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Leadership competencies within BIM-oriented project management

based on an analysis of project manager and BIM manager

Master's thesis in the Master's Programme Design and Construction Project Management

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DEPARTMENT OF Architecture and Civil Engineering
Division of Construction Management

CHALMERS UNIVERSITY OF TECHNOLOGY
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ABSTRACT

Over the past 20 years, the construction industry has faced numerous challenges in terms of project performance and efficiency. Fragmentation, coordination complexities, ineffective communication, and inadequate planning have hindered effective collaboration among multidisciplinary actors. Collaboration failures, caused by inconsistent standardization, complex contracts, and multi-actor behavior, have led to project planning issues, delays, and cost overruns. To overcome these challenges, Building Information Modelling (BIM) has been identified as a technology that facilitates collaboration among multidisciplinary teams involved in BIM projects.

However, success in BIM-based construction projects relies heavily on the efficiency, behaviors, and skills of leadership aspects throughout the project lifespan. Project leaders must possess a range of competencies, including both hard skills (software and modeling skills, data management, presentation skills) and soft skills (communication, negotiation, and decision-making skills). Leadership plays a critical role in comprehending the project life cycle and leveraging information across design, construction, and facility management stages.

Individuals possess unique leadership characteristics that can either benefit or hinder the implementation of BIM. Therefore, understanding the valued leadership characteristics in BIM-oriented construction projects is essential. This paper aims to explore different leadership competencies of mainly project managers and BIM managers within BIM-oriented projects and identify the suitable leadership competencies for BIM project management, focusing on improving project performance.

Key words: leadership competency, BIM-oriented projects management, communication, construction 4.0, project managers, BIM managers

Contents

PREFACE

This master thesis is considered as the last step of the master's program Design and Construction Project Management in Chalmers University of Technology.

First, I would like to say thank you to my family for their support in my education and my growth.

I would also like to express my sincere gratitude to my supervisors Martine Buser and Mathias Petter Gustafsson, they have helped me a lot during my project. Mathias supported me with his understanding on BIM and leadership in the beginning, especially suggesting me with good literature and together his thoughts on this topic. Martine has helped me a lot by keeping me followed every process and kept me updated with her feedback and suggestions on my writing, especially for the interviews and discussion part of my project.

Big thanks to my respondents as well. They have contributed to my project through unique experience and input on this topic.

Thank you to Swedish Institute for funding my master studies in Chalmers University of Technology.

Lastly, I would like to say thank you to my friends, Chen Zhao, Lulu Li, Haixi Li, Mengbai Tao, Jingxuan Zhang, Abubakar Khatry and my colleagues for their great help in my life, study, and work in Sweden.

Chunliang Hu, July 2023

NOTIONS

AEC	Architecture, Engineering and Construction
BIM	Building and Information Modelling
BPM	BIM-based Project Management
CAD	Computer-aided Design
HVAC	Heating, Ventilation, and Air conditioning
LOD	Level of Development
MEP	Mechanical, Electrical and Plumbing
VDC	Virtual Design and Construction
AI	Artificial Intelligence
IoT	Internet of Things
ICT	Information and Communication Technology
IT	Information Technology
IFC	Industry Foundation Classes
CEO	Chief Executive Officer

1. INTRODUCTION

This chapter encompasses the basic information and background about the research area followed with the purpose and aim of this study. Research questions, scope and limitations, and thesis structure show different contents in every sub chapter.

1.1 Background

In recent decades, the construction industry has faced challenges in terms of project performance and efficiency. Factors such as fragmentation, coordination and interoperability complexities, ineffective communication, and inadequate planning have contributed to those challenges. These issues further impede effective collaboration, making it difficult for multidisciplinary actors to work together efficiently. It is recognized that inconsistent standardization, complex contracts, and strategies can lead to collaboration failures, particularly on a project level, resulting in problems like planning mistakes, postponement, and cost increase. Additionally, multi-actors' behaviors in different ways, sometimes working without interaction, and sometimes because of culture difference, those factors also contribute to collaboration failures. To overcome these challenges, Building Information Modelling (BIM) has been suggested as a tool that can facilitate behavior among different teams involved in BIM projects.(Raja *et al.*, 2021) BIM integration into construction projects is not an infancy approach, as it has emerged as a highly efficient technology to address challenges and overcome obstacles in the architecture, engineering, and construction (AEC) industry. (Durdyev *et al.*, 2021) Its introduction and adoption have facilitated cooperation, coordination, and problem solving among various disciplines and stakeholders within AEC projects. (Chan *et al.*, 2019)

A BIM model encompasses different characters, for instance, geometry data, spatial connections, geographic information, quantities, properties of building components, cost estimation, materials, and scheduling etc.(Azhar, 2011) BIM makes it possible to be considered as a comprehensive virtual process by integrating different aspects, disciplines into one single virtual model, enabling more accurate and efficient collaboration compared to traditional methods.(Van Tam *et al.*, 2021)

In the study conducted by Chan *et al.*, (2019), it was highlighted that achieving a balance between scope, cost, and time within the project management triangle is a critical reason for adopting BIM in the AEC industry. However, this objective is not easily attained. The success of a project depends largely on the efficiency, behaviors, and skills of leadership aspects throughout project lifecycle, and this applies to BIM-oriented construction projects as well, as emphasized by Omer et al., (2022). Leaders, largely referring to project managers and BIM managers, need to adapt and possess a range of leadership competencies, including both hard skills(for instance software skills, modelling skills, data management, presentation skills)and soft skills (for instance communication and negotiation skills and

decision making skills), as highlighted by Lee *et al.*, (2021), since technology and management are in interaction.

