additional rating systems have been developed by their influence globally. The first Green product standards got developed in the 1980s and increased during the establishment of the guidelines in the 1990s, nowadays there are estimated to be around 600 green product certifications on the market. Also, the development of guidelines for each country increased over the past ten years. The essential four guidelines for Green Building Certification are as shown in the following table (n.a., 2019):

Guideline	Description
Building Standards	- "a document, established by consensus, approved by a recognized body that provides for common and repeated use as rules, guidelines, or characteristics for activities or their results." (ISO) - developed by professionals evaluating different sections like energy efficiency and air quality and their requirements
Green Codes	- established by law and developed by several councils as mandatory requirement - prescripted: fast, definitive and conservative approach to code for materials and equipment to meet a certain level - performance: to achieve particular results - outcome-based: target energy use level and reporting to meet their goals
Product Certification	- outline and confirm that a product meets standard and performs environmentally friendly - independent party conducting and testing product to award the certification - examples for Certification: Energy Star, WaterSense, GREENGUARD
Building Rating and Certification System	- not only product, furthermore whole project estimation - integrated design process to assume the responsibility and define the measurements

Impact on Sustainability

Sustainable construction refers to an environmentally sound building that is resource-efficient throughout its lifetime. It incorporates recyclable processes not only for resources used but also the impact on the environment due to its building design, construction, operation, maintenance, renovation and finally demolition.

Environmental benefits	Economic benefits	Social benefits
preservation of the ecosystem and biodiversity	diminished building exploitation expenses	improved air quality
raised air and water quality	raised value added	raised comfort level and healthy living conditions
less solid fuel	support to the local manufacturers and economic	diminished spare load to the infrastructure

Table 1: Benefits of Sustainable Construction (Retzlaff R. , 2015)

Sustainable construction covers significantly more than just environmental aspects. A healthy economy is also important when the environmental issues are undertaken. Sustainable construction always offers the greater value for economy over its lifetime. However, a sustainably built environment also increases the productivity to work and create awareness on using resources which have a clear economic benefit. Therefore, understanding environmental, economic and social aspects are the prerequisite of energy efficient and sustainable construction. Together these three aspects are known as ''the three pillars of sustainable con struction''. (Charles Atombo, 2015)

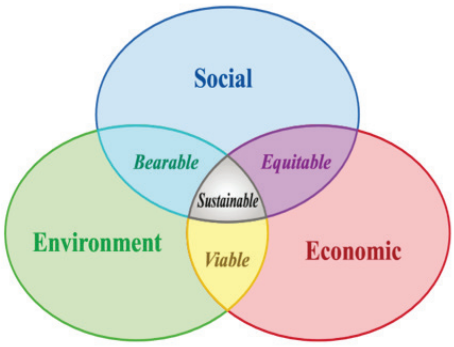

Figure 4: Pillars of Sustainable Construction (Dréo, 2006)

Environmental Impacts

Climate

Climate change is the essential natural concern which has critical impact on sustainable design, planning and related construction. Practices of energy efficient and sustainable development ought to have the capacity to incorporate the natural energies (for example solar power and wind) as parts of its design highlights. A sustainable construction plan starts with layout of the streets, allocation of buildings, orientation of buildings and day to day operation of the building in order to maintain the climate condition and regional aspects.

From an eco-efficiency perspective, construction of a sustainable building should focus on following viewpoints:

- The way buildings or structures effect on the environment both during construction and operation period-locally, regionally and globally. Important aspects are; rational and efficient use of resources such as land, level of energy consumption, type of energy used, water consumption, emissions of substances, and impact on biodiversity.
- Today's climate regime affects structures, enclosures and building materials in terms of use, maintenance and prolonged service life.

Climate change has three spheres of impacts:

- Primary (temperatures, wind speeds, water tables, floods, driving rain, extreme climatic events)
- Secondary (ranges of flora and fauna, biological agents and disease)
- Tertiary (social, behavioral and institutional). (Holm, 2003)

The process of identifying, understanding and controlling climate influences in construction is the most critical part. Depending on the requirements of a building or structure design and construction various types of data and information is required. Relevant guidelines and standards have already mentioned in the previous chapter. Considering all those aspects and based on the design requirement, essential information should be identified to develop the climatic design implication.

- The climatic elements for building thermal design include:
- Information about the site (such as latitude and longitude).

- Data on temperature (such as dry-bulb temperature (DBT).
- Data on humidity (such as wet-bulb temperature (WBT), dew-point temperature (DPT) and relative humidity (RHM))
- Rainfall Data (Madhu Mathi, February 2014)

Place or region-oriented design is also an important element that should be followed in sustainable construction as the different reasons of the world has different climates. For example, hurricanes in Florida, drought in sub-Saharan Africa, to mudslides in Guatemala and tsunamis in Indonesia, each place has a different type of climate conditions and requires different type of sustainable solutions. (Cubick, 2017)

Figure 5: Brock Environmental Center, Virginia (Chance)

Energy Efficiency

In recent years, incorporating energy efficiency, renewable energy, green design in sustainable construction process became the top priority for the architects and engineers. In any kind of construction process energy efficiency can be achieved by using insulation materials, improved technical analysis and design refined construction practice. Reduction of energy demand to operate building and reutilizing of energy is required to develop energy efficient and sustainable construction.

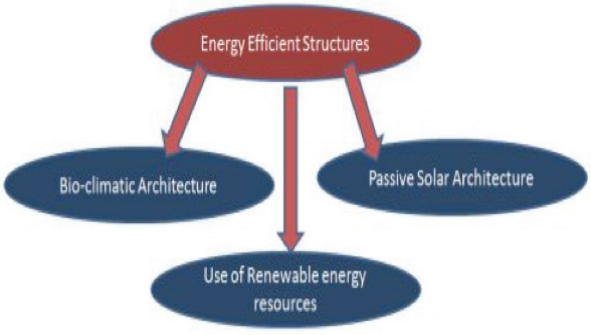

Figure 6: Flow Chart: Energy efficient structures (JK, 2016)

Energy efficiency in construction can be achieved maintaining the following elements:

- Bio climatic architecture: building's location, shape and orientation, placement of windows or openings, solar protection and passive solar systems. In addition, onsite generation of renewable energy through solar power, wind power, hydro power or biomass can reduce energy load. Effective window placement ensures natural lighting and reduce the need of artificial lighting and electricity.
- High performing structural envelope: proper insulation (i.e. design oriented wall, celling and floor), glazing façade and windows, place awnings, porch, trees, air sealed materials and avoidance of thermal bridges.
- High performance- controlled ventilation, mechanical insulation and heat recovery. (Ph.D Jelena Božić, 2011)

Material use

In sustainable construction, green building materials are the ones in which low environmental impact actions have been carried out for their production, placement and maintenance. One of the significant qualities of the material use is reusability keeping the durability as must. Availability in local market is a prerequisite for selection of items in sustainable development. Lately unique sorts of reasonable tech materials are accessible in the market which are durable and can introduce diverse advancements, such as harvesting energy, co2 reduction while dispensing with contamination. These materials can be utilized for long terms as they have comparatively lower cost than the regular materials. (SUSTAINABLE BUILDING MATERIALS, n.d.)

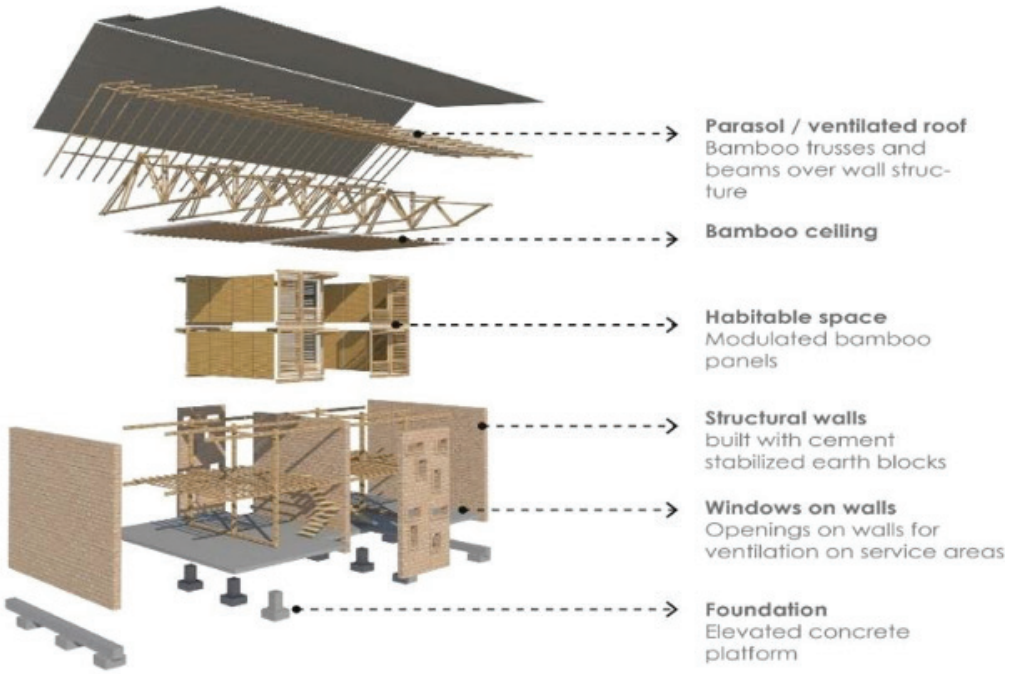

Figure 7: Utilization of sustainable materials (researchgate, n.d.)

Bamboo and timber, ecology blocks (i.e. sundried clay bricks), dimension stone, recycled stone, recycled metal with their lowest environmental impact on production and life cycle are known as the basic green construction materials. Other highly recommended, non-toxic, reusable, renewable, and recyclable materials are tress, linoleum, sheep wool, panels made from paper flakes, compressed earth block, adobe, baked earth, rammed earth, clay, vermiculite, flax linen, sisal, seagrass, cork, expanded clay grains, coconut, wood fibre plates, calcium sand stone, concrete etc. Polyurethane heavily reduces carbon emissions therefore polyurethane blocks as a creative sustainable material is more recycling with less cost and environmentally efficient. (polyurethane.americanchemistry, n.d.) Construction material production site should be offsite to minimize waste and maximize the recycling process but closest to construction site to avoid transportation cost. The next main chapter of this work will contain more information related to materials and their use in sustainable construction.

Waste reduction

One of the important key factors to ensure green development is the reduction of waste during the construction period and incorporating methods of waste management during a building's lifecycle. Due to lack of proper planning in material supply and selection of wrong materials and equipment cause construction waste. Well-designed construction always helps to reduce the amount of waste by providing on site solution such as composite bin to reduce the unwanted landfill. In addition, waste materials can be used directly in the generation of heat or electricity, often as part of the incineration process. They may also be used to create useable fuel such as methane, methanol or ethanol. (Jannatun, 2014)

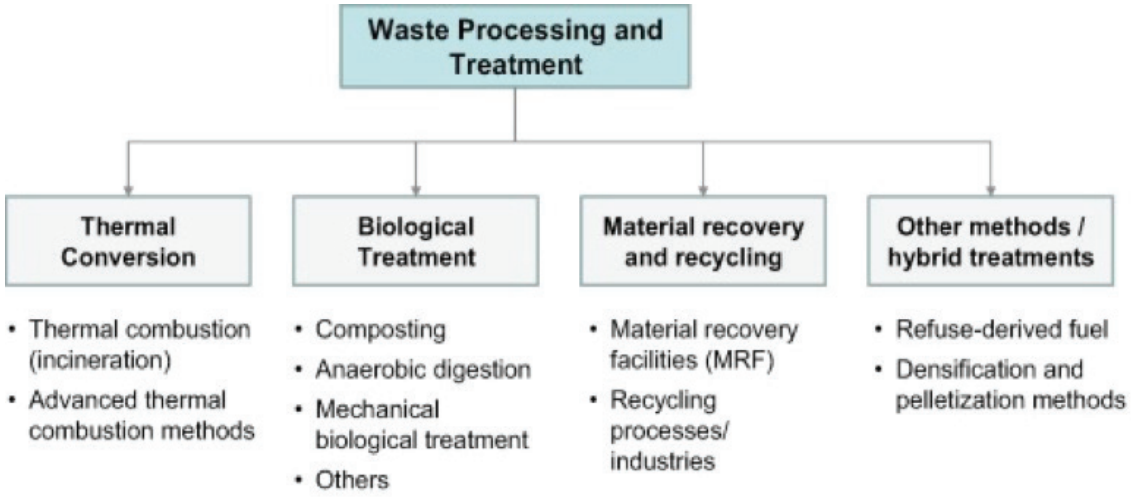

Figure 8: Construction waste processing and treatment (JoãoAleluia, 2017)

However, during construction phase it is necessary to ensure the waste management and recycling treatment plan of the structure for its operational phase. For example, recycled grey water can be reused in agriculture, firefighting, car wash, bathroom flushing and many more uses. At the same rain water collection can reduce water usage of the occupants. Grey waste such as biological wastes produced from daily life can significantly be used as fertilizer and is a resource of fuel and energy (i.e. bio gas) production to reduce energy consumption.

Economic Impacts

The construction cost and selection of materials has been measured in term of economic and social aspects at the early construction stages and it continues throughout the building lifecycle. The architects and engineers are working and offering ideas to design economically optimal structures. It ensures environmentally acceptable constructions with maximum benefits and minimum cost. Green development dependably offers utilization of manageable assets, recyclable nearby materials, monetary development frameworks and a consistent method to diminish cost. Notwithstanding, some sustainable developments are relatively higher at the underlying stage however without a doubt will gives a cost-benefit over the venture's lifetime and will balance the higher beginning expense. The technique and execution procedure of sustainable construction includes intensive management of man- hour and working period. This specific management results reduction of wastage of unnecessary labor & construction machines. Moreover, sustainable systems and practices are also followed in construction site work which improves work environment and workers productivity. Sustainable constructions is resource efficient and it reduces the energy waste by recycling materials and wastes hence it offers minimum economical waste to the occupants. (Retzlaff R. C., 2009)

Social Impact

Sustainable construction also includes creating buildings that allow user to continue enjoying the standards of living we experience today, while at the same time ensuring that future generations will have access to the goods and services needed for their survival. Sustainable construction is related to improvements in the quality of life, health, well-being and security. The social benefits of sustainable design include knowledge transfer, improved environmental quality, neighbourhood restoration and reduced health risks from pollutants associated with building energy use. Now a days, architects, engineers and occupants are being more interested and aware about sustainability in construction which encourages new business opportunities and have greater marketing potential.

Materials in Sustainable Construction

Introduction of sustainable materials

Since the construction industry is recognized as one of the largest consumers of natural resources and the biggest CO_2 producer with almost half of the whole emissions (Kibert, 1994) the relevance on how to decrease these impacts should be considered in each stage of every project. The correct selection and use of the materials and the importance of a passive architecture design are key factors to reduce the emissions involved in each project.

This chapter is going to analyze how materials define their carbon footprint in order to figure which aspects should be considered at the time of selecting the materials to be used. In the same way, this chapter will also make the focus on parameters and techniques that allow a good rational and passive architectural design reducing the use of mechanical sources.

Carbon Footprint

Since the mid-nineteenth century until nowadays, the construction materials evolved leaving the local simple materials normally used in the past to more engineered composites, mixed materials assemblies and unlimited use of chemicals to produce them. The shift also implicated the centralization of the materials produced in places where abundant and cheap resources can be found and their costs of pollution or ecosystem destruction are not taken into account. (Calkins, 2009)

The developing countries gather the perfect conditions for centralizing the production with abundant resources, inexpensive labour, and minimal environmental regulations. (Calkins, 2009)

What is more, a further consequence of this change in the industry is the fact that designers lost the interest of materials impact and they don't either know where the materials come from. (Calkins, 2009)

As shown below in figure 9, "the life cycle phases of construction, products, and materials" implicates at least three types of inputs, a whole material`s life cycle and many types of outputs that produce different environmental and social impacts. Those impacts produced, could be classified in at least seven groups: global warming, loss of biodiversity and natural habitats, air pollution, acidification, toxicity (ecological and human), deforestation and arable land loss, and water resource depletion and pollution. (Calkins, 2009)

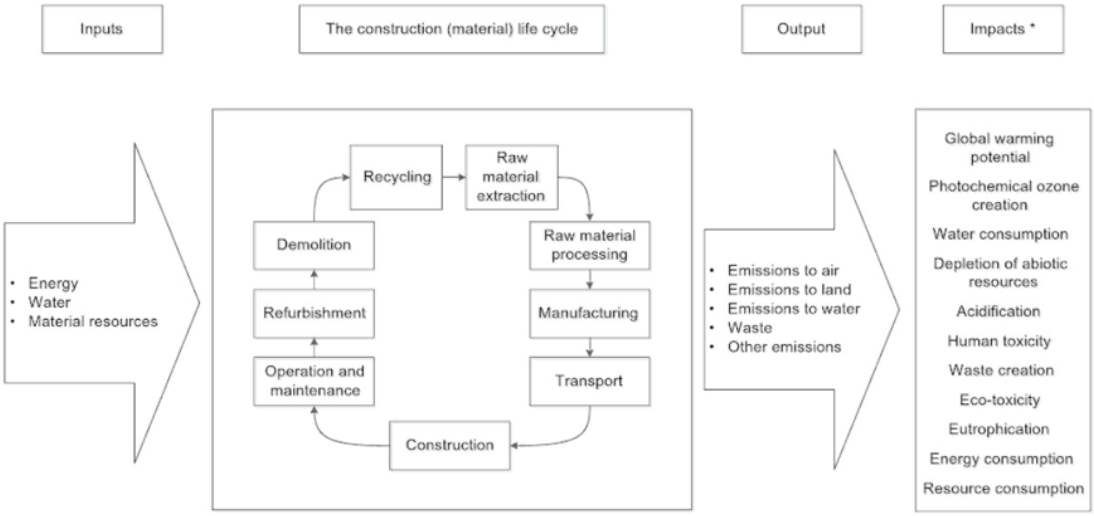

Figure 9: Life-cycle phases of construction, products and material (Khatib, 2016)

The global warming issues are related to a complete chain of use of materials extracting, manufacturing, transporting, installing, use, maintenance, and disposal. The loss of biodiversity comes after the clearance of land for construction or extraction of construction materials. Construction materials also contribute to air pollution by producing airborne particles and gases during the manufacturing process and transportation. During the same phases of the manufacturing process and transportation, the chain of construction materials affects the acidification by the production of gases like sulfur and nitrogen and to the toxicity by burning fuel fossil. The construction industry is also affecting the deforestation by using huge amounts of timber, and at the same time, the water resource depletion increased with the excessive construction of impermeable surfaces. (Khatib, 2016)

Due to all these reasons, more than ever the selection of the correct material for each part of the project should focus in the whole Life Cycle Assessment, leaving the past situation when usually the materials selection was predominated by the costs, availability, and aesthetics. (Khatib, 2016)

Impacts during the production and construction phases

The whole chain starting from the raw material extraction until the disposal affects in a different way many aspects of the environment and human health. It is important that the designer recover the consciousness that has lost about the impacts each material produces in the different phases. Early in the production chain, when the raw material is usually improperly extracted from natural resources cause damage to ecosystems and habitats along with a huge amount of waste generation and excessive use of energy. The construction industry uses more than three billion of raw materials every year and most of them come from extractive industries. Out of these only, 5% are from renewable sources. (Khatib, 2016)

Later, the processing of raw materials consumes a lot of energy and usually, non-renewable fuels are used for it. Hence, the production of raw materials leads to a large amount of greenhouse gas emissions to the atmosphere. In

the case of waste generation due to the processing of raw materials, the proportion of waste generated with respect to metals produced could be as high as 3:1. (Khatib, 2016)

During the manufacturing phase, materials are converted into different products through fabrication, assembly or finishing. These are done with much more efficiency in a more controlled industrial process which creates much fewer wastages than previous stages. However, they still consume a huge amount of non-renewable energy and emissions (like chemicals and toxic gases) to air and water. (Khatib, 2016)

Once the production phase is completed, the materials are transported from the source to the site during different stages of construction and these freight movements contribute up to 30% of greenhouse gas emissions in the product life cycle. This is due to the dependency on fossil fuels by most of the vehicles which are used for the freight movement. Hence, it is of high importance to select the mode of transportation and local availability of materials to assess the sustainability of construction material. (Khatib, 2016)

Furthermore, the construction phase is not free of impacts. Waste generation and pollution are common problems associated with construction activities. Laborers are exposed to harmful toxins and pollutant from the use of construction equipment and materials. Use of prefabricated building material may seem like a sustainable solution for this issue because of their production in controlled manufacturing processes. But in reality, this may lead the use of massive equipment and in turn, lead to increased energy consumption. (Khatib, 2016)

But maybe one of the most important links of the chain is the operation and maintenance phase, which is usually not taken into account. Operation phase is the longest period in the lifecycle of a building and it causes around 80% of greenhouse gas emissions. The HVAC system is the major consumer of energy used by buildings. About 32% of total global energy is consumed by the building sector and 19% of energy greenhouse gas emissions are caused by the same. Use of sustainable materials with better mechanical properties including insulation or thermal characteristics can improve the energy efficiency of buildings. Also, the use of renewable sources like solar energy can reduce the dependency of buildings on traditional fossil fuel-based energy. (Khatib, 2016)

In the same way, designers should be aware that every new change in the design produces impacts that should be measured. In order to keep up with customer requirements, buildings are often subjected to changes and enhancements. The renovation activities face the same challenges as in the construction phase. Renovation of buildings when the building is still in use may affect the health of occupants. Using sustainable materials during renovation can enhance the energy performance of the building. (Khatib, 2016)

The demolition as the final link of the chain is important in order to guarantee appropriate final disposal. Even though it consumes very less energy compared to the other stages of the life cycle of a building, demolition causes a huge amount of waste generation which is a threat to the environment. Demolition can generate up to two tonnes of waste per square meter. The wastes include solid waste, harmful metals and other pollutants which is often turned in to landfill. (Khatib, 2016)

But many times, after the demolition comes to a further sustainable practice that should be more and more boosted by the industry, which is the recycling. A high proportion of materials used in construction are non-recyclable. Construction waste may vary from 20-40% of all the waste generated, according to the country. However, a lot of materials can still be recycled and thus reducing the production of more raw materials. (Khatib, 2016)

Sustainability concerns when selecting materials

Depending on material's impact

In order to achieve a more sustainable industry, the production of materials should shift from the use of resources and fuels from non-renewable to renewables, start reusing and recycling and taking care of the life-cycle costs instead of only the initial cost. (Kibert et al. 2002). It should also implicate low or no human and environmental health risks. (Calkins, 2009)

In that way, the Life-Cycle Assessment (LCA) is a useful tool for designers which concerns about the impact each construction materials produces. The assessment accounts all inputs and outputs through a product`s life cycle allowing designers to have an accurate comparison between the materials. (Calkins, 2009)

The decision of choosing the right material to be used in a sustainable way directly depends on the location of the project, regional issues, project budget and the performance required. (Calkins, 2009) Each project is involved in different conditions so that it requires an individual assessment and decisions making to find the correct material to be used in an environmentally friendly way.

The parameters (figure 25 – appendices) in which those decisions should take place are defined by the different associations already presented in this publication (LEED, BREEAM, etc.) which assess the sustainability and possible certification of every project. They basically are grouped into 5 areas: 1) Resource efficiency, 2) Energy and Carbon, 3) Human and Environmental Health Risk, 4) Support social and general well-being and 5) Support for sustainable processes. (Khatib, 2016)

The first point refers to the relevance of choosing those materials that have high reusability or recyclability in order to reduce the need to extraction and production of new elements, and also the preference for those materials which have longer durability avoiding early replacement. (Akadiri, 2013)

After that, the selection should follow the levels of embodied energy in each material, trying to avoid those which require fossil sources of energy for their manufacturing. (Zhen-Yu, 2012) In the same way, the selection of local materials would aid by omitting the need for long-distance transportation. (Akadiri, 2013) This is related to energy and carbon consumption. Related to the human or environmental health risk aspects, the concern is to avoid or reduce materials that emit toxins, pollutants or heavy metals with the least impact not only on the long-term user health but only on a construction worker (Khatib, 2016)

But the selection should not only care about strict environmental aspects it should also focus on parameters involved to the contribution to social and general well-being, and in the same way to those materials that support sustainable construction processes. The fourth and fifth points refer to these topics.

Figure 25 shows a list of parameters that should be taken into account when selecting materials, gathered into five groups which attend different sustainable goals. It is a helpful tool for designers to have a clear and orderly overview of the aspects to take care of.

Rational design and passive architecture

A responsible way of designing in concordance to sustainable goals is also related to the strategies and decision taken during the first conception of the project. Decisions like reducing the size of a structure or by retrofitting an existing one, could save virgin resources and reduce the ecological rucksack of waste. In the same way, if the projects include the reused on-site or even in place of materials the transportation impacts are eliminated. But there are also other possible ways to get the material needed beyond the project site with low consumption in transport, reworking or refinishing. Fortunately, the exchange of material between local parties is more and more common nowadays, mostly thanks to the opportunities given by websites that connect both stakeholders. The increasing landfill`s costs lead to a growth in the material reprocessing facilities. (Calkins, 2009)

A new trend in many EU countries is the development of take-back programs in which manufacturers are required to take back and reuse or recycle the packing for their products. Furthermore, some companies offer take-back programs for their product as well mostly among carpeting and flooring manufacturers. (Calkins, 2009)

The installation of the materials can also be planned in a manner where the possibility of an easy removal allows reusing the same element in future construction. For example, the use of metal fasteners rather than welding. (Calkins, 2009)

Flexible design helps also to minimize future impacts due to refurbishments. The adaptability of sites with open plans and multiuse spaces allows owners to renew without the necessity of deep changes that require new resources. (Calkins, 2009)

The reduction of material used in new constructions can be also planned from the scratch of the project by designing smaller structures with fewer elements and modular material sizes minimizing the waste. The selection of durable materials with long useful life will avoid the necessity of frequent maintenance or either replacement. (Calkins, 2009)

A smart design which concerns about sustainability not only takes care of the impacts of each material but also use the features of different materials combined with the general design of the project. This idea is related with the concept of “passive architecture” which refers to those designing techniques that allow reducing every environmental, air, light and sound mechanical control by using the right material for each element of the project. (Architecture, 2014)

The design of each façade should be directly related to the orientation of the building taking into account the incidence of the solar radiation by affecting the light levels and the temperature of the spaces. For example, depending on the orientation of each façade could be necessary to design curtain walls, solar protection or sound barriers. (Architecture, 2014)

In the same way, the material used in every space should be the most appropriate one in order to achieve the environmental condition that that room requires avoiding extra mechanical efforts. (Architecture, 2014)

In the following pages examples for such those material is taken and contain additional information for the reader.

Alternative cement clinkers

For every ton of Ordinary Portland Cement (OPC) produced, a similar amount of CO2 is released into the atmosphere, that is roughly 6% of all man-made carbon emissions. Reducing emissions is needed on product cost of new regulations, green taxes and escalating fuel prices. In this regard, locally available minerals, recycled materials and (industry, agriculture and domestic) waste may be suitable for blending with OPC as substitute, or in some cases replacement, binders. Fly ash, Blast furnace slag and silica fumes are three well-known examples of cement replacement materials

that are in use today that. The first is a by-product of coal combustion, the second of iron smelting and the third of electric arc furnace production of elemental silicon or ferro-silicon alloys. (Imbabi, Carrigan, & McKenna, 2012)

Concretes with OPC substitutes can be classified in 4 groups:

- Reactive Belite-rich Portland cement (RBPC) clinkers
- Belite-Ye'elimite-Ferrite (BYF) clinkers
- Carbonatable Calcium Silicate (CCSC) clinkers
- Magnesium Oxides derived from Magnesium Silicates (MOMS) clinkers

RBPC and BYF are "hydraulic" clinkers, that harden when exposed to water, CCSC is a "carbonatable" clinker, that hardens when reacting with CO_2 gas) and MOMS is both hydraulic and carbonatable. (Gartner & Sui, 2018)

Ferrock

Ferrock is a concrete made 95% of recycled steel dust (which is normally discarded) and silica from ground up glass. When poured together, they react with the CO_2 in the atmosphere, creating an iron carbonate that binds this CO_2 into the material and adds to its strength. This process results in the material being carbon-negative, as it absorbs large amounts of CO_2 when hardening, more than the released CO_2 of its production. In this way, Ferrock locks greenhouse effect gases permanently.

The resulting material, stronger and more flexible compared to common Portland cement, is especially useful in environments with seismic activity. Chemically, it is relatively inactive, in the case salt water, the salt makes it stronger and there is no deterioration. Given its sources from waste, it is also a much cheaper alternative. (Bonnefin I. , 2018) (HRL Tech, 2019)

Organic Concretes

Hempcrete

Hempcrete is a firm, self-insulating material made of a renewable biomaterial such as shredded hemp shiv, bind with natural hydraulic lime (an abundantly quarried material) and a small proportion of cement. The carbon from the hemp production, as well as the residual one from lime production, are offset and reabsorbed as the lime cures, making this material carbon-negative. As an insulating and breathable material, it regulates humidity and temperature in buildings. It can be used as an infill in timber frames and can produce floor slabs if an aggregate is added. (Abbott, 2014)

Timber Crete

Timber Crete is a material made with a mixture of cellulose (recycled timber or sawdust), sand, cement and binders, in a process that traps carbon, producing structural blocks in a variety of shapes, sizes, etc. Sometimes blended, the sand is selected to increase the load bearing capacity (MPA) and prevent the entry of water. Density and performance are improved with Portland cement and other materials that also help in waterproofing, including a non-toxic "deflocculte". (Timbercrete Pty. Ltd., 2015)

Timber Crete's embodied energy is substantially lower, compared to clay-fired bricks. It has all the advantages of traditional masonry, but compared to masonry bricks, blocks and panels, its insulation value (R) is higher. It has a slow release of stored thermal energy, known as workable thermal mass. Structurally, it has higher resilience and its breaking load resistance is higher than concrete products and unreinforced clay, in comparison to these, it is up to 2.5 X lighter and has the workability of timber when nailed or screwed. In terms of fire resistance, it outperforms clay, concrete blocks, steel, and timber construction, with the highest possible fire rating. Constructively, it is reinforced with strapping, and finished with different sealers for exterior and interior walls.

Earth-based walls

Cob

Cob is the simplest earth-building technology, consisting of wall creation by mud molding and piling without internal structure or formwork. The mixture is similar to mud brick, but with a higher content of straw, that makes it stiffer and helps mud keep its shape when piled. The shape is given with hand or trowel atop a structure of about 45 cm height surrounding the building's perimeter. A pitchfork or cob fork is also used.

Rammed earth

This thousands-of-years-old technique consists of compacting soil with simple tools to produce structures the equivalent of sedimentary rocks in its hardness. These walls are built in more humid, damp climates, where fabrication of adobe bricks is impossible, the used soil is the same in both cases, being most suitable with small aggregate of gravel,

along with clay, silt and sand. The content of clay, which ranges 15-18%, determines waterproofing and durability properties. In rammed earth, the preferred content of clay is higher than in adobe bricks. Initially, in rammed earth walls there is a lower moisture content, making them less likely to dry or shrink. (Niroumanda, Zainb, & Jamil, 2013)

Adobe

The energy investment in adobe's materials is quite low. Adobe brick walls present advantages in security and solidity. Their sound-transmission levels are very low, their thermal insulation levels are high, and they are fireproof. On the other hand, a major disadvantage of adobe walls is the wall thickness that reduces usable space in the interiors. (Niroumanda, Zainb, & Jamil, 2013)

Natural materials

Straw bales

Straw bale is a simple method of construction reappearing in the 21st century. As waste from agriculture, straw is commonly burned or buried by farmers. Its use in construction represents an alternative to finite resources depletion, and an option cheaper than traditional materials and prone to decrease in price even more in upcoming years due to its increased use. Thermal-dynamic and life-cycle assessments have shown that straw bale buildings have an outstanding thermal performance and low embodied energy. ECO46 assessment shows characteristics similar to low energy construction standards. Nonetheless, in summer, straw bale constructions require attention to manage overheating. (Chaussinanda, Scartezzinib, & Nik, 2015)

Mycelium

When dried, the thin fibers of fungi that run underground are used as a strong building material with fire, mold, water- and fire-resistant characteristics. Mycelium is added to crop waste and the mixture is put in molds, grown into particular shapes. Processes are thus reduced. It can be grown into furniture, bricks or made into a composite board (Myco-board) that can be used like MDF (without the toxic formaldehyde of this, a cause of respiratory illnesses). A brick of mycelium is can take around five days to grow and be used, but its development is still undergoing. Its compressive strength is 30 psi and thus cannot be compared to that of concrete (4000 psi). However, it is stronger than concrete if compared with relation to its weight: a cubic meter of mycelium weights 43 kg, and one of concrete 2400 kg. (Bonnefin I. , 2017)

According to electron testing with microscope scanning, another possible use of mycelium is to replace polystyrene foam. Compared to the latter, it produces around 8x less energy and 10x less CO_2. Mycelium is a 100% biodegradable and non-toxic material, and at the end of its life cycle it can be easily be recycled. (Arifin & Yusuf, 2013)

Sustainable Renovation

Most of the buildings we use now are old. Also, there were no particular energy standards prevailing when most of the residential building stocks were built. So, a majority of buildings have inefficient, outdated systems for functional operations which consume lots of energy, hence they cannot meet current energy standards. They consume a huge amount of energy mainly due to lack of proper insulation, outdated heating and ventilation systems. Another problem is the health and comfort of the inhabitants living in old building stocks. Also, the existing old buildings lack the functionality that the occupants need. Sustainable renovation of the existing buildings will help the governments to achieve their energy targets and reduce CO_2 emissions.

Renovation of old buildings is an essential part of smart growth. The uncontrolled growth of the city will lead to its expansion to more and more green areas in the outskirts. Renovation of existing buildings will help in utilizing the existing building stock of a city to the maximum and thereby limiting the urban sprawl. Also, instead of demolishing the existing and constructing a new building, reusing by a renovation of the existing building is more carbon efficient. In a sustainable context, the existing buildings should be treated as cultural resources and valuable assets of human activity which can be recycled for other purposes. (Ryu, 2014).

Sustainable renovation can be defined as "a process of conception and works in order to transform an existing building to fulfil the requirements of protecting the environment and the health of its users and taking into account the social and societal needs while achieving economic viability" (Labadi, 2014). The goals of sustainable renovation are:

- Improving the comfort, well-being and the quality of life
- Reducing energy consumption and dependency on fossil fuels
- Enhancing natural resources
- Reduce the amount of waste generated (Trachte & Salvesen, 2014).

Air tightness

Although there is an increase in the level of insulations used in buildings over the past decades, there is no point in adding more layers of insulation without making the building airtight. If the building is not properly sealed, the heat will pass through gaps and holes regardless of how much insulation is provided. Even if the building is built tight, improper ventilation may lead to bad indoor air quality, dampness and growth of mould. It is common to blame airtightness for these conditions, but it is actually because of inadequate ventilation. (Morgan, 2018).

A large amount of heat is lost due to air gaps. If considered separately, almost 40% of heat loss in a building is caused by draughts. As a result, for every 100€ spent on heating, 40€ is caused by air leakage. Significant savings in heating and carbons emissions can be achieved by making the building more airtight. Furthermore, increased comfort levels can be gained by better control of conditions inside. The building will be less influenced by external climate and danger of fabric deterioration can be decreased. (Morgan, 2018).

- Buildings can be made airtight by considering the following factors during renovation:
- During design, the air control layer should be depicted in all drawings. Also, identify the possible points of infiltration and batch them to focus on the regions where works are required to be done (Morgan, 2018).
- Replacing the sealing of windows and door is the most cost-effective way of sealing a house. If the old sealing is in bad condition, this replacement will lead to significant savings. Sealing the joints between windows or doors and the external wall is another easy way of saving energy (Häkkinen, et al., 2012)

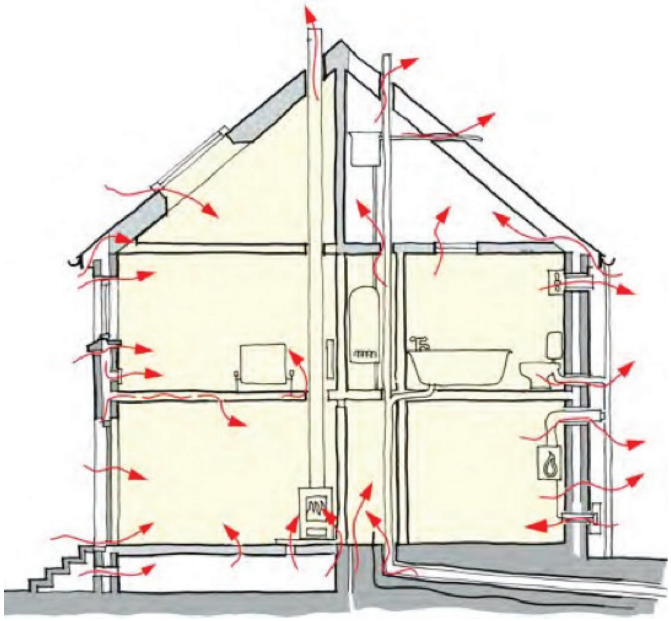

Figure 10: Different ways of air infiltration and heat loss due to gaps (Morgan, 2018)

- Proper sealing should be provided to holes for ventilation, electrical installations and water and wastewater channels (Häkkinen, et al., 2012).
- Pressurisation test, which can assess how airtight a building is, should be carried out twice. The first at the point when all airtightness layers have been introduced, yet before these are enclosed by other finishes. The second towards the completion of works (however not so late that there is no time for corrective works!) (Morgan, 2018).
- It is useful to use thermography during the pressurisation test is carried out to check whether there are some concealed issues (Morgan, 2018).

Figure 11: Pressurisation test (Morgan, 2018)

Space

Space in structures is costly. We pay to frame a protected and weatherproof building around it, we pay to fill it with both pragmatic and alluring things, we also pay to keep it warm and comfortable, and we likewise pay to preserve it and keep it clean. In certain conditions, we pay to fix, redesign and replace portions of it and for some situation to wreck it. It pays, in this manner, to contemplate how we can utilize space as successfully as possible. (Morgan, 2018).

If the property is big enough, there are different ways to utilize the space and create monetary benefits out of it. One of the underused rooms can be offered to lodgers or friends or with elderly relatives who live alone. One of the other issues that impacts space, is clutter. Most people get overwhelmed by the mess and expect that the best solution is to stretch out their property to determine the issue. It once in a while does, though putting the time in 'cleaning up' and better-stockpiling choices is less expensive and beneficial. It isn't the absence of room that is the issue, yet the view of that space. Storage at that point turns into a vital subject since efficient storage not only just helps maintain things in control, but also encourages a simpler life with a potential decrease in mental pressure. Sustainability in housing and retrofit is not all about better energy efficiency, health and comfort. (Morgan, 2018). During renovations following proposals can be considered to achieve more sustainable spaces:

- Allocate space to grow and store food
- Spaces for making, fixing and maintaining things
- Spaces for recycling and reusing materials and installation of composting barrels for organic wastes
- An arrangement of living spaces for flora and fauna by adding small water bodies, planting more trees, bushes, plants for birds, bees and butterflies etc. (Morgan, 2018).

Time

Most of the space we paid for is really unfilled or under-utilized for much of the time. Even though there are a different kind of occupancy patterns, we still spent a lot of money to maintain the space warm and clean. During refurbishment, efficient design can help in achieving better multi-purpose rooms with more innovative and engaging use of space. The idea is to consider separate functions and combine them wherever possible. There is no point in building an expensive guest room extension for parents or relatives who only show up a few times in a year. Use of a fold-down double bed in an already available study room could be a solution for this purpose. The usual desire for unsuited bathrooms is not so good for sustainable housing, whereas "Jack and Jill" bathrooms which have two doors, allow the occupants to utilize the space separately while permitting the alternative access from the rest of the house when required. (Morgan, 2018).

This strategy can also be used in case of furniture and can make it do more than one function when needed. Sofa-beds is a good example for this purpose, but other alternatives should also be considered which can unlock space in a house (which is under-utilized) and contribute storage spaces. Use of bed with a raised platform can create more storage space, extendable tables and foldable chairs could be used for big groups only when it is required. Another aspect of time is opportunity. If several houses in a multi-family housing have plans for renovations like the filling of cavity walls, improvement of roofs etc, it is economical to utilize the opportunity to do renovations required for the house at the same time while the scaffold is up. (Morgan, 2018).

Heating

Renovation of the heating systems is usually done when the existing system is at the end of its technical life cycle. Under other conditions, renovation to the heating system is done to change the whole system to a more energy efficient system. In this case, technical lifetime is still not over for the system components. There are many circumstances for the selection of a particular heating system. These situations may vary according to the expansion in the district heating network, and technical changes are made to the existing building. However, regardless of which system is selected, it's important to maintain the heating system in good condition. And when it reaches the end of its lifetime, possible alterations are considered. Economic feasibility studies should be carried out before the alterations for heating systems because they are technically large operations.

The following aspects should be taken into account while planning a renovation for the heating system. (Häkkinen, et al., 2012).

1. The present condition of the heating system like losses in heat production, the lifetime of the system and components
2. Whether there will be any rise in price for the planned fuel in the future
3. If there are any environmental effects for the planned fuel
4. Understand the technical requirements for the heating system renovation
5. The amount of maintenance essential for the system (Häkkinen, et al., 2012).

Building heating plants for each building has a big environmental impact than the district heating. Buildings can be connected to a district heating system by considering the availability and cost of the connection. Renovation using centralized geothermal heat pump system is also a sustainable way of heating. A geothermal heat pump utilizes the heat of the ground. By horizontal piping, installed to one-meter depth, from a vertical hole drilled into the solid rock, can extract the heat from the ground. With the help of a circulating heat transferring fluid, heat is transferred into a heat pump. It can be used for floor heating because of the low operating temperatures than radiator systems. (Häkkinen, et al., 2012).

Another method is to attach solar heat into water-circulated oil or electric heating system. In this method, the solar energy heats the heat transferring fluid in the solar collectors. The heat transferring fluid then transfers the heat into the heat storage tank or a boiler. The circulator only starts when the temperature is much more than the temperature in the heat storage and stops when the temperature in storage is adequate. The solar collectors are normally oriented between south and south-west. Also, with the help of supporting frames, collectors can be installed to the right angle. The main components used for this kind of heating include solar collectors on the roof, the distribution circuit and a storage tank. This method can be used for hot water production or for heating of spaces which will reduce the energy consumption of the building. (Häkkinen, et al., 2012).

Ventilation

An effective ventilation system will provide good quality air and better comfort inside a building by removing impure inside air and harmful emissions from interior materials. During a renovation, a heat recovery system should be equipped along with a mechanical ventilation system since it can reduce the heating and cooling demands of a building. This system utilizes the heat from exhaust air a warm up the supply air. They can recover about 80% of heat from exhaust air which will increase the energy efficiency of the building. Furthermore, it is very beneficial to moisture-prone home since it can replace the humid air with fresh air. However, renovation of a ventilation system requires a feasibility study and it should not decrease the indoor air quality. (Häkkinen, et al., 2012).

The buildings that have only natural ventilation are provided with a new mechanical ventilation system. New ventilation channels should be built and the demolition and installation work of such large scale, will be costly and the new system should abide by the current building regulations. During the installation of new systems, the structures which are not airtight should be sealed properly to avoid the reduction in the efficiency of ventilation and wastage of heating energy. (Häkkinen, et al., 2012).

By making sure that the components of the ventilation system are working at their design values, and by making small adjustments and proper maintenance energy consumption can be reduced. Refurbishment of ventilation systems includes removing and changing unfit system components, fixing and renovating parts in need of maintenance, improving quality standards and eliminating detected problems. Inadequate airtightness of windows and unsatisfactory design of the air distribution causes draft-related problems. By considering energy efficiency, it is not possible to eliminate the effect of poor windows with improvements in a ventilation system. The energy consumption of the ventilation system increases, when the air flow rates are increased due to the basic adjustments. (Häkkinen, et al., 2012).

Lighting and Appliances

In order to achieve sustainability during a renovation, the efficiency of lighting and electrical appliances should be also taken into account. There are three major motivations for this. Firstly, electricity from the national grids are usually expensive and are dependent on fossil fuels which lead to greenhouse emissions. Secondly, due to the huge consumption at certain peak times, there will be considerable pressure on the grid, and it is better to reduce the pressure on the grid. Finally, the exponential growth in energy consumption is expected to continue in the future because of the rapid increase in the use of electrical gadgets and electrification of transportation. Hence, any measures which can mitigate this issue is to be welcomed. (Morgan, 2018).

Avoiding the need for electricity

The best way to minimize energy consumption is not to need it in the first place. The idea is to utilize the availability of sunlight as much as possible to reduce the dependency on artificial lighting. In countries where there are long winter and short days, this can even enhance the mental health of inhabitants. Large windows can help in the entry of more sunlight into the room and curtains should be drawn fully back from windows for the same cause. In the case of darker rooms, more windows can be added if the renovation is extensive. Use of white window frames and small ponds will reflect more light into the interior. Window glass should be cleaned or replaced if needed which will enable more penetration of light. If possible, roof lights can be added which is much better than vertical windows in letting the sunlight into the room. Furthermore, if interior finishes need renovation, application of light finishes can enhance the overall lighting level in the room. External shading should be provided for too big windows because it may lead to overheating of the interior in well-insulated homes. (Morgan, 2018).

Component Efficiency

The use of electrical gadgets and appliances is increasing day by day, so during renovation its crucial to use the appliances which are more energy efficient. Traditional lamps like incandescent and CFL should be replaced by LED lamps which only takes minimal energy, gives more light output and better lifespan. During the purchase of new appliances, those with good energy ratings could be selected, Automated lights can be installed in places where lights can be left on, which turns off automatically when not needed. An overall reduction of 10% in energy consumption can be achieved if the lamps and associated fittings are cleaned and well maintained. In the case of electrical and communication equipment which are subjected to frequent upgrade, providing service voids or running cables within conduits will enable easy upgrade with less disruption, expense and waste. (Morgan, 2018).