The inefficiency in the AEC industry, according to Keung, Yiu and Feng, (2022), can be largely attributed to the missing of soft skills and inadequate combination of knowledge and skills with the industry's culture. To leverage the benefits of BIM adoption and enhance project performance, it becomes essential to bridge this gap by evaluating the value of BIM-effected factors on project productivity. Leadership, being a critical success factor across various industries, becomes more and more significant in this context, particularly in the AEC industry. Leadership competencies are vital for comprehending the project lifecycle and leveraging information throughout the stages of design, construction, and facility management.

However, leadership skills and individual behaviors are natural and cannot be controlled. Individuals possess unique characteristics that can either benefit or hinder the implementation of BIM. Therefore, it is important to understand the valued leadership competencies in BIM-oriented projects. (Omer *et al.*, 2022).

So, in this paper, different leadership competencies of mainly project managers/BIM managers will be discussed within BIM-oriented projects and the aim of this research is to find out the suitable leadership competencies for BIM-oriented project management regarding to improvement of project performance, and also how to identify those competencies from a project/BIM manager.

1.2 Purpose

The purpose of this paper is to analyze different leadership-featured roles of BIM projects by discovering the BIM project management, talk about how different actors are implementing leadership for BIM-oriented projects, examine and evaluate the most valued and significant leadership competencies, find out what is best for BIM-oriented project management and how those competencies are indicated, with an aim of improving the project performance.

1.3 Research Questions

To fulfil the main aim of this study and make contribution to the future research, the following research questions are addressed by the authors:

1) Question 1: What has construction 4.0 and BIM brought to project management?
2) Question 2: What leadership competencies are valued in a BIM-oriented project?
3) Question 3: How to find out if a manager has these competencies or not? What are the indicators of the mentioned leadership competencies?

1.4 Scope and Limitations

In this thesis, the focus will be on the art of leadership of BIM-related roles. It is mainly restricted to investigating in construction-based companies, other stakeholders will also be in the scope such as the client, but rarely discussed. Even say so, design sectors are also considered as a part of construction-based companies, since a large scale of projects are implemented by the same company for both construction and design. Different leaders will be taken into consideration, mainly, project manager and BIM manager.

One of the limitations is that it is mainly discussed in Sweden's construction industry, even though some interviews come from Chinese companies which are based in Sweden. It is difficult to be representative from an international perspective, also due to the reason of limited interviews. Data is collected based on management levels and roles, other features such as age, gender, etc. are not taken into consideration.

1.5 Thesis Structure

This thesis includes the following 6 chapters, see *Figure 1*:

- Chapter 1: Introduction where specified background, study purpose, research questions and the scope and limitations of this thesis.
- Chapter 2: Literature review study where investigated the theoretical understanding of BIM project management under construction 4.0, differences between management and leadership, significance of leadership under new era, the relationship between leadership and BIM roles, leadership competencies valued for BIM-oriented projects etc.
- Chapter 3: Methodology which is used for conducting the thesis.
- Chapter 4: Empirical data which are collected from the interviews.
- Chapter 5: Discussion part where empirical data collected will be discussed by the theories mentioned above and authors' own opinions are integrated.
- Chapter 6: Conclusion which concludes the findings of the thesis and answers the mentioned research questions in chapter 1.

Figure 1: Thesis structure

2. LITERATURE REVIEW

In this chapter, theories and research from articles are studied to picture out a path for analyzing the collected data and then the discussion. To answer the research questions and provide valid knowledge to investigate how renewed leadership styles and competencies can help managing a BIM-oriented project, research ideas are stepped taken as follows:

What has construction 4.0 and BIM brought to project management? Why do we need to emphasize leadership in project management and what is their difference? Does leadership really play an important role in BIM-oriented project management and this new era? If yes, then what kind of leadership competencies are valued for what kind of roles in a BIM-oriented project? Also, how we can identify these competencies, how we can know if a project/BIM manager has or has not these competencies to be a good/bad leader?

Those are the main paths for discovering the listed research questions in this paper.