Renewables

The first thought that comes to the mind while considering renewables is a solar panel on the roof. But it is only one of the factors that should be taken in to account. New developments in technology are making the renewables more efficient and inexpensive but they should be considered only after reducing the overall energy demand of the building as less as possible. Electricity can be generated renewably by utilizing the solar energy, wind and rivers – using photovoltaic panels, wind turbines and hydropower plants respectively. In renovation projects, wind and hydropower are not usually considered, but solar energy is an integral part of retrofit works. (Morgan, 2018).

Solar panels which bear a resemblance to traditional slates or tiles can be used for better aesthetics. The panels are more efficient when installed due south at an angle between 30° and 50°. During design, panels should be well positioned for avoiding shading from nearby buildings or foliage. It is cardinal to get quotations from multiples companies who will deliver design and estimations of energy output. Companies would also provide guidance on inverter, storage and grid connection possibilities which are important constraints which should be considered. When the project is not off-grid, the excess electricity produced can be contributed to the main grid and receiving it back at times of low production. It can be financially profitable in cases where there is a large area available to install more panels. (Morgan, 2018).

Case Study: Pardis Khaneh

Tehran is the twenty-fourth most populous city in the world with 8,848,000 citizens. According to the latest census data of March 2017, the daily population of Tehran is 13,260,000. The average density in Tehran is 973 people per square kilometre, and in the centre of Tehran there is an increase to 10,000 people/km2.

Green space is the more important issue in urban life, especially in the big cities. Development of green spaces can play the main role to reduce and balance the air pollution. Centralization in Tehran has caused many problems for citizens such as traffic, air and noise pollution (iribnews, 2017) (Sawe, 2018).

According to the WHO index of air pollution with 91.34 (annual mean ambient PM2.5 ug/m3) we can see Tehran is in the high level of air pollution (Nambeo, 2016).

The share of each person in Tehran for green space is between 7 to 12 square meter per person which is less than the United Nations Environment Index (20 to 25 square meters per person) (daneshnameh.roshd, n.d.). At present, Tehran Parks and Green Space Organization attempts to achieve sustainable green space development and improve urban environment. Planning processes are implemented in accordance with the criteria and indicators of sustainable urban development (Feizi, n.d.).

Residential land in Tehran is very expensive and the construction potential is high, so sustainable development and use of environment-friendly materials is the main criteria in the construction industry. Accuracy in planning and supervision of construction should always be considered. In the past in Iran the average life cycle of the building was 40 years and owners only paid attention to the economic aspects of investment. Today, the government and the people are more attentive to sustainability and the environment and with following the new guidelines, we are witnessing the successful projects in terms of sustainable development. In recent projects, we have seen that pursuing sustainable rules has not overshadowed economic issues, and owners are more willing to move towards sustainable development.

Project Information

Project name: Pardis Khaneh
Location: Jordan, Tehran
Architects: Nima Keivani & Sina Keivani
Executer & Investor: Khak group
Site Manager: Mehdi Khosrovani
Architectural Supervisor: Nima Keivani
Project Manager: Mehrdad Amini
Land area: 415 m2
infrastructure: 2650 m2
Residential Units: 10
Unit Area (m2): 122 ~ 132
Project Year: 2017

The reason for choosing this project as a Case Study is the **Pardis Khaneh** is one of the distinguished construction projects in Tehran with the highest criterion of sustainability. This project is located in one of the busiest neighbourhoods in northern Tehran and is different from the rest of the region's projects in terms of the method of construction and appearance. This project has had a record sales in that region, and units have been sold 27% higher price than other expensive projects in that area.

Pardis Khaneh is a residential project having 5 stories above ground devoted to 10 units. The project was located between two public gardens in both north and south sides. In order to link the two gardens, the whole project was designed as a connective vertical garden, which has drawn its design inspiration from Persian gardens, especially Bagh-e Takht in Shiraz. The facade is a combination of a simple planar surface that completely encloses a volume by making diagonal section cuts. The main surface is a lattice made of wood carving which is cut in some points to reveal the stone volume. The wooden surface has a special pattern design inspired by the growth of plant leaves, metaphorically the cedar, while the other surface is totally covered by turquoise stone, with it's unique colour that has always had a significant role in Iranian gardens either used as tiles or the existence of water itself. (Keivani, 2019)

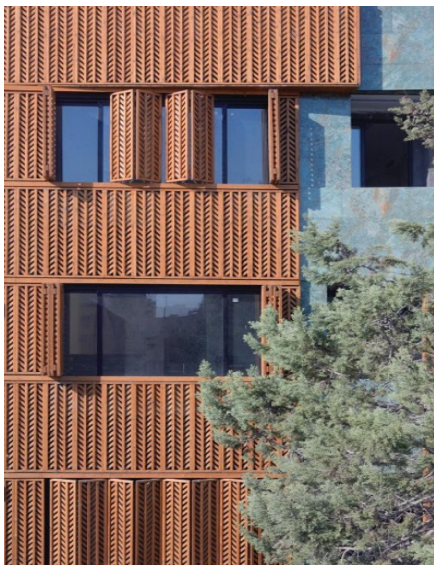

Figure 12: Northern façade of Pardis Khaneh (Keivani, 2019)

The mentioned concept in volume design, the diagonal section cut, is also reflected in interior spaces like walls of corridors or leaving rooms. The terraces covered by turquoise stone have created a link between the outer and inner space, they are all made of glass enabling the residents to have the entire view of green outer space beside the joy of attractive patterns created by sunlight. Like the main planting pattern of a hanging garden, there are cedar trees on the

facade planted on the floors. The dynamic wooden lattice is so flexible that can be opened or closed by users to adjust privacy. There is a small garden in the lobby and in the backyard there is a sunken courtyard surrounded by floored trees, with a small pond inside. The special attention to gardens is also seen on the roof of the building. (Keivani, 2019)

Sustainability in this project

Energy saving

- The use of foam concrete as an insulation material on all floors before final flooring to prevent the exchange of thermal energy between floors.
- All the windows are double glazed with thermal break frame.
- All mechanical piping is insulated by Rockwool.
- All walls are made with bricks of LECA (Light Expanded Clay Aggregate)
- The double-skin façade controls the sunlight and helps to conserve energy
- Intelligent electrical system (ABB-Germany) is installed in the building

Material

Nearly all the materials used in this project are environmentally friendly and recyclable, such as wood, iron, stone, aluminium, steel and concrete.

- Steel structure with steel deck is used in this project for skeleton and slabs
- The exterior skin of façade is made of German thermowood (BAU). This timber is durable and resistant against climate change.
- Thermal break aluminium windows
- Cast-iron pipes are used for the disposal of sewage
- An extremely durable timber (IPE Brazil) is installed in the roof garden. This kind of wood is 100% natural wood decking and 8 times harder than California redwood trees.
- In some parts of the main façade's skin, Turquoise marble stone (from Mashhad-Iran) is used, as well as other marble and travertine cladding.
- The floors of the units are made of natural wood.
- All walls are made with LECA bricks (Light Expanded Clay Aggregate)
- Steel decks are covered by concrete (Keivani, 2019)

Construction Technologies

The specialized software for project design has been Revit and step by step all the patterns have made as a 3D model before construction. The façade is moving and is adjustable by the user, therefore before construction, Studio Keivani made an animation of all models of facade's movements.

Figure 13: Façade inspired by the growth of plant's leaves (Keivani, 2019)

All elements of exterior façade's skin are designed and made by Keivani engineering team. The maximum distance between vertical timber in façade is 8 millimetre and iron is used inside the vertical timber frame to prevent the buckling over time to enhance the durability. Most design and execution prices have been linked to BIM technology. (Keivani,

2019)

Grey water purification

The building is equipped by a water purification system. All wastewater from the bathroom and kitchen are purified to irrigate the entire building plants. The pool water is 100% purified.

Intelligent Drip Irrigation System

Drip Irrigation System is working with the main panel controlled by individual software that is adjustable based on the species of each plant and the amount of water needed. In the roof garden, the anti-root drainage system is used.

Safety technology

All electrical wiring are equipped by Children Care fuse (Schneider-Germany). The Children Care fuses will disconnect electrical power immediately if touched by any person.

The emergency electrical power is installed in order to light the staircase, corridors and common area, in addition, the elevator is equipped by UPS battery to supply power in an emergency situation.

All common areas are monitored by central CCTV.

Fire detectors and Fire alarms based on the firefighting guideline is installed in the necessary places (Keivani, 2019).

Summary

Although it is difficult to achieve a 100% sustainable construction in reality, in this project with more investment in sustainable design and attention to the principles of sustainable development, the positive impact of implementing these measures can be seen. The development of green space has been the main goal of the designer for Pardis Khane. Now, in one of the over-polluted neighbourhoods of Tehran, it is possible to relax in the roof-garden and take a deep breath. In addition, the usage of environmental-friendly materials with natural resources and durable quality helps to reduce the pollution of nature in the long term over the whole life-cycle of this particular building. At present, due to the limited natural resources and commitment to the next generation, the demand for a more sustainable way of building is increased and the building trade is a great consumer of natural resources. Therefore, in this building the target has been to choose the durable materials based on their recyclable property and most of the implemented materials are green with the lowest environmental impact and minimum manufacturing pollutant levels.

Case Study: Jabal el Zeit wind farm and Benban solar park

Introduction of the projects

Project names: Jabal el zeit wind farm / Benban solar park

Location: Egypt

Landscape Areas: 35 km^2 / 37,2 km^2

Owner: New and Renewable Energy Authority

Project years: 2017 / 2019

During 2014, Egypt was facing a crisis that threatened all key sectors as there was a continuous never-ending electricity blackout which made daily life for most citizens more and more complicated. The political leadership categorized the electricity and power demand as a national security demand and an immediate plan has been developed to increase the capacity of the national electricity grid and provide power to all sectors in the country and as soon as possible. (Gadall, 2018) An overall budget of 515 billion Egyptian pounds (EGP) was allocated for improving electricity sector of which 433.5 billion EGP was allocated for the generation, 54.5 billion EGP to support the transmission network and 27 billion EGP to upgrade the distribution network. And in summer of 2015, the dream became true and the government was able to provide reliable power to all sectors without any further blackouts which had a great impact for providing the investing environment and political stability. The current Egyptian administration is eager to maximize the use of renewable energy as a source of clean and affordable energy in the long term. (Gadall, 2018) Sustainable renewable power sources (like wind and sun-based power) will decrease the contamination caused by the regular thermal power producing stations which may produce vast volumes of oxides of nitrogen and carbon (CO_2). (Shumkov, 2015)

Wind Energy

The Gulf of Suez is viewed as a prime worldwide area for on-shore wind energy because of its unique air currents and high velocity. The Egyptian government, in coordination with the Japan International Cooperation Agency (JICA), established the largest wind farm in the Middle East and Africa located in Jabal el Zeit on an area of 700 sq.km. It features the latest turbine technology in the world with a capacity of over 200 megawatts. (EGYPT, 2018)

This installation will be the first wind farm executed under a 'BOO' scheme (Build, Own and Operate). KFW Bank in Germany and the European Investment Bank (EIB), as well as the European Commission, financed the project with more than 270 million USD over a 30 month period. The plan contemplates private sector participation that will reach 60%. (Shumkov, 2015)

The wind park consists of 100 pieces of 2-MW turbines that have the combined capacity to generate up to 800 GWh of electricity per year. This would cover the annual power needs of about 500,000 people. (Shumkov, 2015)

Figure 14: Jabal el Zeit wind farm (MacFarlane, 2018)

Solar Energy

To reach the Egyptian government goal of generating 20% of the total electricity grid from renewable resources by 2022, the largest solar complex in the world is being constructed in Benban village located in Aswan governorate. The Benban solar park is huge, 37.2 km^2 and consists of 41 plants with a total capacity of 2000 megawatts. The private sector investors have signed agreements to implement solar projects with a capacity of 1465 megawatts. (Raven, 2017)

The task got financing from Bayerische Landesbank (BLB) for 85% with the other 15% from Arab African International Bank [ar] (AAIB). The German government has given Euler Hermes trade credits (ECG), covering the BLB advance. As a major aspect of the German outside exchange advancement program, it bolsters Egypt's objective of meeting more than 33% of its vitality necessities by 2035 through sustainable power sources. (PRABHU, 2017)

The Benban solar power plant will help Egypt implement its massive potential for solar energy, and is expected to employ 4,000 people once it is fully operational. (Mbogo, 2018)

Figure 15: The Benban solar park (Mbogo, 2018)

Summary

Energy demand is rapidly increasing as a vital catalyst to wider social and economic development enabling better health, education and creating jobs. The era of heavy reliance on fossil fuels has come to its end. The renewable energy solutions in mitigating climate change has been widely proven. Transitioning to renewable energy resources supports significant progress on the Sustainable Development Goals (SDGs) not only for the seventh goal, affordable and clean energy but also for other goals related to global warming, air quality and human health. Sooner or later all nations will adopt renewable energy strategies.

Some of the benefits of the renewable power sources

Provide power with very low carbon dioxide footprint

Provide a good model for clean energy to follow for the industrial sector in Egypt to compete with other polluting sectors

Opportunities for national investments to contribute to the construction of the project, thus stimulating the local economy

Case Study: Galata Bridge

Information:

Project name: Galata Bridge.

Location: Istanbul, Turkey.

Engineering designed by: STFA Construction CO. (Sezai Türkeş and Feyzi Akkaya)

Total length: 490 meters

Width: 42 m

Longest span: 80 meters

Figure 16: Galata Bridge nowadays
(Source: https://rustytraveltrunk.com/galata-bridge/)

According to statistics, the average life of a bridge is 70 years, and in Turkey it is typical to rehabilitate the bridge at the middle of the lifespan. Noticeably, the biggest problem is corrosion of decks and it is indeed an expensive problem, it costs for inspection around 1000 U.S. dollar and 1.5 M for replacement meanwhile, the cost of maintenance exceeds 130.000 over 40 years. One of the most crucial bridges in Istanbul history is called Galata Bridge, it is the longest bascule bridge type in the world and built in duration of 1985-1993 after replacing old pontoon-type bridge and the wooden bridge that had built in 1912 and 1836 respectively. (Bozdag, 2006)

However, after it has been in service for about 5 years, many dangerous deformations and cracks have been noticed on the flaps of the bridge. Some improvements like modern Portland cement and additives combined with steel rein-

forcement have been used to sustain the stabilization. The Galata district contains many heritage sites and historical buildings, and makes a strong connection between the old and new centres. I specialized in research on the Galata bridge by making some of experimental stress and tests on the flaps after the last renovation. (Bozdag, 2006)

Background of the Bridge

The purpose of building a bridge over the Golden horn is to link both sides, there were planning to construct the first bridge in 1502 by Sultan and Leonardo da Vinci, however, it was planned to construct a bridge on the Golden horn in 1502-1503.

Sultan Bayezid II requested Leonardo da Vinci to design a bridge for the Golden Horn. But this bridge was not constructed as the approval of Sultan was not received. The Sultan assigned the same task on Michelangelo but the craftsman refused this offer. The Bridge of ''Hayratiye'' was constructed between Azapkapı and Unkapanı by Sultan Mahmud II in 19th century. Then, this bridge was also demolished and the second bridge in 1863, the third bridge in 1875 and the fourth bridge in 1912 were constructed in the place of this bridge. (Demirarslan, 2017)

In the place of fourth Galata Bridge which burned in 1992, the fifth Galata Bridge was constructed in 1994. Today, it has become traditional icons of Istanbul and new Galata Bridge which links two cultures carries a figurativeness characteristic as it links new Istanbul with old Istanbul. (Demirarslan, 2017)

Galata wooden bridge

The wooden bridge was rebuilt four times, the first and second were quite similar in term of shape and the pattern and the third and fourth were embraced with steel plaques and the length of the bridge was around 480m with 14 meters width rested on 24 pontoons to let the ship passes from a side to another needs to shift the pontoon. It was periodically reconstructed nearly every 18 years (Demirarslan, 2017).v

Figure 17: Wooden Galata Bridge in 1880s

(Source: https://www.pinterest.com/pin/170433167124906732/)

Galata Concrete type of bridge

Recently, Galata Bridge was constructed on the same zone along seven-years' time period from 1985 to 1993), they changed the old one because of collapsing after 9 decades of taking a service. The bridge was built on a hollow steel pile with quality S355 with minimum yield strength 355 MPa (see table 2) (Piling, 2018).

Table 2: Grade of Steel piles (Piling, 2018)

Steel Grades for Sheet Piling

Mechanical Characteristics				Chemical Composition				
Material	Minimum Yield Strength	Minimum Tensile Strength	Elongation	C	Si	Mn	P	S
	Mpa	Mpa	%	%	%	%	%	%
European Standard EN10249								
S235	235	340	26	0.25	-	1.4	0.035	0.035
S275	275	410	22	0.27	-	1.5	0.035	0.035
S355	355	480	22	0.27	0.55	1.6	0.035	0.035

The bridge has two decks and contains two fundamental longitudinal beams crossed with fourteen girders in perpendicular direction. The deck plate formed with trapezoidal ribs to strengthening the plate of deck, and the plate thickness is varied, it's around 12 mm to 40 mm ribs to strengthen the deck plate. See figure 18. (Ozden Caglayan, 2015)

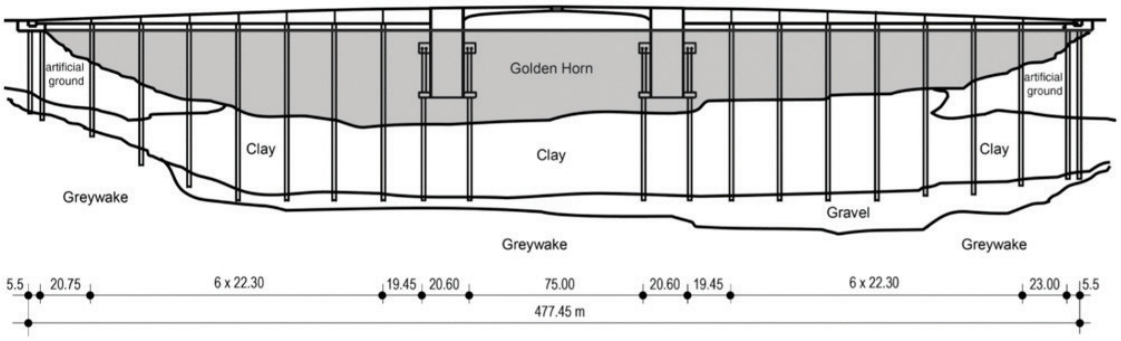

Figure 18: Side view of Galata Bridge designed with steel piles (Ozden Caglayan, 2015)

The Flap Plates

Four towers equipped with linear beams, where the control rooms are located in on support for crossing ships. Flaps are opened by hydraulic actuators, that shift the longitudinal beams clock and anti-clockwise directions around two bearing points to assist the manoeuvring movement-opening and closing processes- of the flaps. (Ozden Caglayan, 2015)

At the last three cross girders, the concrete counterweight, which is suspended to them is nearly 1,600 tons. Additionally, the bridge has front and rear locking systems in order to keep opened positions of the flaps. The counterweight is rested on steel piles which support all above. Recently, some of cracks occurred in the steel piles. (Demirarslan, 2017)

A general overview of the bridge is given in Fig. 17. The bridge is still giving service in such a way that opening of the flaps are not controlled by computer but manual. Material used in the bridge is S355 quality structural steel. Young's modulus for steel material E was taken as 210,000 MPa. (Ozden Caglayan, 2015)

Assessing the bridge after renovating the cracks for sustainability construction

After building the new bridge, many different dangerous cracks and deformation were observed on the third flap of the bridge in 1998 (see figure 22), fundamentally, after analysing the flap by using intensive shells with Cosmos programme to evaluate the stress distribution, they figured that on the 14th cross girder was unevenly distributed and systematically disordered (see figure 22) (Bozdag, 2006).

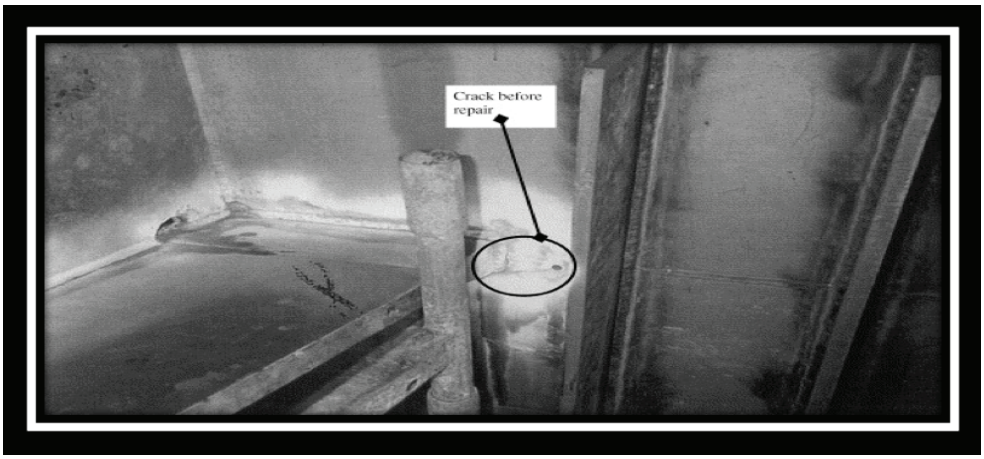

Figure 19: Crack from bottom of bridge (Bozdag, 2006)

Methodology: analysing finite element modelling

Using shell elements for steel beams whilst concrete blocks linked to the three cross-girders were formed using solid elements and a point called tie element which is assembling all anodes around it, although, it's a benchmark to denote the rotation axis of the flap. (Ozden Caglayan, 2015)

Dynamic analysing for bridges was something controversial, they used COSMOS/M (2008) software in static analysis for gravity loads and used three rotation cases of flaps : (a)-horizontal-zero degree-, (b)-raising the flap up to 45°, an

(c)-increase the flap to form full opening mode which is 84° COSMOS/M (2008) was used for static analyses. Additionally, thermal intervention on the upper and lower face of the flap by -50°C and -35°C respectively. The static analysis outcome for the horizontal and full opening modes are shown in figure 23. (Ozden Caglayan, 2015)

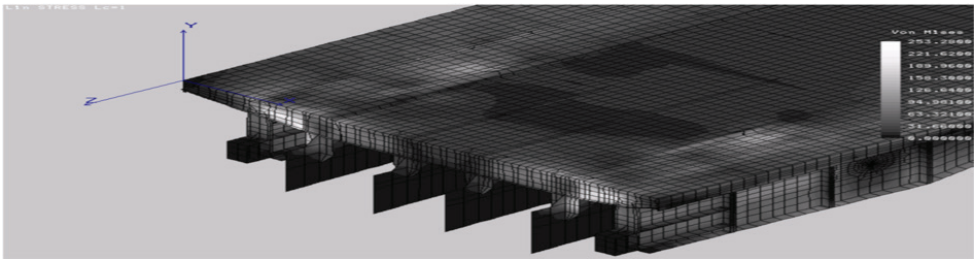

Figure 20: Stress distribution on zero-degree (Ozden Caglayan, 2015)

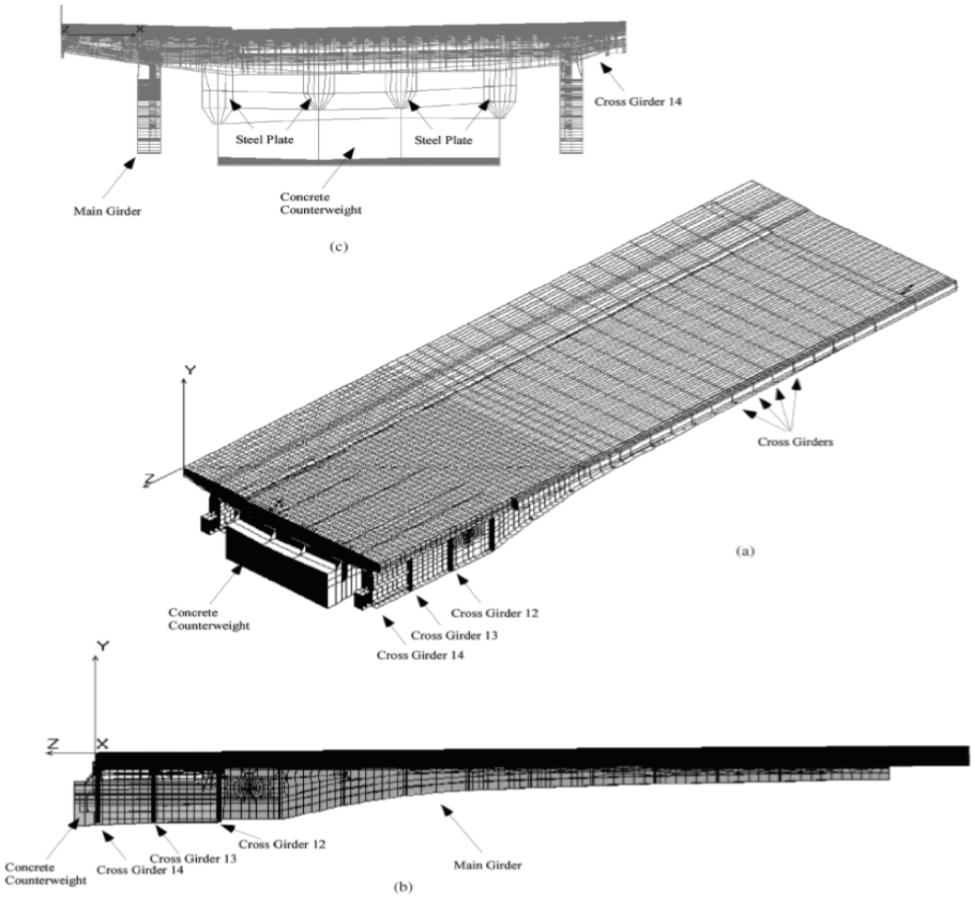

Figure 21: Modelling views (Ozden Caglayan, 2015)

Fracture Analysis

By using the Charpy V-notch (CVN) -which is the standard CVN energy in Joules and in kilo Pascal E is Young's modulus - to assess the fracture toughness of the specimens that had been taken from a member of the cross-girder. In this method, toughness measurement is illustrated as the energy values digested by the material sample. "KI, empirical stress intensity factor formula based on the amount of CVN values" and after testing many specimens the values had appeared as described in table 3. (Ozden Caglayan, 2015)

Table 3: CVN values at temperature °21C (Ozden Caglayan, 2015)

Test plate number	Notch type	Test temperature (°C)	Impact energy (J)			
			I	II	III	Average
1	Charpy V	−20	135	130	135	133
2	Charpy V	−20	196	191	191	193
3	Charpy V	−20	172	183	150	168
4	Charpy V	−20	174	183	177	178
Mean value						168
Standard deviation						22.08

Fatigue Analysis

Although there is a steel plate welded in the cross-girder and the concrete weight, some cracks had occurred at the welded connection which is linked to the concrete weight to the cross-girder number 14. To find out the reason of the crack, you need to assess the strength of welded connection according to AASHTO specifications (AASHTO, 1996), it shows in table (3) the details of allowable stress nodes in accordance with specified fatigue categories and the stress range was calculated based on this equation below (Ozden Caglayan, 2015).

$$S_r = S_r^c \cdot \left(\frac{0.06 + 0.79H/t_p}{1.10t_p^{1/6}}\right)$$

Where “Sr” is the allowable stress range and “S_r^c” the allowable stress range for category C (table 4).

Table 4: stress values of factor C (Ozden Caglayan, 2015)

Table 2. Stress Intensity Factor Values for Models

Models	Nodes	Stress intensity factor values for 0° position (MPa $\sqrt{m}$)	Stress intensity factor values for 84° position (MPa $\sqrt{m}$)
I	Node 1	43.10	61.65
	Node 2	28.12	84.81
II	Node 1	54.86	88.48
	Node 2	11.66	11.82

Crack repair

Using the equation below to predict the fatigue values for the steel contents under the cycle loads.

$$\frac{\Delta K}{\sqrt{\rho}} = 26,26\sqrt{\sigma_y}$$

” Where ΔK is the stress-intensity factor range in MPa root of m, and σy is the yield strength of the steel in MPa”. (Ozden Caglayan, 2015).

Summary

In this case study, dangerous cracks were found at the third flap of the bridge. By using Charpy V-notch (CVN) technology, they figured out the solution to repair cracks in the hardest mode (opening mode). Today, this bridge is in service without any problem, it is stable and no cracks have appeared, also the traffic density and congestion has been decreased in addition to the improvement of most facilities using in the bridge. For instance, popular restaurants and shops on the lower deck.

This is a good example of how to take advantage of an old project, not only with good reconstruction and renovation techniques, but also by providing new facilities and services without drastically affecting the transportation capacity.

What really makes this bridge important is not just the way to reach the other side of the city centre over Golden Horn strait. It had to retain its sustainable development through the ages, despite the enormous cost, but for keeping something really important that influences the local economy and politics. It is a historical landmark and heritage structure which stands among important eras.

Conclusion, summary and recommendations

Summary and Conclusion

As shown in this report, the topic of Sustainable Construction is wide in content. The following section will summarize the whole report shortly and answer the research questions which were discussed in the introduction.

What is the impact on the construction site by sustainability?

The construction sector is a slow moving industry when it comes to improving technologies and using them in practice. Even though "sustainability" is a well-known phrase, quite often it is not clear how to use sustainability in the construction sector. Rather than Green Building, Sustainable Construction is not only restricted to building a facility sustainably. All three pillars of sustainability (Environment, Economic and Social) have to be covered within the construction project. Furthermore the Development Goals, created by the UN, do have to be followed to create not only a building with less environmental impact, moreover a whole property with benefits for the urban area and the people living in and next to it. Concerning these aspects and the given conditions of the particular country sustainability is already impacting the construction site.

Which methods and technologies support sustainable construction?

Sustainable Construction can be achieved on different levels. The whole project should be planned with help of softwares and technologies to reduce the waste in time, manpower and resources. Also the aspects of sustainability should be considered in the whole design phase. The possibility to upcycle, recycle or down-cycle of materials nowadays is enormous. The use of such materials to decrease the impact on resources is another step to be considered. Various environment friendly materials and methods are described in section five. Life-cycle management and assessment is also one of the main management tools when it comes to sustainable construction. Combining the management within the background of waste reduction is a common tool to attain a sustainable construction project saving the impact in different stages of its lifetime. Technologies like solar and wind power are always a good solution to save energy by using natural resources. The second case study is a good example of how these technologies can be used to increase their benefits for a whole country.

Are there international differences or similarities in sustainable guidelines and goals?

Sustainability is known world-wide, even though there are differences in development and views on this topic. Every country has its own regulations and guidelines to reach the international goals in the upcoming years. Also the type of managing and controlling the development of sustainability in construction is different in execution world-wide. The SDGs is one of the best benchmarking tools today.

How to deal with existing properties?

The most important question for sustainable construction is how to deal with existing properties. Section seven contains the renovation issues of an existing facility or flat. However, the conditions and impacts are completely different and depend on the whole environment of the project. Weather conditions are the most powerful in renovation, so this section only gives the readers inspiration to reach their goals. Airtightness, proper ventilation and indoor air quality have to be given prime importance because errors in those will lead to over consumption of energy or unhealthy buildings. Effective use of space, time and renewables can help in bringing down the overall energy demand of the existing facility. Also, the social aspects should be considered to bring positive changes, as in the Galata Bridge (case study 3). This project achieved the connection of people, transport, work and normal use after the renovation.

Recommendations

To reach sustainability in any construction project it is important first to understand the meaning of it. The first stages of the construction process are the most important. The biggest impact on the project can be achieved here, therefore the use of hardware and software to design, plan and manage the activities are reliable techniques. Furthermore the whole life-cycle should be in view, so materials that can be reused after demolition and technologies to reuse natural resources do not only bring benefits for decreasing the impact on environment, also the economics of the building will be increased by cost-saving in maintenance and refurbishment. Within this report many examples and recommendations are given for the inspiration of the reader, but the most important is to start impacting construction sustainably.

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Appendices

Materials or products that minimize resource use:

- Products that use less material
- Reused material and products
- Reprocessed materials
- Post-consumer recycled-content materials
- Pre-consumer recycled-content materials
- Products made from agricultural waste
- Materials or products with reuse potential
- Materials or products with recycling potential
- Renewable materials
- Rapidly renewable materials
- Durable materials
- Materials or products from manufacturers with product take-back programs

Materials or products with low environmental impacts:

- Sustainably harvested or mined materials
- Minimally processed materials
- Low-polluting materials in extraction, manufacture, use, or Disposal
- Low water use materials in extraction, manufacture, use, or disposal
- Low energy use materials in extraction, manufacture, use, or disposal
- Materials made with energy from renewable sources (e.g., wind, solar)
- Local materials

Materials or products posing no or low human and

- Low-emitting materials and products
- Materials or products that avoid toxic chemicals or by-products in their entire life cycle

Materials or products that assist with sustainable site

- Products that promote a site's hydrological health by reducing storm water runoff quantities and improving hydrologic qualities
- Products that reduce the urban heat island effect
- Products that reduce energy consumption of site operation
- Products that reduce water consumption of site operation

Materials or products from companies with sustainable

Figure 22: Parameter for sustainable sites defined (Made by Gonzalo Manuel Ruiz-Liard Moyano, related on (Calkins, 2009))

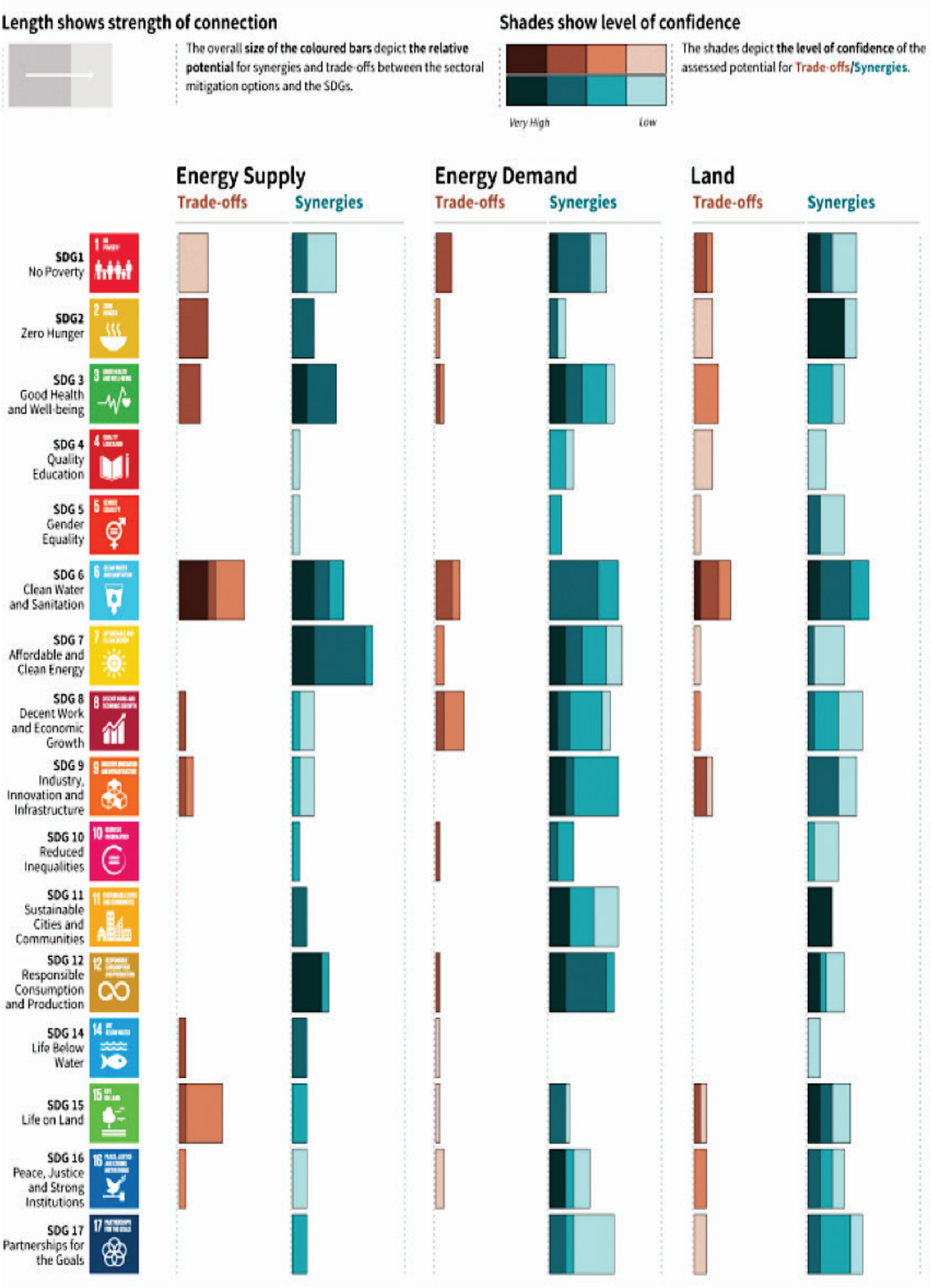

Figure 23: Indicative linkages between mitigation options and sustainable development using SDGs. (Intergovernmental panel on climate change, 2018)

Sustainable Project Management

Case Studies 1: Building and Refurbishment

Construction and Real Estate Management

Supervisors: Eric Pollock and Ana Reinbold

April 2019

Authors: Atoosa Aliheidarloo, Naela Al-Atout, Akriti Machhan, Jeton Gjolleshi, Sureshraja Venkatachalam, Aisha Naqash, Jose Pineda Figueroa, Mariana Tabini Cacho, Rushabh Shah, Uche Julius Obaye, Mohammad Emran Hossain and Sanjay Joshi.

Abstract

This section studies certain knowledge areas of project management. The study will briefly describe but not compare project management styles between the four case countries. A questionnaire is used to collect data from project managers whose projects are situated in Iran, Guatemala, Albania and Nigeria. In addition to their geographical differences, the scale of their projects is also different and hence a direct comparison shall not be made. The goal is to understand how project management works in the above-mentioned countries. The study shall also highlight how 'Sustainability' is incorporated by the Project managers in their respective projects. Project information and data concerning technology, communication, waste management, site safety and human resources are studied. Also recommended improvements to the existing project management styles are presented.

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Introduction

A project is something temporary and not a perpetual activity, with a fixed start and a fixed end. These fixed boundary conditions give the project a well-defined scope and resources (Project Management Institute, 2019). Project management can be sub-divided into five categories. These categories are mentioned below:

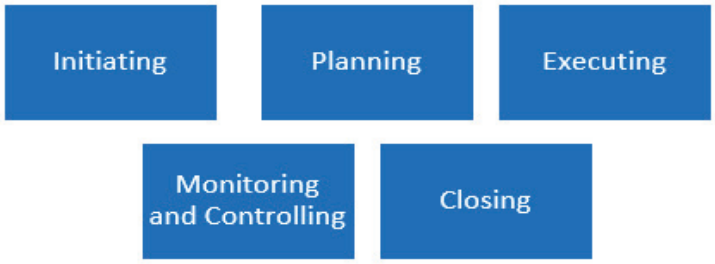

Figure 1: Project Management Processes. (Project Management Institute, 2019)

These five groups have been defined by the 'Project management body of Knowledge'. These groups have been defined to help plan, execute and control a project. During initiation, the key stakeholders of the project are identified, and the scope of the project is defined. This is a very important stage of a project as the identification of stakeholders can make or break a project. During this stage, ideally, a project manager shall be appointed. This stage helps formally authorize a project (The Five Traditional Process Groups Explained - Project Management Academy, 2019).

Planning is a crucial element and it helps in establishing the scope of the project. Some may argue that the scope was already established in the previous stage; however, here the scope is charted out on a more detailed level using various planning techniques and trials. The objective of planning is to help the team think through the entire project well in advance and prepare them of possible hurdles during the construction (The Five Traditional Process Groups Explained - Project Management Academy, 2019).

Executing a project is directly related to the performance of its project team. The project manager should not only build his team very carefully but also develop and improvise its performance by use of team building exercises. Execution is the phase where most of the allocated budget is utilized. Execution needs to follow certain deadlines and hence the monitoring and controlling come into play. Quite often when we are executing the work, the focus is shifted away from the main goal. The monitoring and controlling of the project help bring back this focus by keeping a track of the ongoing activities in accordance with the planned schedule (The Five Traditional Process Groups Explained - Project Management Academy, 2019).

Quite often, Closing is not formally performed. The project manager should hold a formal closing meeting. This meeting should aim to archive the records, discuss what was learned from the project and release the team so that they can move on to another project. Project management topics draws its knowledge from the below mentioned 10 areas. Mason, S. . A., 2004. From Conflict to Cooperation. Zurich: SWISS FEDERAL INSTITUTE OF TECHNOLOGY ZURICH.

Procurement management relates to the hiring of vendors/contractors from outside the organization. The process has an impact on the budget and scheduling of the project (Westland and Westland, 2019). Hence, this process should be timed in such a manner that the vendors are able to work on site as soon as the site is ready for construction without any downtime.

Figure 2: Project Management Knowledge Area (and leadership, 2019)

Making a risk register which will be used to make a note of all the potential risks to the project is dealt with under Project risk management. Here the risks are processed, classified and prioritized. Risk control is often practiced by review of the risk register and deletion of risks, which will not affect the project (Westland and Westland, 2019).

All knowledge areas of project management are important; however, communication is pivotal. Communication keeps all the team members at all levels informed about the progress of the project. Communication should be managed by detailing how the information will be transferred and what will be its frequency. Also, who needs to be contacted in case of any change or delays should also be detailed out. (Westland and Westland, 2019)

The success of the project is largely based on its most important resource, the team. The team should be happy and making progress in the project as per the planned schedule. A human resource management team shall conduct roles identification and hire suitable candidates for the job. Regular training and team building exercise shall be carried out to make the team perform at its best potential. This team performance should be observed, and any internal clash shall be resolved upon identification (Westland and Westland, 2019).

Project A: Commercial-office building in Iran

General Project Description

Company History

Paidar Hezareh Sevom Consulting Engineers Group Company (TOPS) established in 1975 in Tehran. The primary activity of the company was structural engineering. Gradually, the company developed into a design and execution firm. After construction of many buildings such as villas, towers, apartment, etc. the company grew into a multi-functional structure. Now, after 620 projects the company consists of:

- Architect Department
- Structural Department
- Interior Design Department
- Construction Department
- Inspection Department
- Planning Department
- Financial Department
- Customer Service and Maintenance Department
- Marketing Department
- Research and Development Department
- Human Resource Department

The TOPS is an independent company with the “We shape a better country” slogan, applies the talented and dedicated designers, engineers and managers to deliver its project (http://www.topsfirm.com/about/about.html).

The Modern Plaza building is in northeast Tehran, Iran, with commercial-office space of 7700. Although the numbers of days planned for the construction of this building were 975, it was completed in 1550 days. (11.2014- 01.2018). The CEO of the construction company was also one of the stakeholders in this project. Therefore, some issues related to the stakeholders and contractors were solved more easily. The construction of the building begun after carefully reviewing the feasibility studies. In addition to this, the total cost of construction was also accurately calculated. However, the project exceeded the budget and missed its deadlines because of the financial downturn and sanctions in Iran. Financial issues became the big challenge to the extent that stakeholders drew loans from banks. Nonetheless, the building was constructed with a 6 month delay. Some notions of sustainability such as High-tech façade, insulation system and the usage of generators to generate water and electricity at least one week after earthquake were considered in this project. Precise estimation of the amount of material to reduce wastes was the other strong point of this project. The studies before construction demonstrated that this project could have been more profitable, however the sales of commercial units was poor because of financial issues in Iran.

In terms of the built environment, ‘life cycle’ refers to a product, building or service over the course of its whole life (Designingbuildings.co.uk, 2019). This includes design, construction, operation, and disposal.

Figure 3: Road side view of the Modern Plaza (Photo by Company)

Specific Details about the project

The TOPS Company try to use eco-friendly materials for their projects. Aluminium facade systems are used for the exterior of buildings and other major construction parts. It was one of the most important design aspects, as it offers specifiers unlimited design freedom and protects the interior of a building from various climates. It strengthens the construction and has good corrosion resistance. Aluminium was also used on the double frame window and claddings.

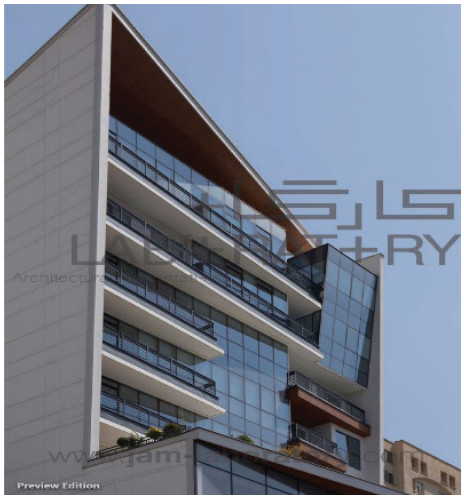

Figure 4: Aluminium facade

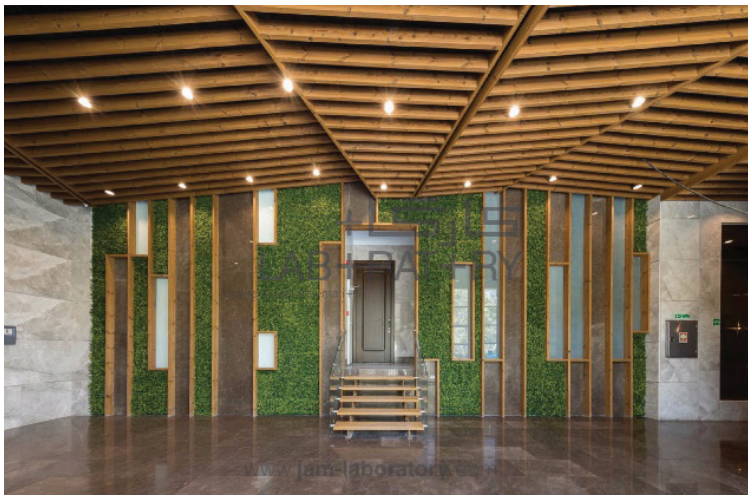

Figure 5: Modern Plaza Lobby (http://topsfirm.com/)

The Modern plaza project used timber for most of its interior design. The timber they used was thermal timber wood imported from Finland. It has properties of reduction of wood shrinkage, non-toxic and slower absorption of humidity. The timber goes through a heat treatment, which extends its life cycle. It does not include any harmful chemicals, so it is a healthy, non-toxic material.