2.1 BIM-based Project management

2.1.1 BIM development

Industry 4.0 became well known after its first indication in 2011 in Germany. It is charactered by the implementation of digital technologies, the IoT (internet of things), big data and AI (artificial intelligence) etc. Industries, for example, manufacturing, agriculture, finance, have benefited from it where significant performance has been improved. With its vast size, the construction industry also has the potential to benefit from leveraging digital technologies by incorporating tools like BIM and cloud-based project management. (Forcael *et al.*, 2020) The concept of Construction 4.0 is emerged since it enables the integration of Industry 4.0 principles into the construction sector. It encompasses the transformative impact of technological advancements, encompassing changes in work methods, software, hardware, and their practical applications across all facets of the construction industry.(Yang *et al.*, 2022) As a part of it, BIM is highly emphasized. Within the AEC industry, it is considered to sit in the central spot in construction digitization.(Oesterreich and Teuteberg, 2016)

The ineffective sharing and flow of information are the primary culprits behind information waste in projects. In traditional projects, the exchange of information between players and processes is often disorganized. BIM, instead of being considered as a single dimension-based model or just software, can be better understood as a process where models with rich semantic information within a shared data platform are involved.(Pan and Zhang, 2021) It enables engineers to anticipate project performance with greater ease prior to construction, respond swiftly to design alterations, optimize design through analysis, modeling, and visualization, and generate superior building documentation.(Sinenko *et al.*, 2020) Cloud BIM, particularly, has been improved to promote enhanced collaboration among project participants with diverse backgrounds and knowledge, rather than encouraging working in

isolated silos and snapshots. It makes it easier to share digital collaboration environment, such as project servers and cloud-based communication systems, where information can be gathered, managed, and shared in a structured and digital way throughout the entire project lifespan.(Pan and Zhang, 2021) Essentially, BIM serves as a data repository for storing vast amounts of data collected from data-integrated components, inputs, files, sensors, software, and other sources within projects.(Sacks *et al.*, 2018) This extensive collection of data intricate details of the parametric model and the execution process, providing valuable support for project leaders to make better decisions and also enables users to evaluate changes' impact on the overall design realistically and in real-time, minimizing issues with outdated data handoffs, backflows, and rework. (Hattab and Hamzeh, 2013; Pan *et al.*, 2020) Exploring this wealth of information is crucial for uncovering the undiscovered knowledge and then enhancing the significance and value of BIM in project management. (Pan *et al.*, 2020)

BIM Task Group in UK defined BIM maturity levels by the following, where in 2020s, interoperable data are generated and stored where collaboration spaces expand over time as Pan and Zhang, (2021) discovered.

Level 0 – 2D CAD drawing

Level 1 – 2D/3D CAD drawing

Level 2 – BIM is shared across the various project members and design stages for public works

Level 3 – BIM as a dimension dedicated to the entire life-cycle management of a building

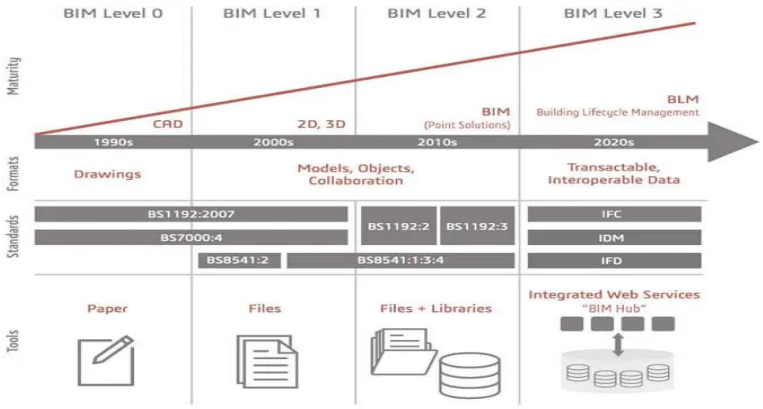

Figure 2: BIM levels in the United Kingdom (BIM Task Group, 2011)

2.1.2 BIM and project management

The research areas of BIM and project management have witnessed significant attention and extensive research efforts. BIM is recognized as a process which contributes to the improvement of project management practices, especially Cloud BIM. Consequently, exploring these two concepts from an interdisciplinary perspective can offer fresh insights into related research. (Sinenko et al., 2020)

Project management is widely recognized as a comprehensive approach to achieving organizational synergy by integrating various disciplines and procedures. According to Chan *et al.*, (2018), as AEC projects increase in scale and complexity, the abundance of information of a project can be devastating if it is not effectively and structured managed. Additionally, since a project is executed by collaboration among various stakeholders and probably different disciplines, promoting coordination is definitely one of the primary responsibilities of project management. With BIM integration into project management, it transforms into a customized and integrated information and communication technology (ICT), surpassing its initial role as a mere simulation technology limited to specific areas and disciplines. BIM offers extensive capabilities to enhance project management, particularly in terms of information management and collaborative work. (Chan et al., 2018)

This brings change for project managers because as project leaders, they need to update the working scope and responsibilities distribution while implementing BIM, as well as BIM managers, leading to the emergence of a new project management paradigm called *"BIM-based project management (BPM)"*. BPM is a concept where the functional applying of BIM is enriched by project management requirements at different stages of the project, aiming to achieve efficient project management with BIM implementation. (Ma *et al.*, 2018)