The floor slab was made of concrete over a steel deck. A steel deck is a cold-formed corrugated steel sheet supported by steel joists or beams (Canam-Buildings, 2019) The steel deck was used not only to reduce the thickness of the slab but also for easy installation. No joints or support is required as in formwork slabs. The slab was installed on each floor without depending upon another floor which lowers the material, handling, and erection costs.

Figure 6: Steel deck Slab (Ehsan Bodaghi)

Views on Waste management

"*Waste Management is devoted to the presentation and discussion of information on solid waste generation, characterization, minimization, collection, separation, treatment and disposal, as well as manuscripts that address waste management policy, education, and economic and environmental assessments*." (Management, 2019)

The first step in construction waste minimization is good management and great planning. Accurately ordering the materials with the best quality and making sure that the sizes and standards are being reached is a very important role at the beginning of the project to minimise waste and rejection. This approach can reduce the amount of material needing to be recycled and bolster profitability and economy for the builder and customer (Constructionwaste.sustainablesources.com, 2019).

For the Tose Paidar Hezareh Sevom Consulting Engineers Group Company (TOPS) waste management is a very important part of the progress of the Modern Plaza Project, this is to improve the quality of the city, as well as the site. To manage the waste within the site three major sub-divisions were applied to control the waste. With the help of the contractors and sub-contractors on site in such a big project the goal was achieved.

- Sub-divisions applied:

  Carton and Plastic,

  Metal Waste (e.g.: - iron, steel and aluminium),

  Construction Waste (e.g.: - cement, concrete, sand, bricks, etc).

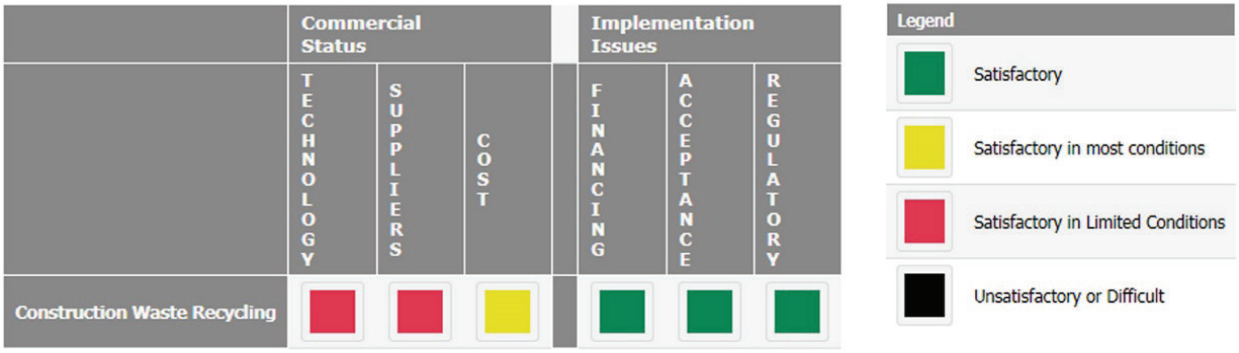

Figure 7: Construction Waste Recycling (Constructionwaste.sustainablesources.com 2019)

Carton and Plastic

To keep the site always on point and clean the workers collect all the waste daily and sends it to the recycling machines. These recycling machines are owned by the municipality (governmental based) where they support this act by paying the companies a small amount of money in return of encouraging the recycling act.

Metal Waste

This is known as the precious waste, meaning the most important waste that can be found on site is usually metal based such as steel, iron, aluminium and any kind of metal alloy. For its importance, the site workers not only collect the metal that is on site they also separate the different types of metal gathered. This is then stored on site for a minimum amount of time.

This happens because such materials can be sold to many contractors for a profit. The contractor that buys the metal usually takes it to a recycling plant located in Isfahan, where it's usually recycled to make construction elements.

Construction Waste

The one waste that might be a downfall for the waste management industry is usually the construction related waste: cement, sand, bricks and concrete. In this specific project the manager would make sure that the waste was collected and stored for a maximum one-month time in a specific area on site. Then a contractor trucks this waste either monthly or weekly. The waste is usually transferred to an area called Rudehen in Iran.

Views on Technology

Technology is a fast track industry that is being used to help in different ways to make the life of an engineer easier. Using technology to help get a sustainable outcome from any project is the ultimate outcome.

BIM (Building Information Modelling) is an intelligent 3D model-based process that gives architecture, engineering, and

construction (AEC) professionals the insight and tools to more efficiently plan, design, construct, and manage buildings and infrastructure. (Autodesk.com, 2019)

BIM is important in getting a better sustainable outcome from any construction site. It was used in different ways by the company to enhance the projects organisation and outcome. Some of the software's used were AutoCAD, V-ray, E-Tabs, 3d Max, Revit, Microsoft Office, Primavera, Civil 3D and many more. The as built plan was digitalised to help the electrical and mechanical engineers to organise the plumbing and electrical systems in the building according to the as built drawings, this is used to get approval and a certificate from the municipality confirming the wellbeing and readiness of the project to go ahead and finish the project.

Figure 8: List of software (Software Training Institute in Guntur, Dream India Technologies 2019)

The construction industry has improved drastically through design development. Creating BIM models is being emphasized more during design. Technological enhancement presented a new way to develop strong and long-lasting buildings. Building Information Modeling (BIM) is a system that collects information digitally about buildings under construction on regular basis. Engineers as well as designers get better communication. Almost perfect models and projects are being drawn and provided by Computer aided designing (CAD) with the help of the latest technology and which also detects clashes and helps in resolving them before construction.

A major difference is recognised between new and old construction methods. Use of latest machinery has made it a lot faster, easier and more efficient for civil and architectural engineers. A lot of the building parts are pre modelled within any modern software, this increases the speed of construction.

The green revolution (green buildings, sustainable living engineering) has also some effects on this industry. The global movement of saving the natural environment has emerged, which means while constructing buildings, natural environment should be taken into consideration by either not spoiling the surrounding nature or making sure that the materials used for building or even the construction industry must be eco-friendly. This concept should be implemented to all types of construction including residential as well as commercial construction. Following the regulations to save the planet and environment is what makes the construction green and provides an eco-friendlier construction system. (Understand Building Construction, 2019).

A Feasibility study is made to minimise the amount of material being used and not to have any excess of any material used, this will ensure the sustainability of the project and the minimum amount of materials needing to be recycled. This is achieved with the help of the new BIM software's; it helps in calculating the correct amount of a specific material and give up to almost the exact quantity as well as quality. No software is used for the control of waste management after any feasibility studies, since the feasibility study would have assured the best outcome of the minimum waste loss.

There are 3 different phases where the BIM system was used to do more feasibility studies in the Modern Plaza Project:

Before:

This was during the site selection and land surveying, where a Leica (TS06) Total station camera survey was used. Then the coordinates and direction of the site were transferred to an Auto-Cad file. This led to the Design part where the concept design of the project also took place in Auto-cad.

During:

Land survey for column plans were prepared and transferred to the software for modification and printing. A second certification from municipality must be realized to go on to the third and final round of the construction phase.

After:

As-built drawings for the completed building. The municipality, the facility manager and the client have the final as-built documentations from the constructed building in both hardware and software copies to insure easy access for future maintenance.

Views on Communication

Construction companies always try to fill the communication gaps, which obstructs their productivity, so they can reduce the inflated mistakes related to poor communication. Also, preventing misunderstandings issues, especially between stakeholders and clients, is another challenge of Construction Company. In this project, the participation of the CEO of the construction company as one of the stakeholders had led the stakeholders to participate in all the construction stages, especially in design phase. The consequences were the; delivering the clients' requirements precisely and easier communication between client and contactor.

Communication in different zones

In the Plaza Project, the specified relationships were defined to save time and increase the process of project. Different sectors were in contact as follows:

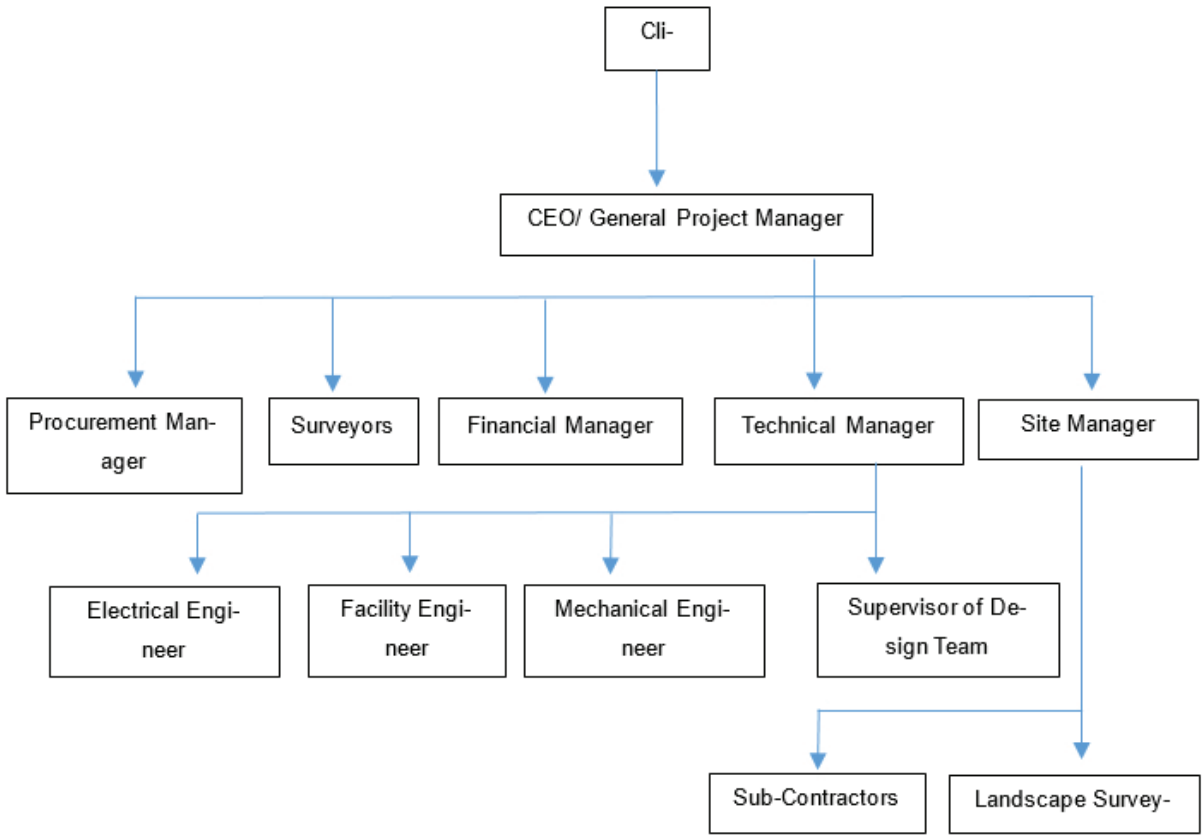

Figure 9: A part of communication chart in construction of Plaza Building (by Author)

Types of Communication

Live Weekly Meetings

The construction company had its own design team. At design phase, the weekly meetings were held for design group to adjust the structural and architectural designs, to review and give technical feedback for the design process at main office. The core communicative tools among the structure designers and architectural designers were Revit software, which maintains the coordination between design and construction information. Revit improves the collaboration in different sectors of design. So, the errors and modifications were easily noted in Revit. If any changes were required, the new determinations were made by the supervisors of each department during the meetings. Consideration to the last changes and errors has been done at the beginning of each meeting. All decisions and alternations, which were prepared in the meetings, were recorded as the minutes. Also, the minutes should be signed by all supervisors of each

department.

The weekly meetings continued even in the construction stage, on the site. The documents were recorded in two copies, one for the office on the site and one for the main office.

Email: Electronic mail was used to organize and arrange the communication between members of the project. The messages were easily distributed to the all the team members. The Emails included attached file, requirements, etc. all the emails were saved in case of misconception and confusion.

Fax

Some signed contracts, which were sent by fax, were acceptable in some cases especially with sub-contractors. Also, sometimes fax was a tool to send the documents from main office to site and vice versa.

Parcel and Mail Delivery

To choose the construction materials, especially the accessories, some production companies sent the samples of materials to the office by mail.

Views on Human resources

The identification of skilled human resources and organizing the people to complement the process of a project are two of the main challenges of the construction companies. Based on the size and the necessities of a project, HR managers decide the number of people, the sets of the required skills, and responsibilities. TOPS Company believes in the skilful managers for its projects and usually employs the managers with more than 10 years experience instead of inexperienced. However, for the design team the younger generation designers, who have the potential to make progress, are preferred. Company try to invest on its members, to improve and advance the company if workshops are needed, human resource department organize them.

In this project, since the number of skilled employees were enough, and the members had adequate knowledge to complete the project so, the department of human resource of the company did not increase the number of the teams and no workshops were conducted.

View of Site Safety

In every construction project, there is a high risk involved in accidents and bodily injuries, which may range from mild to very severe. Most accidents in construction are falling from heights, objects falling from overhead, defective equipment, tripping hazards, chemical exposure, vehicle accidents, electrical shock, noise and vibrating tool hazards, collision and crashes and abrasion. This is mainly because of the crowded worksites with people and materials everywhere, the changes in the construction design, poor working conditions, non-continuous work over the changes in seasons, open-air activities, and manual material handling and most important the environment of the worksite polluted with noise, vibration, and dust. “Sustainable construction means designing, renovating or converting a building in compliance with environmental rules and energy-saving methods” (Ecobuild.Brussels, 2019). Like any other construction company Tose Paidar Hezareh Sevom Consulting Engineers Group also had to get the safety measures to prevent any kind of accidents and provide a safer and Sustainable construction. The guidelines for the safety measures go from preparing for work, setting up the site and waste disposal without harming the environment.

The modern plaza worksite had a different department for the safety measures. Every employee needs to go through the procedure. Otherwise the written complaint was sent to project managers. If one does not follow the rules under safety measures, strict action was taken against them. All the equipment were taken from the department before entering the worksite.

The department checked that the working conditions are healthy and safe before work begins. They made sure that the work will not put anyone in risk including the neighbours. Planning and organization were mandatory in such cases. Planning was important considering the changes in the site through the work progress – from welfare arrangements during the set up to the dismantling of site such as the huts made for the labours.

The department of HSE has to gather all the information of the project before the actual worked started. Sources of information include: the client information, the design team which may travel for the inspection in site, documents such as of contracts, the main contractors and specialist on the site, trade and contractor organizations, several supplier’s information of the equipment and material used and the guidelines of the HSE.

The work site of Modern Plaza was almost at the centre of the city surrounding by commercial and residential buildings. They researched about the history of the site and its surroundings to investigate the unusual features which might have affected the work and the surroundings. The features include unusual ground conditions, contaminants like asbestos, underground line services etc. The site was left vacant for a few days for site radiography. Certain allowances were made for the safety measures so that the work goes on smoothly. In case of accidents, the work does not stop.

The equipment, which was hired from the supplies, had all the health and safety information manual with them. It was made sure that precautions and health risks arising from equipment are written in the manuals. There were additional

manuals for some of the equipment about information written about different methods so that it is less hazardous to the environment.

There was also the problem to store the equipment because the site area was limited. It was a bit challenging for the safety department to safeguard the equipment under a suitable temperature. The proposed working methods were discussed with employers and contractors, to how the equipment and facilities will be provided. There were also some employers who trained to operate it. They have provided Safety Training to the workers. It was mandatory for all new or old employees to undergo through the regulation and thorough training regimes. Employees were not allowed to operate equipment that they are not qualified to use.

It was made sure that to have safe access in and around the site for people and vehicle. They managed to keep the loading/unloading areas for the vehicle in such a small area. Construction work was nicely fenced off which protected people from site dangers. The fence also solves the purpose of any theft and demolishing. The barriers kept other people away from the mess created by the construction work. Precautions were kept during working hours and that night-time protecting the working area. No one was allowed to enter the area if their information were not there in the info office. So, it was compulsory to carry the identity card or permission letter to get inside the site.

The walkways were kept clean from trailing cables, materials and waste. The walkways were lighted up in nights by solar lights. All flammable waste materials were cleaned away regularly to reduce fire risk. The storage for the flammable substance such as liquids and gases and other hazards materials were kept away from the site. It was necessary to keep such storage away from the site as well as emergency escape.

To reduce the wastage of electricity the workers tried to work under natural lights in the day time. Emergency lights were also there but it was not of high voltage. Emergency routes such as the corridors and the passageways were kept well-lit when workers were on the site.

In case of emergency, the plan procedures of emergency were already prepared. Bells or sirens at a number of places where installed to raise the alarm. There were the arrangements for calling the emergency services such as Fire Brigade in case of fire. Modern plaza construction has mostly used the wood work for the interior, so fire precaution was given extra attention. But no such emergency took place throughout.

There was also the arrangement for the first aid box with enough equipment to cope with the number of workers on site. According to HSE, they should be a certain qualified first aider which depends on the risk of injury and ill health on site. Personal Protective Equipment (PPE) was given to everyone who was getting inside the site. PPE includes protective-clothing, helmets, goggles or others equipment.

Numbers employed at any location	Number of first aid personnel
• Fewer than five	• At least one appointed person
• 5 to 50	• At least one first aider
• More than 50	• One additional first aider for every 50 employed

Figure 10: Details of First aid for staff (Source: http://www.hse.gov.uk/)

Working in height was also was challenging. Certain precautions were to prevent or minimize the risk of injury from a fall. Selecting the right means of access and work equipment was necessary so it was just to have a trained person always on the site. Commonly used equipment's working at height involves the use of scaffolds, ladders, hoists, and gantries, etc. Guard rails and toe boards were widely used to prevent falls. MEWPs (Mobile elevating work platforms) provided excellent safe access to high-level work. Rope access techniques were used for inspection and other similar activities. A podium was used for reaching the ceiling inside the buildings

.

Figure 11: Obligation Signs (www.firesafe.org.uk)

Project B: Infrastructure in Albania

General Project Description

Dragobia Hydropower Plant is a project located in the Northern Alps of Albania. This plant has a run-of-river project scheme which means that there will be no water reservoirs and dams and depending on the water flow it will have a total installed capacity of 21.9 MW at the end of the 2 years of its construction duration time. Gener 2 Company holds the concession to build and operate the Dragobia Hydropower Plant and at the end of the concession time the plant will be managed and operated by the Government of Albania as it is a public-private partnership. Gener 2 is one of the biggest construction companies operating in Albania, completing complex infrastructure projects such as roads and highways, ports, processing plants and an airport control tower. The Trans Adriatic Pipeline (TAP) was also a Gener 2 project, a natural gas pipeline from Azerbaijan and crosses Albania and the Adriatic Sea to come ashore in South of Italy (Gener2.al, n.d).

Specific Details about the project

The Dragobia project consists of building two small run of the river hydropower plants located in the river streams nearby, one is in Ceremi stream, which is a branch of the Valbona River, and the other is in Valbona River near the village of Dragobia (Gener2.al, n.d). We should emphasize the fact that this project is located in the National Park of Valbona and it is a project strongly opposed since its early stages by the locals and environmentalist that held various protests for the impact that this project might have. The company suspended the construction works for 8 months to sort out the popular concerns. In contrast to their belief, the riverbed will not be affected at the segments where the water will be diverted through underground penstocks, because this water will be returned to the river and continue its natural flow.

Run-of-river (ROR) hydroelectricity is considered ideal for rivers that can endure a minimum flow and they differ dramatically in design from conventional hydroelectric projects which need to store a huge amount of water and there is the need to build reservoirs. Thus, there is always the risk of flooding the land nearby and at the same time, those reservoirs can be a base of methane and carbon dioxide emissions due to decomposition of organic matter. This is the main reason why ROR projects are considered to have less environmental impacts during their life cycle, producing in this way a sustainable energy (Douglas T, Broomhall P, 2007).

The major components of Dragobia Hydropower plant are as following:

- Dam
- Decanting Chamber
- Fish Pass structure
- Intake Structure
- Tunnel
- Fore bay
- Penstock
- Power house

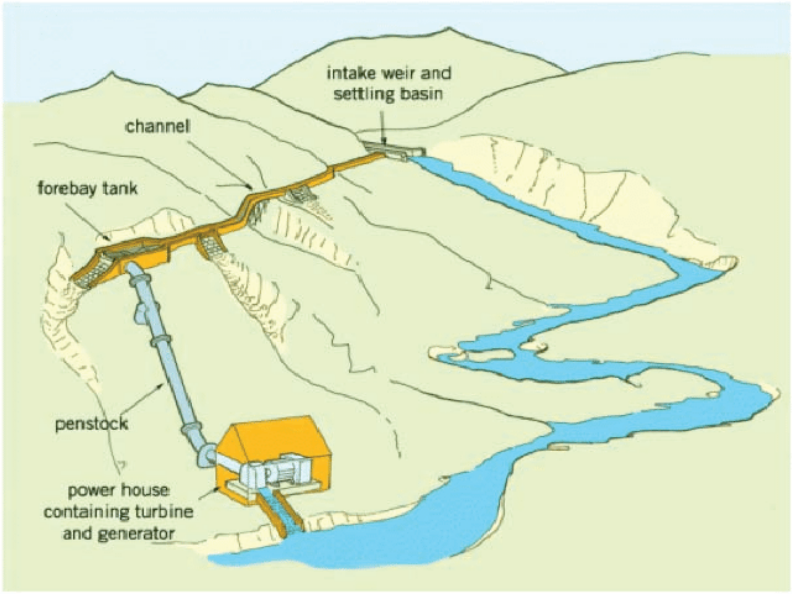

Figure 12: Layout of a small run-of-river power plant, Credits: Mercy Mwaniki, John Gichimu Mbaka

The water is temporarily stored in a fore bay before going into the intake structure and is usually used when the intake necessity is less. The water is then directed into the penstocks. Intake structure is also used as a debris filter (and to

prevent ice entrance into penstocks during the winter) providing in this way clean water for the powerhouse. Penstock pipes carry the water from intake structure and deliver it along with some slope through the tunnels to the powerhouse. The Powerhouse is a structure needed to protect all the hydraulic and electrical equipment. Another important part of this project is the fish pass structure which is done to preserve the endemic species and to minimize the environmental impact of the project.

Despite all the actions and sustainable methods used in this project, construction always impacts the environment where it is applied especially during its construction phase, and in this project, we see its impact mainly while constructing the access roads and installing the penstocks. The construction company claims that at the end of the construction phase there will be a revitalizing phase in which they will rehabilitate with its resources and manpower, not only the area where the project affected but all the area that is damaged due to human intervention and will return it in its original state.

This project has been a very challenging one for all the stakeholders, managers and constructors because of the public sensitivity regarding the location of this project and the concerns that environmentalists have regarding nature and all the living and non-living organisms. These concerns played a major role in the early design stage and in all the decisions related to this project as all the stakeholders and developers were aware of the consequences.

Views on Waste management

The construction industry has a dynamic part in the socio-economic development of a country. The quality of life is improved by building different facilities and infrastructure projects like schools, hospitals, airports, highways, and housing. However, this industry is considered as one of the biggest generators of air pollution and unwanted environmental impacts.

In order to identify potential impacts of construction, additional studies and measures are required. According to the company who is building the hydropower plant, all parts of the Environmental Impact Assessment Report provide all the information needed to be able to make the proper decision-making process before, during, and after the construction of this project. Managing the waste was very challenging for this project mostly because of the geographic location and the importance of its location (National Park of Valbona). According to the Project Manager of this project, the company takes the sustainability topic very seriously and it is also reflected in managing the construction waste. They show a great care regarding to these concerns, starting from preserving the top layer of the soil in order to reuse it for the revitalization process. In the areas where the construction had major impacts and the other soil generated by the excavation, they use it into the zones that have been affected by erosion.

Moreover, the debris waste generated mainly by the tunnels is used partly for building the retaining walls by mixing it with concrete and building gabion walls. The other part is preserved and refined, and it will be used for building the plant houses of this project, accompanying and preserving in this way, the traditional lines of architecture style of the zone (stone and wood). This waste is transferred to the areas where they will be reused through covered trucks. However, not all the waste can be reused. In this case, the company recycles them through different eco pits that are located 25 km from the construction site and outside the National Park area. Conceptualizing the project in this way since in its early stages made it possible for them not use any kind of software for the process of waste management.

Figure 13: Power House Project, Credits: Gener 2 Company document

Views on technology

Hydroelectric power plants are complex structures and involve large amounts of capital with a long-running construction period. It is proved that successful project management enhance the project success whereas mismanagement of project leads to significant problems such as completion time delays, cost overruns, poor site safety, redundant design, and hazardous environmental impacts. In order to avoid these risks, it's imperative to conduct proper planning for effi-

cient and smooth workflow, and to have a preparatory phase of the planning. The data throughout the case study has been gathered from Gener2. To ensure there's a proper plan for executing strategic goals and the final outcome, some software and equipment methodologies are used. The Planning process involves five main phases: Basic Evaluation, Preliminary Design, Final Design, Planning Permission Application, Execution Planning / Construction Design.

The complexity of these phases requires the use of essential technologies in a structured or standardized way from the beginning of the planning process until project completion. In this project the main software used include FEM, Civil 3D, AutoCAD and Microsoft Project. These programs allowed moving away from paper to digitally online real time sharing of information to assist with project collaboration, timely progress tracking, risk assessment, quality control and, it is anticipated, better and more reliable project outcomes. These capability-building programs enabled simplification of critical tasks producing noticeable improvements in key performance metrics.

For the construction design phase equipment used involved drilling probes, diggers, steel hark, self-driving anchors, splashing robots and so on. However large-scale implementation of technology was quite challenging as tools were introduced without explanation of their benefits or insufficient training of users.

Finite element modelling was a standard feature in tunnel modelling, calculating stresses and displacements in tunnels. Specialised features allowed for analysing a wide range of geotechnical problems and coming up with effective design solutions such as accurate modelling of the structure's behaviour during construction using the method of elastoplastic nonlinear analysis, modelling of geotechnical layers using boreholes, fast and reliable optimization of circular and polygonal slip surfaces, modelling of water in joints and tension cracks, computation of load-settlement curve, design of reinforced concrete cross-sections etc.

Microsoft Project was used for providing better monitoring and controlling of the project thus enhancing Time Management and Cost Management. Schedule lists were generated depending on the plan, resources assigned to each task and the workload. Individual calendars were developed for each resource representing its time of availability, number of assigned tasks as well as the associated cost. The execution of each scheduled task was then based on resource availability. The cost for each task would be the working hours times the rate. Critical paths were generated, and the project was categorized into different levels based on user accessibility. The resource category involved Work Resources (people and equipment), Cost Resources (financial cost associated e.g. transportation) and Material Resources. The reason behind opting for MS Project was its affordability, ability to handle complex problems involving constraints and easy to modify inputs and maintaining of the records.

AutoCAD: was used for technical specifications and drawings. It facilitated drafting complex geometry, design iterations and the modification of as built drawings without having to start from scratch thus streamlining time consumption. This was crucial in eradicating errors in retaining walls which needed different reports and drawings. Almost 80 percent of the cases were approved by the main contractor. Also, the AutoCAD civil 3D was used for designing the access roads. Road alignment was created and plotted using a coordinate system for precision. The In-built features were used for calculation of sight distance, radii of horizontal curves, length of vertical curves and computation of excavation quantities.

For tunnel boring the rocks were classified into five categories ranging from 1-5 based on hardness, water content, rock mass properties, etc. This called for alternative strategies for e.g. probing and grouting. Detailed measurements of the advance rates of the probe drilling and the grouting pressure were done. These measurements enabled proper prediction of the ground ahead of the drilling. Site conditions and tunnel section anchoring was completed for various lengths using probe machinery. This was followed by filling up the holes with cement injection using cement pumps. The specification of the steel section used was T HEB 120 and the reinforcement was electro welded. Grouting stabilizes the weak zone by cutting off water inflow, however, if the category was between 1-3 explosion method was adopted.

Figure 14: Tunnel Machinery (Shpati Gjolleshi. Gener2)

Views on Communication

Communication is an important aspect in the project. Effective communication between all the stakeholders is essential for a successful project execution. Communication can be done by expressing the thoughts or ideas by using words or any other suitable methods. Lack of communication leads to failure of the project.

Internal information exchange is the step in which most of the decisions of the project were made, regular meetings were conducted, and information was exchanged between the stakeholders and stand-up meetings are done every day for a quick status update. In the Information management, information regarding the project was communicated to all the stakeholders and if any changes were made in a project, it was also communicated in this process.

Communication Structure

Figure 15: Communication in construction of Hydro power plant (by Author)

Project Manager decides the communication strategy and he is the head of the communication process. Site manager collects all the necessary information from the Project Manager and discusses it with the QA/QC officer. HSE officer is the next to receive all the information, he after examining all the information, sends them to the Environment officer for further analysis. After full analysis the EO communicates with site engineers and other members of the project.

Types of Communication

Weekly meetings, IRF (Information-Response-Feedback), and RFI (Request for Information) were the two formal communications held between the stakeholders in the project.

Weekly meetings were held at every phase of the construction of the Hydropower plant, as the project manager met with structural and architectural team at an early stage to minimize errors in the design of the project. Software like FEM, Civil 3D and AutoCAD were the main tools used by the architectural and structural team. Site engineers of every department also take part in the meeting and consult about the on-site problems and solutions were discussed and implemented as early as possible.

IRF was a communication tool used in the hydropower plant project. The design team gives data or information to the site engineers of every department, in the form of structural drawings and plans. Site engineers read those drawings carefully before implementing on-site and if there were any errors found in the given drawings, site engineers have to note it down and report back to the design team so that they can correct the errors and provide necessary feedback to the engineers. IRF helped to minimize the errors in the construction stage and was useful to speed up the project.

A Request for Information RFI is issued when there is any confusion or missing information. Site engineers can always ask for necessary information from the design team. This communication tool was used during the start of the construction stage and was very helpful to the reduce problems on-site. The information can be requested through a written document signed by the senior engineer and the site engineer of the project.

Views on Human Resources

A project is incomplete without human resources. Thus, the human resource management hires the employees of the project team; it also deals with performance, safety, motivation, benefits and training of the employees. This hydropower plant is a massive project and nearly 300 employees were hired. The hiring process was done using written tests and formal interviews.

Types of training

Work at height training: Working without any safety equipment at heights is considered risky, thus necessary training and safety equipment were given to the employees before entering into the project site. Safety belts, helmets, safety jackets, boots, gloves and other tools were offered during the training and employees were strictly ordered to follow

the rules. Confined space training was necessary as it is not applicable for everyone to enter. Places like maintenance and service areas are commonly used by well-trained employees and not for the public. These places were always kept locked and secured.

Site was always a risky one, so special care was taken in the training of the lift operators. Construction materials and other construction tools were carried using the lift. The Lift operator should always be aware of the surroundings. Operating the lift during the night without proper lighting was strictly prohibited in the project. Only the trained personnel should operate the lift and it is been kept locked when it was not in use.

Housekeeping training was given to the employees in order to keep the office area and other public areas clean and tidy in the construction site. Employees were hired to work on a daily and weekly basis. They are fully responsible for the cleanliness in the project site.

The project manager has to be an engineering graduate, with foreign language skills (English), and have at least 7 years of experience with very good communications skills.

Site Safety

Safety techniques and tools were provided before the project began. Every employee has been kept inside the project area, food and other needs were taken care of. In case of any accident during the work, using the emergency plan, the workers can be easily transferred to the nearby hospital and taken care of. Tools and other construction devices were provided to the employees daily.

Unforeseen accidents might pose a serious threat to life by causing deaths or physical injuries. Significant factors that threaten the safety of employees at the hydroelectric power plant stations are lack of training and supervision, non-observance of safe work procedures, lack of management commitment and lack of periodical checks on machine operations. It is of utmost importance that these loopholes are combated hence an effective health safety and environmental plan was devised by GENER2 in compliance with the International Certification Network, IQNet, and its partner TUV Austria. All the necessary data in this case study has been obtained from GENER2. The HSE plan fulfilled the requirements of the international standards of OHSAS 18001:2007 and ISO 14001:2004.

The other principle rules that were a part of health and safety policy include:

- Pursue the goal not to harm our employees, collaborators and communities
- Manage HSE matters as every other critical business activity
- Promote a culture in which all contractor employees share this commitment
- Promote employee welfare as an essential part of doing business
- Be in compliance with the relevant national and European legislation, and project regulations or requirements.

To supervise and ensure proper functionality of the activities of “Hec Dragobia” a HSE organization chart was formed with 10 experts on board. The structure followed a hierarchical manner and was further sub divided into 4 levels:

Level 1 – HSE Manager

The Health Safety and Environmental Manager formulated, administered and coordinated programs for the company to reduce the risk of loss due to employee injury, regulatory non-compliance, general liability, fire, theft, or damage. Detailed policies and procedures covering elements in the Safety, Health and Environmental Program were developed. He was responsible of all the implementation health safety and environment in the entire project.

Level 2 – HSE Coordinator/ Occupational physician

Each project had an HSE Coordinator who under the direction of the HSE Manager was responsible for monitoring the implementation of the HSE Plan and the coordination all the activities Training, Meetings, Emergency Response, Reporting System, Audits and Inspections. The Occupational Physician was responsible for the determination of medical surveillance protocols and for review of examination/test results performed and managing emergency situations on site.

Level 3 – HSE Officers

HSE officers or supervisors under the direction of the HSE Coordinator were responsible for the control and monitoring on daily bases the work activities at the sites like the training session, hazard identification, reporting, use of PPE, engineering control, emergency response, confined spaces and all the procedures of the HSE plan to ensure that the works were executed according to the safe work method.

Level 4 – HSE Data assistant

HSE Data Assistant was responsible for all the documentation of the HSE Management System and procedures to be saved and managed according to the document control procedure.

Scope and objective

The Objective of the HSE plan was to improvise the working condition by eradicating hazards. Its assurance needed the formulation of objectives relevant to the scope. The following actions were enforced:

- To have all personnel appropriately trained, responsible and accountable for health, safety and environmental management.
- The protection of the Health of its Employees and of those who may be affected by its operations
- The prevention of damage to the Environment which could be caused by this operation
- Providing adequate human, technical and financial resources
- Providing suitable safe arrangements for the handling, transport and storage of articles and materials
- To give priority to the Health and Safety of our employees and all those who are involved in the work, either directly or indirectly
- To comply with all relevant and other recognized standards, applicable codes and statutory requirements.
- To provide efficient communication and continuous performance review.
- To provide warning of hazardous situation and take steps to implement mitigation measures
- To provide the required Personal Protective Equipment (PPE) to all personnel
- To implement all relevant / approved supporting plans

Site inspections and safety meetings

Regular Site inspections were conducted to identify critical issues which might contribute to potential hazards if critical actions were not taken. These unacceptable conditions were prevented by addressing the concerned problem. The workplace was reviewed for identifying the potential hazards; the risks associated with it, defining the safety recommendation and lastly control the residual risks. For identification of risks a method statement that described activities in detail was developed. The Complete and accurate Job hazard analysis was generally developed by the Gener2, Line Supervision and HSE Representatives.

This was done by getting to know the concerns of the workers. Equipment was checked for noise, vibration, electricity, radiation and pressure. Attention was paid to items that were most likely to develop into unsafe or unhealthy conditions this may be due to physical, biological, chemical and ergonomic hazards. The next step was to assess the magnitude of consequence of threat by quick understanding of all the hazards associated with the activities and the likelihood of their occurrence. Then finally based on the evaluation of risk subsequent mitigation measures and engineering control was adopted. All the observations are then documented under risk assessment; once it approved the HSE organization is responsible for monitoring the implementation of the mitigation measures and engineering control on daily bases and is responsible for the direct safety of its personnel.

The HSE meetings were conducted weekly or monthly based on the ground situation. They were set up with the commencement of work in the “Manual- SECURITY MEETINGS PROCEDURE”. It was mandatory to conduct HSE meetings with all the concerned parties like SSHA before any task was embarked upon. The main goal of each meeting would be to define tasks, objectives and professional figures that need to be implemented.

Emergency plan

The emergency response plan is a written document which was drawn up by the health and safety manager. The aim was to control the risk by familiarizing the workforce with emergency procedures. The emergency plan further strengthened the construction safety. They were tested in form of safety training to make sure they work so that the operations can be quickly resumed with no or minimum damage. The plans were posted on the site and were presented in the Manual “EMERGENCY PLAN PROCEDURE”. The emergency plans developed for the project include Fast help, Fire Plan and Atmospheric Illusions.

Project C: Hotel building in Guatemala

General Project Description

Kawilal is a hotel located in Amatitlan, Guatemala just around 26 km away from the capital centre. Its location is unrivalled as it stands in the vicinity of one of the country’s largest lakes. Construction of the 2,300 squared meter complex lasted approximately one year and three months ending in December 2012; it was also during this month that it received a LEED gold certification for its outstanding construction methods. Planning stages were 10 to 12 months before the start of construction. The resort was designed by Guatemalan architecture firm W502. Its conception comes from the idea of providng a place to stay for visitors of “Santa Teresita Spa”, a traditional destination for local tourists (Robles, 2019).

Figure 16: Kawilal One Bedroom Rooms. Source: www.kawilalhotel.com

The hotel features a geothermal energy generator, green roofs, the use of local materials, a reduced intervention to the site and rooms without the supplement of air conditioning. These are characteristics of the hotel that can be observed during its operation. Nonetheless, the project implemented management and construction techniques are analized here. As authors, we believe that a project in a developing country that achieved a LEED certification is worth studying as it may serve as an example of proper construction management procedures and techniques. Engineer Enrico Robles, the main contractor's manager during the construction phase of the project, provided insight to such methods (Robles, 2019).

The project was realized with the collaboration of several experts and specialists in construction such as an architectural studio, lighting design, structural design, soil studies, environmental impact studies, electrical design, plumbing design, LEED certification management, land and earth movement teams, civil works, glazing, electrical installations, plumbing installations, water treatment plant, pool specialists, and finishing teams. These were all hired through contracts which established the requirements, a time window, a description of the job to be realized and other terms and conditions. The contracts served to transparently manage the diverse teams that were involved in the project (Robles, 2019).

Kawilal faced a tremendous challenge in its context as LEED certified buildings are atypical in the region. Its originators wanted to break the common idea that construction cannot be done in a clean and orderly fashion under strict quality, health and security standards. In order to achieve this, several processes and regulations were established for the execution of the project. These were reinforced with strict and regular supervision under the aim of reducing the construction's environmental impact. LEED certifications require an ethical plan for environmental procedures (Robles, 2019).

The project management team consisted of several professionals and experts in their unique field. A general contractor was hired for the management of the construction; it was under his umbrella of responsibilities to hire and manage subcontractors in charge of specific works. Permanent workers were also involved on site such as: Foreman, warehouse keeper, procurement manager, and a team of accountants to follow up on the budget. These people all played a key role in the developing of the project and in making sure the process was complying with the requirements and the schedule (Robles, 2019).

Specific Details about the project

The architecture of Kawilal Hotel responds to the environment, the room modules emerge from the topography of the place and are integrated into nature, existing in such a way that it seems that they have always been there. The inner and outer barrier is diffused by bringing nature into the interior space and projecting the spaces outwards through terraces, balconies and large openings. It seeks to generate an architecture that is not alien to what surrounds it, an architecture that is integrated into the environment.

According to the USGBC, the hotel has a GOLD category that reached a score of 60 on its scales, which evaluate: (Council, 2009)

- Sustainable sites 23/26
- Water efficiency 6/10
- Energy and atmosphere 12/35
- Material resources 4/14
- Indoor environmental quality 8/15
- Innovation 4/6

During the construction of Kawilal Hotel infrastructure, which has 2,300 square meters, 120 direct and 250 indirect jobs were generated. This project helps the preservation of 26,000 square meters of regenerating Mountain Forest, in addition that with its focus on sustainable tourism in Amatitlán, an annual economic flow of €460,000 is provided with national and international visitors. (Robes, 2019)

It was very important for the whole construction and design process to break with the paradigm in Guatemala that building cannot be done in a clean and orderly way observing quality standards for industrial safety and occupational health. Processes and regulations were established for the execution of the project in addition to constant supervision to ensure compliance with these standards. Another important strategy was to have the least impact on the environment, certification requires ethical compliance with the environmental management plan. A financial feasibility study was made based on a market study and the financial model, and the design is part of the LEED certification to meet the requirements to obtain the Gold grade. (Robes, 2019)

The estimated life time is 50 years and the life cycle of the project was basically based on empirical data. In general, the empirical data used was characterized by the compilation of a large amount of data and many demands of the project (Robes, 2019). The empirical method is necessary to enter previously unexplored fields, because this project was the first project with certification in Guatemala. The empirical method requires more intuitive skill in the professional, which is always why we had professionals trained in the project. (Robes, 2019)

Views on Waste Management

As previously mentioned one of the main goals of the project was being sustainable and reducing as much as possible all types of waste. In order to do so construction waste was divided into construction and personal scrap. Construction scrap was then classified into sub groups: steel, plastic (PVC and CPVC), rubble and others. Personal waste was classified into plastics, organics, paper and aluminium (Robles, 2019).

A portion of the waste was used as landfill under the buildings. Recyclable materials were collected and sold to recycling companies in Guatemala and the rest was sent to municipal waste deposits. The deposits for scrap were located about 6.4 km from the construction site; this short distance reduces the unforeseen impacts that any construction site carries with its development (Robles, 2019).

Figure 17: Night view Kawilal Hotel lobby. Source: www.kawilalhotel.com

Technology was not incorporated into this process. There was no deployment of software in order to calculate and manage the amount of waste being generated, recycled, reused and/or disposed. This is not a common practice in the region and its incorporation would also require the requirement of specialists in the field. Such training is not available

in Guatemala making the integration of technology challenging (Robles, 2019).

Views on Technology

Advanced knowledge in engineering requires software manipulation. For the design and master plan, AutoCAD was used, for the programming and scheduling Microsoft Project was used, Microsoft Excel was used for budget, and Open4Business was used for the execution of the hotel. All the software played a key role in the overall development of the project (Robes, 2019). Although BIM methodology is being implemented worldwide, it was not used in this pro-ject.

It was decided to use the Open 4Busines (O4Bi) software for the execution process, because it is a simpler program, and that it has the necessary tools for the type and constructive system of the Latin American countries. O4Bi is an information system that covers the needs of an ERP (enterprise resource planning) for the management of business resources. It integrates the operative and productive procedures of companies. It incorporates internal processes (Back office) as well as business procedures (core business) while allowing management to control the relationship with customers, suppliers and others (Software, 2018).

- It meets, among others, the following objectives:
- Optimization of business processes.
- Access to information.
- Possibility of sharing information for all components of the organization.
- Delete unnecessary data and operations.

BIM applications allow for the building to be drawn in real scale, the usual tools are: walls, pillars, beams, slabs, doors, windows, furniture. You can also generate tours of the building through video or three-dimensional perspectives. Possessing a model at a real scale conformed by elements with unique properties, managers can get a more accurate budget. It is for this reason that we should not confuse BIM with a simple 3D since we obtain a lot more information about the model, although it is true sometimes it is not necessary to use very complex and specialized programs for the development of projects, the BIM methodology results can be very effective (Abós, 2014).

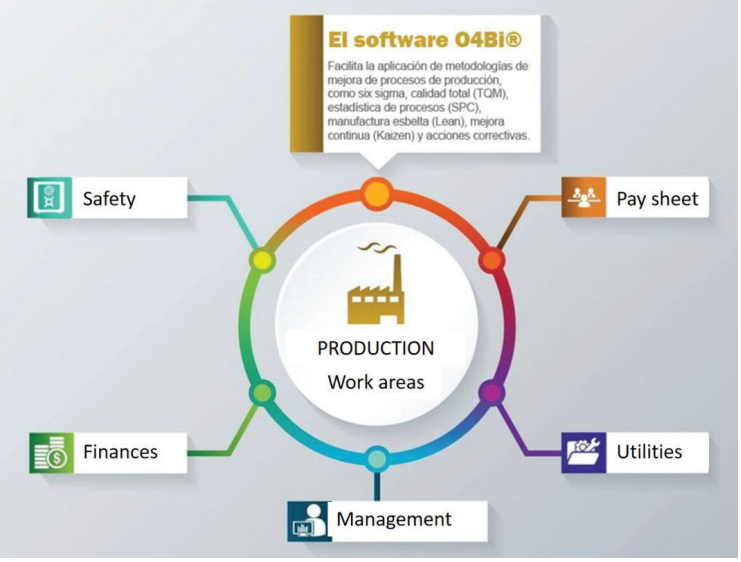

Figure 18: O4B, Work areas (https://www.setec.co.cr/consultor%C3%ADa/o4bi-produccion/)

Our recommendation is instead of using several parallel programs, having the possibility of error, it is recommended to use the BIM system, which offers certain advantages compared to the traditional method.