2.1.3 Obstacles for BPM (BIM-based project management)

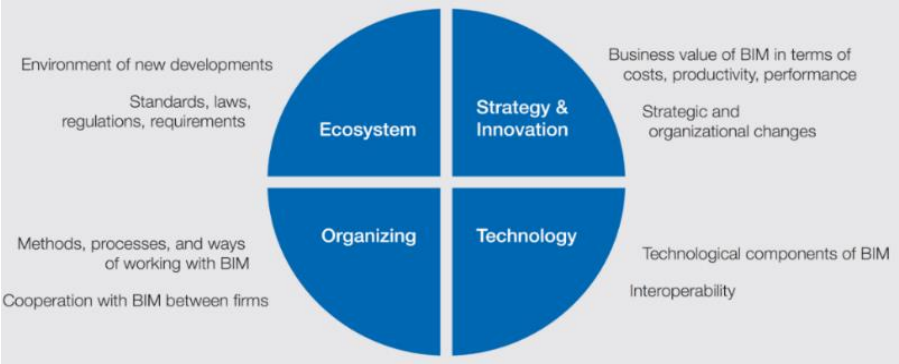

Figure 3: Holistic research model to BIM implementation(Sundquist et al., 2020)

Sundquist *et al.*, (2020) have undertaken research which aimed to summarize the obstacles for BIM implementation, interviews and questionnaire data are collected from past master theses in Sweden. Their research is carried out with a holistic research model where four key factors are emphasized and organized into gains and hinders. Details shown in *Figure 3* and *Table 1*, where organizational factors are significant shown such as the working method differs referring to process management and information flow, as well as the lack of efficiency of cooperation within internal team and external team. This is directly related to leadership efficiency and productivity in the team. Other factors, from a perspective of strategy, bring also challenges for management team regarding how to reduce cost and enhance payment process and productivity, which is also investigated in the research from Ayinla and Adamu, (2018). Additionally, BPM encounters obstacles in gaining acceptance.

Resistance to change is another common challenge during project management. How often have we encountered teams or individuals who oppose changing their established ways of doing things, particularly when it involves such a radical shift as adopting BIM? However, it is important for us to be empathetic, recognizing that change is difficult for everyone. (Chan *et al.*, 2019)

One of the identified factors contributing to those issues are the absence of leadership (Alwan *et al.*, 2017), which is people-oriented. For traditional projects, management from a project manager, which is task-oriented (Madsen, 2019), is well applied and often efficient. The differences between management and leadership will be detailed discussed in the next chapter. But on the other hand, BIM-oriented projects make it possible that more individuals with new skills within new technology and working methods to be involved in the project, and this brings change compared to traditional projects. Therefore, people-oriented leadership, instead of task-oriented management, necessarily becomes a emphasized point for project management. (Madsen, 2019)

Table 1: Obstacles/hinders data from These. (Sundquist et al., 2020)

Factors		**Obstacles/hinders**
Ecosystem	Standards	Lack of standardization for codes/names
		Turnkey contract needs to be updated to include BIM
	Laws, regulations, requirements	Need for industry standards on legal binding models
		Design-Bid-Build contracts complicated for BIM application
Strategy	Costs	BIM costs more money compared to traditional design
		Consultants want a new payment model for BIM design
	Productivity, performance	Lack of case studies regarding efficiency/quality
Organizing	Methods and processes	Limited use of BIM for visualization on construction site
		Quality of BIM is not good enough (lack of information for the construction site)
		Use 2D-drawings and BIM lead to diverging information
		Lack of education, knowledge transfer and support on BIM for employees on construction site
		No template system in work to organize the data contained within the BIM-model
		Lack of dedicated time for employees to drive and practice BIM related issues and learning software use
	Cooperation with BIM between firms	Unfamiliarity with BIM professional roles
		BIM for logistics: different work methods cause loss/overload of information
		Clients lack in knowledge and in setting demands on BIM
		Designers lack in skill on BIM requirements and design
		Difficult to agree on a suitable level of detail in the model
Technology	Technological components	Lack of supporting BIM in tablets and smartphones
		Difficult to take measurements in the model
	Interoperability	Software/tools are un-user-friendly and complex
		BIM is not automatically synchronized in software
		A lot of different programs for different disciplines
		Lack of filtering information for BIM objects

2.2 Management vs. leadership

We have talked about BIM-based project management in chapter 2.1, but to reach our goal in this paper, we need to take a deep discovering in the specific branch of management, which is leadership, that we have already mentioned in the end of last chapter. But what is the difference between management and leadership? Are they the same? Can a project

manager be a leader at the same time? This is confusing for many people. Even though many researchers have identified them as 2 different things, but it is still under discussion what is the overlapping, especially for nowadays' BIM development and construction 4.0 since the increasing integration of information, people and processes.

The difference between management and leadership has been discussed for a long time ago. Different individuals have employed the terms "management" and "leadership" in various ways. According to Ratcliffe, (2013) and Nizarudi, (2017), some consider them interchangeable, while on the other hand, others perceive them as entirely separate concepts.

"Leadership is different from management, but not for the reason most people think. Leadership isn't mystical and mysterious. It has nothing to do with having charisma or other exotic personality traits. It's not the province of a chosen few. Nor is leadership necessarily better than management or a replacement for it: rather, leadership and management are two distinctive and complementary activities. Both are necessary for success in an increasingly complex and volatile business environment."(Kotter, 2003)

Similarities could be that they do share numerous common responsibilities, such as collaborating with individuals and influencing them to attain objectives, while on the other hand, differences are emphasized by many researchers.(Ratcliffe, 2013) Management is primarily concerned with navigating complexity, accomplished through effective planning and budgeting. Organizing and staffing enable management to develop the necessary capabilities to execute their plans, while control and problem-solving ensure the successful implementation of those plans. Managers play dynamically in maintaining smooth operations within the organization. They are adept at effectively utilizing resources, coordinating teams, and ensuring efficient workflows. Managers bring stability, structure, and effective implementation to the organization's strategies and plans. They primarily accomplish the work by using their authority and involving the team members in their responsibilities, largely because they receive compensation for their work. A skilled manager is versed in consistently producing products and services in a daily structured working method, within the required budget and meeting consistent quality standards. This requires rationality, logic, and the application of specific skills and methods. (Algahtani, 2014)

On the other hand, leadership is focused on managing change. A fundamental aspect of leadership is setting the direction for that change.(Kotter, 2003) Leadership revolves around setting goals, improving existing practices, and motivating and guiding teams toward a new and shared path. Behaviorally, leadership encourages vision sharing, instigating meaningful change, leading, and empowering the team, and facilitating a favorable environment for team building. Leadership is not solely determined by specific skills but rather by one's approach to assignments and their ability to connect others. Algahtani, (2014) further supports this distinction by stating that leadership is multidirectional, whereas management is one-way authoritative. (Nizarudi, 2017)

Bennis and Nanus, (1985) succinctly captured the distinction between leaders and managers, stating, *"Leaders do the right things; managers do things right"*.

Furthermore, Madsen, (2019) argued that to thrive in the twenty-first century, a new generation of leaders is essential. She indicated that leaders are about to conquer the challenging, while managers tend to surrender to it. Managers and leaders are essential for the success of any organization, and their influence should be seen as complementary to each other.(Algahtani, 2014)

Madsen, (2019) also indicated that a key distinguishing factor between management and leadership lies in emotional intelligence (EQ). Managers may possess high cognitive intelligence (IQ) or technical skills, their EQ may not be equally developed. They may have a good ability of executing and following management systems effectively but struggle to communicate change or inspire others. Leaders, however, are more willing to understand others, to inspire them to enhance productivity. They effectively manage their mood and are willing to be a compelling example for others. They are often described as transformational instead of transactional since they have good communication skills. These leaders can strengthen convincing relationships, while individuals with low EQ may struggle with social interactions and face challenges when working in teams due to their individualistic behaviors. (Madsen, 2019)

Madsen, (2019) summarized her research into the following figure where the central point is management is task-oriented and leadership is people-oriented.

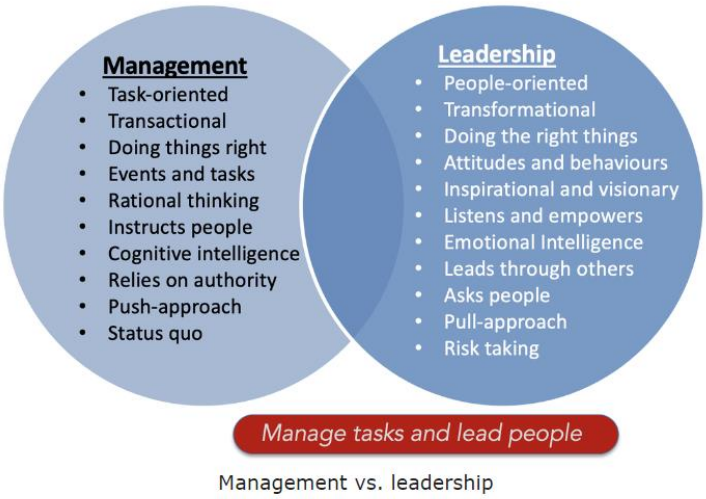

Figure 4: Management vs. leadership (Madsen, 2019)

According to Liu *et al.*, (2017), experiences from a technical level and characteristics like being rational and logical, and critical thinking are preferred when identifying project managers. They usually do a good job in analyzing and managing activities, making reasonable decisions based on calculations. Their focus is on tasks and ensuring that they are completed. For project managers, the priority is to return the right result to the client

within time, cost, and quality, which is agreed by the client from the beginning. Sometimes they do not care so much about why the client needs it and what is the impact in its development and operation. Their advantage lies in drawing out the picture of client's vision instead of defining the picture.