BIM and CAD represent two different approaches for building planning and documentation. CAD (Computer Aided Design) applications imitate the conventional “paper & pencil” handle, as two-dimensional electronic drawings are made from 2D realistic components such as lines, hatches and content, etc. CAD drawings, additionally to conventional paper drawings. BIM (Building Information Modelling) applications imitate the genuine building process. Rather than making drawings from 2D line-work, buildings are essentially modelled from genuine development components such as dividers, windows, slabs and rooftops, etc. This permits designers to plan buildings in a comparable way as they are built. (SE, 2019)

Since all information is put away within the central virtual building document, changes are consequently followed-up. With this coordinated approach, BIM not only offers critical efficiency but also serves as the premise for better-coordinated plans and a computer-based building model. (SE, 2019)

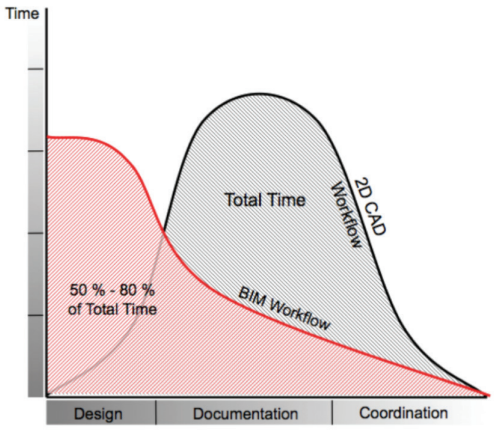

Figure 19: Differences between CAD and BIM (https://www.graphisoft.com/images/open_bim/about_bim/image-CADvsBIM.png)

According to our experience (as architects working with CAD) we are accustomed to detecting inconsistencies in the documentation: pillars, ventilation shafts, chimneys that do not match from one floor to another, windows that are not aligned. In BIM models, you change only change it only once, you move the window, that movement is updated in all plans and documentation. If we decide to expand the section of a concrete, just select and modify the necessary amount of concrete. This avoids many oversights and above all, many problems at work. Another advantage of the BIM methodology is the exchange of data. As mentioned before, several programs were used in the project, totally separated from each other, that is, no program was used that covered all the stages of the construction process. With the methodology used, a set of plans is sent to the person in charge of quantification, another to the structural calculator, another to the installation engineer and then all those documents have to be coordinated to see if there was any interference between the modified elements. With the implementation of BIM software, the project could have saved time, money and man hours by sending the IFC (Industry Foundation Classes) file which is the data exchange standard for BIM (what in CAD was the DXF) and when the information returns to the designer, it is easily integrated and updated automatically within the model. It is important to point out that in the BIM methodology they can do previous studies in preliminary phases such as energy efficiency, sun studies, temperature studies and winds, information that could prove to be of major importance in the construction of a hotel as it seeks to create an environment with the greatest possible comfort (Abós, 2014).

Views on Communication

Information flow and how people communicate in all project is a key matter that can make any project successful or not. Without a proper structure for broadcasting instructions any enterprise can easily fall into disorganization. It is also important to mention that decisions should be transcript into a form were all decisions are backed up in writing, this to avoid any misinterpretations or confusion (Robles, 2019).

The Kawilal construction site has its own communication structure that enabled them to complete the project without delays or the production of unnecessary waste. The owner of the hotel had direct contact with the architect and supervisors. The latter oversaw giving directions to the foreman and warehouse keeper which subsequently managed a team of operating personnel. Subcontractors were in charge of their own workers but were still under the general supervision of the architect and site supervisor. In order to avoid confusion, if subcontractors needed any type of instruction, they received it from their leader who was in direct connection to the site leaders. No formal means of communication was implemented. As accustomed in most construction sites of the region, most requests were delivered via emails or phone calls. They were not documented and archived as it is done in more structured organizations (Robles, 2019).

Personnel and teams were initially coordinated by the designing architect. Once the planning phase was over, the general contractor's managers took charge of organizing the involved teams. Weekly meetings were held with team leaders and subcontractors in order deliver instructions and receive feedback of the current status of the site. The conversations held in such sessions were recorded into minutes in order to materialize what was decided (Robles, 2019).

Views on Human resources

Human resource is one of the key factors in managing of a project. The impact of human resource impacts the profitability of the project. Projects in which time is spent on understanding the projects needs and absorbing the right talent and providing them with training can help the client and impacts the overall budget of the project. Provision for effective management of human resources has now been considered utmost important in any project.

In El Kawilal Hotels management of human resource was a key factor for the complete project. The contractor had provided and effective training to the engineers in use of Microsoft Project software. The company was using MS Project to monitor its day to day progress, allocate the right resource and keep a check on materials that are consumed.

Since, most of the engineers were not well versed with this software an effective training program was launched to train these engineers so they can work on MS project. Such trainings are vital for organization as it helps to use more computer-based programs and help the engineers to progress in their field. As being a LEED certified building using the correct amount of resources was need and Lean construction was followed even in the management of men and machinery to keep the check on.

One of the important facts of the human resources is monitoring of men and work, this was effectively achieved with Microsoft Project. All the resources were equally distributed and levelled in such a manner to provide a continuous flow of work and complete in dedicated time period.

Human resource management played a key role as a robust tool in providing onsite solution to a vital resource which is usually disorganized in most of the projects. In this project with effective management all the human capital was pooled under one roof and effectively divided and professionally used.

Project D: Office building in Nigeria

Figure 20: Proposed NLNG Head Office Project_3D Presentation

General Project Description

The project is the construction of head office complex for the Nigeria LNG company. The 100,000 m² site is located in Niger Delta region (South) of Nigeria, in Port Harcourt, about 49 km from Bonny Island (the gas plant production site for Nigeria LNG). There are twenty-two (22) buildings currently under construction, covering a totalled of 37,214 m² surface area. Bouygues Construction Nigeria, a Bouygues Construction subsidiary, is undertaking the head office development project. The project also includes renovating some buildings and mammoth infrastructural works with the end goal of accommodating 400 employees from the Lagos head office due for relocation by the end of 2019.

Specific Details about the project

Project Delivery Method

The project was awarded as an EPCC contract, involving the provision of detailed engineering, procurement, construction and commissioning work for the head office. It is a Design-Build project delivery method allowing the construction expertise to play a role in the design processes and also contribute to the design. In this case, the contractor takes responsibility until the project is commissioned and until the defect liability period is over.

Project Duration and Contract Sum

The time of completion of the project is 30 months from the commencement date, and 12 months for the Maintenance period. The contract sum is a fixed-price contract in US dollars. Variations are allowed where the client makes changes to design and can either be positive (if the client pays an additional fee) or negative (if it is a reduction of scope).

Strictness of Contract

There is a liquidated damage of an amount per day for project delays beyond the completion date and, maximum 10% of the contract sum.

Project Status

Project is in-progress: 85% overall completion in February 2019.

Project is delayed by 15% as a result of client request for design changes & modifications and force majeure.

Views on Waste Management

The Bouygues Construction shares a Quality, Occupational Health & Safety and Environmental policy that supports the protection of the work station environment by analyzing the impact of the construction activities and implementing mitigating measures. Waste management is one key performance indicator in the performance assessment of projects. Correct management of waste is essential to ensure compliance with legislation, international standards and good industry practices. Incorrect segregation and disposal of waste could lead to environmental damage, cause harm to people and affect the company's reputation.

The project management strategy for waste management centres was source reduction, re-use, recycle, and ultimate disposal. Source reduction is the principal concern, and where this fails, the company considers re-use, recycle and perhaps disposal to a practicable extent where waste is unavoidably generated. Treatment of waste (where possible) was also considered after reuse, recovery and recycling options have been completely exhausted and disposal at a designated and approved area or facility is identified. Refer to figure below for Waste Management flow chart practised on the project.

Waste Inventory and Classification:

Before the start of the project, a complete inventory and handling methods of the anticipated wastes has been prepared as shown in Figure 5. This was essential for the quick assessment of the potential impacts on the environment and also set priorities for the management of the wastes. For the sake of planning and budget, the anticipated wastes are broadly classified into two categories, namely:

Non-Hazardous Waste: Timber, Food Waste, Metal scrap/ Rebar Waste, Office Waste, Non-hazardous chemical waste, Electrical & Mechanical wastes, Concrete wastes.

Hazardous Waste: Waste lubricants (spent oil), Used filets, oily rags, Oily Sludge etc., Batteries & Hazardous chemical waste, Medical waste, Contaminated sand (oily sand), Sewage sludge, Tires.

Waste Tracking:

The waste manifest is used as the document for tracking waste movement within and outside project site, information about the originator; dispatcher, driver, type and quantity of waste are part of the vital information required in the waste manifest. This is required for traceability and to control the amount of waste against Budget. Refer to Figure 6 for implementation sample. This serves to provide means to check excess and determine project performance (Control) in waste generation and management

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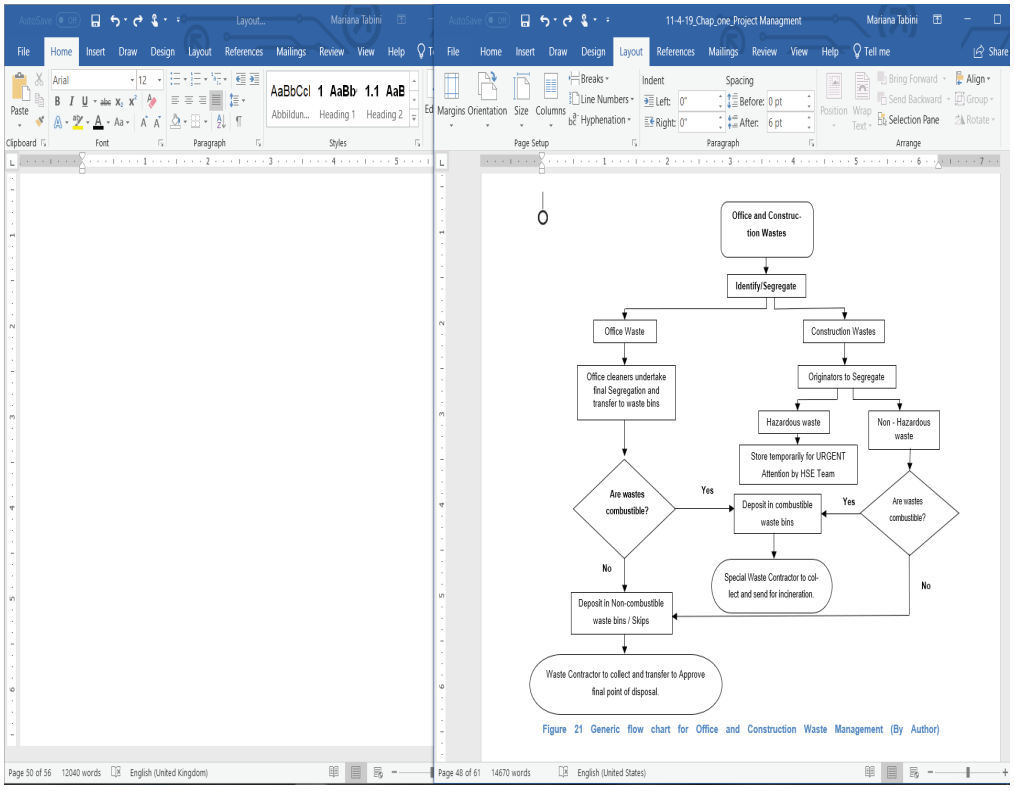

Figure 21 Generic flow chart for Office and Construction Waste Management (By Author)

Figure 21: Generic flow chart for Office and Construction Waste Management (By Author)

S/N	WASTE TYPE	ESTIMATED QUANTITY MONTHLY (TONS)	ESTIMATED QUANTITY YEARLY (TONS)
1	Metal Scrap	0.02	0.27
2	Wood Scrap	0.2	0.10
3	Plastics/Rubbers	0.03	0.30
4	Papers	0.1	0.10
5	Concrete Waste	0.2	4
6	Soil Waste	0.3	4
7	Used Oil Filters	0.01	0.15
8	Sewage	0.05	100
9	Medicals	0.01	0.15
10	Electrical Lighting bulb.	0.001	0.001
11	Food Waste	0.1	0.4

Figure 22: Waste Stream Table showing anticipated types of waste and volume
Source: Waste Streams for NLNG RA school expansion project

Views on Technology

The importance of technology in project management cannot be overemphasized. Special technologies adopted on the project are classified based on their applications and they include the following:

eDoc Software

eDoc is a software solution for technical documentation management. eDoc was specially designed to meet the needs of project teams where large documentation works and use of the operating manuals/ design drawings is key to operational process. Bouygues construction uses eDoc platform to manage documentation, providing storage cloud for information sharing. Every project team is given access to project documentations, procedures, method statements and designs through to the eDoc. No printing is allowed unless it becomes absolutely necessary to print.

Project Scheduling Software

Primavera P6 project management software is deployed for planning, scheduling, tracking and reporting construction progress on the project. Primavera is an enterprise project portfolio management software. It is easy to use, with collaboration and control capabilities and provides a better user interface and integrates with other enterprise software such as Oracle and SAP's ERP systems. This makes it different from Microsoft Project Software.

Views on Communication

The communication structure for the project is a top-down and upward system of information dissemination as detailed in the organization chart. Every departmental head (Sectional Manager) is responsible for his or her department as per the contract scope but information must be approved by the project manager. There are two types of communications on the project; The internal and external communications.

Internal Communication

Internal communication occurs between the project team, inclusive also of the subcontractors and design consultants. This communication occurs via official emails, Letter headed letters, internal memo, coordination meetings (frequency defined) and notice boards.For construction execution, only stamped Approved for Construction (AFC) drawings are used on site. Quality control procedures are developed for the control and storage of documents, drawings and records.

External Communications

This is a type of communication is between the client and the contractor. Communication in this case occurs via emails, site meetings and technical meetings.

Site Meetings

The attendance is normally between the main contractor, client project management and external consultants. During this meeting issues related to contracts, finance, progress, bills of quantities and variations are discussed.

Technical Meetings

During this meeting, issues related to production are discussed. Various quality control tools had been developed to document technical approvals in this meeting. They include the Construction Technical Queries (CTQ), Request for Information (RFI), Site Design Amendments (SDA), and Engineering Technical Queries. See sample in Appendix D.

Views on Human resources

One of the difficult parts of project management is the aspect of human resources. The contract placed some constraints, requiring 70% of the unskilled labour and 30% of the skilled labour to be supplied from the host communities. This is a challenge because very few people who are employable are not productive. There was also an issue of keeping the quality standards and HSE requirements on the project. Though this caused lost working hours with training and support, the project was able to bounce back. The skill set required for a project manager is the planning skills, past experience of project control and of course must be a graduate with an engineering background.

Staff Mobilization Strategy

The mobilization of the staf is per the planned start of activities. No staff is mobilized on the project earlier than the scheduled start of activities. This is to avoid incurring an overhead cost (salary, housing, transport, medical services) with zero productivity. The human resource mobilization plan is developed by the project manager based on the Overall Project Execution Planning for implementation by the Human Resource department.

Project Management Strategy

As a Design-Build contract (EPCC), project management strategy adopted on the project involved complex interphase management of all phases of engineering design, procurement, construction execution and commissioning, with the sole aim of ensuring timely delivery of projects without compromise to quality, safety and budget.

Organization Structure

Based on the expected deliverables and scope of the contract, a comprehensive organization structure was set-up as detailed below. The project manager sets up and identifies the working team for design, procurement, construction, and commissioning. Once the project is initiated (Initiation phase) and is commissioned to start, the project manager moves to site for office set up.

Planning & Scheduling:

A level 4 fast-tracked schedule is developed from the baseline schedule, which forms the basis for tracking the project progress and performance.

Developing the Project Execution Plan:

The project manager with the support of the project quality manager develops the project execution plans for all the phases of the project. The project execution plan highlights the following which forms the basis for project controls and monitoring:

- Sub-contracting Plans
- Planned Programme of work
- Production Strategy;
- Financial Tools and Project Cost Control Plan;
- Project Meetings and Frequency;
- Key Performance Indicators and Targets (See Sample in Appendix B)
- Training Plans
- Procurement Plan
- Commissioning strategy
- Audit Plan
- Quality & HSE (Health ,Safety and Environment)Objectives
- Project Review Strategy

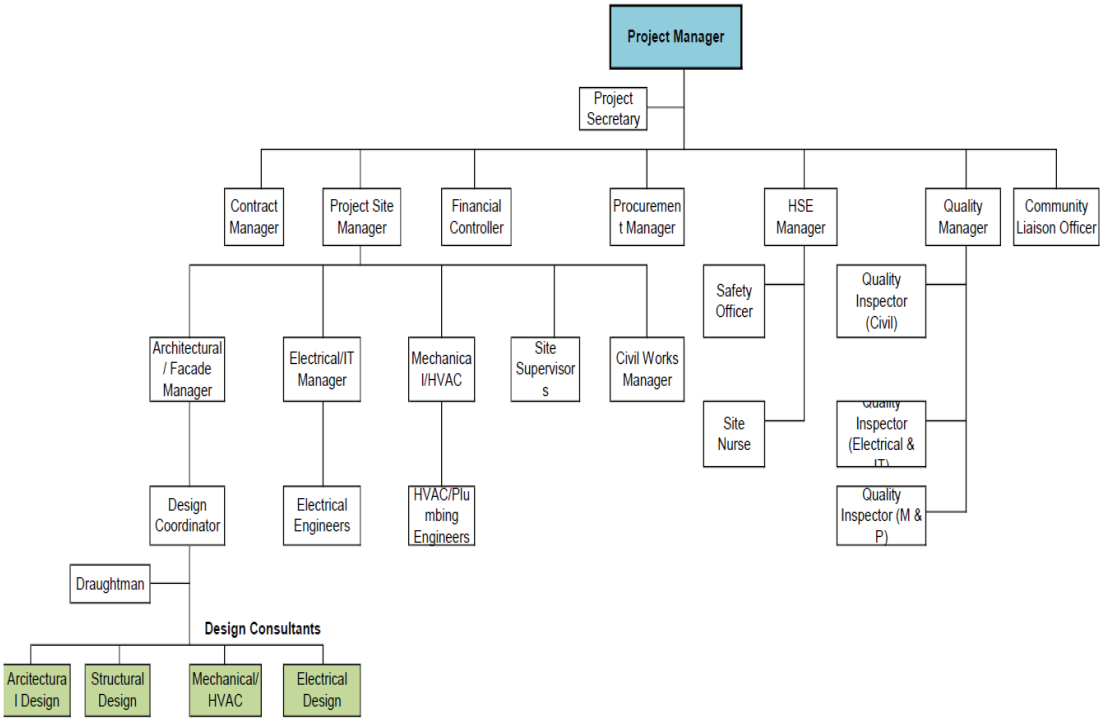

Figure 23: General Organization Chart.

Source: Adapted from BCNL_Project Construction Plan NLNG HOD Project

Design

This aspect of the contract was subcontracted to different reputable design firms (Architectural, Civil & Infrastructure, Electrical, Instrumentation, IT, Plumbing & HVAC Systems). Challenges encountered were that of managing the designs interface, improving productivity, controlling the quality of deliverables and managing comments.

Figure below shows the adopted strategy in managing the design phase of the project and ensuring designs meet the required specification. A design manager was deployed whose main job function was to coordinates and manage interphases between the different design contractors. The design manager is further assisted by in-house subject matter experts (SMEs). Before the documents are dispatched to the client for approval, the designs are reviewed and vetted for quality, poor representations, adequate referencing, etc.

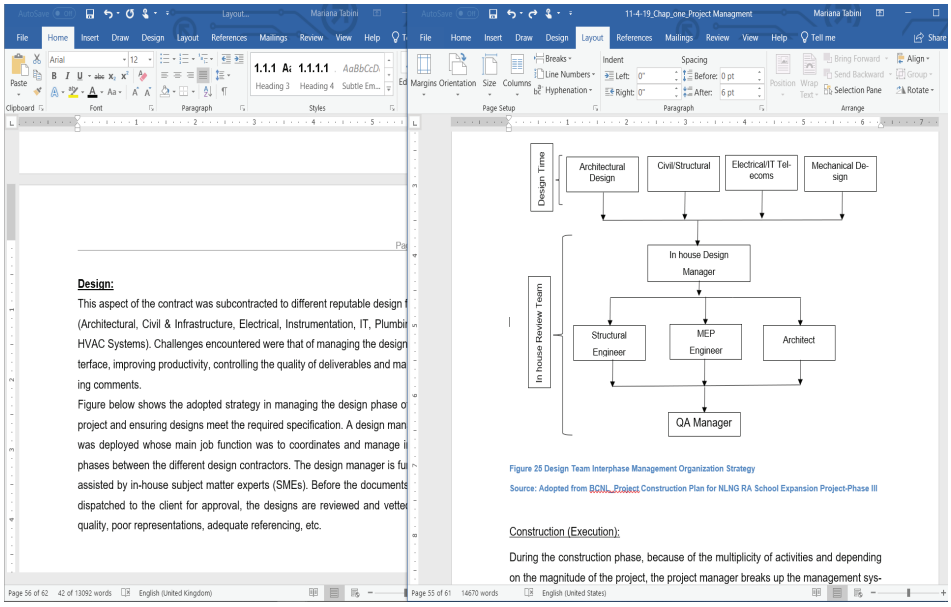

Figure 24: Design Team Interphase Management Organization Strategy (Source: Adopted from BCNL_Project Construction Plan for NLNG RA School Expansion Project-Phase III)

Construction (Execution):

During the construction phase, because of the multiplicity of activities and depending on the magnitude of the project, the project manager breaks up the management system into trades or by discipline. Package managers are responsible for the effective implementation of the contract requirements per discipline or trades, e.g Civil, Electrical etc. They manage the allocated budget for the trades towards ensuring timely completion and in good quality. The Project Manager controls and holds final approval of all expenses after the Financial Controller had checked traceability to the allocated budget. At the monthly interval, there is a cost control review meeting where the budget is reviewed and discussed tied to the planned and actual progress of the project.

Procurement:

The procurement officers work with the trade managers to identify long lead items or equipment in the contract. The long lead materials or equipment are materials that take a long time to manufacture due to design specifications and freighting system. They are always on the critical path and the procurement processes are started earlier as soon as the design is finalized.

Conclusion

The primary constraints that affect most projects are the triple constraints of budget, time and quality. A project manager, therefore, works his best at ensuring a balance of these constraints while meeting or exceeding the expectations of the company's Board of Directors and the client. As it can be seen from the report, the key to successful completion of these unique projects is corroborated by the project management plan, which is the document that describes how the project will be executed, monitored, and controlled. Identifying project specifics and deliverables and setting up the appropriate (competent) team is imperative to successful project management.

With regards to waste management, most countries have a very strict process to manage waste. Waste is properly segregated and disposed of/ reused. The project from Albania can be a good learning example wherein the topsoil was retained and later reused for the rehabilitation phase. Also, the site from Nigeria has a restricted waste management policy. These efforts put in by the company illustrate how much serious efforts are put in by these countries towards reducing the damage to the environment.

Communication is vital for the project's success. The project in Albania teaches us how disputes between locals and project stakeholders could have been avoided by organizing a dialogue between the concern parties. The project from Guatemala teaches how important it is to document formal and informal forms of communication.

The construction industry is undergoing a major shift in technology. With the advent of BIM and related technology in the field, the company needs to be able to adjust and implement these into their own projects. These new technologies have proven to be useful in reducing the cost of production and also increase profits. The Guatemala project would have been more cost-effective with effective using BIM. The Nigerian project stands as an example of how documents were managed with bits of the help of technology and reducing the number of prints, thus reducing the stress on the environment. The project in Iran made use of high-end façade material which proved cost effective for the client and resulted in cost saving.

Human resource is sometimes not given its due importance during the life cycle of the project. The negative impact of this can be learned from the Albanian project wherein the cost of labour could have been reduced by providing training to local workers. Projects often generated work opportunities for the locals, like the one in Guatemala. It generated close to 370 new jobs in the local area. Human resource management effectively understood this and managed the hiring of locals accordingly.

It is likely for a project to deviate from the planned program, deviation which could be in the form of overspending, a schedule slippage, a departure from the project scope, etc. but it is utmost important to know at all times the position of the project in comparison with the baseline program. If there is a variance, then it becomes ideal to know the amount and cause of the variance and take corrective action to get back on the track or minimize the variance.

As can also be seen, different process groups (Human Resources, Procurement, Quality and others) come together which forms "a must" knowledge areas for a project manager from the initiation stage to the closing of the project. While also ensuring efficiency, it is important that a team head (with requisite expertise) is assigned the management responsibility of each knowledge areas under the project manager.

By conducting interviews with Project managers who are working in different parts of the world, we are able to conclude that the styles of Management differ in different parts of the world. However, most of the Project Managers are now working towards developing a sustainable project with the use of latest technology. There are making attempts to have better communication both within the team as well as with the stakeholder. We hope this report will serve as good reading for project managers who wish to learn from others and try to avoid similar mistakes in the future.

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Appendices

Appendix A for project based in Iran

https://1drv.ms/b/s!AuVD68im3uaJiA9dyEo8B4eKrmho page 1-9

Appendix B for project based in Albania

https://1drv.ms/b/s!AuVD68im3uaJiA9dyEo8B4eKrmho page 10-17

Appendix C for project based in Guatemala

https://1drv.ms/b/s!AuVD68im3uaJiA9dyEo8B4eKrmho page 25-34

Appendix D for project based in Nigeria

https://1drv.ms/b/s!AuVD68im3uaJiA9dyEo8B4eKrmho page 18-25

Technology Developments in the Construction and Real Estate Industry

Case Studies 1: Building and Refurbishment

Construction and Real Estate Management

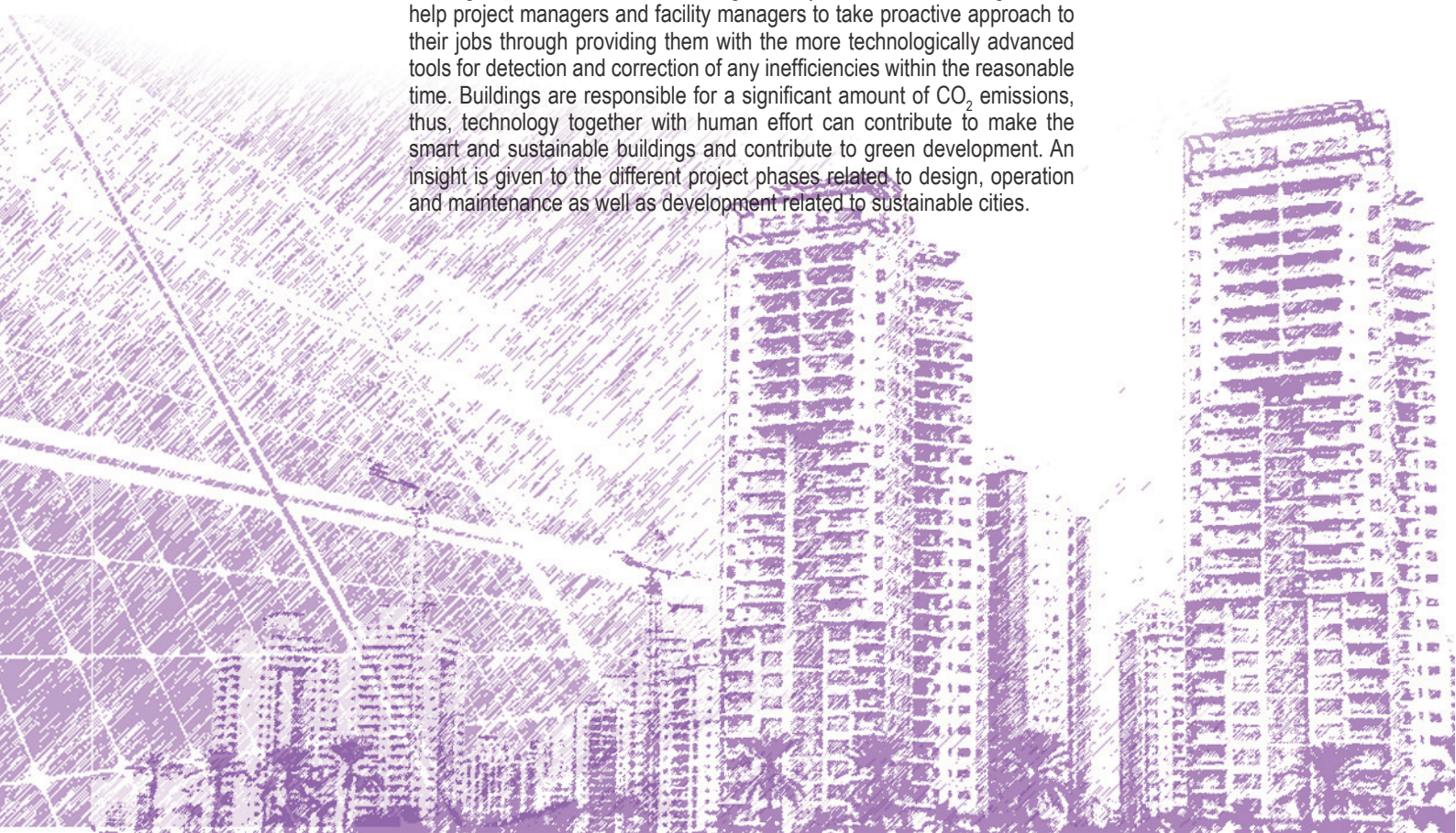
Supervisors: Eric Pollock and Ana Reinbold

April 2019

Authors: Mehrzad Vali, Gjergj Zhebo, Richa Srivastava, Diana Kustdavletova, Armin Alaei and Lisiena Dimo

abstract

With the advent of industrialisation and technological advancements, the digital era holds utmost importance. As design is becoming more complex there is a greater need of enhanced efficiency and productivity in terms of sustainable construction. This report focuses on the technological developments made so far in the field of construction and the potential it holds for the future. The integration of Artificial Intelligence, the Internet of Things, Building Management Systems and Zero Energy Buildings promise low cost and high value structures with a longer life cycle. These technologies also help project managers and facility managers to take proactive approach to their jobs through providing them with the more technologically advanced tools for detection and correction of any inefficiencies within the reasonable time. Buildings are responsible for a significant amount of CO_2 emissions, thus, technology together with human effort can contribute to make the smart and sustainable buildings and contribute to green development. An insight is given to the different project phases related to design, operation and maintenance as well as development related to sustainable cities.



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BIM Technology and Its Application in the Construction Industry,

Mehrzad Vali

Introduction

Nowadays, Building Information Modeling (BIM) technology is widely used by the large number of advanced countries of the world as a novel solution to improve the accuracy, understanding and speed of the lifecycle of a building including initial studies, design, construction, exploitation and even destruction of various types of buildings and structures (Wong, et al., 2009).

Currently, this approach has been implemented in various private and public sectors of the United States, England, Finland, Denmark, Norway, Hong Kong and Singapore. Also, institutions and large companies (such as Autodesk, etc.) are implementing and extending this method in advanced countries of the world. (Wong, et al., 2009)

Day by day, the lifecycle of a project becomes much more complicated due to the involvement of different natural and juridical persons, various methods of building, extensive modern materials and equipment in various stages of this cycle including initial studies and design of different parts (architecture, structure, mechanical and electrical equipment). This has resulted in an increasing demand for accuracy and the use of novel and precision approaches (Figure 1). On the other hand, stringent standards, design requirements and implementing sustainable design and Green building create this demand for each member of the building team (employer to the beneficiary) to have the most visual perception and the least errors at different stages of the work. The other purpose of using BIM technology is the correct transfer of information and demands of the project owners to the design team. Then, from design team to the building team and finally from building team to the beneficiary in such a way that the initial goals of team members will not be diminished or deviated (Chelson, 2010).

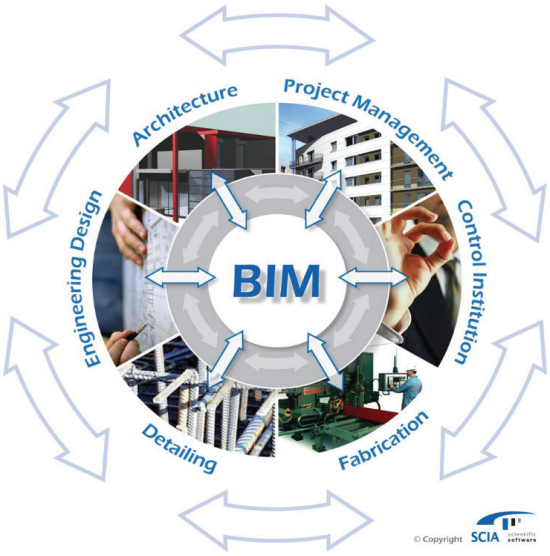


Figure 1: Project lifecycle and all factors involved in the BIM process (Scientific software, (2008), SCIA)

What is BIM (Building Information Modeling)?

BIM is a digital representation of the design and construction process of a building to facilitate the transfer of information and concepts as well as enhance the interoperability and interaction of all individuals involved in the lifecycle of the project (Kymmell, 2007). In other words, BIM and its related tools can simulate the whole process of construction and design in a virtual environment (Eastman, et al., 2011), Simulation makes it possible to examine and analyze all the processes in a digital environment and minimize the occurrence of any risky and costly mistakes.

A simulated model that can meet our goals in acquiring and using BIM technology should be (Kymmell, 2007):

- Digital
- Solid (3D)
- Measurable, dimensional and parametric
- Comprehensive and pervasive
- Accessible for all factors involved in the project
- Durable in all phases of the project

Definition of Parametric Objects

- Understanding parametric objects is one of the most important and fundamental concepts that directly plays a central role in the definition of BIM technology. Parametric objects differ greatly with the definition of merely traditional objects or components (3D). Accordingly, they can be defined as follows (Eastman, et al., 2011) (Figure 2)
- These objects include their comprehensive geometric information.
- The geometry of objects is integrated and free of any redundant information that causes error and inconsistency in other objects. As an instance, the plan view and elevation view of an object must be perfectly harmonious, identical and without any contradiction. Also, any change in the geometric properties of the object should be automatically applied in its generated views.
- These objects should have the ability to modify their dimensions and sizes while integrating with other objects (parametric) with respect to the condition and geometry of the object. For example, a door is automatically placed inside a wall (and a warning should be made in case of the contradiction in placement and difference between the wall and door) or a parametric wall can automatically change the difference after a collision with the elements in the ceiling (like the dropped ceiling). The placement of mechanical and electrical equipment at the appropriate level and height of parametric walls can be considered as another instance.
- If the object has various components, they are defined in different levels in order to be worked together in an integrated manner. For instance, if a wall is multi-piece or the material of each member is changed, the total weight of the wall should be adjusted (modified) automatically. Also, if the material of each layer of the wall is changed, its heat transfer coefficient should be modified.
- It should be possible to define specific relationships, rules and constraints between the dimensions and sizes of an object or object set in order to ignore any change that violate these rules. As an example, according to the dimensions and sizes of the door at a particular factory, it is possible to make change and definition in the production range of the factory.
- Objects should have the capability of linking, receiving or transferring their information and features to other BIM-related models and apps. For example, the structural information, materials, acoustic information, energy data, etc. of each object should be easily accessible by applications which are compatible with BIM.

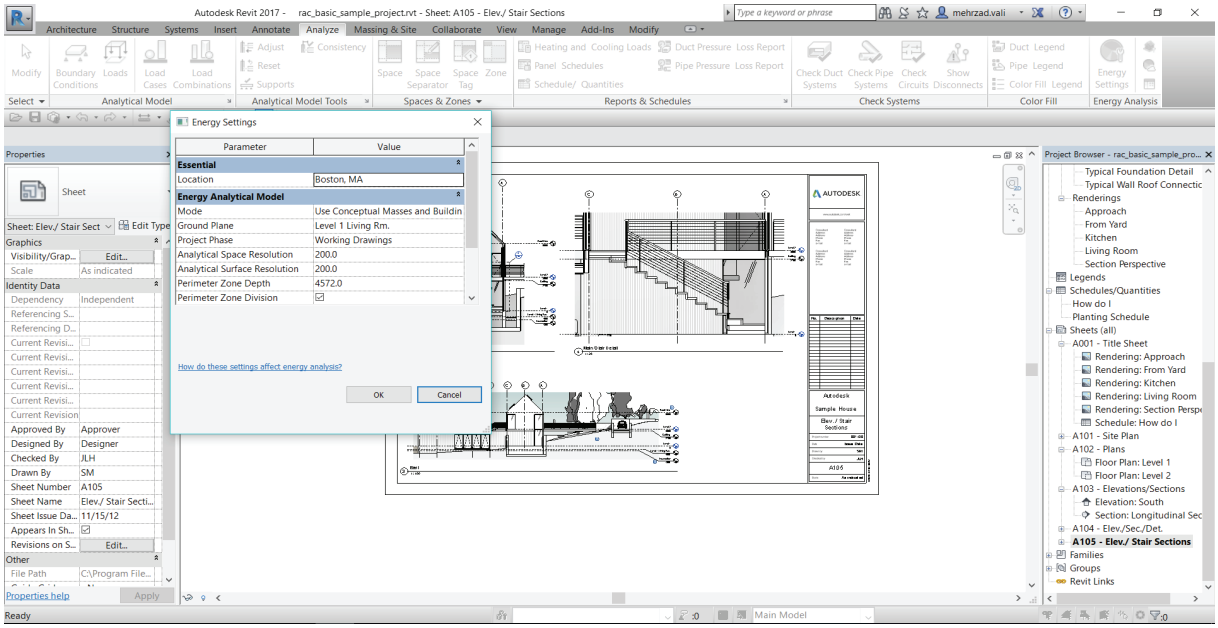


Figure 2:An example of the definition of a parametric object (Autodesk, 2019)

Which items are not considered as BIM technology?

Today, BIM technology is the hot topic of scientific and technical communities. A great number of well-known computer product manufacturers are beginning to coordinate and produce BIM-based products. Introducing features that exclude the product from the scope of BIM technology is considered as an approach to make distinctions between the products and tools based on this concept and other products (SCIA, 2019).

- Models that only contain 3D information of one or several objects and do not have the information of the object's features. These models are merely employed for visualization, but they do not provide any support for feature information
- Different applications in the lifecycle and construction of the project. For example, Google's SketchUp is a significantly powerful and useful software for instant schematic and 3D production of a building while it has very limited applications in the analysis of the building. Google's SketchUp can be applied in the BIM process of a project with the help of other applications.
- Models that do not have any parametric information.
- Models that need to be linked to 2D CAD files for extracting their information since it is not possible to ensure the availability of an efficient, accurate and intelligent model (being based on non-smart 2D files).
- Models that have the ability to make a change in the view of the software while the other views will not be automatically altered.

BIM Technology Applications

As stated before, BIM technology can be applied as a concept and novel approach throughout the entire lifecycle of a project, from the initial studies and feasibility to the demolition phase of the project. Table 1 provides information related to the use of this technology in different stages of the project lifecycle (Anumba, et al., 2009)(Table 1)

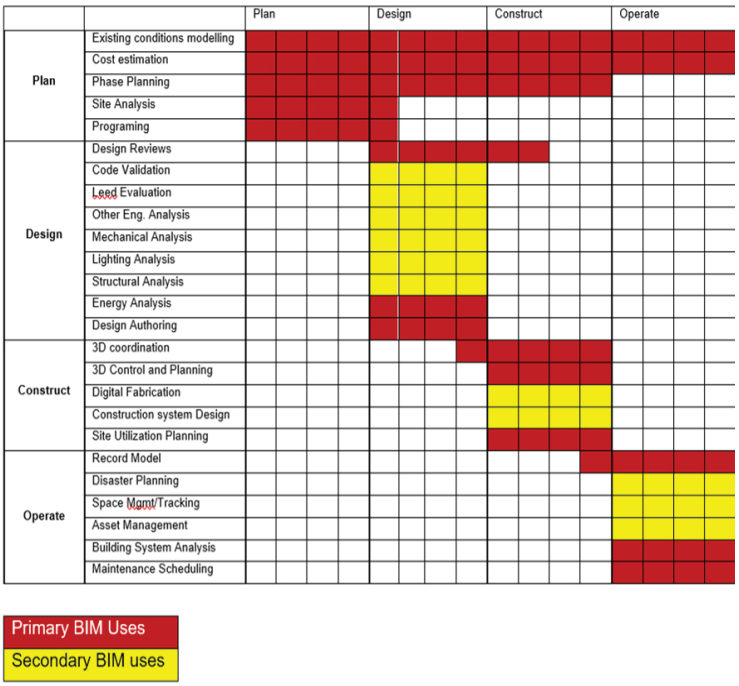


Table 1: Application of BIM technology in different stages of the lifecycle of a project (Anumba, et al., 2009)

A large number of experts believe that applying BIM in the design phase of the project is one of the most attractive and important applications of BIM technology. Using the information collected and modelled based on the BIM concept, the following studies can be conducted accurately with minimum computational error:

- Green and sustainable design of the building
- Energy analysis of buildings and achieving the optimal use of fuel and energy (approaching the concept of Zero Energy) (Figure 3)
- Analysis of the internal and external lighting and more importantly, the use of optimal daylight as well as creating illumination during various times of the year at anywhere on the earth (Figure 4)
- Analysis and study on the effect of wind energy on buildings (Figure 5)
- Structural forces analysis and structural design

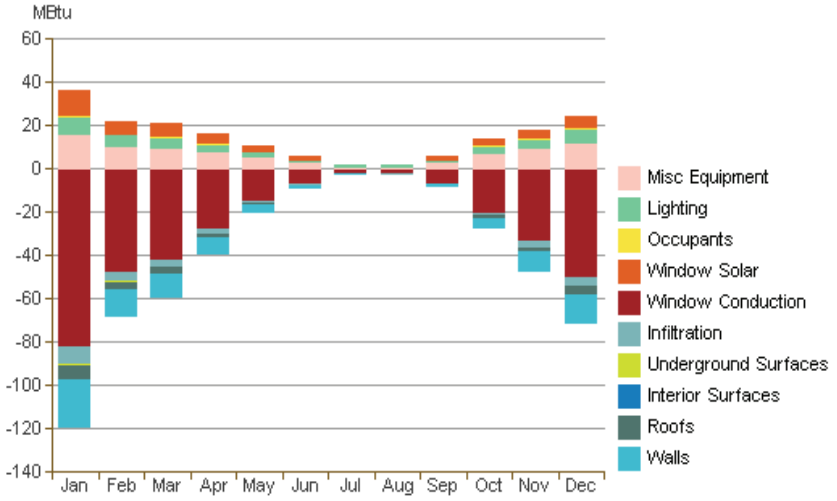


Figure 3: Energy analysis using model information (Autodesk, 2019)

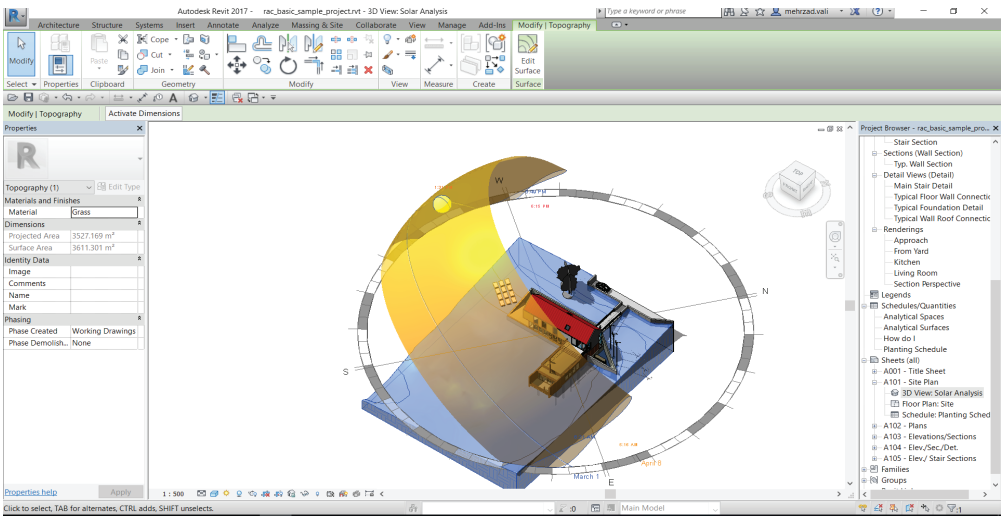


Figure 4: Analysis of the amount and mode of the absorption of solar energy in different days and hours (by Author)

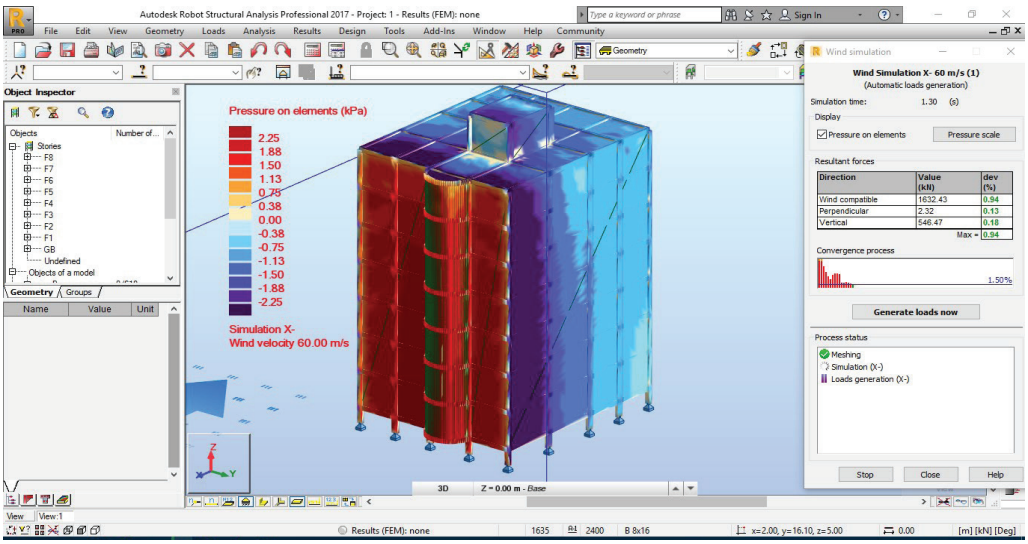


Figure 5: Analysis of wind effects on the buildings (Autodesk, 2019)

The most momentous features of BIM technology in the design and construction phase are as follows:

Visualization:

In the culture of the East and the West, people say “I see” when they understand and accept a concept. In fact, this is related to the importance of visualization for individuals. One of the most practical benefits of 3D models is the growth of the visual understanding (comprehension) of all project-related members (from employer to beneficiary).

BIM provides one of the most powerful visualization tools in all areas for members of the project lifecycle (Hergunsel, 2011)

Collaboration:

Collaboration between the various members of the project team including the owner, design engineers, executive engineers and beneficiaries is initiated and felt from the early stages. Models produced in this area contribute to the collaboration and precision of the design and construction team (Hergunsel, 2011)

Site Coordination:

This technology plays an important role in the sustainable and targeted management of the site of the construction projects and helps to control and enhance safety, logistics management, etc. Daily operations in the executive site and several scenarios can be simulated using this technology and related applications (Hardin & McCool, 2015)

Elimination:

BIM technology will notably help to reduce the inconsistencies, technical incompatibilities, losses, destruction of materials and technical forces and eventually the risk of the project.

Fabrication:

BMI technology is known as a major revolution in the building industry, as a great number of manufacturers have remarkably enhanced their capability and accuracy of construction using the information of models produced (Hardin & McCool, 2015). Some examples of using BMI in the building industry are as follows:

- Constructing skeletons and structures
- Electrical and mechanical components
- Concrete prefabricated sections
- Internal and external glass systems of the building

Prefabricated Buildings and Sections:

This technology can reduce the workforce and construction time and lead to an increase of accuracy and quality in the prefabricated industry (Hergunsel, 2011). As this technology becomes pervasive, prefabricated industries are coordinating their software with it so that many modern Compute Numerical Control (CNC) machines are able to adapt to BIM models and produce their products.

Design and construction of prefabricated complex concrete and metal structures, curtain wall, prefabricated walls, mechanical and electrical equipment are some of the applications of this technology.

Cost Estimation:

Contributing to the project estimation is considered as one of the most powerful and extensible abilities of BIM models.

Clash Detection and Reporting:

Detecting clashes between various created models in project design group (architectural, structural, mechanical, electrical) is one of the substantial applications of BIM. Designers provide their designs in the form of separate models for BIM managers. These models can be merged together to create a single model of the project. Indeed, before starting any operation, all the future processes in desired locations can be observed in the simulated form to solve any clashes of members and omit the probability of occurring these problems in reality. Management teams observe all the clashes and report required information with the exact location of the clash to the designer in order to solve or preserve it. (Figure 6)

Heritage Building Information Modeling (H-BIM):

According to UNESCO, the World Heritage Site is divided into natural, cultural and underwater heritage. Methods have been used to preserve them so far, BIM technology is one of the newest methods for modeling old works in order to model, remodeling and maintain them, which we can model in a number of ways, as shown in (Figure 7)

Scan-to-BIM: Re-Creating As-Build using point cloud and photogrammetry:

in order to change part of the plan, to refine the plan, renovate and rebuild all the work that needs to be rebuilt, levels of a built building from A to Z have a specified and standardized step. Now, if they want to make changes at the last stage, they need to have a redesigned plan according to the current situation, that in case engineers try to take of some information of buildings with the deferent method that These methods are measured traditionally through meters and appliances, as well as through the new methodology like point cloud and photogrammetry with engineering BIM software help. (Figure 7)

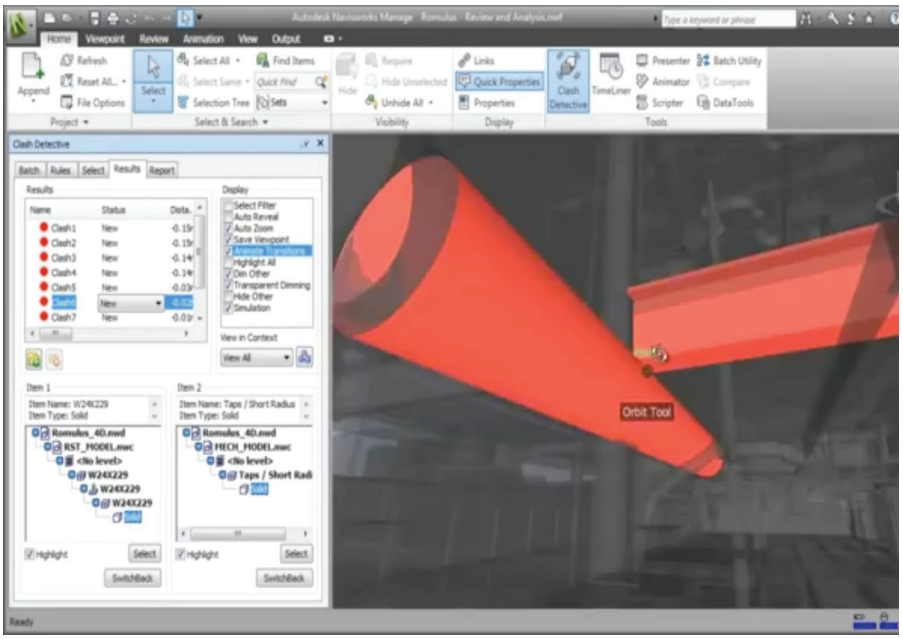


Figure 6: Detecting clashes between structural and mechanical models and specifying them by the BIM management team (By Author)

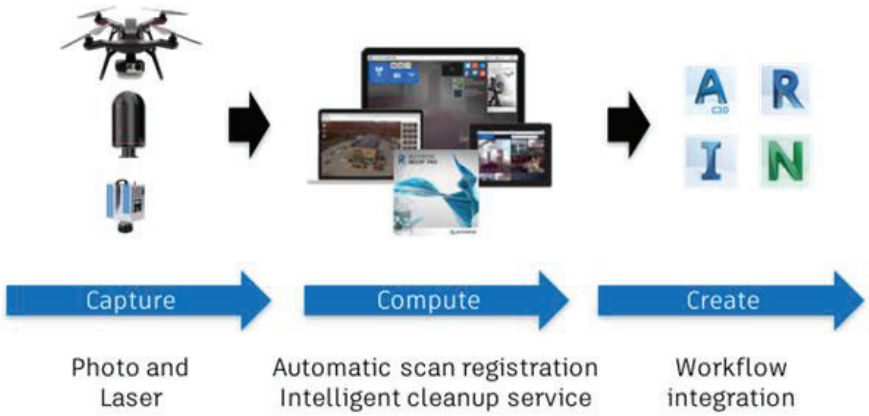


Figure 7: The steps to acquire information and implementation with BIM technology in as-built projects and modeling heritage, (Adapted by Author)

Planning and Scheduling of the Project:

Another attraction of BIM technology is the ability to produce 4D and 5D models. This technology has entered into the field of project management and construction by adding project management files (Primavera, MSP, Vico, etc) and assigning activities to various elements in 3D models. (Figure 8)

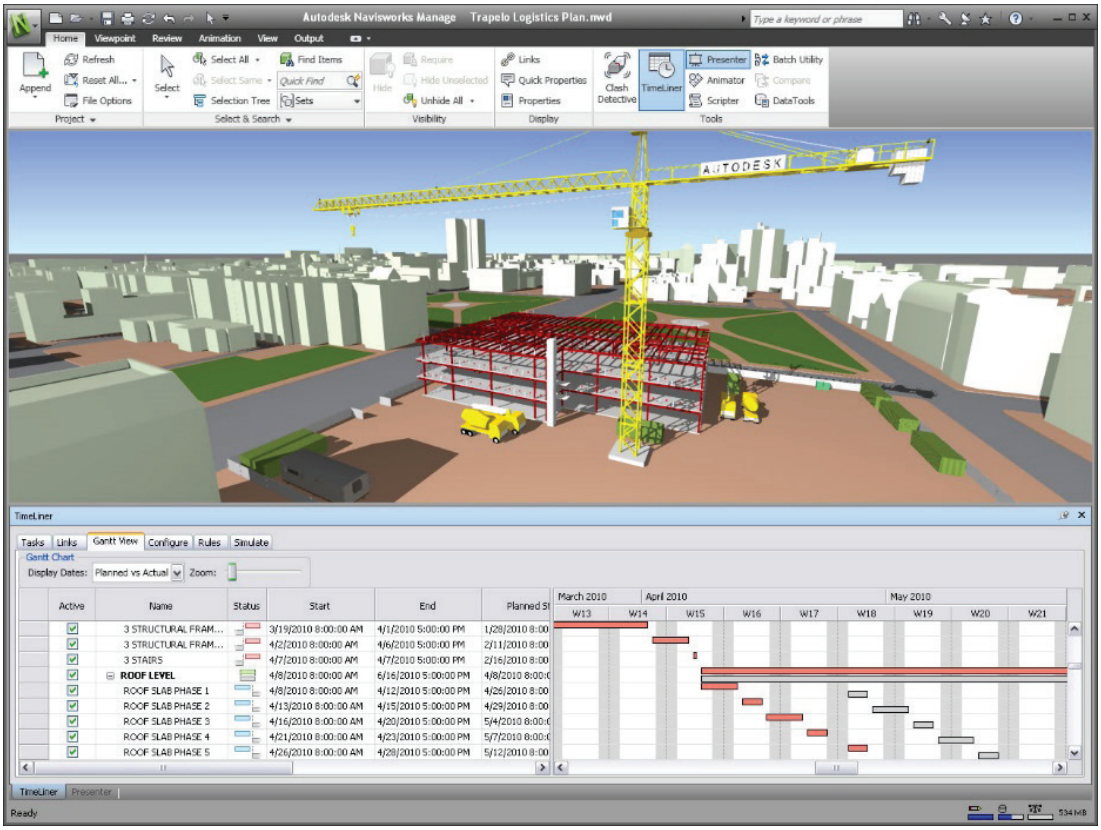


Figure 8: : Integration of BIM models, project management models and production of 4D model (Autodesk, 2019)

BIM technology needs to upgrade it in the future

The need for designers and engineers to achieve quality and reduce their consumption and energy requires them to use the technologies of the day.

As a result, they are trying to improve their construction projects using technology, while this relatively new technology has some shortcomings that need to be improved in the future. In the first step, the perceived needs can be divided into two groups:

The short-term goal is BIM can recognize the best producer of objects like the window or door in a wide range of companies which is befitting the project. It selects them from a database that they registered in before and BIM selected them from that database. In this case it has to join AI technology for detecting their identity and offer them to the architect or engineer, in hence it can help to save time and energy and project quality.

The long-term goal is to create an AI that can make design decisions and thus alleviate architects' and engineer designers' effort. These decisions will be made based on what an intelligent agent perceives to be its environment, for example, occupant preferences and local climate. (Karan & Asadi, 2019)

Conclusion

Owing to the increasing complexity of construction projects and building industry's approach to environmental issues and sustainable building, the need for an efficient and effective method is felt more than ever. The BIM concept, which can be used in all phases of the project, is one of the most successful and efficient approaches widely used in today's world. In addition to the use and implementation of this technology in advanced countries, researchers in developing countries are also providing proper solutions for practical implementation in different phases of the project.

Different software and applications have been produced and developed that are compatible with BIM. Some of the most popular ones are as follows:

Autodesk Revit (Architecture, Structure, MEP), ArchiCAD, Bentley, Tekla Structure, Autodesk Ecotect, Analysis, Autodesk Vasari, Autodesk Navisworks, Autodesk Robot structural analysis and Solibri

The technology is auspicious and useful, and now it has a lot of prosperity, so that in the advanced societies it feels more needed, In the near future, we will see that a new generation of engineering and construction technologies such a AI cooperation with BIM is helping to preserve the natural environment and natural energies, which is in line with BIM's main goal.

Energy Saving and Renewable Energy Technologies in Building Sector,

Gjergj Zhebo

Abstract

As the world faces significant changes in the last decades with increasing population, rapid urbanization, developing countries and technology, energy is the main challenge and opportunity also laying ahead for the world. As development continues it comes with the cost of global climate change which is strongly affecting our planet and our everyday lives.

The energy sector and the building sector more specifically, is one of the major contributors to the global greenhouse gas emissions and if not proper measures to mitigate the problem will be taken it can affect the short and long term future of the planet. When considering the building energy sector the two related fields are the energy saving or efficiency and the possible renewable energy sources that can be used to produce clean energy.

The focus of this report is the energy saving and renewable energies for the building sector. The approach of the research is the technology development of the related fields. The research raises the following questions:

(i) Which are the best practices to more efficient energy usage and saving in the building energy sector?

(ii) Which is the most sustainable approach to energy; consume less or produce more clean energy?

(iii) Which is the most optimal and efficient renewable energy source in an environmental approach?

The objective of this report is to go through the latest developments in the field of energy efficiency and renewable energies in the built environment sector. The report supports the United Nations Sustainable Development Goal 7, for affordable and accessible clean energy.

Background

Energy is one the major contributors to climate change, with around 76 percent of the total CO2 (Carbon Dioxide) greenhouse gas emissions, due to burning fossil fuels, powering industrial processes, deforestation, and other wasteful land uses. Other types of greenhouse gas emissions like CH4 (Methane), N2O (Nitrous Oxide) and F-gases (Fluorinated Gases) contribute to the global greenhouse gas emissions respectively as indicated in Figure 9. Currently, the world energy sector relies heavily on fossil fuels mostly for transportation, industrial production, heating, and electricity production (IPCC, 2014)

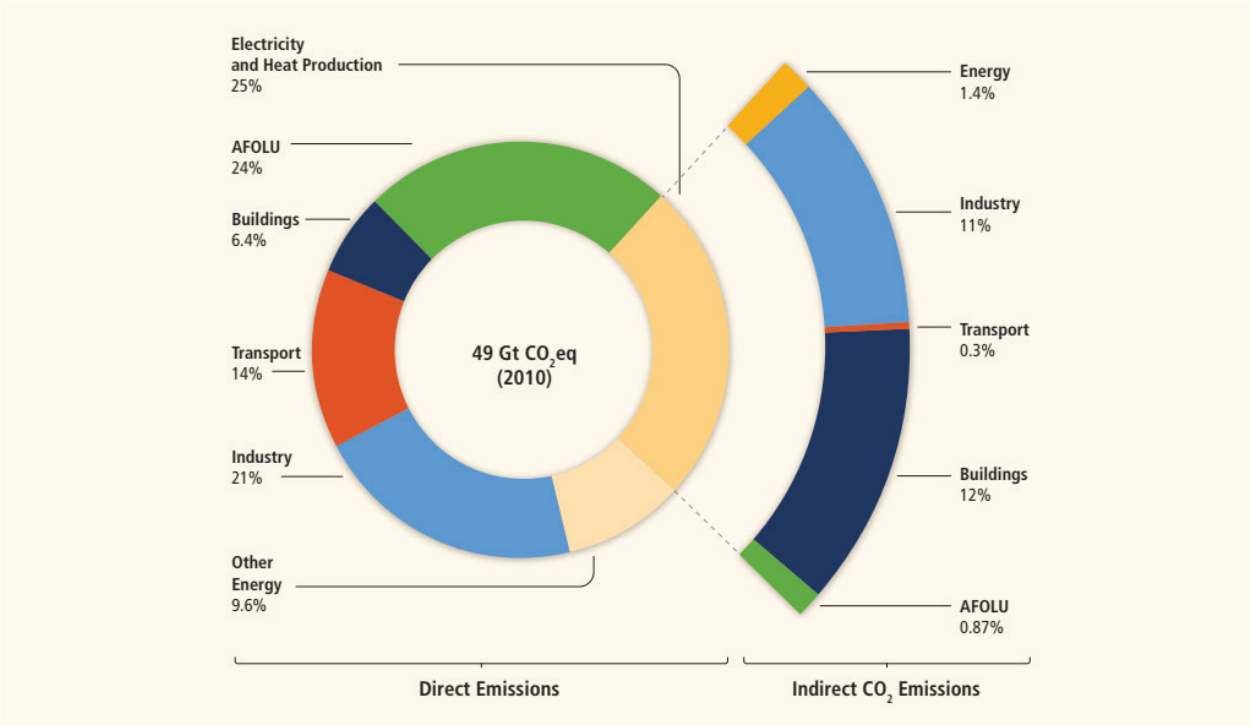


Figure 9: Greenhouse Gas Emissions by Economic Sectors (IPCC, 2014) fig. TS.3, pg.44

The energy demand has steadily increased in recent years and the most significant contributors to this trend were a higher energy demand driven by the rapid economic growth in developing countries an and increase of the share of coal in the global fuel mix (IPCC, 2014). In order to reduce the contribution of the energy sector to the Greenhouse Gas

(GHG) emissions, multiple options were analysed in the Climate Change 2014 Mitigation of Climate Change report. These included:

"energy efficiency improvements and fugitive emissions reduction in fuel extraction as well as in energy conversion, transmission, and distributions systems; fossil fuel switching; and low-GHG energy supply technologies such as renewable energy (RE), nuclear power, and carbon dioxide capture and storage (CCS)" (IPCC, 2014)

At the present moment, the global energy sector is having significant transformations including growing electrification, expansion of renewables, upheavals in oil production and globalization of natural gas markets. Choices made in the next years by policymakers and governments will shape the future of the energy industry (IEA, 2018). According to the International Energy Agency (2018) in the World Energy Outlook 2018:

"the energy demand is set to grow by more than 25% to 2040, requiring more than $2 trillion a year of investment in new energy supply" (IEA, 2018)

As noted previously the energy sector is one of the major contributors to the world GHG emissions and the biggest in the CO2 emissions. Consequently, the decisions to be made in the coming years will determine the future of GHG emissions and climate change impacts to meet the long terms climate goals of the Paris Agreement 2015 for reducing the air pollution and ensure universal energy access (IEA, 2018).

Buildings contribute 19% of the global GHG emissions by economic sector (IPCC, 2014). Consequently, making the building sector one of the main topics for discussion and study of this report. The two main directions to be studied are energy efficiency and renewable sources for more clean energy in the building sector.

Electricity is one the most significant source of energy that buildings use and the electricity market is the one that is undergoing the major evolution driven by the increased demand by the digital revolution, electrical cars, and technology change. Electricity demand is growing with the fastest pace and it will be doubled by 2040 (IEA, 2018). Hence, it makes the major field to study for renewable energy sources in large scale for supplying the increased demand.

Low Emission and Net Zero Energy Buildings (NZEB)

When considering the sustainable energy approach of buildings, the most significant term used is the Zero Energy Building (ZEB). According to Torcellini, et al. (2006), a zero energy building is a building which through appropriate energy efficiency measures and renewable sources applied, can supply the amount of energy needed for its operation. Moreover, depending on how the zero energy target is determined affects the overall design choices to successfully achieve the zero energy balance. Furthermore, at the foundation of the ZEB concept is the purpose that the building has to meet its energy from low-cost, locally available, and non-polluting renewable sources (Torcellini, et al., 2006).

Following, Torcellini, et al. (2006), introduces the main subdivisions of low and zero energy buildings where connection to the grid is crucial for the energy balances. The four types of decision goals can be summarized as:

Net Zero Site Energy, when the building generates as much energy as it needs within its site boundary. This might include Photo Voltaic (PV) or solar hot water collectors, small scale wind power generators, and geo-thermal sources available within the building or property footprint.

Net Zero Source Energy, when a building produces as much energy as it uses as measured at the source.

Net Zero Energy Costs, is the case when the building in financial terms produces the same amount of energy as it is charged on the utility bills.

Net Zero Energy Emissions, is the case when e ZEB generates an overall amount of energy from emission-free renewable sources which is at least as it uses from emission energy sources.

As a conclusion to what Torcellini, et al. (2006) have set as the foundation of ZEB we can deduct as the primary goal of the buildings is to optimize and maximise their energy performance so that the remaining amount of energy required could be generated through the available renewable sources on-site or off-site. Furthermore, the Zero Energy or Low Emission buildings could be achieved by using a whole building design process which needs to start since the early stages of the design process, whether it is for new buildings or existing ones (Torcellini & Crawley, 2006).

Additionally, Torcellini and Crawley (2006) emphasize the importance of documenting the energy performance of the buildings is powerful to understand how the building is performing. In this way, it can be possible to learn from this experience to further optimize energy efficiency and adopt new technologies for achieving the final goal of Low Emission, Net Zero Energy Buildings. To create LE, NZEB we must set concrete and measurable energy goals for all building projects, strive to meet those goals by using the building envelope and measure and report the building's performance (Torcellini & Crawley, 2006). Moreover, the goals of ZEB should be extended through the whole building lifecycle (Cole & Kashkooli, 2013).

Finally, the summary of the Low/Net Zero Emission Energy Building (NZEB) includes two main aspects which are the energy efficiency and renewable energy sources. The energy efficiency includes decisions since the early stages of

design and building operation and maintenance. Meanwhile, the renewable energy sources comprise the additional aspect in order to achieve as much as possible the target of NZEB. Both aspects need decision making since the early concept design phases and measures to extend their effect through the whole building lifecycle (Torcellini, et al., 2006; Cole & Kashkooli, 2013).

Early Stages of Design of a Low/Net Zero Energy Building (NZEB)

Through the early stages of design, as emphasized previously, the most important decisions are made, which will set the foundations of the new NZEB. The initiators of a new building to design are always the architects, which generally are also the team leaders of the design team. The architectural design process starts with the urban analysis and special requirements coming from private investors and public authorities. The overall set of requirements and is translated in what is called the architectural or building program. This is the most important phase where the criteria and target for Low/Net Zero Energy Buildings should be established (Attia, et al., 2012).

Consequently, the outcome building is a product of multiple constraints and requirements which makes the design of a NZEB a complex and difficult task. In traditional and conventional design, the process goes into a trial and error steps that makes the design of a NZEB resource and time consuming with a non-certain outcome since the human ability to process a great amount of information and multiple decision criteria is limited. Furthermore, the conventional design methods lack the simulation tools in order to assess the building energy performance once the design model is created. (Attia, et al., 2012) Moreover, as Bogenstätter (2000) emphasizes is that the 20% of the decisions made in the early stages of design will affect the 80% of the building energy performance through its whole life-cycle.

Consequently, the need for an early simulation and decision support tool since the first design phase is a necessity for the designers. (Attia, et al., 2012) This is where the technology plays an important role due to its latest developments in the field of design software and simulation support tools. Nowadays, it is possible that architects and designers can include the concept design phase fundamental constraints and requirements for a better energy performance of the model. Through the Building Information Modelling (BIM) it is possible that by the selection of materials and building envelope characteristics the design team can access the data analysis of the energy modelling/ simulation. (Gerrish, et al., 2017)

The next step after the model creation and generation of the first data and simulation is the fine tuning of them in order to achieve the final target of NZEB. Further developments of technology have introduced the parametrization of the building parameters so that the computer based simulation tools can go through a vast amount of options by fine tuning a multiple set of parameters. (Touloupaki & Theodosiou, 2017)

In their work, Touloupaki & Theodosiou (2017) have proposed an architectural workflow methodology that combines parametric modelling and Multi Objective Evolutionary Algorithms to integrate Energy simulation in the early stages of design with the target to minimize the life-cycle energy requirements and achieve the NZEB requirements. The Work Flow can break down in two stages:

Stage 1: Parametrization

The stage when the designer choses the building parameters that will affect the energy performance such as, but not limited to general layout and form, building envelope characteristics, passive and active energy systems.

Stage 2: Optimization and Performance Simulation

Where as stated by the authors, the identification of the design variables and constraints is made. Furthermore, the simulation tool is chosen and the optimization algorithm is run until the optimization convergence is achieved.

Consequently, the parametric design offers a powerful tool for designers to explore and improve the building energy efficiency performance since the early stages of design and decision making. (Touloupaki & Theodosiou, 2017)

Concluding, the technology developments in the design stage can significantly help in the decision making phase for achieving the NZEB targets by applying the right simulation tools and adequate requirements and constraints.

Energy Efficiency in the Operation and Maintenance Phase

Even though the design phase is very decisive for the building energy performance, the life-cycle of the building is what comprises the real performance of the building during the operation and maintenance period. As Cole & Kashkooli (2013) concluded in their definition of NZEB, the goals of energy efficiency should extend during th whole building life-cycle. (Cole & Kashkooli, 2013) In this sub section the focus of the research is the latest technology develoments in the field of operational energy efficiency of buildings.

When considering the energy sector, it is with no doubt strongly connected to the building sector. Moreover, in the last years with the rapid digitalization of the energy sector and smart buildings, they have become more integrated with Information and Communication Technologies (ICT). The latest developments have created significant solutions for energy efficiency and management by presenting a decision making framework in the smart building sector. (Marinakis & Doukas, 2018)

The basis of the system for intelligent energy management system proposed by Marinakis & Doukas (2018) relies in the Internet of Things smart sensors positioned in the whole building with the aim to collect data about the energy consumption of the buidling which later on are ellaborated and analysed to be visualised for the decision making process. The data analysed by the IoT system will provide monitoring and controlling activities, energy analysis, and users behaviour patterns to help operating facilites making decisions on energy savings and optimization on building level. The outcome is presented in the form of an action plan in short and long term periods (Marinakis & Doukas, 2018).

As shown in Table 2, the operating process of the system is built on 4 pillars which are the building's data, energy production from renewable sources, energy prices, weather data and End-Users behaviour. The input data are analysed in real time the outcome is visualised in action plans or notifications and recommendations, from which CO2 emissions are reduced, energy consumption is reduced and moreover the users experience and comfort is increased significantly (Marinakis & Doukas, 2018).

Another innovative concept introduced lately is the Internet of Energy, which through smart sensors networks offers opportunities for smart grid applications from power monitoring, demand-side energy management, coordination of distributed storage and integration of renewable energies. These applications generate a significant amount of data which needs to be processed for obtaining the expected results. The necessity to store this Big Data and analysing them raises a challenge for building and city managers. Nevertheless, Internet of Things and Energy combined with smart grids and renewable energy sources are going to make our life easier and smart to tackle the global problem of sustainable energy efficiency (Jaradat, et al., 2015).

The Internet of Things offers great opportunities to the energy management sector by applying smart domestic appliances and sensors. Through the data collected, we can be capable of analysing them and better manage our resources by optimizing them. Moreover, through the identification of End-Users behaviour patterns the energy demand can be tailored to the specific needs and functions. The only problem raised is the big quantity of data collected by these sensors.

	DATA INTEGRATION				
Pillars	❶	❷	❸	❹	❺
	Building's data	Energy Production	Energy prices	Weather data	End-Users' Behaviour
Input	Electricity consumption Indoor temperatures Presence detectors	Renewable Energy (PV)	Real time market data	Temperature Weather conditions	Comfort feeling Schedule/location
Decision supported	**PREDICTION MODELS/RULES**				
	⬇				
	ACTION PLANS SUGGESTION				
Pillars	ENVIRONMENT-"WE"		USER-"I"		
Benefits	CO_2 emissions reduction Energy consumption cut down		Experience improvement Energy Cost		

Table 2: Operating Process, Source (Marinakis and Doukas, 2018), Table 1, pg.3

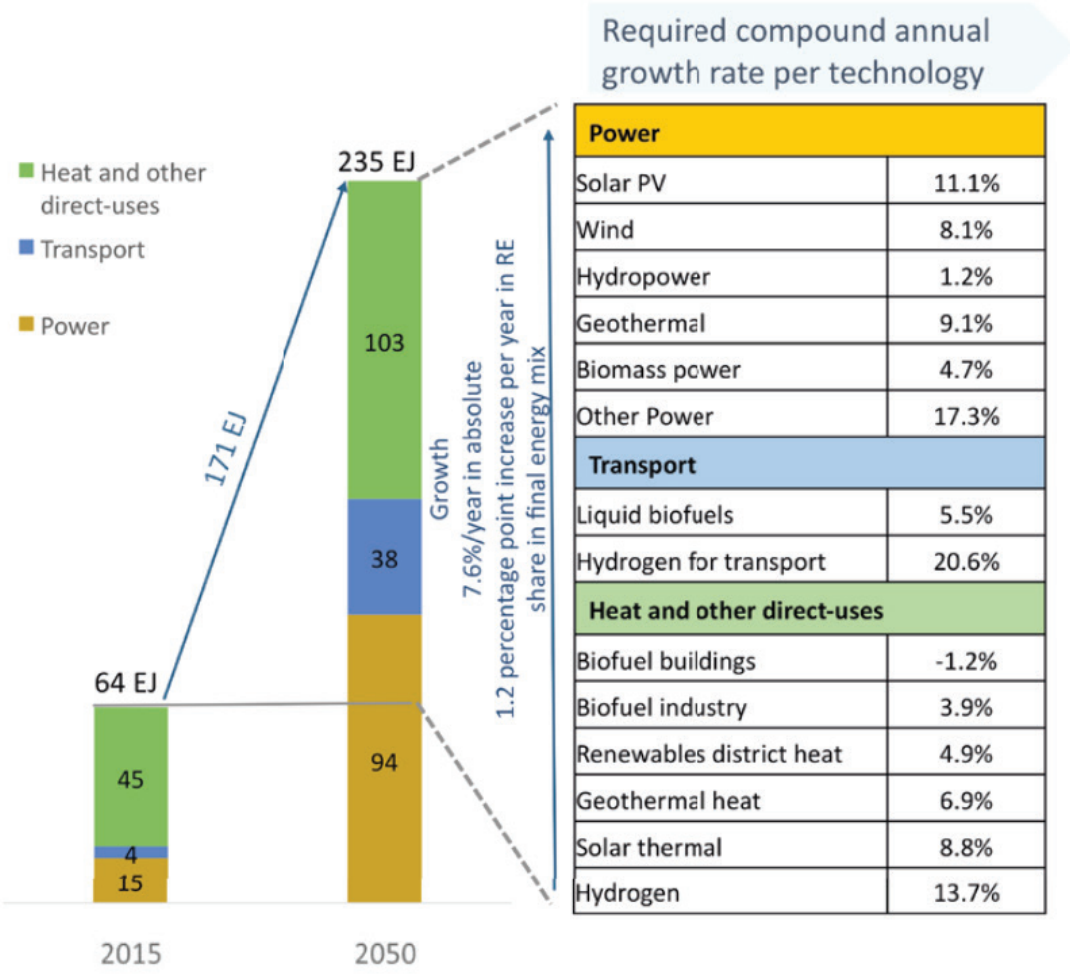
This problem as concluded by P.Plageras, et al., (2018) can be tackled by Big Data Analytics and Cloud Computing as the latest technology developments in the technology field. The outcome of this technology could lead us in to smart energy efficiency and more Green Smart Buildings (P.Plageras, et al., 2018).

Renewable Sources of Energy

Energy is the major challenge when it comes to sustainable development goals, because it is the main source that powers development. According to United Nations (2015) goal 7 the target is to make possible affordable and clean energy accessible by 2030, double the rate of improvement in energy efficiency and increase substantially the share of renewable energy in the global energy mix (United Nations, 2015). Furthermore, the world needs a decarbonised energy sector, a target that is achievable only by energy efficiency and renewable energies (IRENA, 2017).

According to IRENA (2017), International Renewable Energy Agency, the potential to achieve such goal exists from renewable energies which by 2050 if properly deployed as technology can count for two-thirds of primary energy supply. Achieving this would come from the growth of a mix of renewable energies in different sectors. In end-use sectors, solar thermal and bioenergy would be the most significant key actors. Meanwhile in the power sector wind and solar would drive the fastest growth (IRENA, 2017).

In Figure 10 the potential types of renewable energies according to respective sector are shown in percentage growth as per IRENA (2017) estimates, targeting year 2050 as medium to long term goal. In this report for the growth of these types of renewables according to the predictions it is crucial that certain policies need to be implemented and followed such as: (i) Nurture Innovation as a crucial matter for the decarbonisation of the energy sector, (ii) Pursue Power-System Integration through innovation in system integration, (iii) Decarbonise end-use Sectors through a combination of electrification technology, (iv) Expand Innovation beyond Research & Development through the complete technology life-cycle and all aspects of renewable energy integration (IRENA, 2017).



Required compound annual growth rate per technology

Power	
Solar PV	11.1%
Wind	8.1%
Hydropower	1.2%
Geothermal	9.1%
Biomass power	4.7%
Other Power	17.3%
Transport	
Liquid biofuels	5.5%
Hydrogen for transport	20.6%
Heat and other direct-uses	
Biofuel buildings	-1.2%
Biofuel industry	3.9%
Renewables district heat	4.9%
Geothermal heat	6.9%
Solar thermal	8.8%
Hydrogen	13.7%

Figure 10: Required Compound Annual Growth Rate in Renewable Technology Options by 2050, Source (IRENA, 2017), Fig. ES:1, pg.13

Obviously, as clearly stated in the IRENA (2017) report the United Nations Sustainable Development Goal 7 for affordable and clean energy is feasible and the only way to achieve it is through innovation and technology. The aim of this sub section is to investigate the latest technology developments and find the most attractive source in the field of renewable technologies and their integration in the different energy sectors.

When discussing about the renewable energy sources the most important issue is to rate the most feasible one among them. Renewable energy sources like bioenergy, geothermal, hydropower, ocean, solar, and wind are the most common sources.

Bioenergy, as a modern energy source includes biofuels produced from bagasse and other plants; bio-refineries; biogas produced through anaerobic digestion of residues; wood pellet heating systems; and other technologies. Liquid biofuels are a convenient renewable substitute for gasoline and are mostly used in the transport sector (IRENA, 2018).

Geothermal power is a renewable source that is found in the inner core of the earth. The main advantage of this source is that is available all the year round in an equal generation quantity in comparison to the volatility of solar and wind power (IRENA, 2018).

Hydropower is the most expanded source of renewable energy source, dating since the ancient times. The kinetic energy of flowing water is transformed in electricity, and nowadays modern hydro-turbines can achieve a high conversion rate as much as 90%. The main problem with this kind of source is the unavailability in time of draughtiness (IRENA, 2018).

Ocean, is an energy source that through tides, waves and currents can be used to produce electricity. The ocean power is still in the research and development phase and still not commercially available (IRENA, 2018).

Solar energy is one of the most popular of renewable sources due to the possibility to be harnessed directly from the sun even in cloudy weather. The main use is to generate electricity and heating water. The solar power is generated by Photovoltaics (PV) which convert direct sunlight into electricity; Concentrated Solar Power (CSP) that uses mirrors to concentrate solar rays and then heat fluids which creates steam to drive a turbine and generate electricity. The CSP method is used to generate electricity in large scale power plants (IRENA, 2018).

Wind power is also one of the oldest type of energy source that uses the kinetic air energy to transform it in electricity using wind turbines or wind conversion systems. This type of source is increasing significantly and is the fastest growing renewable energy technology due to the falling costs. Also due to latest innovative technology the conversion rate has increased. Wind power is categorized based on location type such as onshore and offshore, where the latest offers a tremendous potential. (IRENA, 2018)

Renewable energy can be produced by multiple sources such as solar, wind, bioenergy, ocean and geothermal. Among them the best practice according to an evaluation by Demirtas (2013) the wind energy is the best renewable energy alternative. The evaluation was made on Analytic Hierarchy Process (AHP) for the Multi Criteria Decision Making Problem (MCDM) where 12 evaluation criteria were analysed in terms of technical, economic, environmental, and social impacts. Moreover, electricity produced by wind turbines do not emit CO_2, SO_2, NOx, particulate matter and mercury air pollutants that other conventional power plants emit. (Demirtas, 2013)

Wind technology can offer significant impact in the renewable energy sector with the latest innovations of offshore wind farms while costs have fallen by more than 30% since the first wind farm was implemented and the market share has expanded a lot in the last few years. Offshore wind has grown form a modest few megawatts of installed capacity in more than 12 gigawatts in the last 15 years. The blade size of wind turbines has more than doubled and reached a level of 100+ meters in length. Also the rotors have increased significantly in size and productivity by making the overall electricity production more feasible. As a result, the offshore wind power is essential for the decarbonisation of the global economy. (IRENA, 2016)

In terms of innovation the offshore wind technology has progressed significantly in a shorter period of time and the installation will continue to be simplified and making the installation of turbines in less time and efforts. The installed capacity of a single turbine will continue to grow and from current 6 MW with rotors diameter around 150m, they will grow to 10 MW by 2020 and 15MW by 2030, which will be feasible to be commercialised. Nowadays, wind turbines are being installed in deeper water more than 50 meters due to innovation in foundation technologies. New floating foundations which are buoyant structures maintained in position by mooring systems have reduced the costs and made possible the installation of turbines in areas previously inaccessible by opening now new vast areas for implementing such technology. Furthermore, the interconnection of offshore wind farms has evolved and new technologies such as High Voltage Direct Current (HVDC) is being used to reduce losses and cable costs. (IRENA, 2016)

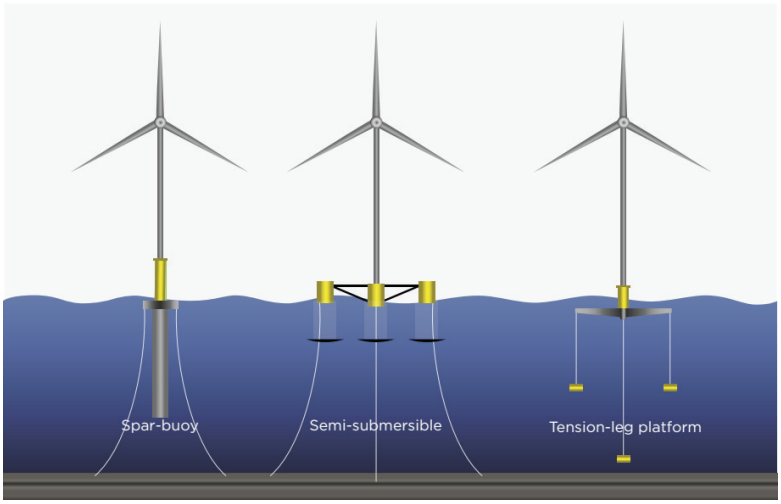


Figure 11: Different types of floating foundation for offshore wind turbines, Source (IRENA, 2016) Fig. S7, pg.6

The outlook for the future according to IRENA (2016) is that by 2045 *"offshore wind energy will grow from a commercial technology to an industrialized and important component of the global energy mix"* (IRENA, 2016).

This will be achieved by increasing the installed wind farms and their capacity from 100's of MW to multi GW pipelines. Turbines with larger rotors and blades will increase their productivity and deliver more electrical energy. Interconnection will be simplified and the transmission network will be more efficient. Floating foundations will make possible the

deployment of wind farms in sites deeper than 60 meters. Environmental impact will be sophisticated by more data collection to improve the mitigation of the environmental impacts. In this way the offshore wind will be among the world's fastest growing industry. (IRENA, 2016)

Conclusion

While the energy sector faces the challenge of rising energy demand, the new technology developments are giving innovative solutions to mitigate the problem. New sources of renewable energies are becoming more accessible for the mass consumption and with lower costs by accelerating the deployment of these technologies. The environmental impact of the renewable energies is significantly lower than the traditional fossil fuels which will make the goal of decarbonisation of the energy sector more achievable.

Even though the building sector is one of the major contributors in the global greenhouse gas emissions, energy efficiency and renewable source emissions can be reduced significantly. The best practices in the building sector are the Low/Net Zero Energy Buildings (NZEB) which reduce the amount of energy required to operate the building to that amount that can be supplied by renewable sources of energy on-site or off-site. These buildings have a sustainable approach by consuming less energy and producing more clean energy until the point that the overproduced energy can be exported to the grid. It clear that the most suitable energy type is the electricity, which on the other hand is the biggest type consumed in the building sector.

In order to achieve such goals as the NZEB, action must be taken in the early stages of design where the latest technology developments such as BIM and parametric design offer great opportunities to set the foundations for energy efficiency. Moreover, this approach can be extended through the whole building life-cycle where the Information and Communication Technology (ICT) sensors, Internet of Things (IoT) and big Data Analysis are valuable tools to evaluate the building energy performance to further take actions on optimizing the consumption and overall building performance.

Among the different renewable energy sources available in the environment, in the power generation sector and more precisely for the electrical energy, the offshore wind energy offers the most significant potential. Offshore wind farm technology has increased productivity and offer a large scale supply source compared with other type of renewable sources. Also the direct and indirect environmental impact is lower, no emissions are released in the atmosphere by making it the decarbonisation of the energy sector more achievable.

Building Management System (BMS) Technology in Construction Management

Richa Srivastava

Abstract

This paper examines the potential use and application of the Building management system (BMS) as a tool to visualize and manage a building's performance and also to explore how the integration of BMS with Building information modelling (BIM), Artificial intelligence (AI) and the internet of things (IOT) can additionally advance this performance optimization tool. The soaring expansion has led to a dense concentration of people in buildings and as we know that buildings are responsible for 30% of the greenhouse gas emissions and 70% of the energy consumption (McGraw Hill Construction, 2019), thus the situation demands smart building management system solutions based on IOT applications. The building management system can be alternatively called a Building automation system (BAS) or Building energy management systems (BEMS), is a computer-based system responsible for automation and optimization which monitors and controls the buildings electrical, mechanical and HVAC equipment such as ventilation, lighting, fire systems, power systems, and security systems. The current focus in terms of BMS is to optimize the use of energy in terms of usage and consumption.

In order to assess the performance building management system various sensors are installed in all modern buildings. However, these systems are not equipped enough for data inspections, which in turn restricts their usage in efficiency analysis, building performance and benchmarking. It is predicted that BMS protocols and operations will be assimilated in the fifth generation mobile communications (5G), consequently augmenting user experience and optimizing energy consumption. This paper highlights the prospects of BMS in construction and real estate (Martin Feder, 2019).

Key words:*Building management systems, Building information modelling, Artificial intelligence, Internet of things, construction and real estate, Facility management.*

Introduction

BMS is a micro- processor based system which automates, optimizes, controls and monitors operations and management. It provides safe and comfortable environment by regulating the heating, cooling, ventilation, lighting and other building services (fire and life safety systems). The main objective of BMS is to improve occupants comfort with reduced energy consumption, to increase the efficiency of operations at a reduced cost and time and to improve the overall life cycle of utilities. The system should also be enable to take corrective action before and after an event (Kumara, et al., 2013).

A building management system consists of a server, a database, and sensors. Because of the complexities involved systems like ventilation and security requires daily reading and regulations 24/7 which the BMS tracks with the help of sensors. The data tracked by the sensors are sent to the server and if the pre-defined conditions are not met an alarm is triggered. The system reacts according to the pre-characterized circumstances. All the information and response is stored in the database (Kumara & Waidyasekara, 2013)

Figure 12: Building management system, Source: (Tariq, et al., 2012)

Background

The building management system was introduced in 1970 with basic features but with new technologies a lot of advancements were made. Initially, it was restricted to power and lighting, then heating and air conditioning were introduced and finally alarm systems were added for security. Closed-circuit television (CCTV) helps in monitoring invasions (Tariq, et al., 2012).

Characteristics of BMS

- BMS has four main functions of controlling, monitoring, optimizing and reporting.
- Breakdown and energy loss can ocur if BMS system is installed incorrectly.
- 40% of a building's energy usage is linked to systems connected via BMS, this number can go up to 70% if lighting is included.
- BMS is mostly executed in large projects with complex mechanical, electrical and plumbing systems (Brambley, et al., 2005).

The BMS gives significant importance to maintain a standard temperature inside the building by managing heating, cooling by providing proper ventilation, fans, and dampers. The system focuses on the minimization of carbon dioxide in the building by keeping a tab on temperature and humidity inside. (Manic, et al., 2016). The five main service providers of BMS globally are Cisco, Johnson controls, Honeywell, Schneider electric, United technologies and Technavio (Business Dictionary, 2019). This building management system manages and control following functions:

- Electrical Distribution Panels
- Lighting Control
- Air Conditioning System
- Fire Alarm & Fire Fighting
- Public Address
- CCTV System Monitoring
- Elevators
- Access Control, Parking Access, Intrusion Detection
- PABX (Private automatic branch exchange)
- UPS (uninterrupted power supply)
- Water Consumption

Some of the significant benefits of this system are that buildings can be controlled centrally and remotely with greater occupants comfort, automation of individual rooms depending upon the requirements, reduced costs in management of buildings and longer lifecycle, enhanced monitoring of plant life and reliability (such as AHU, Fire pumps, plumbing pumps, Electrical supply, STP, WTP etc.). (Manic, et al., 2016)

Building Stakeholder	Benefits
Building owner	Higher rental value Flexibility on change of building use Individual tenant billing for services
Building tenant	Reduced energy consumption Effective monitoring and targeting of energy consumption Good control of internal comfort conditions Increased staff productivity Improved plant reliability and life
Occupants	Better comfort and lighting Possibility of individual room control Effective response to HVAC related complaints
Facilities manager	Control from central supervisor Remote monitoring possible Rapid alarm indication and fault diagnosis Computerised maintenance scheduling Good plant schematics and documentation
Controls contractor	Bus systems simplify installation Supervisor aids setting up and commissioning Interoperability enlarges supplier choice

Table 3: Benefits of Building management system, (Source: CIBSE Guide H, 1999)

What is a Smart Building?

Smart buildings are well equipped automated infrastructures that provide occupants comfort in a sustainable and reliable way (Pukite & Geipele, 2017).

- They provide safe and secure workplace and are cost effective.
- Consume less energy and hence low operating costs.
- They use smart-grid and broadband etc to connect in real-time.
- These buildings are highly reliable, efficient and sustainable.
- Smart buildings facilitate control and automation to the building systems

The four elements of smart buildings are systems, structure, services and management. Smart control systems in smart buildings are responsible for the facilities. These systems are as follows (Kheirabadi & Talebiyan, 2015).

- Fire, Gas leaking and theft alarm system.
- Lighting and integrated control system.
- Earthquake warning system.
- Calling telephone system.
- Control through remote, digital key, landline, cell phone and internet
- Scenario description.