Being logical and task-oriented is not inherently problematic. These skills are essential for project managers, no matter what stage of the project. Being proficient in management is not a negative trait, it becomes an issue if it is the only style in their repertoire, applied to managing both tasks and people and communicating with customers. For project managers, it is important to have both management and leadership skills because they are about to effectively manage tasks and at the same time, lead people. (Madsen, 2019) Building a team with good performance, fostering strong relationships with clients, and guaranteeing efficient delivery while matching the requirements of clients cannot be accomplished by only logic. Being creative, empathic, willing to take risks, being visionary, and importantly, being communicative are absolutely required from a personal level. (Baldwin, 2019)

According to Madsen, (2019), leadership is a rare and specialized quality that is not easily found. While becoming a manager can be achieved through training, being an effective leader is a natural ability. When dealing with projects, proper management is crucial, but when dealing with human minds, leadership is essential. In the context of BIM and its technology, anyone working in this field needs to possess both managerial and leadership skills. (Succar *et al.*, 2013)

2.3 Significance of leadership under construction 4.0 and BIM

The importance of leadership in driving innovation within the construction industry was first highlighted by Nam and Tatum, (1997), followed with subsequent research which explored the influence of various leadership competencies on innovation within AEC industry. It is widely recognized as a significant skill and a critical indicator of success for project management in various industries (Alvarenga *et al.*, 2019), which we have also discussed slightly in former chapter. Leaders are expected to set the goal and create vision and strategy throughout the project. They are valued to influence, guide, monitor, and evaluate their team's performance. But the findings are still fragmented and dispersed even though valuable insights have been provided by literature on leadership under new era within construction 4.0 and BIM project management. (Yang *et al.*, 2022)

According to the study result from BPM in *chapter 2.1*, it is indicated that BIM project management can be challenging for many companies due to its novelty, which often results in unstructured processes leading to time and cost overruns, as noted by Grytting *et al.*, (2017) and Sundquist *et al.*, (2020). Moreover, Davies, Wilkinson and McMeel. (2017) emphasizes that the most considerable obstacle for BIM project management is its conformity between individual and organization, instead of technology gaps. We are not lacking tools and skills for BIM implementation which are hardly to say *"mature"* but in its successful way of improving in different LODs, instead, we are lacking approaches

which can lead better consistency between individual actors and organizations, which is especially true for project managers. This recalls the significance of leadership since it is already mentioned as people-oriented and good at dealing with changes.

Yang *et al.*, (2022) has a broader research perspective when talking about the significance of leadership under construction 4.0. They indicate that after noticing the importance of technological advancements in the transition to construction 4.0 by researchers and professionals, the industry's bureaucratic, conservative, and risk-averse nature are still standing in front of the way. (Criado-Perez *et al.*, 2022) This has resulted in a lack of motivation among practitioners to embrace new working method by adopting new technologies. On the other hand, the construction sector is significantly fragmented, where different stakeholders have different demands and requirements. This fragmentation poses a challenge to collective visional efforts towards embracing Construction 4.0. The good news is that effective leadership plays a vital role in overcoming these obstacles and facilitating the adoption of construction 4.0 practices.(Zulu and Khosrowshahi, 2021) While the responsibilities of leaders may vary depending on their positions, their impact on organizational performance has been demonstrated through various means, including fostering an innovative culture, attracting talented individuals, and building trust. (Islam *et al.*, 2020)

Leadership styles

Different leadership styles and competencies have been studied from different perspectives and many researchers have categorized them.(Avolio *et al.*, 2004). Different leadership styles exist, including autocratic, democratic, transformational, transactional, and laissez-faire. Autocratic leaders make all the decisions and expect others to comply without question, which works well in the short term but possibly is not effective in the long run. Democratic leaders involve others in the decision-making process before making final decisions. This approach may result in popular decisions but probably not necessarily the best ones. Transformational leaders tend to motivate their teams to contribute to the decision-making process, which brings a lot of advantages when team members are committed to a better performance of the project. Transactional leaders focus on achieving results and often use rewards to motivate subordinates, but opponents argue that this style is too narrow in focus and ignores important concerns. (Liphadzi *et al.*, 2015)

Both transformational and transactional triggers are important for effective leadership, including charisma, motivation, encouraging, personalizing consideration, etc. Liphadzi *et al.*, (2015) also indicate that effective managers are expected to have the ability of realizing what leadership style is necessary and finding the best option for a given situation, while relying on previous studied successful characteristics. It is believed by Toor and Ofori, (2008) that in the construction industry, good managers should have the real passion to lead the projects. Instead of being self-focused, they are motivated by their colleagues, teams, and organizations as well. They are culture builders for teams, constructing an environment

of trust, cooperation, transparency, and happiness. On the other hand, they do not shy away from their mistakes and weaknesses. This can help them to have accurate feedback, better planning, promoted estimation and higher potential of learning. Therefore, they are not constrained. Kernis and Goldman, (2006) indicates four pillars of leadership style which are:

"Awareness: having trust in one's motivations, feelings, desires, and self-relevant cognitions.

Unbiased processing: not denying, distorting, exaggerating, nor ignoring private knowledge, internal experiences, and externally based self-evaluative information.

Behavior: acting in accord with one's values, preferences, and needs.

Relational orientation: valuing and achieving openness and truthfulness in one's close relationships."

From another point of view, In the context of BIM projects, it has been emphasized by Ozorhon and Karahan, (2017) and Alwan *et al.*, (2017) that strategic leadership plays a critical role. Strategic leadership refers to the project manager's ability to express a long-term vision for the organization or a specific area of it, and to inspire and motivate others to adopt and work towards that vision. Effective implementation of strategies to manage employees and the ability to influence and facilitate organizational change are also key aspects of strategic leadership.