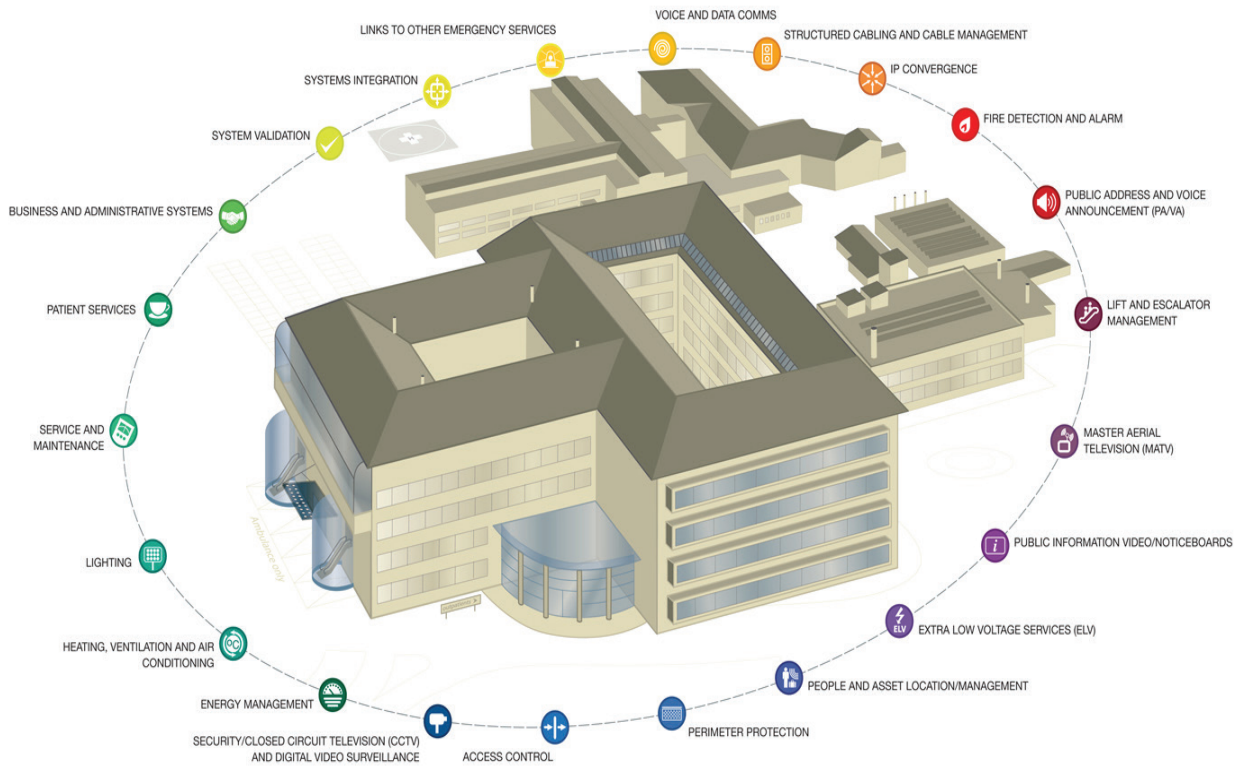


Figure 13: Building management system, Source Honeywell hbs retail complex diagram

LEED NEW		GREEN SL		BREEAM	
Sustainable Sites		Sustainable Sites		Pollution	
Light Pollution Reduction	1	Light Pollution Reduction	1	Reduction of night time light pollution	1
Energy and atmosphere		Energy and Atmosphere		Energy	
Fundamental Commissioning of Building Energy Systems	.Req	Fundamental Building Systems Commissioning	.Req	Reduction of Co2 Emissions	15
Minimum Energy Performance	.Req	Minimum Energy Performance	.Req	Sub-Metering of Substan-tial Energy Uses	1
Optimize Energy Performance	to 19 1	Optimize Energy Performance	-10 1		
On-site Renewable Energy	to 7 1	Renewable Energy	8 - 1	Sub-Metering of High Energy Load and Tenancy Areas	1
Enhanced Commissioning	2	Additional Commissioning	1		
Enhanced Refrigerant mgt	2	Ozone Depletion	1	External Lighting	1
Measurement and Verification	3	Measurement and Verifi-cation	1	Lifts	2
Indoor Environmental Quality		Indoor Environmental Quality		Health & Wellbeing	
Minimum Indoor Air Quality Performance	.Req	Minimum IAQ Performance	.Req	Glare Control	1
Environmental Tobacco Smoke (ETS) Control	.Req	Smoke (ETS) Control	.Req	Internal & External Lighting	1
Outdoor Air Delivery Monitoring	1	Outdoor Air Delivery Monitoring	1	& Lighting Zones Controls	1
Increased Ventilation	1	Increased Ventilation	1	Potential for Natural Ventilation	1
Indoor Chemical and Pollutant Source Control	1	Indoor Chemical and Pollutant Source-Control	1	Indoor Air Quality	1
Controllability of Systems-Light-ing	1	Lighting Controls	1	Thermal comfort	1
-Controllability of Systems thermal comfort	1	Comfort Controls	1	Thermal Zoning	1
Thermal Comfort-design	1	Thermal comfort,design	1		
Thermal Comfort	1	,Thermal Comfort	1		
Water Efficiency		Water Efficiency		Water	
Water Use Reduction	to 4 2	Water Use Reduction	to 4 2	Water Consump-tion	2
				Water meter	1
				Major Leak de-tection	1
Total contributory points	45	Total contributory points	33	Total contributory points	**32**

Table 4: Building management system contribution in green rating system, Source: (Kumara & Waidyasekara, 2013)

The concept of applying Building management system (BMS) in a building

An integrated management system saves time, energy and human resources. It takes a short time to assemble all the smart control systems and display information. BMS has proven to be remarkable in managing all the smart control systems used in industrial and non- industrial fields. Smart control systems contain a group of equipment such as controllers, Input and output field devices connected further with buildings electrical and mechanical equipment (chillers, boilers, pumps, high-low voltage switchgear, alarm systems, CCTV, lifts and escalators, air conditioners and generators, etc.). These systems are responsible for control and performance settings to make the buildings energy efficient, safe and secure. Some of the basic scenarios controlled by the smart controlling systems are temperature control, audio and video systems, commands to switch on/off, open/close, active/inactive of electrical mechanical devices, schedules, changes in outdoor temperature, liquid levels, monitoring with status and pictures, etc. (Kheirabadi & Talebiyan, 2015).

The building management system is a framework of control systems connected to a central (server) with an adjacent user stations computer with an aim to combine, monitor and incorporate data or status of the remote control systems. This leads to being aware of the changes in data and performance scenarios of the local control systems and furthermore correcting the defaults if needed. This saves a lot of time and energy as the user does not need to check individual local control systems scattered all over the buildings. These are a series of systems which even work if BMS grid goes off circuit or any malfunction occurs. The recent update in the Building management system is the use of the World Wide Web in providing a common platform for communication systems in the world and controlling the buildings through it. Now the occupants can access their buildings from any part of the world through login with the required username and password. Special electronic display panels are installed in different parts of the buildings to showcase various data related to the control systems (Kheirabadi & Talebiyan, 2015).

Below are some of the benefits of the building management systems (Kheirabadi & Talebiyan, 2015).

- Safe and secure environment for the occupants.
- Reduced maintenance costs and increased life cycle of equipment by their optimised utilization.
- Monitor and control of all the equipment via smart devices or internet.
- Reports are provided form the facilities on how to enhance the utilization, optimisation and operation.
- Removing the need of a permanent building contract and reduced operator's error.
- Installing controlling systems skilled to schedule the operations.

Elements of BMS

BMS is a controlling system consisting of sensors, controllers and Actuators. The three parts are further joined via a connection mechanism which comprises of two parts (Kheirabadi & Talebiyan, 2015)

1. Wire, radio waves and fiber optics (conductor)
2. Communication protocol

Thus, the three parts are connected through conductors according to the communication protocol. In order to communicate signals we need a series of common language rules called as protocol. The rate of compatibility in elements of system's control equipment can be increased by applying a standard protocol in BMS. Below listed are the different types of protocols.

- KNX (the most common building automation protocol with range of choices in configuration)
- X-10
- LON Works (Local Operating Networks)
- ZigBee
- BACnet (Building Automation Control Network)
- S-BUS
- Z-wave
- Bluetooth

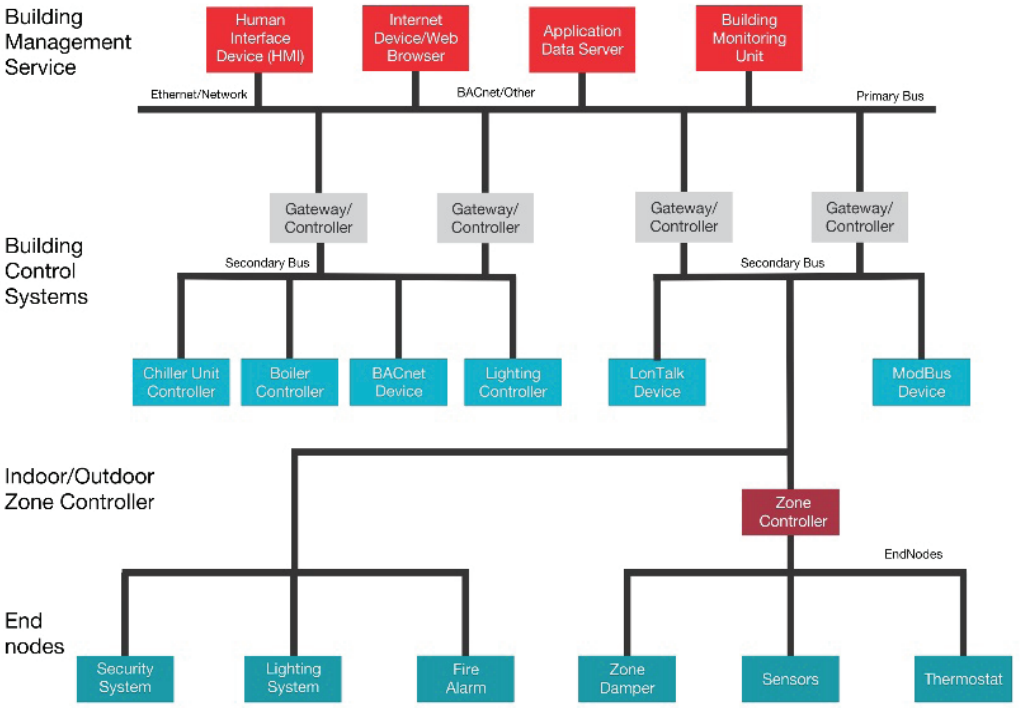


Figure 14: BMS (Source Jiang, et al., 2011)

Elements of BMS

BMS is a controlling system consisting of sensors, controllers and Actuators. The three parts are further joined via a connection mechanism which comprises of two parts (Kheirabadi & Talebiyan, 2015)

Wire, radio waves and fiber optics (conductor)

Communication protocol

Accessing and controlling facilities in smart building

Below mentioned are the different ways in which one can access and control facilities (Kheirabadi & Talebiyan, 2015).

- Central control panel
- Radio wave control
- Remote control
- Automation
- Scenario

Challenges faced by BMS

As a result of recent advancements and urbanization in the field of construction and technology, buildings are becoming more dynamic and complex and there's a higher need of high-performance energy-efficient buildings. Traditional BMS is now outdated. Some of the challenges faced by traditional BMS are as follows (Sinopoli, 2012).

- Limited integration capabilities,
- Inadequate and elementary analytic tools,
- Proprietary programming languages,
- A dearth of software applications and
- Legacy user interfaces

Challenges faced by the traditional BMS is the inclusion of new energy and sustainability systems (shading, sun tracking, rainwater harvesting, renewable energy, switchable glass, and water reclamation, etc.) which were not a concern

earlier. Another aspect related to BMS is that it is an IT system with server, IP address, database and software connected to an IT network, and the manufacturers of BMS are mostly not aware and equipped with latest IT developments. The ever-increasing complexity related to management of building operations and facilities is also a matter of stress. (Sinopoli, 2012).

Integrating IOT and AI with BMS

The internet of things is bringing a change, in particular, all the industries and its impact can highly be seen in Building management systems as opposed to earlier where only large vendors were provided the control systems the IOT has opened the market for competition and as a result, an extensive range of start-ups have ventured the market (Paczek, 2018) .

- The cost impacts in sensing communication and installations.
- Cheap secure communication with no wiring has been enabled by LPWAN.
- The core of a new model promises higher performance and savings
- Big data analytics manages and monitors the smart building and cities through the data uploaded to the cloud.
- Enhanced performance can be recorded in building penetration, battery life, and inbuilt security protocols.
- The internet of things facilitates communication between the different components. However Artificial Intelligence is needed to convert the data into useful information. Artificial intelligence helps in discarding the useless information which saves a lot of time *and energy.* (Nguyen, 2018)

AI makes a building smart in the following ways:

1. Improved occupants comfort:Through the use of AI, tenants can give feedback and inputs on how toimprove or enhance the model. AI helps in advancing the BMS model by recording the data received by an array of variables. It monitors the building operations and prevents errors which creates an ideal environment for the occupants.

2. Fault detection and maintenance: AI, when combined with machine learning, proves to be remarkable in the detection and diagnosis of inconsistencies and faults. These technologies record and analyse data from different systems by studying the input and output variables. Thus AI optimizes everyday solutions

3. Energy optimization: AI excels in energy management platforms, it maintains a comfortable temperature inside the building by studying the 'uphill' and 'downhill' of building operations. AI together with machine learning precools the building when the energy price is high (uphill) and during inactivity, it decreases the cooling (downhill).

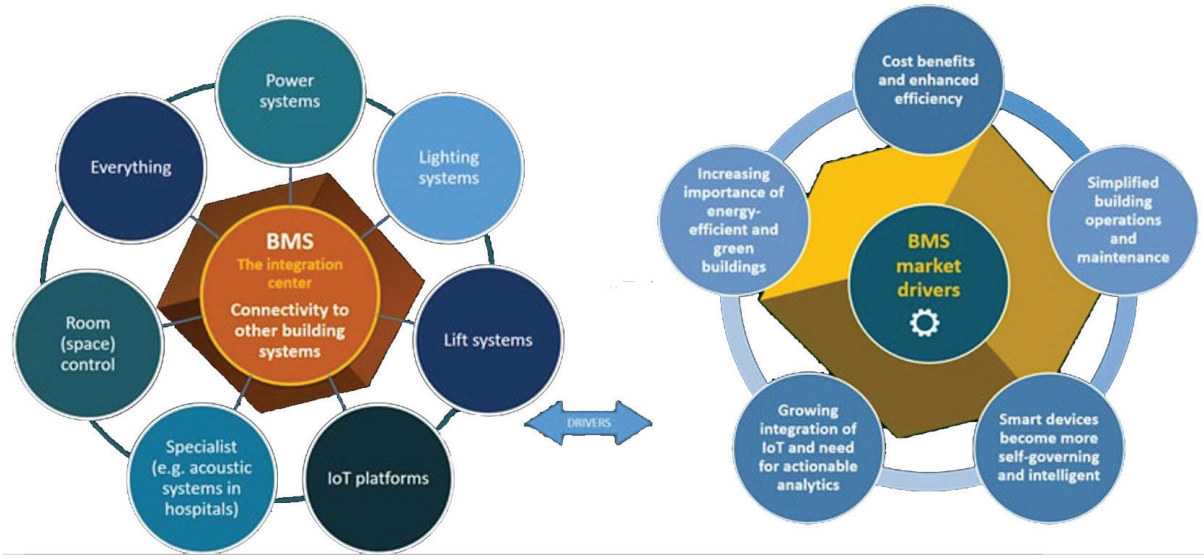


Figure 15: BMS market drivers (Anon., 2019)

BMS for construction and facility management

Facility management information systems (FMIS) or computer-aided facility management systems (CAFM) traditionally were responsible to operate maintenance, cleaning, and waste management in a building. They were earlier used for

decision and benchmarking of building operations based on efficiency and performance (space, asset, and energy management) (Kucera & Pitner, 2018).

The BMS encompasses a vast amount of up-to-date detailed information supporting everyday operations in a building. In comparison to traditional FMIS/CAFM systems, BMS provides more relevant and precise data. Processing building information data retrieved from automation systems is highly profitable to facility managers for the purpose of benchmarking and decision support (Kucera & Pitner, 2018).

Conclusions

To conclude, integration of the building management systems, the internet of things and artificial intelligence can upgrade the current BMS systems and can further optimize and enhance it to face the situations arising in the future. This can yield an advanced system which is more sustainable, stable, stronger and wider applied. Emphasis should be given on providing tools that are dynamic, flexible and user-friendly which can be easily grasped by the facility managers. With the recent advancements and complexities, there is a much higher demand for enhancing the performance and providing the data in a simpler format. The building management system needs to be properly specified, installed, commissioned, operated and maintained to use it to the maximum potential, the occupant's type and requirements should also play a major role in deciding the type of system to be installed. Thus, an effective building management system will represent a significant strategy in respect to social, economic and environmental perspectives.

Artificial Intelligence in Facility Management

Diana Kustdavletova

Introduction

This report explores the fourth Industrial Revolution and Disruptive Technology developments such as Artificial Intelligence (AI). The aim is to define the AI and explain the most important features and processes of AI, as well as describe the difference between human intelligence and AI. Also, the Internet of Things (IoT) and AI are discussed.

Facilities Management (FM) is discussed in the next chapter, where FM will be defined and its current trends and challenges will be outlined. The role of technology developments to solve those challenges in FM will be examined, among those IoT and the AI's place in it. Potential use of AI for preventative maintenance, predictive analytics and building operation will be considered. Further, AI-powered devices such as robots will be discussed and their importance in aging societies, as well as in terms of labour cost reduction, efficiency and safety will be reflected. Moreover, FM services that could be delegated to AI-powered devices will be illustrated. Finally, the report will briefly discuss the impacts of AI on employment in FM.

The Fourth Industrial Revolution and Disruptive Technology

The World Economic Forum 2016 has predicted the transformation of labour markets within the next 5 years due to the "Fourth Industrial Revolution", which is often defined as the current environment of technological advances and trends, such as the Internet of Things (IoT), robotics, virtual reality (VR) and artificial intelligence (AI). Such disruptive technologies are already changing the way we live and work. (Ware, et al., 2017)

Business Dictionary (2019) defines disruptive technologies as "new ways of doing things that disrupt or overturn the traditional business methods and practices". This term has also been used to describe a process of either a new product or a new service entering the market, elevating it up to the next level, where its competitors are often unable to compete, and therefore giving this new product or service a competitive advantage. (Bhasin, 2018). Hoar (2018) describes Artificial intelligence (AI) as disruptive technology, which stands apart from the innovations that we have become used to in our daily lives and work. It represents a major step to a change that will impact everyone to a greater or lesser extent.

Developments in the fields of information and communications technology always have and are continuing to change the way most of us do our work and interact with others. Hoar (2018) claims that technology improvements have eliminated inefficient and non-value-adding processes, and created new business opportunities. The pace of technology development is predicted to accelerate even more with AI entering into our work and life.

What is Artificial Intelligence (AI)?

The term 'Artificial Intelligence' was first created in 1956 by an American computer scientist John McCarthy, who is also known as the father of AI. He has organized the famous Dartmouth Conference, where researchers such as Allen Newell and Herbert Simon were promoting AI as a field of computer science that could transform the world. (Ray, 2018) (Anyoha, 2017).

Although AI is very wide in scope, the definition offered by one of the most influential people in the fields of computer science and AI- Andrew Moore is as follows: "a science and engineering of making computers behave in ways that, until recently, we thought required human intelligence." (High, 2017). Oxford Dictionaries (2019) describes such traits as "visual perception, speech recognition, decision-making, and translation between languages", as those which normally require human intelligence.

The central parts of AI are knowledge engineering and machine learning (ML). It is only possible to imitate human behaviour by machines, if machines have plenty of information or knowledge about the world or if they are able to learn this information. ML is described as a science or system that provides the AI the ability to routinely acquire the knowledge and advance itself from experience without being explicitly programmed. Its primary aim is to let the computers learn automatically without the human involvement or assistance. (Expert System, 2019)

Very important feature and the difference of AI from human intelligence is the ability of AI to process information that is not limited by time or space. AI is able to not only process large amounts of data with speed and accuracy, it is also capable of analysing data trends and patterns. (Clavero, 2018)

Internet of Things (IoT) and AI

Rajagopalan et al. (2017) defines Internet of Things (IoT) as a sensor technology that enables the systematic capture and harnessing of data. With IoT, according to the authors, it is possible to measure, monitor, and manage the condition of practically everything in the environment in near-real time.

Rouse (2018) describes IoT as non-standard computing devices that have the ability to connect wirelessly to a network and have the ability to transmit data. IoT has multitudes of connected things such as sensors, meters, actuators, etc. The great advantage of the IoT is the ability to extend internet connectivity beyond electronic devices over to non-in-

ternet enabled everyday objects, for instance, chairs, coffee machines, lighting devices, etc. Having embedded IoT technology in these objects or devices, it is possible to create communication and interaction between them over the internet, and to monitor and control them remotely.

Kranz (2017) claims that AI cannot work without Internet of Things (IoT). He compares the whole concept of AI and IoT to the human body, where IoT is described as sense organs that human body uses for getting information about the world around, such as eyesight, hearing, and smelling, tasting and touching. In his opinion, all information gained by those "sensors" are sent to the brain, which he is comparing to the AI, for processing, sorting and analyzing such vast amounts of information into something on which further actions of a human body could be based. In other words, IoT is the facilitator of AI's ability to act, i.e. the data generator, and AI's task is to make smart decisions based on that data provided.

The very first basic levels of IoT was used to generate data in order to trigger alerts, when specified threshold was exceeded. There was no need for AI for such a system to work. However, as IoT gets more sophisticated and uses dozens of sensors to monitor every aspect of specified task, it therefore produces enormous amount of unstructured data in real time, the use of AI to analyse the created data is inevitable. Actually, data produced by IoT devices has limited value without the analytics performed by AI; AI enables more services for the user and adds more significance to IoT utilization (Kranz, 2017).

Facilities Management

International Facility Management Association (IFMA, 2019) defines facility management (FM) as "a profession that encompasses multiple disciplines to ensure functionality of the built environment by integrating people, place, processes and technology". FM provides the core services related to the management and operation of buildings including health and safety of the tenants, maintenance of the engineering systems in a facility, operational services such as cleaning, helpdesk, possibly catering etc. It could be said that FM supports the core business or daily life of all tenants in a building through the management of all essential services.

In the life cycle of any asset, the biggest amount of resources consumption happens after the construction is complete and a building is handed over to a client for the operation and maintenance phase. Figure 15 demonstrates the approximate duration of each life cycle phase of a standard facility, which illustrates the amount of the typical expenditure over the years of an asset life.

Teicholz (2013) estimates that a typical cost of designing and building is facility is less than 15 per cent of the total life-cycle cost figure, therefore leaving 85 per cent to the FM from the handover until the disposal of a building many years later. Therefore, he believes that the total life cycle cost of facility is actually more than the initial costs by 5 to 7 times.

That is why it's quite natural to look at the O&M stage of a building when talking about reduction of life cycle costs.

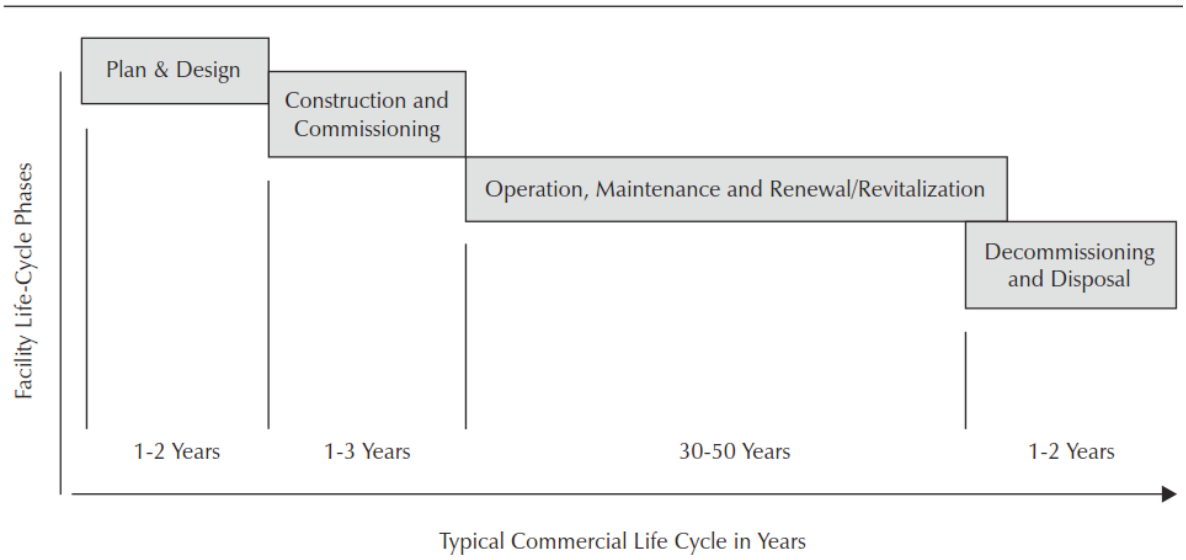


Figure 16: Typical Commercial Life Cycle in Years (Source: Cotts et al. (2010) Facility Management Handbook, 3rd ed. p. 182)

Current trends and challenges in Facilities Management

According to Konanahalli, et al. (2018), FM organizations operate in a very competitive environment, and are often facing rising pressure from the clients to manage buildings not only cost efficiently but also in an environmentally con-

scious way.

Herczeg, et al. (2014) claims that buildings are responsible for 42% of all energy consumed, this, therefore puts a huge pressure on FM professionals in terms of energy consumption, as well as performance of buildings' complex engineering systems. In order to achieve such targets, Herczeg, et al., (2014) advise to closely monitor the building data such as energy usage and cost, air quality, temperature, lighting space demand and utilization. Not only energy costs are escalating every year, but also there are increasing expectations in terms of comfort, usability, changes in technology and shifting economies are also having a profound impact on building management. (Konanahalli, et al., 2018)

Moreover, according to Rajagopalan et al. (2017), in today's increasingly digital world, the nature and function of building facilities is constantly changing, therefore, burdening Facilities Managers with pressures to adapt to fast-evolving workplace and regulatory requirements. Rajagopalan et al. (2017) explains that all of these challenges create more demand for so called intelligent or smart buildings, which are able to operate and be maintained with minimized energy demand, while being environmentally friendly to the surrounding area, comfortable for its users and flexible for various functions.

Although the concept of a smart building is well known, only a few companies have truly brought the concept to life. Nevertheless, it's predicted that intelligent buildings will be commonplace by 2020 (CBRE , 2018). Rajagopalan, et al. (2017) forecast that together the digital transformation and the use of the Internet of Things (IoT) and AI will bring unprecedented opportunities for FM to optimize operating conditions by providing deeper insights and better services.

Potential use of AI in Facilities Management

As noted previously in this report, both AI and IoT can reach their full potential only through combined use. The following examples of potential AI use areas are to be performed through collaborative partnership between IoT and AI.

Preventative Maintenance and Predictive analytics

Since AI is capable of learning on its own through Machine Learning processes, it can learn and analyse the patterns that lead to failures in any given system. It can then predict potential future failures, and recommend actions to fix it before it fails. Kranz (2017) describes how this opportunity is already being harnessed by Enedis, a French power supplier, for its preventative maintenance. The company has advanced a system of big data utilisation for analytics to prevent breakdowns in its network of generators. Machine learning and availability of data has increased the predictability of failures and their locations, and enabled the machines to generate specific maintenance schedules in order to prevent outages. (Kranz, 2017)

Another potential use of AI could be the analysis and recommendation on to how to operate the equipment to maximise its useful life, balancing its performance and longevity of its life cycle (Kranz, 2017). Machine learning makes the analytics system "smarter" as time goes on and more data-sets and patterns are available. It is only important to feed a quality data on devices operation, maintenance and failure into the system, in order to get more accurate predictive analytics (Kranz, 2017).

Building Operation

Google has revealed that by using AI it was able to reduce its data centre cooling bills by 40% in 2016 (Rajagopalan, et al., 2017). This is another proof of potential improvements in energy consumption in buildings through the data collection of every aspect of building operation. In fact, Watson IoT created by IBM already offers a workplace management solution, such as space and energy management, which combines data from sensors and equipment with powerful analytics to optimize the functions of the facility management. For instance, the under-utilized space could be identified through this system, giving the FM choice of using the space more efficiently or getting rid of that extra space.

AI is also being used to monitoring and optimize energy consumption behaviors for both offices and private houses. The approach is to install smart devices in a facility that observes and learns how energy is being used by occupants, including lighting, HVAC, lifts, etc. and offering practical solutions to optimize the energy use. Such devices could also be connected to the outside weather and act accordingly to save unnecessary wasted energy for cooling or lighting, for instance. Janssen (2018) claims that such technology can successfully save 10-12 % of monthly energy use.

AI powered devices for manual operations

Being an extremely labour-intensive and service-oriented sector, FM requires smooth operation of all its repetitive tasks in the facilities. Hoar, et al. (2017) predict that the act of AI will be felt mostly in FM services. AI powered devices such as robots, autonomous guided vehicles, drones, thermal-imaging cameras and smart applications could be used for various services normally performed by FM personnel, such as maintenance, cleaning, security services, catering and transporting tasks.

Using self-optimizing systems, powered by the Internet of Things (IoT), artificial intelligence and Machine learning, can totally change the current FM scene. With the ability of AI machines to acquire new knowledge, it is possible that FM repetitive tasks will be delegated to them, for their real time data analysis and further search for solution and reasoning. For example, devices such as self-vacuuming and self-mopping combined with artificial intelligence which will be able

to understand the location and the moment of required cleaning, organizing actual cleaning, and then going back to its original station. (QSI Facilities, 2018)

Moreover, with the rapidly aging societies as well as the increasing costs of manpower and it's only natural for FM to look for ways to address those challenges. According to CBRE (2018), robots could potentially be viewed as a means of responding to this key challenge in the industry and in general society. Specific environments such as hospitals are already using robots and Automatic Guided Vehicles for transporting food and linen. (CBRE , 2018). According to the International Federation of Robotics (2019) the sale of professional cleaning robots has doubled in 2015, and the global demand for general service robots used for transportation and medical utilization has increased globally by 25 per cent.

The main benefits of robots, drones and other devices with AI working alongside humans will be the reduced labour costs and increase efficiency through automation. (CBRE, 2018). They could perform jobs that are dangerous, for instance, working at height or lifting heavy loads, as well as work out of office hours. Increases in capital expenditures, such as purchase of IoT powered AI devices could be offset through savings in operational expenditures that are life-long and continuous for any facility's life cycle, such as cleaning, catering and security, etc. (Hoar, et al., 2017)

Impact of AI on employment in Facilities Management

Since, there is a possibility for smart apps to talk to each other, as well as acquire more knowledge all the time, it might eventually lead to the out-performance of artificial intelligence machines compared to human intelligence, where the productivity will be raised and human error possibilities minimized. However, Hoar, et al. (2017) assumes that job losses in FM sector will happen, however, that only repetitive and monotone jobs will be taken over by machines, where they could replicate human actions within reasonable limits. Moreover, according to Ismail (2017) the full potential of such technology can be only achieved with the human touch. Smart new technologies such as AI will require smart people who are able to run these machines. Smart buildings filled with smart devices have promised a competitive advantage but that doesn't always happen, because the technology by itself is not enough. That is why people who wish to continue working in the sector should be trained appropriately to run and maintain such devices, grow their technological expertise and skills to be able to achieve great results.

Conclusion

Technology development is inevitable, it creates new opportunities for improvement and changes the way people work. It is predicted that disruptive technologies such as IoT and AI will impact the technology development even further through allowing the access to data generation and analytics as never before.

Various pressures on FM have been pointed out and discussed in this report. FM plays an important role in helping organizations to increase the operational efficiency, save money, while maintaining comfort and productivity. In order to gain competitive advantage, FM companies need to realize the importance of data collection, storage and analysis of the critical features in the systems of buildings they operate. The importance of IoT devices and AI-powered analytics cannot be understated. The powerful collaboration of these two disruptive technologies has enough examples of successful implementation and results that are transforming industries.

It is recommended for FM companies to harness such technological advances as soon and as profoundly as possible, because such powerful tools to monitor and analyse energy consumption, space utilization, etc. give opportunity to strengthen and boost the proactive approach to building operation and maintenance.

Advances in technology always have originated discussions of their impacts on employment of people within various industries, however, it is obvious that for such technology to work and achieve its full potential, well trained and skilled people are required.

Smart Cities and the Impact of Technology

Armin Alaei

Introduction

By 2050, is estimated that around two-thirds of the world's population will live in the cities. Urbanization is happening faster than at any time in human history and cities cannot add housing at the same velocity like now, fast enough although, nine hundred million people are still having residency in slums and from a consumption point of view cities consume three-quarter of the world's energy each year and responsible for around 50% of greenhouse-gas emissions. (The Economist, 2017)

There is a vast majority of challenges, and our cities have been facing for decades. Some city leaders, businesses and even citizens are taking new approaches to tackle these old problems through innovation in housing, food, and water which give us some way of the forward-thinking city that might be only the right solution. Finite resources of drinking water, the constant-secure source of energy, and clean power supply are the key issues for future cities. All of these make us think very differently about how to solve these problems, however, there are tendencies that force the architects and city planners to think about the problem solving when they posed by completely different degree of complexity emerges now in the 21st century.

Among elements of what has a great impact on developing the cities in the future, the use of technology by far has seen as the key to tackling the big challenges in the future of cities. Technology as one of the most effective tools can create new cities that are more compatible with the human being's need in the forthcoming future. On this way, maybe the question is, what is the real meaning of the word "technology" for the cities and what kind of ways it can be contributed towards having a better quality in human's life? One of the ways with the city government for the people who have a realistic perception of it is that they do not take themselves into the risk to go ahead, invest in the infrastructure or to make the city, smarter and better connected city. So, it is on the government to set the sort of regulation to encourage people through a positive and influential association which is equipped with means of support for the unpredictable situation.

What is a smart city?

There is no general and agreed definition today on this title, but what is clear about smart cities, they are specific to the city. Although the categories of the cities to transform as a smart one is similar, the extent of the issue and the solutions are going to be very specific. (LinkedIn Learning , 2017)

In a smart city, sensors have a determinative role. In general, Sensors collect data, which are specific to the city and even designated to a specific region in the same town, then the analysis will be started by the models which are proved base on previous results and former outputs. So, to describe a city as a smart one is directly related to the amount of collected data and the level of applying collected data and the depth of the processing stage. To describe a smart city characteristic would be of advantage to mention the sub-elements of what it should consist of:

- Smart People
- Smart Governance
- Smart Economy
- Smart Mobility
- Smart Environment
- Smart Living built

This definition encompasses general at the same time. This definition clears and tries to enlighten these six items which are considered to be the constituents in the future of every Smart City project. Smart People or smart citizens includes the degree of sensible people and their reaction to the environment of their living area, Smart People also as one of the most important factors refers to the social connections such as openness and it is worth to remind that the more educated people are, the more advantageous it is for the environment. Integration and interaction, on the level of Smart Economy, includes the competitive advantage of cities, innovativeness, entrepreneurship, productivity, international perspectives, and effective labor market. On the other hand, Smart Government also includes citizen participation in decision-making procedure, open government data and transparency seems to be vital in this stage. So democracy as a compliment toward this goal will be inevitable. Smart Mobility talks on effective location services, ICT services, and good transport system, local and international accessibility which provide to act and react to different matters with a high degree of flexibility.

Smart Environment defines to be aware of the environment, sustainable resource managerial skills, and protection of the environment. Smart Living is more precise and mentions to a town with a good quality of life, healthy situations of inhabitants, the safety of people who live there, reduced crime, elderly care, and good social well-being services. (Adedayo, 2016)

Figure 17: Smart City Features, Source: https://forbestechcouncil.com/Council, Forbes Technology

Where does the need for preparing for Smart Cities originate from?

A great number of the world populations migrate to the cities around the world, this makes the administration of the cities seeking appropriate answers to common urban difficulties and preparing the citizens for every day challenging problems. City planners in the 21st. century are facing a number of issues such as over-population, pollution in different fields such as air, soil, and water resources, Dwindling financial resources, poor infrastructures and declining growth in agricultural products. Cities also deal with a traditional urban obstacle and one of the most impressing issues is the problem of global warming. The effects of increased temperature are already being experienced in most countries and the problems getting more tangible. To halt the side effects of global warming on the earth's climate and reduction in the amount of greenhouse gas emission needs to be taken seriously. (Adedayo, 2016)

The implementation of Smart City projects not only will be a choice anymore but also a necessity. Smart Cities take advantage of ICT to improve service provision in towns. Water and management of waste, telecommunication, means of transportation, power plants which generating electricity, and other social interventions can be fully enhanced to create eco-friendly urban areas in which the main goal is to reduce greenhouse gas emission.

There are some other certain reasons which describe the importance of to deal with a smart building which leads having Smart Cities. Social welfare and mechanism of society amenities and public services due to an upsurge in the diversity of the urban population urges to build Smart Cities. (Adedayo, 2016) This process has been reduced its velocity because of declining cash flow currently faced by cities and also is putting pressure even on the provision of basic social services. Smart City slogan is to do more with less and helping cities to free up their resources for other urban projects. Development of transport infrastructure due to urban population growth is giving way to Smart City interventions. As it was mentioned above ICT and especially with using smartphone applications such as Uber, for example, City dwellers have access to take a ride by sharing services. Therefore, by reducing the size of means of communication, reduction in CO_2 emission in the city has a direct relation to miniaturization of Central Processor Units of electrical devices and components. This is an expanding field in which you did a huge opportunity doing something that is really meaningful for the community. However, there are still some controversial problems and needed to be answered. Here there are some common problems to the notion of smart cities:

- Network security and cyber security topics such as Privacy of people and Data protection
- Cloud systems and data gathering (IT challenges)
- Presence of human in the city and its controlling role
- Lack of consistency in regulation's updating

Results and Business Impacts

City workers applying sophisticated technology to run the city with smart systems. To understand and transform how the city and its means of transportation works as an example, Firstly, Data is gathered at the stations and then sent to the data center, which all necessary information can be uploaded to their systems, included such as payments, the number of passengers and other relevant information which needs to be modeled due to having the most functional transportation systems. It shows that the entire network relies on continually updating information and receiving, processing and modeling the information as the three factors which are continuously always in action. The collected data also can be used to plan the transport schedule which enables them to figure out where more people need more train or even in what station the number of passengers has decreased. Moreover, the speed and frequency of the trains can be constantly adjusted to keep everything running smoothly. (The Economist, 2017)

An Example in Macroscale:

Singapore, as an island city-state only about half the size of the metropolitan London and they, have to provide accommodation for 5.7 million people while they have very constrained land and resources and that was the big challenge for them. This island city had 1/3 of today's population before and less than 1% of the current GDP and little to no infrastructure during the last 40 years (The Economist, 2017). This city applied high-tech innovative solutions to not only provide enough living spaces for Singapore citizens but also improved quality of life for decades to come. The architects and city planners using sophisticated computer models that help them to improve the quality of the environment in the city. Since the geographical situation of the town is in the tropical area, they plan to encourage the breezes to come through. This happens through a computer Dassault systems simulation that you can actually lay out the Residential, official and commercial blocks and public spaces such as open spaces in such a way to reach this goal.

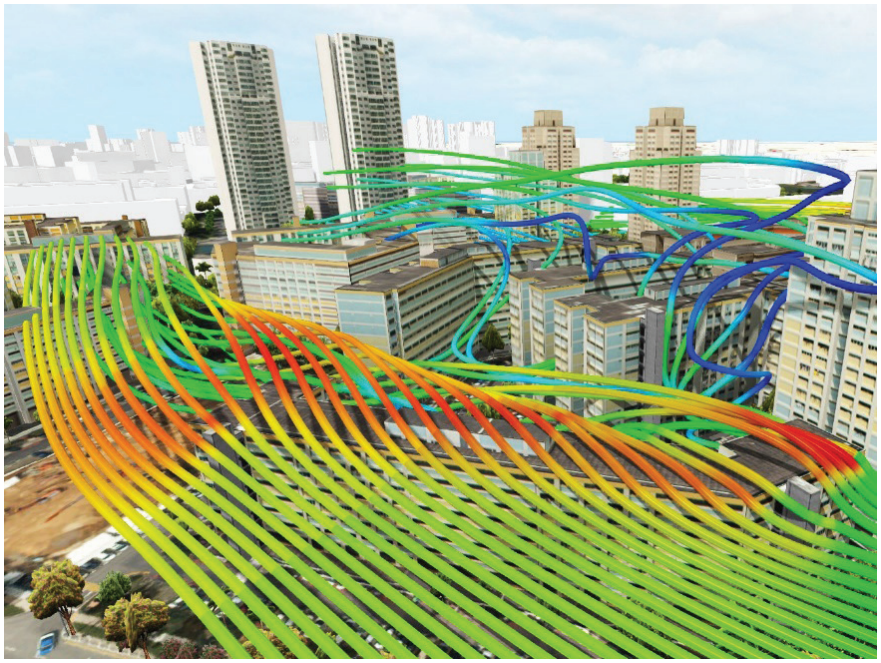


Figure 18: Dassault systems, Source: https://www.wired.com/02/2017/virtual-singapore-looks-just-like-singapore-irl-data/

An example in Microscale:

Technology is a dynamic process, and innovation has an extra impact on other breakthroughs. MIT scientist working on a project in which by collecting data from a sewer alot of results came to true.

"Luigi" is a whole entire robot which consists of a brain and informs it how to function. In fact, it is a probe to understand people's health patterns and health behaviors more at the source. It manages to observe the health crisis. It also shows the variety from prescription painkillers to heroin which reveals lots of data regards Americans opioid crisis since across the country, nearly 2,5m people are hooked on opioids. These drugs are responsible for more death every day than gun crime or road traffic accidents. In Massachusetts between 2014 and 2016 opioid deaths rose by an estimated 50 percent. (1,361 Death in 2014 and 2,107 Death in 2016) (The Economist, 2017)

Data alone will not stop the opioid epidemic, but data could start to provide city authorities with the tools to build better public-health plans, It will also allow them to see information how viruses are becoming more prevalent like an epidemic or not or maybe just an outbreak like influenza in an area.

Figure 19: MIT researchers are sending robots into sewers to help predict disease outbreaks Source: https://www.businessinsider.com/mit-underworlds-sends-robots-into-sewers8-2016-?r=US&IR=T&IR=T

Recommendations

Emerging technological devices have a positive effect on the future of smart cities and forming this procedure needs complicated cooperation between governments and people as smart citizens. So more social-cultural education would be of help. It can include vast generations from the training of school children to elderly people.

The development of wireless connectivity such as ICT tools enables major growth in the number of means of communication systems which facilitate the connections between companies and the general public. So being compatible with future needs such as how to train the general public with some devices such as DRONEs and other means of transportation forces to applying specified regulation.

Because of increasingly relying on Smart devices, power plants and supply sources of energy which has been explained in previous aforementioned chapter of this research will be of importance. To have a more reliable access to a constant mainstream of power is one the most challenging ones in the future. This can generate local suppliers to provide more electricity instead of transferring it from miles away, this is what clears the notion of sustainable development.

Setting up an international organization due to controlling data, prevents from cyber-crimes will be a major issue in the future.

Redundancy of labor will be a challenging issue and setting up new regulations before emerging difficulties is mandatory. Redundancy always leads to major problems which can be a game changer and can be abused by Populist politician.

The smart cities leaders should not do something to maximize their profit, this is an important role on their shoulders since it contradicts the smart city values in is an opposite way of releasing the free flow of information. They should provide for the most amount of people sustainable motivation and provide services for a healthier life.

Embracing AI for secure and reliable Land Information. Blockchain in Real Estate

Lisiena Dimo

Introduction

Technology nowadays plays an important role in managing the world and this is easily seen how it is overtaking every aspect of in life. Moreover, we invented Smart Cities that in short term means, passing all traditional data into digital data in order to become more flexible, efficient and sustainable when using information and telecommunication to improve the life of its inhabitants. The same logic can be followed and used for land administration and Real Estate. Land management and administration includes a lot of features as land implies a lot of features itself. This sub-chapter will explore technology and its benefit in land administration, especially sharing trustworthy information. Using AI means mining, analyzing, storing and exchanging data between stakeholders (citizens, private and public sector) for practical application in the management and planning the future cities. Moreover, an aspect called Blockchain will be explored and how it can help with security in Real Estate in order to improve stakeholder's decision making though Blockchain as it implies anonymity and distributed consensus. (Michael Crosby, 2015).

Key words: AI, Land Administration, machine learning algorithms, Blockchain.

LAND ADMINISTRATION AND ISSUES

As we are approaching a new era in technology a lot of research is being done in different fields to optimize it and make it more sustainable. Especially considering today's challenges regarding information, is fully believed that through technology and new developments we could help this process become more sustainable and internationalized (Thompson, et al., 2016) The focus of this research is towards technology in land administration, especially focused on real estate industry and how it helps in this matter.

Considering that everything comes in a linear chain process to understand better the need for new technologies and their outcomes in real estate administration we should first understand some basic features and issues of land administration.

We have been using land since the beginning of civilization for our living purposes, and this comes in terms of land usage for food production and dwellings. According to studies the number of the global population in 2050 is estimated to reach 10 billion. Considering this number means much more land is needed to host them and to feed them. Another factor that many researchers and GEF Council (Global Environment Facility) are addressing is land degradation because it is the main threat of food production (GEF, 2005). Land degradation means soil erosion, nutrient depletion, soil compaction and salinization of land in use, the outcome of which is loss of soil biota, plant and species habitat (Seckler, 1987).

With this basic information the future management of information resources appears challenging and further studies in the field of land use and administration are needed. However, there are studies conducted from different agencies such as UNEP (United Nations Environmental Program), UNDP (United Nations Development Program), World Bank and other institutions like FAO (Food and Agriculture Organizations), IFAD (International Fund for Agriculture Development), CGIAR (Consultative of Information Agricultural research Centers). They have collected a wide amount of data regarding policy and socioeconomic drivers (such as high population pressure, sectoral and macroeconomic policies, poverty, unclear land rights and land tenue, lack of access to markets, credit and other services), (GEF, 2005). What we lack today is to learn more about adequate technologies for a more sustainable land administration information. Addressing these issues are important to provide enough information for future decision-making and successful investments, yet much needs to be learned about these processes.

According to Barredo (I.Barredo, et al., 2003) the dynamic of the urban land is directly a consequence of individuals, public and public actions made at the same time. This creates changes in land patterns (Wu & Siva, 2010) and it is essential to understand these forces in order to predict speed, intensity and trajectory. In the past these attempts were made through analytical methodologies that narrowed information about land dynamics but with the help of computers in 1950 this gap was lightly shortened (Voorhees, 1959), (Batty, 2004). By introducing AI in the 1970s the traditional methodologies of land analysis have change and this brought deep theoretical understanding of land dynamic use and change by using a high level of complexity (Los, 1973); (Tobler, 1979); (Batty & Longlay, 1994); (Silva & Clarke, 2005); (Silva, 2008b).

According to The World Bank, the use of technology in land administration and land management system can produce an affordable, timely and accurate information system about land resources along with quantity, quality, property and use. However, it is essential to mention that this process, despite the importance of technology, cannot be done without engaging together technology, people and processes for an effective Land Administration System (LAS). This process is even defined by the UN that states *'the process of determining, recording, and disseminating information about ownership, value and use of land, when implementing land management policies'* (The UN's Economic Commission from Europe 1996, 197, (Jacobs, 2015).

There are alot of benefits with a proper land administration. Among the most important one is city planning thus an established infrastructure and facilities, secure and honest land rights for its inhabitants that included women and native people, less land conflicts and more economic stability and prosperity. In this case to solve all these issues using technology has become an important step and there is no more question about do we need technology or not but what kind of technology and what new technology should we implement to make land administration modern and efficient. With this there is a switch from Land Administration System (LAS) to Land Information System (LIS).

Technology for Land Administration

Approaching technology in land administration thus city planning as a solution to many urban issues and an alternative way to process dynamic and complex data. According to Willy Govender, 70% of developing countries do not have a proper land administration system, data transformation and adoption has been slow, digital mapping is lacking data and the judicial approach is fragmented (Govender, 2018). Basically, by introducing AI or implementing technology in above listed issues a modern era of land administration system will come. For the sector this means digital cadaster and land title registry, faster respond times, reduced operational costs, increased efficiency, now service revenue and high level of customer service. The amount of research in attempting to modernize the sector is vast but the aim of this research is to explore the ones close to real estate sector especially related to ownership and cadasters and their impact in escalating issues.

Defining ***'Cadaster** (ca-da-ster) - Comprehensive land recording of the real estate value and/or real property's metes-and-bounds of a country for taxation purposes'* (Ivens, 2018). Real estate is all about profit and interaction between property owners, buyers and sellers and embracing an open source Platform or e-Platform (Jacobs, 2015). These connections became essential. One of these is adapting e-Cadaster as a modernized and reliable way of the traditional paper base cadaster information system (Borzacchiello & Craglia, 2012) consisting of a two parts information, a legal description (title/deed) and numerical/ diagrammatic description (Zevenbergen, 2002). All these papers are stored separately and managed by different governance institutions that often bring many issues regarding complexity and high costs in achieving land information. As a solution to this many governments are switching from paper-based information to digital information system to improve efficiency and accessibility of information system (Borzacchiello & Craglia, 2012), or commonly denoted as e-Government strategies and programs (Jacobs, 2015).

Key Principles of approaching technology

Using technology frameworks in Land Information System (LIS) has three main units that need to be followed to set up an effective technology in LIS. Stakeholders need real-time access to land information like land registry, land resource management, cadaster, valuation, tax property administration or all mixed together *''it enhances the ability to make sound decisions and operate within budget while streamlining cash flow''* (Jacobs, 2015)

Scalability, means that the system should go along with LA function such as volume of transactions and increased functionality.

Sustainability, is related to the life span of the solution after the implementation has been considered as a success.

Security, one of the key drivers when implementing LIS as it prevents false information on land claims.

According to Gasant Jacobs these three features are essential when delivering LIS because they influence directly to the costs and performances of ownership of the LIS technology (Jacobs, 2015). Thus, a long term well performance of delivering the technology. In other words, these three features serve as a pattern in later decision making and deployment. The following pages will focus on the security aspect of technology usage as the main issue that the real estate industry needs to face. James Paine (founder of West Realty Advisor) descries the influence that AI is having on Real Estate in *'3 Ways AI is changing Real Estate'* article (Paine, 21 June 2018).

AI can increase the relevance of recommendations: Real Estate is all about providing costumers the suitable property for them and this implies salesperson's work to talk to them, identify the needs and find out where to look for a solution. Next step is to translate these features into data algorithms. Then AI will accurately figure out personalized solutions what works better for the client by collection data with different touchpoints. For example, when browsing a website for a certain property, an algorithm can do so by checking all of them based on the initial inputs in a short time.

AI can help you to sell better to people: AI models never sleep, this means that clients can surf the website anytime 24/7 and chat with the bot provided on the website and help them out and automate the work workers usually do during workhours. Also, chatbots have proved to pass the Turning Test so they behave almost identically to real humans.

Long-term relationship building: AI is spreading among real estate firms even when it comes on determining relationship between customers and managers by predicting whether people are willing to choose the loan or fail a credit check that will allow firms to work more efficiently. Moreover, AI can monitor vital metrics, crime rates, property prices when maintenance is required or errors occurred and so on.

Blockchain

The meaning of Blockchain

Blockchain is a technology concept released in 2008 by an individual or a group of individuals under the name of Satoshi Nakamoto (identity remains still unknown) as a form of crypto electronic cash called Bitcoin or ''A peer-to-peer electronic cash system''. In other words, Blockchain is a distributed database of records or public ledger of all transactions or digital events that have been executed and shared among participating parties. Once an activity in the public ledger enters, it is assessed by majorities of these parties' part of the network and from that cannot be erased. Every activity made has a certain and easily verifiable record of its own that form the content of a Blockchain.

"The fact is that we live our life precariously in the digital world by relying on a third entity for the security and privacy of our digital assets. The fact remains that these third parties source can be hacked, manipulated or compromised. This is where the Blockchain technology comes in handy. It has the potential to revolutionize the digital world by enabling a distributed consensus where each and every online transaction, past and present, involving digital assets can be verified at any time in the future. It does this without compromising the privacy of the digital assets and parties involved. The distributed consensus and anonymity are two important characteristics of Blockchain technology" (Michael Crosby, 2015).

Blockchain features: Blockchain is a database (Defining '***Database – Large collection of data organized for rapid search and retrieval"*** (The Role of Blockchain in Real Estate Records, 2018)It is shared between a network of computers

1. When entering a record, it is hard to manipulate
2. To ensure authenticity the network makes constant checks
3. It fits financial and non- financial activities

Blockchain in Real Estate

"Blockchain offers an open source, universal protocol for property buying, conveyancing, recording, escrow, crowdfunding, and more. It can reduce costs, stamp out fraud, speed up transactions, increase financial privacy, internationalize markets, and make real estate a liquid asset." – International Blockchain Real Estate Association (IBREA).

The idea to use Blockchain in many sectors of the economy is to secure a more reliable market. The real estate market is known to have price hovering, inefficiencies and suspicious transfers and contracting. Whereas Blockchain will deal with all this tediousness and enable owners, investors, and tenants to define, manage and automate their businesses independently from experts. Real estate companies are always dynamic because stakeholders use them constantly not just at a certain time. They sell, rent, buy and even own more than one property at a time as an investment. The issue stands when selling and buying agents focus more on the present situation and not on the future decisions that make this process time consuming.

Dr. Larry Ivens at Ivens Work Group states that future developments in technology can improve land administration with this new concept, Blockchain can have a significant role in real estate records. This new implementation will not only make this industry better and more efficient, but they will transform businesses at an unprecedented pace and will transform the way that the sector operates (Ivens, 2018). The attempt to use Blockchain in real estate would mean a *"distributed database that maintains a growing list of data items and that is hardened against manipulation and counterfeiting," (Veuger, 2017). When it is implemented within the project it takes the responsibility of the building's passport because it assembles in*formation from ownership to structural details and the latest renovation. This will change forever the way we valuate real estate assets that previously used to be determined by basic expert's opinion based on earlier comparable sales, judgements and estimations. The whole process up to now was prone to errors and prejudices but with Blockchain these assumptions are to be excluded.

Why Blockchain?

According to Jurriën Veldhuizen manager at Deloitte Real Estate NL (Blockchain and Real estate, Mining Unexplored Terrain), with transaction costs and irregular information, the real estate market is a 'Matrix of Imperfection' due to intransparency of data. Another fact is that there is no standardization of this data to be registered and validated, instead doing so the traditional way has high transaction costs in brokerage, ledger, recording and bank fees. For all this stakeholders need third parties to deal with the issues and verify the data more than once in total transparency (Veldhuizen, 2017). While geospatial programs like GIS will improve transparency and diminish distorted data information, Blockchain is supposed to work as a truth data origin. It is built from an encrypted digital shared data ledger that every network's member has a copy of and thus one single use cannot manipulate it. Using this technology would mean using statistical models or computer algorithms instead of expert's estimation in valuation. Just by improving data storage and computing power the level of valuation and thus, predictive accuracy will be high. The advancement in analytics and computing algorithms that implies a large application in machine learning algorithms such as Artificial Neural Networks (ANN) and Support Vector Machines (SVM) will soon open new doors in valuating space. The group sector responsible for property taxation is interested in a correct evaluation of the property otherwise the wrong calculation of tax property will lead to high costs and lawsuit issues. This calculation is done though all properties at a given date by

estimating the value of each property in the tax roll. Mortgage lenders are another group interested in the right valuation as they want to determine property value before extending the loan and getting the wrong value means higher risks. Implementing computational algorithms will improve predictive analytics in valuating properties and machine learning algorithms have proved to be very accurate in doing this (Veldhuizen, 2017).

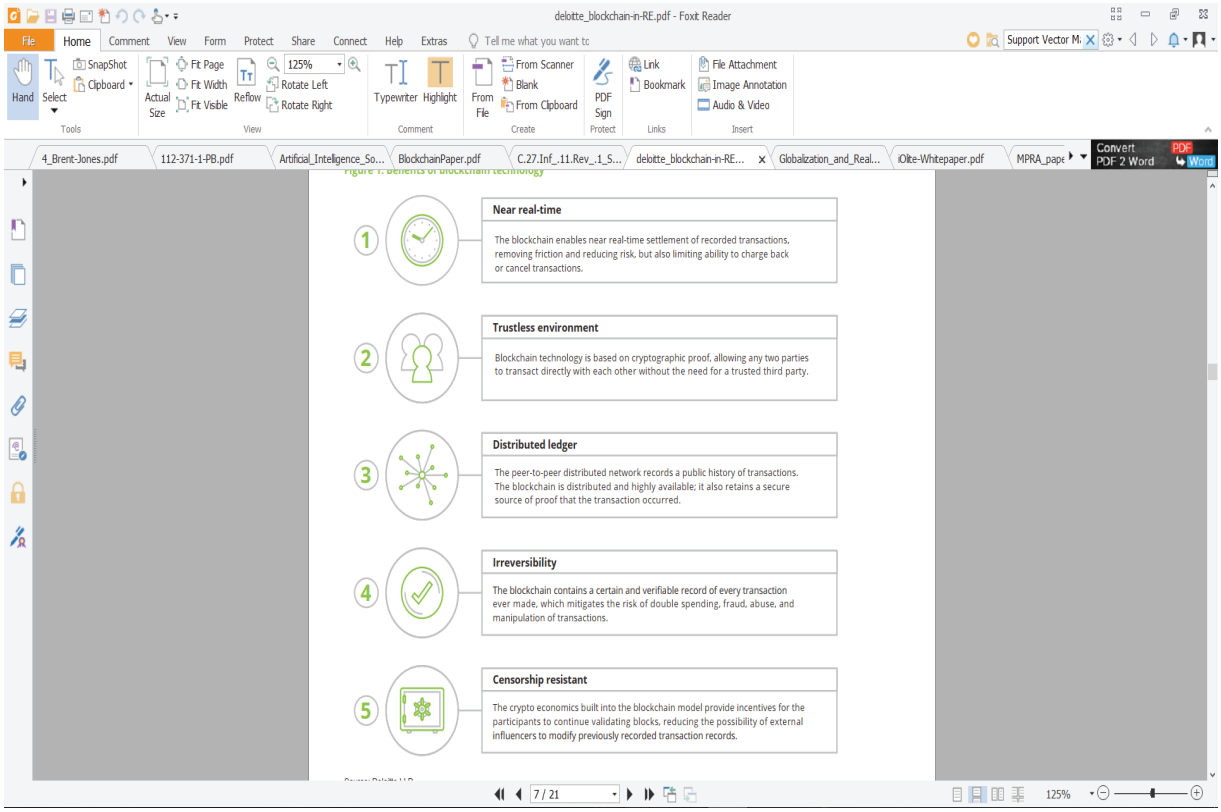


Figure 20: Benefit of Blockchain technology (Source: Deloitte LLP)

Conclusions

AI is an invention to replace the human brain in certain areas as it does a lot of errors with consequences due to emotional decisions. Putting AI to work in machine learning requires feed data to train the algorithms instead of emotions and human decisions. If the quality of these feeds is poor, the less quality of prediction it will be released. This is when Blockchain does its work, by giving accurate data and cutting out anomalies and fraudulent data. Concerning real estate, AI models do automated valuation and transactions for later decision-making. This implies an electronic monitoring system in the cloud (where all the information is collected) and creating a virtual cadaster or e-Cadaster where the information regarding property will be stored, selected and accessed from everywhere no matter the location in total accuracy and security.

Despite all the benefits that technology seems to deal with in future decision-making, there are still some gaps that block this process from happening correctly.

First, the third parties such agents, banks, lawyers, insurance companies, specialists and especially appraisers, involved in this industry are interested in having more profit from the traditional process of real estate, as they cannot keep up with the latest trends and their familiar ways are always prone to modifications.

Second, the question is does the new process reach everyone? Applying technology needs specialists to read and deal properly with Blockchain technology and those experts are still few in number. Hiring them from abroad requires time and investment.

Nevertheless, real-time, transparency and security data are on high demand today.

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Sustainable Transportation

Case Studies 1: Building and Refurbishment

Construction and Real Estate Management

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Abstract

This chapter is presenting the influence transportation can have on city development all over the globe while highlighting the challenges and techniques used to tackle them. Although eastern and western transport infrastructure varies depending on economies and local trends, this document presents a general idea of what level of transportation cities should reach in order to achieve a more sustainable future. In order to demonstrate the challenges and possibilities of modern transportation in cities this paper will present different case studies and innovative ideas and methodologies.

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Figures

Introduction

In the 21st century where the term sustainability emerged, energy is the focus of the majority of sustainable innovations and projects, that and search for balance for energy consumption and natural resources preservation. city planning has one of the biggest influences on that energy issue taking into consideration the scale and categories of city planning. Transportation is one factor that has the most influence, after the housing sector. Old solutions to city transport like individual cars have been proven bad on many levels so public transportation came along and cities evolved into many systems from buses, trains, trams and metros.

Building on the sustainable ideas of public transportation, also avoiding and managing waste, and reducing greenhouse gas emissions is important. Futuristic visions for transport are being invented for better air, sea and land transport by combining with new technologies like underwater railways and Hyperloop.

In this report, case studies will be presented for cities finding solutions to transport problems such as traffic jams, over-crowded roads and too many private vehicles. Existing and futuristic technologies for cleaner and more sustainable transportation ideas are presented.

Istanbul Marmaray Project

Introduction

Istanbul has been facing the issue of transportation since the beginning of the century due to many geographical and economic measures being laterally between Europe and Asia. The city hosts the east and west in culture and religion and is the pathway for the merchants sailing from the Black Sea to the Mediterranean and back. This combination has made it an attractive city to live in especially in the last 20 years as much development took place to transform it from an old city rich in culture but dirty and lacking in basic infrastructure to an organized city with growing development.

The city has had a huge growth in population as it doubled in the 20th century making it one of the fastest growing metropolitan areas in the world with a 3.45% growth rate. This issue has resulted in growing problems with traffic and traffic jams. As much as they tried to solve the crossing issue by building bridges between the 2 continents, it could not catch up with the rapid increase of vehicles and now the traffic jams are found in bridge zones (Istanbul Population, 2018).

Figure 1: The Bosphorus and immersed tunnel alignment (Belkaya, et al., 2008)

The Connection between the two continents (on Marmara strait) is provided by 2 bridges and recently a 3rd bridge was constructed. Ferryboats also cross the strait, but they are insufficient during busy day times. To solve this issue, an interconnecting metro idea arose, designated to provide an underground connection between east and west Istanbul between Uskŭdar and Sarayburnu crossing under the water of the Strait Marmara (Efe & curebal, 2011).

Marmara Strait (the Bosphorus)

Five hundred thousand merchant ships travel through Istanbul strait each year in addition to the minor ships and ferries for people and vehicles across the Bosphorus (Efe, Recep & Curebal, Isa. 2011; Lykke & van de Kerk, 2005).

The depth of the strait varies: in the middle of the channel it goes between fifty and seventy-five meters and near the southern edge it goes down to about 110 meters. The current direction on the surface goes from the black sea to the Marmara Sea but in a deeper level, there is a different current as none-brackish water from the rivers and streams flow to the Black Sea then to the Marmara Sea. But the brackish water from the sea flows in a deeper level from the

Marmara Sea to the Black Sea. Water forces played a big part in the design of the underwater tunnels. You can see the location and metro direction intentions in figure 2 (Efe & curebal, 2011).

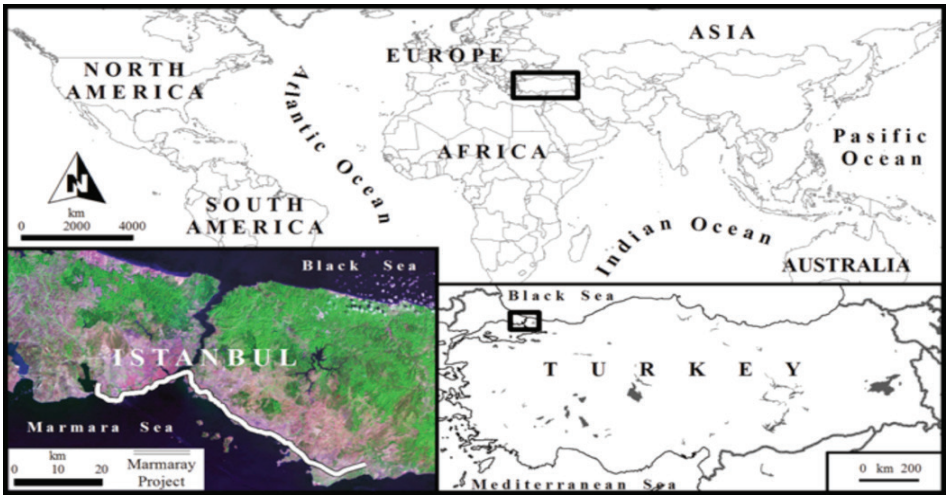

Figure 2: Marmara strait location between continents and seas and Marmaray project location. (Efe & curebal, 2011).

Since the Bosphorus is separating the European and Asian areas of Istanbul people had to decide where to live and do business. In the 50s on 20% of the people in Istanbul lived on the Asian side and that means that 80% live on the European side. But with the improvements of the access for bridges and ferries in between, by 2009 the Asian 20% raised to 40%. Most businesses were established in the European side but with the ease of access, people started living on the Asian side and commuting to work to the European side. In addition, people inhabiting the city rose from one million in the 1940s to 12.8 million in 2009. That is called a red flag for a solution to the huge traffic jams to construct additional projects. Several projects were constructed like the 3rd bridge. The two sides began to balance in number and population after the 1970s as you can see in the graph above with European side population growth decreasing while the opposite Asian side increasing creating balance in the economy. In transportation, traffic crossing the strait increased to the point where public transportation was necessary (Efe & curebal, 2011).

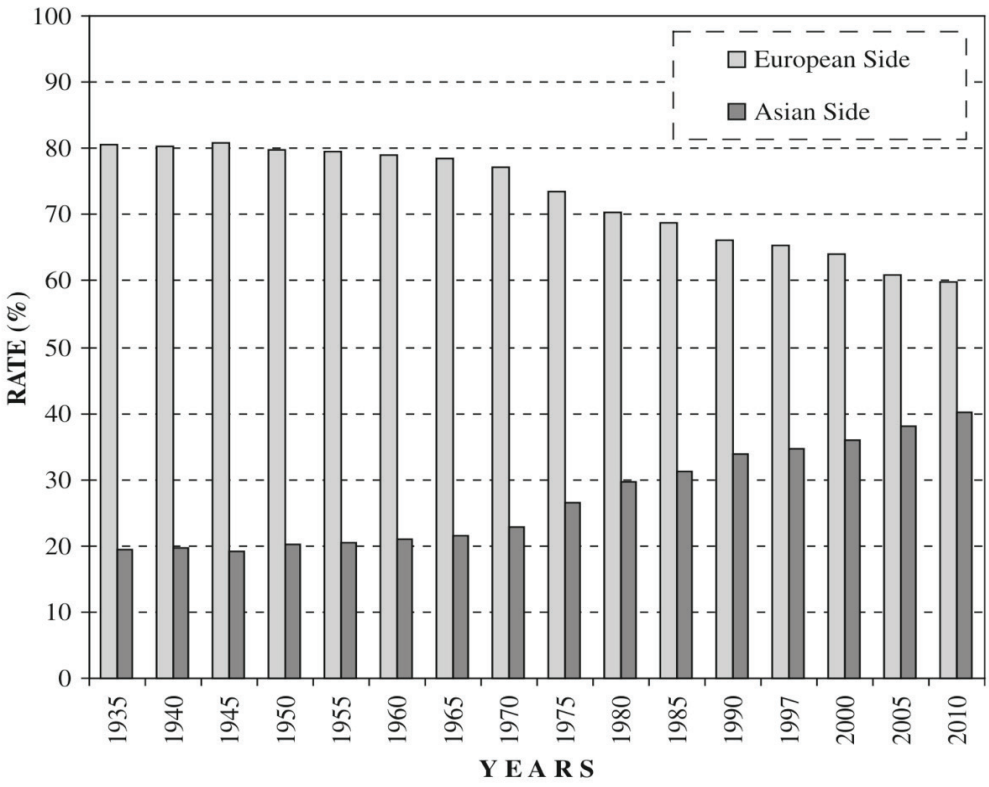

Figure 3: Population change in the Asian and European sides of Istanbul: 2010–1935 (Efe & curebal, 2011)

Project in numbers

About twelve million persons move within the city of Istanbul on a daily basis and the Marmaray is a big part of the city transport. Its length is 76.3 kilometres high-capacity metro which connects Europe to Asia by crossing the strait. The project is owned by the Turkish Ministry of Railways. Opened in October 2013 with a gauge of 1435mm. It consists of existing stations which were rebuilt to utilize the new purpose and new stations. The total amount of stations is 40 with 37 rebuilt and three new ones.

The Intended capacity of the metro for passengers carried per hour is 65,000, to be 75,000 by 2025. Which highlights the fact that it's designed to fulfil the transport needs of the city for 2025 and after. The length of the tunnel is 13.6 km consisting of 3 parts, bored tunnel with 9.8 km and cut and cover tunnel 2.4 km and 1.4 km of an immersed tube tunnel (Marmaray Railway Engineering Project 2015).

How sustainable are the project goals?

By introducing a project with such a dimension and goals it is essential to realize that it won't only influence the day to day traffic pattern of the City of Istanbul but also the development of the city and the greater region. It does introduce a new level to the rail commute system in the city connecting the 2 sides containing Ataturk Airport with an uninterrupted, fresh, high capacity commuter rail system. The major structures include the immersed tube tunnel, bored tunnels, cut and cover tunnels. The Marmaray project is designed to increase the use of rail transport from 3.6% to 27.7%. This number makes Istanbul the third highest city for rail commute use after Tokyo, 60% and New York City, 31%. A sustainable city is a city that uses fewer cars and more public transport and that is the case here (Efe, Recep & Curebal, Isa. 2011).

Part of sustainability is the environmental benefits and Marmaray project is presenting some environmental changes for the City of Istanbul. The capacity of passengers to travel between East and West is calculated to be 12 times more than the capacity of a single bridge constructed between the continents crossing the strait. This lowered street congestion in the old City of Istanbul leads to cleaner air, saving energy, less noise and traffic stress, etc.

This movement will also change the mentalities of residents of the city towards adapting public transportation as a reliable means of transport also with higher safety and comfort. Jobs created by the Marmaray project at its peak will employ around 7,000 people directly and 2 times that number for subcontractors and suppliers, mostly local (Efe, Recep & Curebal, Isa. 2011).

Sustainability in transport can be measured by hours saved on streets which mean more hours into work and development. The journey between two areas in Istanbul like Halkali and Gebze used to take more than 180 minutes which included the ferry ride on the straight. After the construction of Marmaray tunnel, the same journey took about 110 minutes which saved over an entire hour on the road to be invested in useful activity. When the Istanbul Technical University calculated all the hours saved for the 1.5 million commuters crossing Istanbul and the other parts of Marmaray project that adds up to 13 million hours in 2009 and the more commuters the project encourages the more hours are saved. The project was completed in 2018 (Oktem, 2000).

Project tunnelling systems

Crossing the Istanbul strait by the metro takes about 4 minutes instead of 20 minutes by ferry and between 35 and 65 minutes by car using the fully digested bridge road. This transformation was divided by 2 two contracts. One is for the strait crossing of 13.6 km which consists of 3 2 tacks tunnelling systems. Bored, immersed and cut-and-fill systems. The zone included 3 new metro stations. The deepest tunnel is the immersed structure which lies 55m below the sea and it extends to 1.4km, then comes a 9.8km bored tunnel and only 2.4km are done using the cut-and-fill method. The immersed part is connected to the land using the bored tunnel (Gülal, 2014).

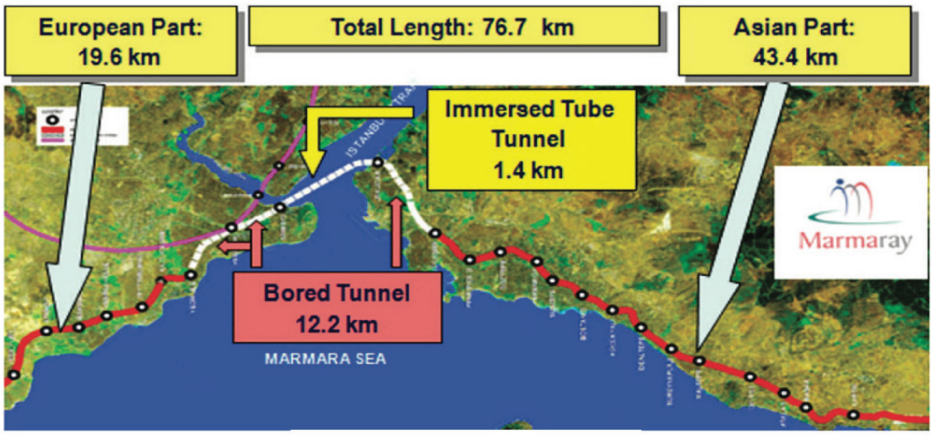

Figure 4: Marmaray Project track (Gülal, 2014)

Cut-and-fill and bored tunnelling are used frequently all over the world but the challenge for this project was the im-

mersed tunnel where natural constraints emerged. The Marmara Fault system on the south side of the Anatolian fault zone is a major earthquake source and that implied having a seismic design for the tunnelling structure (Gülal, 2014).

Another important factor is the work environment under water, adding to the high cost of the tunnelling and advancements in technology it needed precise coordinate systems by a survey engineer designing a survey control system for the tunnel alignment in addition to many other tasks like setting the line of the tunnel and guiding the boring machine and locating the right spot for the drill holes (Gülal, 2014).

The surveying process made use of a complex geodetic surface network that triangulates between points underwater and satellites creating horizontal and vertical dimensions within 100mm+- tolerance (Gülal, 2014).

Summary

The city of Istanbul, between two continents, has been the connection between East and West and sponsor of the silk-road. It has been suffering from an over-crowded transportation situation for reasons related to uneven population distribution within the city that is split into two by the Istanbul Strait of the Marmara Sea. It became clear that bridges are not going to solve the problem and a more effective and sustainable solution was needed.

The idea of a metro line connecting the parts of the city and extending along the most populated area of Istanbul emerged. Resulting in less pressure on the bridges and less street traffic for more comfortable streets from the fact that public transport users rose from 3.6 % to 27.7%. More people using public transportation meant more productive hours along with environmental benefits and energy savings.

Transportation development in Wuhan, China

4.1 Introduction

Wuhan can be identified as one of the top ten cities in China, in an economical and cultural way. It lies in the middle of China and is situated along the Yangzi River (the third largest river in the world). The city has a history of a thousand years and serves as a hub city for merchants travelling through the river and lake network to the entire country.

With a city such as Wuhan, transportation is always the key factor that affects every heartbeat of the city. Comparing the past thousand years to the last 100 years, the technology for transportation has shifted and changed utterly, as well as the population of the city. According to official data published by the Wuhan government, there are 10.86 million people dwelling in the city (Xuejun, 2011).

Therefore, the transportation problem within the city becomes eminent and challenging as well since it is not only about fulfilling the basic transportation needs of citizens and being economical but also becoming sustainable.

This case study will cover different forms of transportation in the city, including car, bicycle, subway, metro, bus and etc., and to analyse the advantages and disadvantages of them, in economic and sustainable aspects in the hope of getting a better sight for the future transportation development of this city.

Background

In 1949, the civil war ended in China, and the status of Wuhan can be described as a ruin, especially a city transportation. There where in total about 1100 old cars and 100 small boats that survived the war (Xuejun, 2011), with a population of 1.2 million. (Kai, 2009) In addition, Wuhan is separated by the Yangzi river, no single bridge exists across the river.

The tide turned when the central government led by Mao Zedong realized the importance of Wuhan for its political and economic position. Alot of investment was prioritized to put into the reconstruction of transportation in the city. In 1957, the first-ever road/rail double layer bridge in China was built in Wuhan.

Figure 5: The first road/rail double layer bridge opening day in Wuhan (Management case library of Chinese government, 2007)

Since then, Wuhan has been one of the few cities in China leading the trend of public transportation. For its particular geolocation, the city allows all kinds of transportation to be tested and compared. Hence it began the fast pace of growth in economy and transportation.

However, it would seem the pace was too fast for the last 40 years (1978-2018), while the GDP of the city grew more than 60 times over (from USD 3.91 billion to USD 224.28 billion) (tanxiao, 2017), and also the number of cars increased during that same period from 1,100 to 2.83 million (Hubei daily, 2018). The traffic becomes too dense in the city and leads to pollution of the air, which forces the city government to think a better way to develop the city transportation.

The author has been living in the city for more than 20 years, therefore has the privilege to witness the transportation development of the city, and its attempt to transform from economical industrialization era to sustainable digitalization era.

Alternatives

Motor tricycle/ three-wheeled motorcycles/ Mamu

In the 1980s, many people from rural areas who went to work in cities were laid-off. In the process of finding a way to survive, they gradually started three-wheeled bike businesses. Since a car or taxi is still relatively expensive to most of the common citizens, the human tricycle filled the streets and alleys of Wuhan. With the continuous development and popularity of three-wheeled motorcycles, more and more electric tricycles have replaced the human tricycles as the main tools for passengers. Many disabled people have used their own disabled motor vehicles to solve their living difficulties. Wuhan's manpower tricycles and three-wheeled motorcycles have reached as many as 40,000 vehicles, including 24,000 vehicles with licenses (Management case library of Chinese government, 2007).

For the general public, the development of bus routes lags behind the development of the city, and the "Mamu" is small in size. It is very convenient to walk down the street, and the service attitude of the "Mamu" driver is satisfying compared to means of other transportation, therefore it became popular among vast majority of citizens.

Figure 6 Motor tricycle blocking the main road in Wuhan in 2003 (Management case library of Chinese government, 2007)

However, when “Mamu” drivers fighting for a customer with each other, they always deadlocked, causing traffic congestion. Seizing the road, endangering safety, influencing order, polluting the environment, and damaging the city’s appearance. In 2003, Government shut down the licensing of Motor tricycles and gave compensation to every owner who handed over their vehicle. Therefore, the Motor tricycle fulfilled its historical purpose and left the stage.

4.4 Metro/rail transportation system

In 1984 a Belgian Railways delegation visited Wuhan and since then preliminary studies of urban rail transit system were prompted by the city. The Wuhan Metro rapid transit system began operation on July 28, 2004, with the completion of a ten-station long elevated line known as line 1 (Wuhan Metro, 2019).

In 2004, the public had no confidence or faith in the metro rail system in the city, due to the noise and jamming traffic, made even more intolerable during its long construction period. However, the government kept up the pressure and continued the long-term plan of Wuhan metro system.

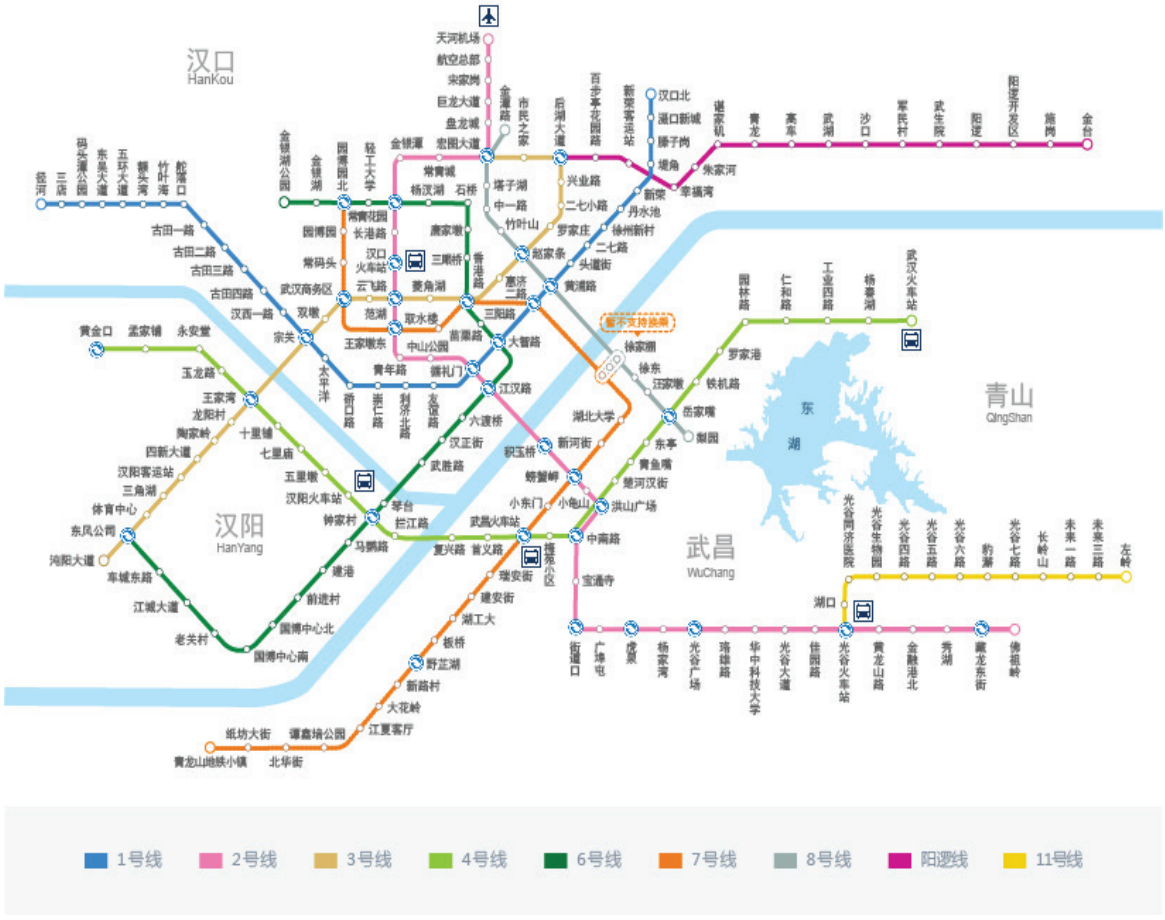

Figure 7: Wuhan Metro line in 2018. (Wuhan Metro, 2019)

As of February 2019, there are 9 Wuhan rail transit lines, including Line 1 and Line 2 (including Airport Line, Line 2 South Extension Line), Line 3, Line 4, Line 6 and 7 (including paper house Line), Line 8, Line 11, Yangluo line, with a total of 216 stations, the total operating mileage of 318 Kilometers (Wuhan Metro, 2019).

The average daily passenger traffic of Wuhan rail transit exceeds 3 million, the highest daily passenger traffic reaches 4,115,500 passengers, ranking sixth in the country, and the passenger flow intensity is 1.5-1.8 million passengers/km, accounting for the proportion of public transport passenger traffic in the city. The share ratio is over 40%. At the end of 2017, Wuhan Rail Transit carried a total of 927 million passengers, with an average daily passenger flow of 2,537,700 passengers, carrying 23.5% of the city’s public transport passenger traffic (Hubei Daily, 2018).

5.5 Shared bicycle

A shared bicycle refers to the bicycle sharing service provided in cities, campuses, etc. At present, the first intelligent shared bicycle mode in China refers to finding vehicles through the App, using a smart way such as scanning code to unlock the bicycle with one button, and real-time monitoring of vehicle condition and operation remotely.

It is a relatively new way of sustainable transportation within the city. In addition, it is also very popular among young

generations to achieve a healthy lifestyle and at the same time reduce the burden of heavy traffic load on the city transportation issue.

Figure 8: shared bicycle app application example (Chutian city daily, 2018)

According to the survey of the Wuhan Municipal Public Transport Management Office, there are about 1.03 million shared bicycles in Wuhan, which has seriously exceeded the non-motorized space carrying capacity of the city (Chutian city daily, 2018).

After the shared bicycle is deployed, the management is not working. Although it is convenient for the citizens, it also adds confusion to the city and increases the management cost and difficulty of the government departments. Bicycles are parked indiscriminately, they are poorly cleaned, and faulty bikes are not repaired.

The ratio of operation and maintenance personnel is not up to standard. None of the three major companies provided a list of operation and maintenance personnel that can be verified and confirmed according to the requirements of the operation and maintenance personnel of the vehicles. The ratio of the operation and maintenance personnel of the enterprise is far from the government's specified ratio of 5% (Chutian city daily, 2018).

5.6 Electronic/gas bus

In 2018, Wuhan has 467 bus lines, more than 8,600 bus vehicles, and 4 million passengers per day (New energy car website, 2018). Most of the buses are old, diesel driven models. This results in a lot of exhaust emissions into the air. In order to achieve a more sustainable city and respond to the cause of becoming a future-ready city, the government of Wuhan started replacing the old buses with new Electronic/gas buses.

The new energy bus has the advantages of no pollution and zero emissions. It optimizes the bus energy consumption structure and reduces the environmental pollution caused by vehicle exhaust emissions.

Figure 9: First 37 Electronic buses put in use in Wuhan in 2018 (New energy car website, 2018)

On June 26, 2018, the first batch of 37 pure electric buses with the first batch of new buses from Wuhan Bus Group of Hubei Province was officially put into operation on the relevant lines. In 2018, Wuhan will continue to update 418

natural gas buses. The proportion of clean energy (pure electric vehicles + natural gas vehicles) will reach 66% during 2018 (New energy car website, 2018).

Proposed solution

Transportation systems in the city can be described as veins in the human body. Metro serves as long distance travelling tool within the city, such as an artery, it has the maximum capacity with high efficiency and can transport to the main district of the city.

The electronic bus serves as middle range distance travelling tool within the city, such as a secondary vein, it can distribute with less capacity to a more precise, accurate small area of the city.

The shared-bicycle serves as capillary, it solves the question of how to get to a destination less than 1km, and since there is a huge amount of them, they fulfil the need for every individual to use it in a cheap way.

Finally, there is a whole transportation network of Wuhan, and with proper management and by creating a digital network and shared information between different transportation modes, it can achieve efficiency and be environmentally friendly, which is sustainable.

As mentioned above, all the recommended transportation means are public properties, not personal, therefore there is no doubt the concept keyword for a better green sustainable future of transportation is sharing. Just like nowadays the rise of Uber, Airbnb, in every aspect of our lives, transportation, living, travelling and more, since it is a way of more economic and also a cost-efficient way of redistributing resources.

Thanks to the new internet technology like the Internet of Things (IoT), and big data management, the spread and management of shared things become visible and information transparent. This allows more precise and proper management to make sure everything stays on track and can be traced.

In summary, Wuhan city has a relatively healthy, fast-growing economy. The best sustainable development for city transportation would be diversity (develop metro, electronic bus, and shared-bicycle), digitalization (network, big data clouds server for shared information) and efficiency (re-distribution and re-utilization of public transportation resources based on analysis of information).

Innovations for a more sustainable future in transportation

6.1 Introduction

In 2019 the climate change signs are more evident than ever. Since cities are consuming two-thirds of the world's energy (CDP 2015), it is clear where our focus on implementing green energy should rely on. Many cities have already begun with this implementation by reducing and recycling waste, reducing the environmental footprint of buildings, minimising the greenhouse gas emissions and embracing more sustainable transportation. This report focuses on sustainable transportation and in particular the new technologies that are already in use or still in the designing process. With this in mind, the question to be answered at the end of this report is: Can a city be sustainable too?

Figure 10: Transjakarta BRT system. Source: (Kartapranata, 2017)

Bus rapid transit (BRT) with a twistThe concept of having dedicated lanes for public transportation is not new. The system is proven to be very successful in traffic fluidisation by offering priority lanes for busses and trams, thus allowing them not to be held up in traffic jams caused by private vehicles. The bus rapid transit (BRT) does just that, and the City of Jakarta, Indonesia is one of the first to have implemented this system. It currently has the world's most extended BRT system with a length of 251.2 km including 260 stops (Figure 10) (Transjakarta, 2019).

Although the BRT system is already proving its worth, there is still enough room for further improvements. One of them being a more profound utilisation of modern technology when it comes to the energy production of the vehicles. A trial road already built in London, United Kingdom, is designed to wirelessly charge the electric vehicles driving on it. It consists of metal coil buried under the asphalt surface of the road which creates an electromagnetic field in the vehicle thus allowing it to be recharged. This innovation combined with other green energy sources such as wind and solar energy would allow the electric vehicles to run practically without external energy costs or the use of any fossil fuels after the completion of the road infrastructure.

In fact, this idea of combining the BRT system with wireless charging roads has been already developed and put to use in South Korea. The On-Line Electric Vehicle (OLEV) is the first such device to be used and was first launched in 2010 (Figure 11). They operate to this day in South Korean cities and have been proven to have a few major advantages over pure electric busses. The driving distance which plagues pure electric busses is no longer a problem with the OLEV bus. Being able to recharge on the go is a huge advantage that not only allows for continuous driving with no necessary stops for recharging but also drastically improves the driving distance which has no limitations (Park, 2016).

Figure 11: On-Line Electric Vehicle (OLEV). Source: (Park, 2016)

Bicycle highways

The metropolitan areas are growing at a high pace and according to a research conducted by the United Nations in 2018, 68% of the world's population is projected to live in urban areas by 2050 (United Nations, 2018). That is a boost of 20% compared to today's urban population. This would first lead to the cities growth in size and later, due to the rising cost of living especially in the most central areas, result in a massive migration of a significant part of the urban population further away from the centre. In order to facilitate the transport between the suburbs and the city centre, it is of high importance to create better means of transportation while also reducing the number of private vehicles used.

One of the cheapest and arguably healthiest ways to commute is cycling and Denmark is one of the few countries where cycling is a main form of transportation. Although the concept of cycling paths connecting different cities has become increasingly more popular in various European cities including Cologne, Berlin and Amsterdam, the Danes have taken the idea a step further. The country has developed a cycling path network called the "cycle superhighway", a highway designed only for bicycles that allows the commuters to reach their destinations faster and more safely. The routes connect residential, work and study areas, and also run near train stations in order to allow a fluid combination with public transportation (Figure 12). By separating the cyclists from other traffic as well as pedestrian roads they are able to ride more consistently and with an average speed of 20 km/h even during rush hour (Super Cykelstier, 2019).

The cycle superhighways do not only accelerate the average commute by reducing the time spent in traffic jams, but they are also proven to have a positive effect on the cyclist's health thus resulting in fewer sick leave days. In 2010 Hendriksen et al conducted a study which collected and analysed data about over 1000 Dutch employees using bikes for their daily commutes. The results clearly proved that cycling has a great beneficial effect on the employee's health

showing that the longer and more often the people cycle to their workplace, the less they report sick (Hendriksen, et al., 2010). Combined with the fact that the superhighways are practically CO2-pollution free it is safe to say that they positively contribute to the national health thus

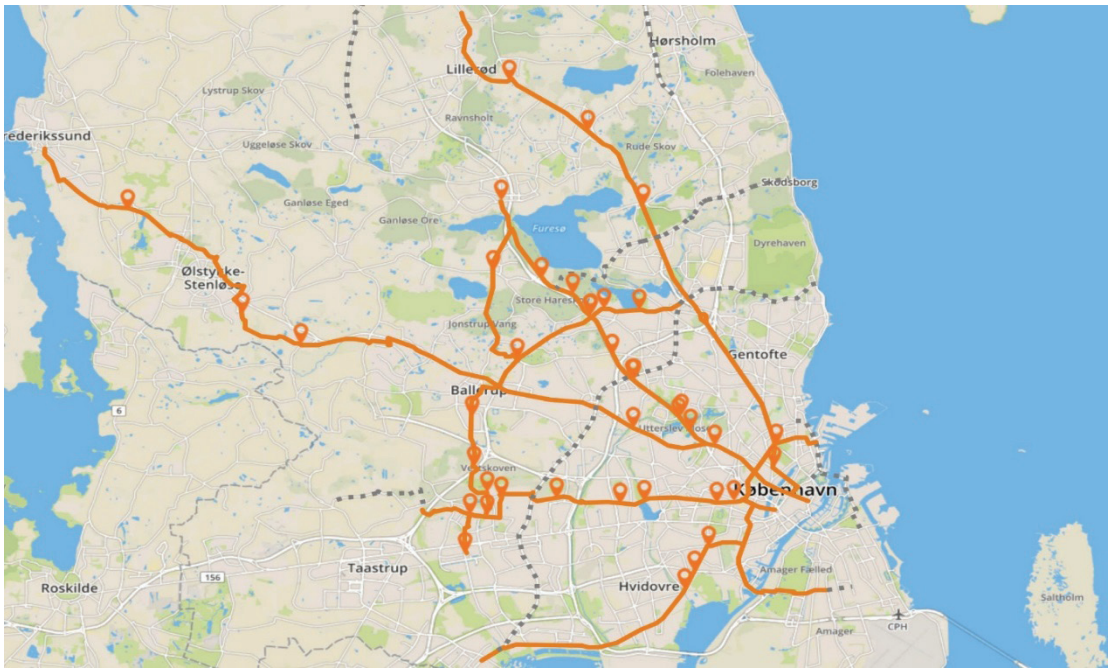

Figure 12: Denmark's Cycle Superhighways. Source: (Super Cykelstier, 2019)

also making them a more economically efficient asset compared to traditional car highways (Super Cykelstier, 2019). According to efficiency research released in 2018 by the company in charge of the superhighways, Super Cykelstier, a single route reaching all the way from Copenhagen to the west coast of the country has increased the number of bike commuters by 23% since the opening of the route in 2012. 11% of these new cyclists were previously using cars for their daily commutes (Super Cykelstier, 2018).