2.4 Leadership and BIM-related roles

Intersection

Project is overseen by an appointed project manager, representing the owner, who is supported by external consultants. The project involves five primary trades: architecture, structural engineering, civil engineering, MEP (mechanical, electrical, and plumbing) engineering, and general contracting. Each trade contributes a dedicated team to the project, as outlined in the project documentation. A project manager and a BIM manager are included in the team for every discipline, apart from the general contractor. (Boton and Forgues, 2018)

According to the research of Beckley, (2020), employees positioned as project managers or other individuals between top management and staff members share the similar significant portion of their time and effort to daily work, for instance, scheduling, meetings, coordination, communication etc. this means they are not only leaders but also followers at the same time. BIM-oritented projects share the same logic, where we can see project manager and BIM manager are holding intersect leadership and can profoundly influence the leadership performance organizationally through their roles as both leaders and followers. The accountability of different actors within BIM projects may sometimes be unclear, resulting in them acting as their own decision-makers to negotiate their roles and responsibilities when working on different projects, or the client may define them. This

leads to overlapping roles with other project members, such as the Project Manager. Additionally, the imbalance between BIM actors and project members can impact their roles, as different levels of internal and external project members possess varying competencies, requiring BIM actors to adjust their practices accordingly. As a result, time constraints and workload increases are major concerns for BIM actors, and they must adapt their work ambitions to align with project realities and pace. (Bosch-Sijtsema and Gluch, 2019)

Figure 5: Managerial roles in the project (Boton and Forgues, 2018)

Therefore, it is difficult to define standard titles for BIM actors since intersection of leadership among them always gets attention. In other words, the same BIM actor may refer to multiple roles and responsibilities.(Uhm *et al.*, 2017) In some special projects, it is also possible for traditional engineers such as structural engineer, HVAC engineer, site engineer, etc. to play as a BIM actor, aiming at BIM implementations (Succar *et al.*, 2013). Bosch-Sijtsema and Gluch. (2019) has done research which also shows that those actors within BIM-oriented projects have absolutely facilitated leadership performance and tried to adapt themselves to the change of working method, but, on the other hand, it is not that easy to change the existing habits and become more efficient. In line with this, when facing urgent questions or problems during the project, there is a huge potential for them to fall back on the old working approaches, since it is time- and effort- costly for them to benefit from BIM implementation. It means they are back to management-based again instead of leadership-based.

This does not mean that the division of leadership, responsibilities, and work content of the main roles in a BIM-oriented project is chaotic, but that the application of BIM technology makes the information flow among project actors smoother, and at the same time, different BIM-related roles now have the requirement for being kept up with and adjusted to this higher demand for collaboration. (Raja *et al.*, 2021)

Even though it is indicated that roles are intersected, it is still necessary to analyze them separately to see the truth, mainly for project managers and BIM managers.

Project managers

In managing construction projects, a diverse range of individuals and organizations come together with a common goal to accomplish a specific task within a designated timeframe. Consequently, effective leadership becomes a crucial characteristic for project managers. Leadership qualities exhibited by the project manager positively influence the project's success. These competencies can be honed through continuous training and learning, but not easily, which is different with routine management skills. There are seven essential leadership skills that a proficient project manager possesses: communication skills, problem-solving and decision-making skills, team-building skills, conflict resolution skills, planning and target-setting skills, sense of responsibility, and time management skills. Among these skills, expertise in planning and target-setting for construction projects is considered the most critical by Zakaria *et al.*, (2015).

According to Liu *et al.*, (2017), collaboration barriers often revolve around "soft" factors, primarily referring to organizational challenges that hinder collaboration. Currently, these challenges are predominantly tackled through "hard" factors, mainly technology. However, it is important for project managers to address the soft factors by systematically applying virtual teamwork principles to adapt organizational settings and structures. This approach proves to be an effective strategy in mitigating these challenges, and it demands immediate attention from project managers. Consequently, project managers should enhance their soft competencies to effectively organize and lead virtual teams in such contexts.

BIM managers

Besides *project manager*, according to Bosch-Sijtsema and Gluch. (2019), BIM actor mainly indicates the other 3 types of roles which are: *BIM manager, BIM coordinator, and BIM modeler*. And those roles are better discovered in both project-oriented and organization-oriented. (Davies *et al.*, 2017)

At the heart of this entire process lies the role of the "BIM Manager." This position encompasses two key responsibilities: overseeing the implementation of BIM within an organization and acting as the organization's representative in project teams. In larger organizations, these roles are often separated, with one person handling internal processes and another person, or a team, taking on project-related tasks. (Baldwin, 2019)

BIM manager is a versatile professional who possesses expertise in construction technology, project management, and various soft skills such as negotiation, instruction, communication, and marketing. When it comes to implementing and developing BIM within an organization, BIM manager's duties may include establishing guidelines, providing training and technical support, and possibly handling software and hardware installation and maintenance. Within the project environment, BIM manager may serve as a technical support resource or act as the project leader, representing their organization's interests in BIM coordination meetings and ensuring compliance with project requirements within their company. (Davies *et al.*, 2017)

A helpful way to envision the BIM manager is as a "T-Shaped" individual—a generalist with deep knowledge in a specific field. The specific area of expertise can vary depending on the organization. While many BIM managers have a strong background in IT or CAD, the choice ultimately depends on the company's preferences. However, the general recommendation leans towards individuals with a robust background in construction or project management. The BIM manager should be consistent with the core business of the organization. (Baldwin, 2019)

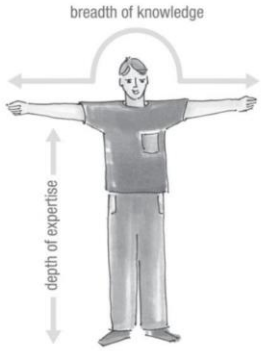

Figure 6: The "T-Shaped" person (Baldwin, 2019)

Davies *et al.*, (2017) has also summarized the main responsibilities and expectations of BIM managers.