Figure 13: Van Gogh Path by Studio Roosegaarde. Source: (Dekkers, 2018)

Another pioneer country when it comes to cycling is, without doubt, the Netherlands which possesses both the appropriate landscape but also innovative infrastructure making biking easy, fast and safe within and outside cities. One of the main reasons people might be avoiding cycling in some cities is the lack of proper, safe biking paths which are accessible also during evenings and night time. The Netherlands has come up with an environmental-friendly solution for this problem called the Van Gogh Path (Figure 13). It is a part of the larger Smart Highways project launched in the country which aims in building more interactive and sustainable roads both for bicycles as well as cars.

The Van Gogh Biking Path is build using special surface material including glowing stones that charge during the day-

time and release that energy as light during the night for a period of 8 hours. This creates the effect of a starry night sky thus explaining the name of the path. The same material and innovation are also used in the sidelines of highways to make them more visible in the dark and therefore safer. The illuminated bike roads are not only beautiful but they also serve a greater purpose by offering the cyclists a safer path to use without the need of excessive illumination provided by separate street lamps which would require the need of external energy (I Amsterdam, 2019); (Studio Roosegaarde, 2015).

Magnetic levitation - The floating future of trains

So far, we have discussed the possibilities concerning buses and bicycles when it comes to innovative and greener solutions for the future but there is still one topic left to discuss the railways. Railways offer the means for mass transportation of people between both shorter as well as longer distances. When it comes to trains, the shorter the amount of time a ride takes and the less fuel it consumes, the more environmentally sustainable it is. This is the key idea of magnetic levitation (Maglev) trains which float slightly above the train rails thanks to magnetic energy and thus allow the train to move without friction, lower energy consumption and reaching higher speeds (NAMTI, 2011).

In comparison to regular trains, the maglev trains have no need for regular repair, since they do not touch the rails or have friction brakes which would require maintenance. They are also not affected by most normal weather conditions such as snow or leaves which can cause problems with regular trains and even though the trains can reach up to 500 km/h maximal speed they create significantly less sound pollution than regular trains (Figure 14) (NAMTI, 2011).

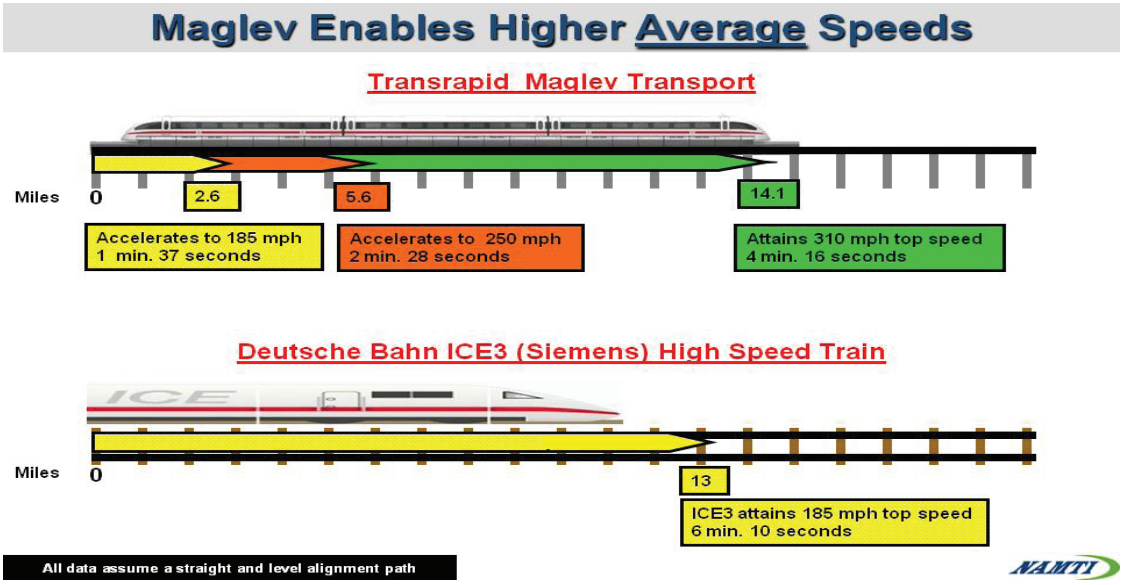

Figure 14: Trans rapid Maglev Transport. Source: (NAMTI, 2011)

The maglev trains are still not completely problem-free and have a few challenges which make them harder to utilise in every country, the biggest drawback being the cost. Since the trains cannot be utilised on regular train tracks, the railway infrastructure needs to be rebuilt. Both the rebuilding process of the tracks, as well as the actual trains, still require more investment than regular trains do. This is the most suitable option for cities wanting to build new train lines rather than rebuilding old tracks (Antlauf, et al., 2004).

There are already some cities utilising this new technology including Shanghai in China and Linimo in Japan. Increasingly more cities are also in the process of constructing or planning the tracks, including Tokyo, Tel Aviv, Sydney and Toronto. The already existing Shangai Maglev Train reaches a top speed of 430 km/h and the future maglev trains running between Tokyo, Nagoya and Osaka (Figure 15) are expected to reach a maximum speed of 505 km/h connecting the furthest cities in a little over an hour (Shanghai Maglev Transportation Development Co.,Ltd., 2018) (Central Japan Railway Company, 2018).

Figure 15: Tokyo Maglev train on test track. Source: (Maryland GovPics, 2015)

Summary

Transportation is responsible for a significant part of the global carbon dioxide emissions. This report has given some examples of what the future holds in terms of transportation methods, especially public transportation by proposing possible advancements and improvements in the sector. While the examples presented in this report are not the only options for sustainable transportation, they show the right way the cities should be heading. Looking at where the technology is now and where it will be in the near future in terms of transportation it is clear to see that there is no end stop to sustainability.

As presented in the report, a perfectly functional BRT system can be improved by combining electric busses with wireless charging roads. This system can be further improved by using green energy sources to charge the vehicles. Bicycle highways have proven to be an exceptional way of accelerating the average commute by reducing the time spent in traffic jams.

In terms of rail transportation, Maglev is undoubtedly the future. With extreme maximum speeds, low energy consumption and minimal sound pollution magnetic levitation trains have the potential to enhance movements between cities to a completely new level of efficiency.

The conclusion is that a city cannot be improved to a state of over-sustainability. Sustainability is an ongoing process and should constantly be improved in order to reach a better future for all.

7 Conclusions

Transportation infrastructure is one of the most important factors for a country's progress. Yet every region has a unique context of culture and terrain to affect its scope and technique. It is clearly understood now that city development in transport can be sustainable as proven by case studies and technologies presented by the report. Good connectivity in the urban and rural areas is essential for economic growth and the research and studies done in this report resulted in a number of conclusions.

1. Population growth is a strong factor affecting the choice of transport means.
2. Building more bridges is not an ideal solution for an overcrowded city split into large land areas.
3. Excessive segregation of land use can create transportation problems in the long run and it's hard to overcome without mega-scale projects.
4. A larger percentage of public transport use is sustainable, providing environmental quality, energy savings, better health and air quality. In addition, more productive hours of the working day with less time on the street.
5. Satellite technologies can now locate specific joining points for flowing water.
6. Big data and internet information analysis plays an important role in the distribution of transportation resources in a more sustainable, efficient way.
7. Single forms of transportation are not enough, the combination of metro, bus and bicy- cle are the key.
8. With climate change and global warming already affecting the population worldwide, it is essential to create more sustainable solutions. Transportation is a great way to start because of it being one of the major emitters of greenhouse gases.
9. While the Bus Rapid Transit (BRT) system has great advantages, it can be improved with wireless charging roads bringing the already great system to a new level.
10. In order to give up on personal car dependency, improved means of public transportation is needed. Improving cycling with bicycle highways is a great way to contribute to national health, economy and offer a CO2-pollution free solution to transport.

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Water management in Egypt

Case Studies 1: Building and Refurbishment

Construction and Real Estate Management

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Authors: Sherif Othman, Aly Hassanein

Abstract

The greatest challenge faced by humanity today is the lack of natural resource, water resources is the most crucial issue among them. The main threat faces the African and Middle East countries is water scarcity which has a big effect on human health, environment and the food supplies for those countries. Most of African countries depend on agriculture to provide the food supply to their people which consume the main amount of water. Water resources plays a major role in the way to self-sufficiency. According to the FAO all the Nile basin countries suffering from malnutrition. (Mason, 2004) The Nile riparian countries, which are partners in the same river need more collaboration between each other's to safe the Nile and achieve development in this threat. Most of the Egypt's water come from the Nile River. The availability of good water in Egypt and in the other Middle East developing countries are decreasing day by day. The population growth has the main effect to increase the need for fresh water annually with the limited amount of water that come from the Nile River. Other factors that lead to this situation are the weakness of infrastructure, water mismanagement and global warming. The Egyptian government needs to think out of box to overcome this issue and to safeguard its life secret from extinction. (Bedawy, 2014)

Keywords: Water treatment, Sludge, AHD (Aswan High Dam), GERD (Great Ethiopian Renaissance Dam)

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Introduction

Nile River countries

The Nile River is the longest River in the world, shared by ten African countries (Egypt, Sudan, Ethiopia, Eritrea, Tanzania, Uganda, Burundi, Rwanda, D.R. Congo, and Kenya). The Nile River is home for more than 480 million people, which means the Nile Basin contains around 40% of the population of Africa. (Mason, 2004)

Figure 1: Nile River Map (Mozambique Resources Post, 2018)

Nile River population

It is expected that the urban population continues to grow. The population growth rate is 2-3% per year. Most of the Nile River countries are highly dependent on river water. The Nile provides Egypt with 95% of its water needs. The population of Egypt grows by more than one million persons per year and it is forecasted to reach soon one hundred million. This growth will put more pressure on the water situation inside Egypt. (Mason, 2004). ear and it is forecasted to reach soon one hundred million. This growth will put more pressure on the water situation inside Egypt. (Mason, 2004)

The 1959 Agreement

The relationship between Egypt and Sudan is determined according to the agreement of 1959 allocated (55.5) billion cubic meters (three quarters) to Egypt and (18.5) billion cubic meters to Sudan (one quarter). The agreement assumed that 10 billion cubic meters would be lost to Lake Naser. This agreement leads to a monopoly of Nile water for Egypt and Sudan. (Mason, 2004)

Water Management in Egypt

Water accessibility in Egypt

The access to water of worthy quality in Egypt is constrained and is getting increasingly more confined. The requirement for more water is due to population growth, industrial production and the development of desert areas. (BADAWY, 2003)

Nile water dependency

The nation depends on the Nile waterway for over 95% of its water supply. Groundwater assets are constrained and the immediate commitment of precipitation. Farming is the largest consumer of water (right around 90 percent), although improvements in the water system and horticulture advancements invigorate water conservation. (BADAWY, 2003)

Water demands

The demand for water in Egypt is developing quickly as a reaction to an expanding population and to the growing standard of life that prompted higher production and larger flats. The water asset board is looking at the present demand for water, to decide how the interests of different parties will be influenced by development and how to predict what the water demand will be in the short term and in the long term. (BADAWY, 2003)

Title	1980	1985	1990	1995	2000	2003	2004	2005	2006	2007	2008	2009	2010	2017	2025
Water uses for Agriculture	49.7	49.7	49.7	49.7	49.7	57.8	58.1	58.5	59.0	59.3	59.3	59.3	59.3	61.8	67.13
Water uses for Drinking	3.3	3.7	4.8	5.9	6.8	5.4	5.6	5.8	6.1	6.5	6.5	6.5	6.5	9.5	6.6
Water uses for Industry	2.2	2.9	3.1	3.6	4	1.1	1.1	1.15	1.15	1.13	1.15	1.15	1.15	6.5	10
Water uses for Balances	4	4	4	4	4	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.15
Total water Needs	59.2	60.3	60.6	63.2	64.5	66.6	67.1	67.75	68.55	69.25	69.25	69.25	69.25	80.1	86.18

Table 1: Water Demand in Egypt (Britannica, 3(2019The challenge of water scarcity

Current water situation

Egypt imports over half of the food it consumes, and the Egyptian populace continues to develop. Egypt cannot satisfy its water demand solely by depending on the Nile stream for its water. Adding to Egypt's valuable water dilemna, the vanishing water from the Lake Nasser evidently surpasses the prior evaluated sum. Egypt is starting now to utilize a greater part of the flood plain of the Nile and it plans to use considerably more. The land recuperation venture in the western desert has even mixed the balance in Egypt on the grounds that those residences in various zones fear their water supplies will be impacted. (BADAWY, 2003)

Lack of water infrastructure

Egypt has completed a few water system projects, for example, the Isna Torrent, Ngai Hammadi, and Asyut Blast, which will unquestionably be influenced by diminished spill out of Aswan Lake. It is the gauge that in 2025 the number of inhabitants in Egypt will grow to around 105 million, prompting a decline in per capita water accessibility every year if water accessibility remains steady. Also, improvement projects in Sudan or Ethiopia could decrease water supply to Egypt. (BADAWY, 2003)

Water policy actors and water sector governance

Aswan High Dam

Water resources management relies upon an unpredictable arrangement of foundations along the whole length of the River. The key component of this framework is the High Dam in Aswan that shapes Lake Nasser. The High Dam protects Egypt from floods, stores water for all year water system and produces hydro-electricity. (BADAWY, 2003)

Figure 2: Aswan High Dam (Ahram Online, 2014)

Nasser Lake capacity

The High Dam stores a large portion of the normal yearly flow of the Nile stream, subsequently giving an abnormal state of the waterway reservoir contrasted with other controlled waterways on the planet. In present-day Egypt water assets is a complex process that includes various partners who use water for the water system, urban water supply, hydropower production and farming. What's more, the water of the Nile has a fragile biological system that is undermined by contamination and abstraction. (BADAWY, 2003)

Figure 3: Nasser lake in Aswan (Britannica, 2019) (Bedawy, 2014)

The impact of GERD on Egypt

The current challenge for Egypt is that Ethiopia continues the construction of the Grand Ethiopian Renaissance (El Nahda) Dam (GERD) that is a risk to Egypt water security. The Dam is situated on the Blue Nile in western Ethiopia. Water resources have not changed since the 1950s, in spite of a developing populace and improvements in the quality of life. The dam can be a threat to Egypt's development. (BADAWY, 2003)

Figure 4: The Grand Renaissance Dam (DW, 2018)

In fact, the Nile River has been the subject of political pressure among the three neighbours; Egypt, Sudan, and Ethiopia. Egypt and Sudan are facing a difficult job in the water disagreement as the Nile can no longer support the hunger for water. The significant test to Egypt's Nile water originates in Ethiopia which has a developing interest for creating water assets to expand the nation's horticulture production, since they have radical deficits of food production forcing ever-growing food imports. Ethiopia is serious in accomplishing independence in sustenance generation at any expense. Vitality is the other key issue. It is evaluated that Ethiopia needs around 20% more vitality. Ethiopia wants to keep more Nile water for its domestic use. In general, Ethiopia represents a bigger and more entangled issue for Egypt's water security than Sudan. (BADAWY, 2003)

The Renaissance Dam will have detrimental affects for Egypt. The dam will force Egypt to accept a colossal water sharing deficiency, causing the end of farming extensions, a considerable decrease in developing territories, and an expansion of saltiness in the northern areas of Egypt. Also, harm to potable water stations and the breakdown of waterways and channels is possible. (BADAWY, 2003)

Water resources in Egypt

The single source of water for Egypt in the Nile River which provides annual flow of 55.5 BCM per year for a population that exceeds 90 million, that means the share per capita is 630 m3 which are below the scarcity limit 1000 m3/year only for domestic use and as the population increase, therefore, the more water is required which will decrease the share per capita. Especially the cities or villages which are not located on the Nile coast and not close to the sea that may use desalinated seawater. If the water supply is not enough for the domestic use that leaves agriculture in a bad situation. (AbuZeid, 2014)

As mentioned earlier Egypt depends on the Nile as the main source of fresh water of 83% and the remaining sources comes from artesian plants of 17.14 % and the rest comes from desalination of seawater of 0.76%., as shown in table 2 the resources of good water in Egypt. (AbuZeid, 2014)

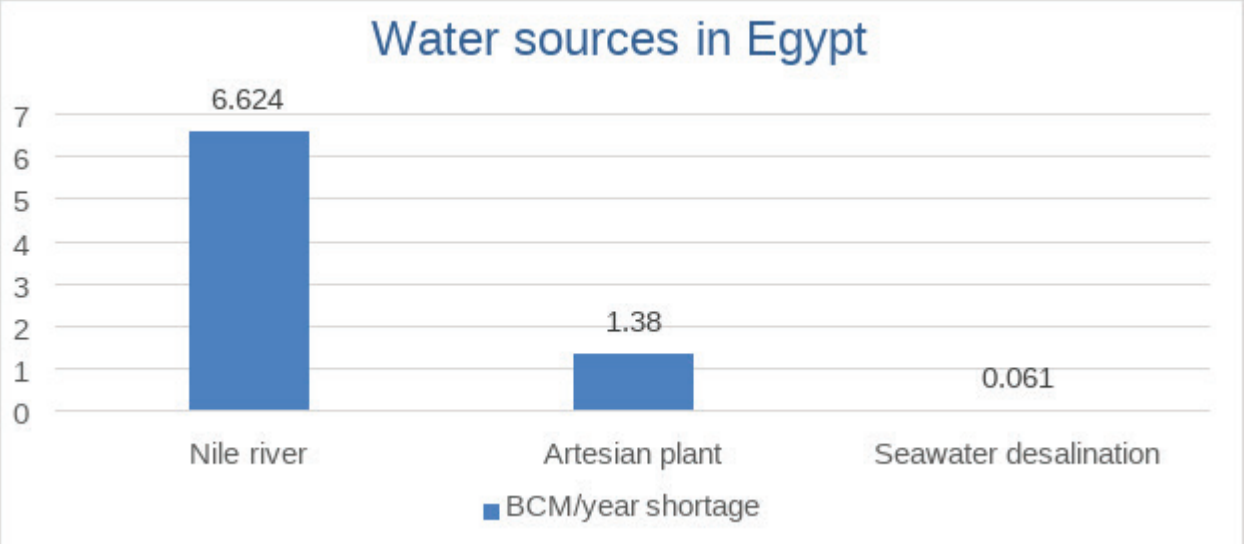

Table 2: Water sources in Egypt (AbuZeid, 2014)

As shown in table 3, Egypt used to cover 100% of it is water needs in 2008 and this percentage started to decrease until it became 90 %. The current situation in Egypt requires more focus and management for the current water resources and that is the key aspect for sustainable development since the water supply is not enough and the demand is increasing every year due to the population growth and as mentioned earlier due to the GERD, then the government should introduce a new water resource to cover this gap. (AbuZeid, 2014)

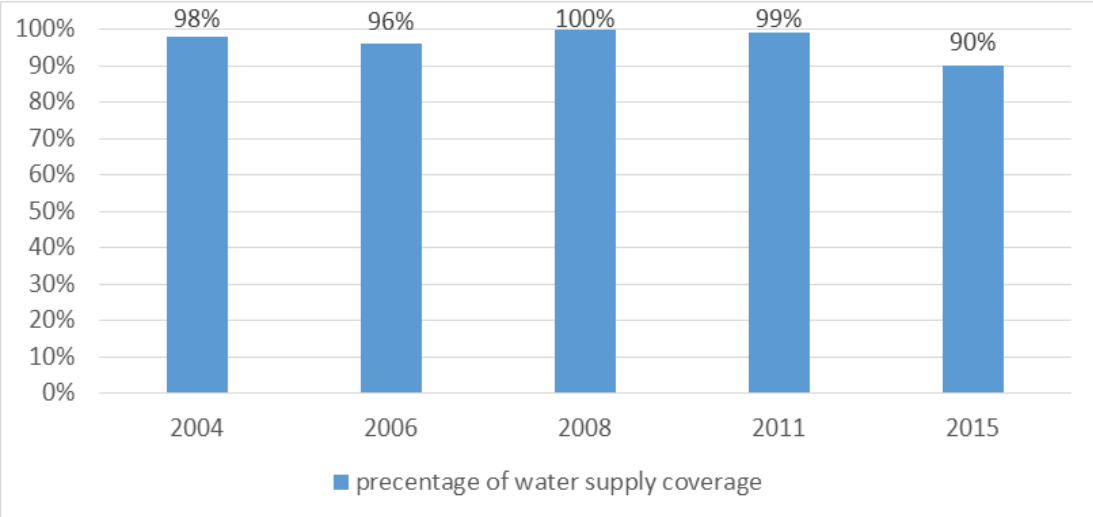

Table 3: Percentage of water supply in Egypt (AbuZeid, 2014)

The agriculture industry which covers 3.45% only of the area of Egypt shares the biggest percentage of water usage of 80-85%. The water treatment is considered the best solution in the current situation as the domestic use is increasing that means more wastewater is produced as well. Through water treatment, we could cover the demand of the agriculture sector which is required for the continuation of life in Egypt. (AbuZeid, 2014)

Type of wastewater

Wastewater includes domestic water and Industrial wastewater and agriculture, also the rainwater is included in the wastewater as shown in the figure below. These different wastewater types are collected through an underground network and goes to the water treatment plant. Treating sewage water is important for several points: (Jebrail, 2016)

- Clean environment
- Produce electricity or fuel
- Healthy environment
- Reduce diseases and infections

Domestic wastewater

Domestic wastewater comes from the laundry, bathroom, kitchen and other domicile usage. Stormwater is included in the domestic network collection system also the stores and shops are connected to this network. (Jebrail, 2016)

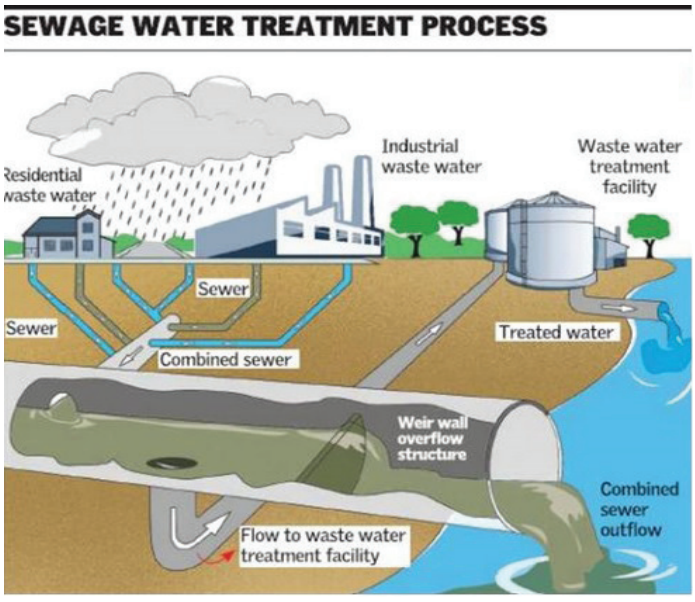

Figure 5: Sewage treatment plant process (Waste solution, 2018)

Industrial Wastewater

Industrial wastewater comes from different industries like printing, pharmaceuticals, metal, etc. This water contains chemical and organic matter and has more alkaline and acids and less living organisms than domestic wastewater (Jebrail, 2016)

Figure 6: Types of Industrial wastewater (Universitat Sturrgart, 2018)

Agriculture wastewater

The wastewater coming from agriculture is already polluted from the chemical fertilizers used which consists of potassium, nitrogen, phosphorous and nutrients. Also, the water coming from cleaning equipment and cleaning the animals in the farms. (Jebrail, 2016)

Wastewater treatment plant

Treating wastewater is very important because the produced water could be used in agriculture if treated to certain levels or could be discharged to fill the aquifers to maintain the water table level. The wastewater treatment passes through several stages as shown in the figure below: (Jebrail, 2016)

- The primary treatment is known as a mechanical stage.
- The secondary treatment is known as Biological stage.
- The tertiary treatment is known as a chemical stage.

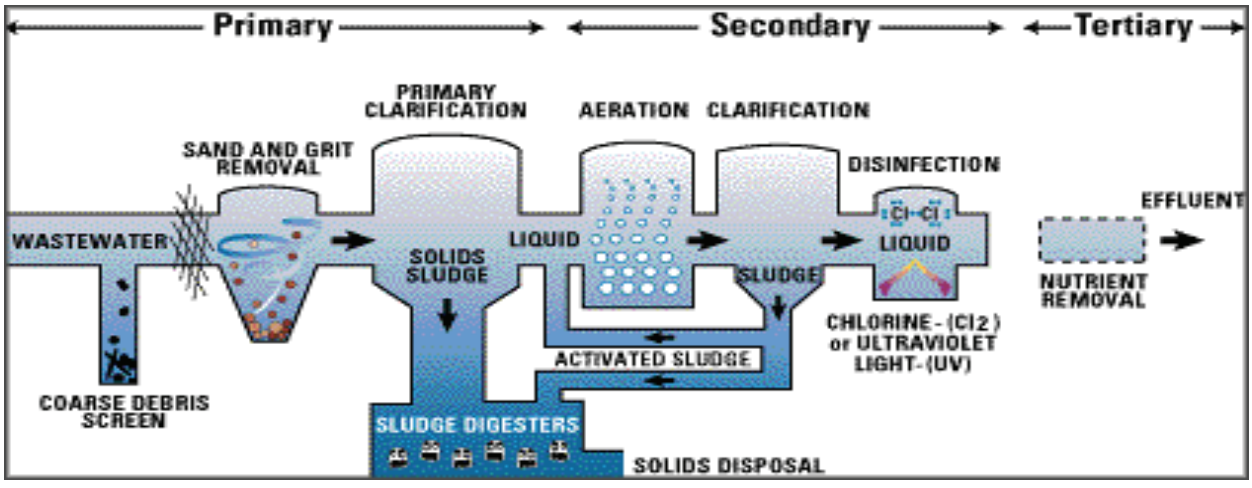

Figure 7: Wastewater treatment plant (Nicolette, 2017)

- Wastewater treatment has many usages:
- The ability of water reuse
- Protecting the living organism in the water bodies
- Produce methane gas which could be used as a fuel
- Produce electricity and fertilizer for the land

Vision 2030

To implement the 2030 vision, a data baseline is required and that was the data of 2011. The strategy to achieve this vision is divided between the first phase for current cities which do not require agriculture expansion and the second phase for other cities for agriculture extension. The first phase includes delta cities as they do not require any agriculture expansion Cairo, Alexandria, Menoufia, Gharbia, Kafr El-Sheikh, Port Said, Dakahlia, kalyoubia. The remaining cities belong to phase two which require agriculture expansion. To achieve this vision, the population annual growth rate was estimated 2.2% as expected by 2030 the total population will be 112.27 million taking into consideration that this population increase in Delta cities will be distributed on the other cities as the expected domestic water annual share per capita is 125 m^3 and the wastewater assumed to cover 80% of the supplied amount. (AbuZeid, 2014)

Upgrade Treatment from Primary level to Secondary Level

Vision 2030 is based on realistic goals that could be achieved by good planning and implementation, as the current situation shows there is a lot of existing primary wastewater treatment compared to secondary or tertiary which rarely exists. However, the plan is to upgrade these primary plants only to secondary by 2030 so that it could be achieved according to the allocated budget and investments. (AbuZeid, 2014)

Transfer of treated Wastewater Out of the Delta Governorates

As the agriculture land in the Delta cities of phase one is already used and no future plans for expansion, so the extra treated wastewater which could be used for irrigation will be integrated in the main drainage network and will be pumped to be used in in the future agriculture expansion in the other cities in North West or Sinai. (AbuZeid, 2014)

The utilization of Treated Wastewater in Desert Front Governorates

The treated wastewater will be used to cultivate the desert governorates and for the land of agriculture expansion as per the strategy. Wastewater disposals into drains for 2011 will be maintained throughout 2030. (AbuZeid, 2014)

The usage of treated wastewater in the agriculture vision of 2030

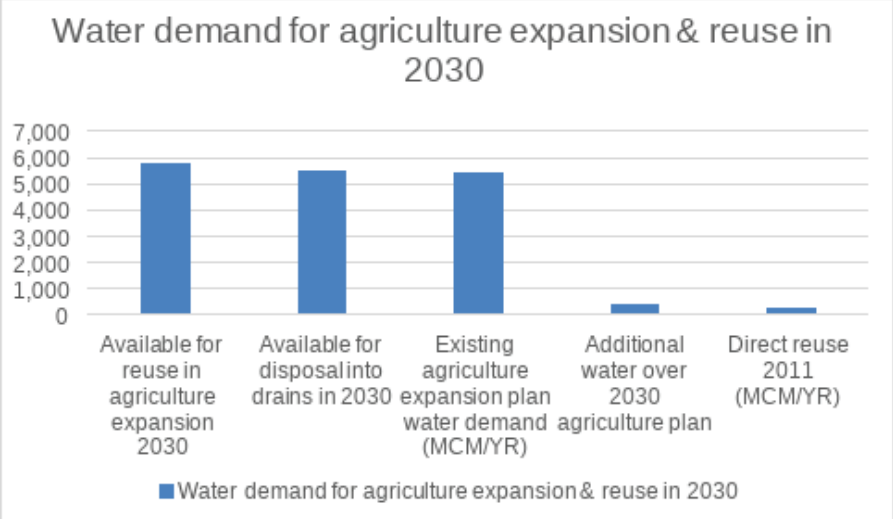

Table 5: Water demand for agriculture expansion & reuse in 2030 (AbuZeid, 2014)

By upgrading the primary wastewater plant to secondary will allow 1.4 million feddans to be reclaimed for agriculture according to the sustainable agriculture strategy of 2030 as shown in table 4 the total required water quantity is 5.42 BM for 4100 CM/feddan/year. (AbuZeid, 2014)

Revision of Reuse Code

Should be revisited and modified to make the best use of the amounts of treated wastewater that will be made available through the adequate implementation of this strategy. The revised code may introduce more variety to the current assortment of crops that could be cultivated on treated wastewater, and according to the level of treatment. (AbuZeid, 2014)

Challenges

To implement the 2030 vision, the government has to consider the below challenges in the wastewater treatment sector to be able to achieve the planned results:

- To update all the primary wastewater treatment plant to the secondary level and to expand the water covering network requires a lot of finances which should be forecasted in the allocated budget
- The location of each wastewater treatment plant as it is important to consider the distance to the planned agriculture lands and the surrounding conditions of the treatment plant.
- Quality control and quality assurance should take place in each plant to avoid any health or environmental problem through using this treated water in agriculture
- According to the Egyptian code using treated wastewater is not allowed for edible crops
- The Irrigation and Drainage Egyptian rules prevent the drainage or pumping of any treated wastewater in the irrigation canals.
- Health and environmental laws and regulations.
- The operation and maintenance cost of the wastewater treatment plant
- The danger of not selling the agribusiness items for fare to neighboring markets, for example, the EU and the Gulf states because of the utilization of treated wastewater
- The Health & Environmental hazards associated with improper handling of the different levels of treated wastewater by users. (AbuZeid, 2014)

As Samra water treatment plant in Jordan

Due to the population growth and water shortage taking in consideration the high energy cost, it was a big challenge for the Jordanian government to balance this equation but they did through treating wastewater to reuse it to cover the water shortage but with the least energy consumption and that was As Samra water treatment plant which is a success story in terms of sustainability and wastewater treatment technologies. (SUEZ, 2014)

Jordan was facing many challenges considering the increase in population which increase the water demand taking in consideration that the energy cost is expensive. Jordan's government decided to meet these challenges to provide the water demand with the least cost. They constructed a successful wastewater treatment plant which achieves these targets which secure the life of the next generation with taking all sustainability factors into consideration. This is As Samra plant shown in the figure17 below. (SUEZ, 2014)

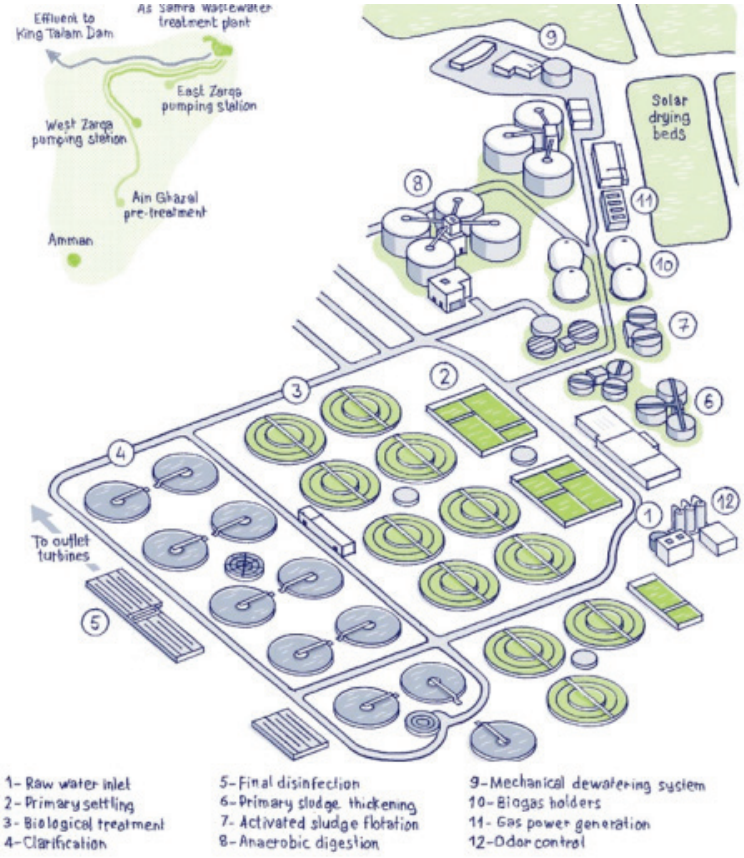

Figure 8: As Samra wastewater treatment plant (SUEZ, 2014)

Stakeholders

- Owner: Ministry of water and irrigation in Jordan
- Project companies: Samra Wastewater treatment plant company
- Sponsors: SUEZ and the Morganti group- Consolidated company (SUEZ, 2014)

Phase 1:

- The Jordan government signed contract in 2003 of 25-year-old BOT contract
- 267,000 m3/day capacity
- Project finished and handed over in 2008 (SUEZ, 2014)

Phase 2:

- It is an extension for phase 1, contract signed in 2012
- 364,000 m3/day total capacity after the extension, which increased by 37%
- Sludge line was upgraded to 80% more capacity
- Operation until 2037. (SUEZ, 2014)

Project characteristics

- Considered as a perfect example symbol of sustainability
- Hydroelectric power is produced due to the water flow in the plant
- Treated wastewater meeting the code standards to be reused
- Odorless which does not affect the neighborhood
- The plant generates it is own electricity using biogas (SUEZ, 2014)

Water line specifications

Raw water inlet

- The water comes from Ain Ghazal pretreatment facility moves through a Ø 1,500 mm pipe into two turbines to deliver power. (SUEZ, 2014)

Primary treatment

- Five tanks for settling.
- Two tanks for grit removal.
- Two tanks for sulfide removal with capacity 2300 m3. (SUEZ, 2014)

Secondary treatment

- Three zones of treatment with eleven reactors for Denitrifications removal of carbon and nitrification.
- There are eleven clarifiers for the activated sludge of diameter 54 m each. (SUEZ, 2014)

Tertiary treatment

- After the secondary treatment, the effluent goes for disinfection in nine chlorine tanks. (SUEZ, 2014)

Sludge treatment

- Thickening process happens for the sludge from the primary treatment and from the secondary in separate tankers
- Digestions happen in seven anaerobic digesters and mixed with mechanical mixers and heating applied using hot water.
- Dewatering occurs using 16 belts filters
- The plant has 18 drying beds to dewater the sludge. (SUEZ, 2014).

Biogas production

- The plant has four gas tanks of total capacity 18,000 m3 to store the biogas which is used to produce electricity. (SUEZ, 2014)

Power production

- The plant generates 80% of self-energy and that happens through the biogas energy and the hydro energy due to the turbines in the inlet and outlet (SUEZ, 2014).

Recommendations

The following recommendations should be adopted to achieve the results required:

- The government should do the extra effort and increase the awareness to decrease the population growth rate.
- Water pollution laws should be legalized and applied through a framework.
- Increase the cooperation level politically and socially with the Nile basin countries.
- The government should increase awareness for the water scarcity problem.
- Invest in scientific research to treat wastewater or desalinization.
- Use new agriculture seeds that consume less water and are disease resistant.

Conclusion

Egypt and many countries on the Nile basin are facing a water scarcity problem and this water shortage is due to lack of vision in the past decade and through the poor infrastructure of the country. The population growth which was not forecasted; now Egypt has the vision 2030 that was recently implemented to solve the crisis but the challenge is the lack of financial resources (Bedawy, 2014).

Wastewater treatment is considered a key aspect for the sustainable development in a country like Egypt which has a shortage of resources for sustainable projects. The only answer reusing their wastewater and to cover the demand. This report discussed how a country with rich water resources can be suddenly striving to survive due to different circumstances. This set the alarm for all the countries to go for a sustainable solution and save the environment because of the resources available today may not be available tomorrow. (AbuZeid, 2014). Through following the strategy to achieve the 2030 vision taking in consideration all the risks and challenges as the Egyptian code does not allow using treated wastewater for edible crops, the amount of finances required to upgrade the current wastewater treatment plant from primary to secondary level, the Irrigation and Drainage Egyptian rules prevents the drainage or pumping of any treated wastewater in the irrigation canals and the health and environmental laws and regulations and other several points that were mentioned above require an urgent solution (AbuZeid, 2014).

The Jordan case study presented an ideal example for a sustainable and eco-friendly treatment plant through producing it is own electricity by biogas produced from the plant and hydroelectric power generated from the turbines on the water inlets and outlets. The government vision 2030 is really important to be achieved for life in Egypt and avoid a real disaster. By following the above recommendations, we hope to see good results and progress by 2030.

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Learning Sustainability: A Conclusion

Eric Pollock

The logos are designed by Mehrzad Valiyousefi

The five chapters in this second volume of research on sustainable cities are Master`s student group works. They are part of the Case Studies Building and Renovation course, second semester. The works are also in preparation for the Master's thesis, beginning soon. Special attention has been given to the correct use of sources for both text and photographs, as well as working in a research team with a similar format. For most, this is the first academic publication of their careers, an important milestone.

The Sustainable Construction chapter research questions are concerned with the UN sustainable development goals, SDGs. The construction sector is slow to improve technologies and use them in practice, and it is not always clear how sustainability in the construction sector is improving. Environmental, Economic and Social levels of sustainability have to be covered within the construction project. Furthermore, SDGs have to be followed to create not only a building with less environmental impact but a whole property with benefits for the urban area and the people living there.

Projects should be planned with the help of softwares and technologies to reduce waste in time, manpower and resources. The possibility to upcycle, recycle or down-cycle materials nowadays are better than ever. Life-cycle management and assessment are also one of the main management tools when it comes to sustainable construction. Renewable technologies like solar and wind power are good solutions to save energy.

Sustainability is now known worldwide, even though there are differences in development and implementation. Management must develop sustainable operations to meet the SDGs, and benchmark their progress on each new project.

For sustainable construction dealing also with existing properties is essential. Airtightness, proper ventilation and indoor air quality have to be given prime importance because errors will lead to over-consumption of energy or unhealthy buildings. Effective use of renewable energy can help in bringing down the overall energy demand of the existing facility. Also, the social aspects should be considered to bring positive changes, by the connection of people, transport, work and normal use after the renovation.

To reach sustainability in construction, the first stages of the construction process are the most important. New softwares for planning and managing the activities are necessary. In Project Management, the primary constraints are budget, time and quality. A project manager must balance these constraints while meeting or exceeding the expectations of the client and setting up a competent team for successful project management.

Most countries have a very strict process to manage waste. In the Albanian case, the topsoil was retained and later reused. In Nigeria, the waste management policy was very strict. These are serious efforts towards reducing the damage to the environment.

Communication is vital for the project's success. Disputes between local residents and project stakeholders could have been avoided by organizing a dialogue between the concerned parties in the project from Guatemala. It teaches us how important it is to document formal and informal forms of communication.

The construction industry is undergoing a major shift in BIM technology. The Guatemala project would have been more cost-effective using BIM. The project in Iran made use of high-end façade materials, which proved cost effective for the client and resulted in cost savings.

Human resources are not always given due importance during the life cycle of the project. Training local workers is a good way to support the local economy, even if it means more training. Procurement and quality by a project manager must be upheld from the initiation stage to the closing out of the project.

Interviews with project managers who are working in different parts of the world conclude that the styles of Management differ. However, most of the Project Managers are now working towards developing a sustainable project with the use of the latest technology. They are making attempts to have better communication both within the project team as well as with the stakeholders.

Technology developments such as Artificial Intelligence (AI) in real estate, AI models do automated valuation and transactions for later decision-making. This implies an electronic monitoring system in the cloud (where all the information is collected) and creating a virtual cadastre where the information regarding the property will be stored, selected and accessed from anywhere no matter the location in total accuracy and security. Also, third parties such agents, banks, lawyers, insurance companies and appraisers are interested in improving their business, compared to the traditional-process of real estate.

Transportation infrastructure is one of the most important factors for a country's progress. City development in transport can be sustainable and is essential for economic growth. For example, building more bridges is not an ideal solution for an overcrowded city split into large land areas, but a metro connection is. A larger percentage of public transport use is sustainable, providing environmental quality, energy savings, better health and air quality. Single forms of transportation are not enough, the combination of metro, bus and bicycle are the key. Climate change and global warming already affect our societies worldwide. Sustainable transportation is a great way to start due to it being one of the major emitters of greenhouse gases. Improving cycling with bicycle highways is a great way to contribute to national health, economy and offer a CO2-pollution free solution to transportation.

Egypt and other countries along the Nile basin are facing a water scarcity problem. This water shortage is due to lack of vision in the past decade and through poor infrastructure. Population growth is high, and agriculture is expanding; now Egypt has the vision 2030 strategy in place, but the challenge is the lack of financial resources.

Wastewater treatment is considered a key aspect of sustainable development in Egypt, which has a shortage of resources for sustainable projects. The only answer is reusing their wastewater to cover the demand. The current wastewater treatment plant must be upgraded from primary to secondary level. The Jordan case study presented an ideal example for a sustainable and eco-friendly treatment plant through producing its own electricity by biogas produced from the plant and hydro-electric power generated from the turbines on the water inlets and outlets.

The challenge is clear. Our societies need more engineers and architects with sustainable management and software tools for future projects to succeed environmentally. Using the SDGs as guidelines, progress can be made if we take sustainability seriously now.

Author`s Comments

Eric Pollock, Editor, Lecturer, Construction and Architecture

This second book on Sustainable Cities case studies presents solutions for sustainable construction of the built environment. Equally important was the work of the five research groups in working together to produce this publication. Teamwork was the key, and the results are encouraging, we *can* build sustainable Cities.

Mika Lindholm, Principal Lecturer, Construction and Architecture

International students work together in ConREM learning both management and team work skills. The case studies presented are excellent research works, great job!

Elina Ala-Nikkola, Publications Coordinator, Metropolia UAS

This book, written and produced in co-operation between students, lecturers and university of applied sciences, is a unique, invigorating and innovative way to learn. I believe this publication will inspire and encourage also other student groups and lecturers as well as readers. Special thanks to Lecturer Eric Pollock for his courage to jump into this project!

Mehrzad Valiyousefi, Graphic designer, Student of ConREM

I would like to give my special thanks to my lecturers Eric Pollock and Mika Lindholm to give me the opportunity to be part of this exciting project and for their invaluable advice and guidance.
Also, a huge thanks to the group of very intelligent and driven people that I had a pleasure to work with.

Ana Reinbold, Lecturer, ConREM

The challenges of writing a scientific paper are numerous, to face them requires necessary dedication and the openness to learn with the feedback from the lecturers and colleagues. This book is the result of the students work, dedication and continuous improvement.

SUSTAINABLE CITIES II

International students in our ConREM Master's programme begin their sustainable development studies in Helsinki, some learning about sustainability for the first time. The goal of this second case studies research book is to study the 17 UN sustainable development goals (SDGs). In particular goal 11 is "Make cities inclusive, safe, resilient and sustainable. Cities are hubs of ideas, commerce, culture, science, productivity, social development and more. " The student authors have worked in groups to study sustainability in major cities in the world, often from their own home countries. The case studies presented here are exceptionally good works, showing how young researchers working together can produce exceptional results.

Mr. Eric Pollock (ed.)
Lecturer, Architect, Metropolia UAS

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