Table 2: Expectations of selected BIM Managers (Davies et al., 2017)

Role	Technical	Process	People	Strategy
BIM Manager (project role)	Ensure software is installed and operating properly	Lead development of BIM Management Plan/BIM Execution Plan	Provide BIM point of contact with client	
	Determine reference points used for projects	Ensure compliance with BIM Management Plan/BIM Execution Plan	Train project staff	
	Analyze model content to ensure it is fit for purpose	Management & quality control of model dissemination; revision management	Facilitate technical meetings with BIM technicians	
	Carry out clash detection & provide clash reports	Coordinate file management processes		

Role	Technical	Process	People	Strategy
	Assist in preparation of project outputs, such as data drops			
	Assemble composite models			
BIM Manager (organizational role)	Implement BIM technology	Crete company-level BIM processes and workflows	Engage external stakeholders	Formulate corporate BIM objectives
		Develop company-level BIM standards and protocols	Collaborate with partners and internal teams	Plan & manage best practice /research
			Company-based change management and training	Prepare and manage BIM training strategy

Currently, architectural and engineering firms are struggling to execute BIM projects seamlessly due to the absence of a leader who can take overall responsibility for project management. While it is possible to find a BIM manager, finding a leader with key skill sets, HR skills, and deep domain expertise in all aspects of virtual construction modeling, such as BIM modeling, coordination, clash detection, and on-site component installation, can be challenging. To be a successful BIM manager, there are several key skills sets to possess: d*eep domain expertise, interpersonal skills, dealing with stakeholders, excellent communication skills, ability to train, time management.* (Davies *et al.*, 2017)

According to (Baldwin, 2019), it is gained that a draft understanding of the leadership skill sets is required for a project manager and BIM manager. For those who have embraced BIM, having a project manager or BIM manager to handle architects and engineers becomes crucial. An exceptional leader ensures seamless project execution, management, communication, and collaboration between different teams, thereby enhancing the growth prospects of the company.

2.5 Leadership competencies

Even though that research has been widely done about leadership, on the other hand, the significance of leadership competencies and how they are contributing to BIM-oriented projects. (Mirhosseini *et al.*, 2020) BIM adoption and implementation require project leaders possessing essential knowledge, skills, abilities, experience, and attributes, which are collectively identified as leadership competencies. Not every BIM specialist is having the required competencies and this is a significance obstacle to BIM implementation process.(Uhm *et al.*, 2017) Identifying and evaluating leadership competencies can yield numerous advantages, for instance, enhancing performance, assisting with training and professional improvement, and enabling certification and accreditation. (Succar *et al.*, 2013)

Ley and Albert, (2023) pointed out there is no widely accepted definition of the term "competency" among researchers while saying although competencies have gained growing importance, it remains an unsettled matter as to what exactly competencies entail. Breaking down the components of competency can provide insight into its workings. These components work together to achieve a quantifiable outcome while also being individually

discernible for targeted analysis. An individual's abilities are the sum total of three components: knowledge, skill, and personal traits. (Succar *et al.*, 2013)

Knowledge: This component encompasses theoretical or conceptual knowledge.

Skill: This component pertains to applied or procedural knowledge.

Personal traits: This component covers other job-related characteristics such as attitude, behavior, or physical ability.

Competency components are interdependent and can be used to define leadership competencies. The importance of each component varies and is contingent on the unique requirements of each measurable competency. For instance, some individual competencies may rely heavily on conceptual knowledge, while others may hinge on practical skills. Additionally, some competencies may necessitate specific personal traits (such as friendliness, empathy, or dedication), while others may not require the same traits. (Succar *et al.*, 2013)

Leadership competencies are inevitably interdependent (Zhang *et al.*, 2013), and at the same time BIM implementation process is considered as complicated because the influencing factors are always changing. Therefore, taking a dynamic discovering of leadership competencies brings better understanding of the mutual cause-and-effect relations and prioritized the necessary competencies for delivering BIM-oriented projects with high performance. By identifying which leadership competencies are important and finding out their interrelationship, BIM managers and project managers will definitely be able to systematically develop a method to minimize the possibility of BIM failure. (Mirhosseini *et al.*, 2020)

Previous studies on BIM have rarely mentioned the clarity of management and leadership. Sometimes when discussing support from the top management, it always means differently with leadership terms. Even though it is true that support from top management will bring convenience for introducing BIM into project management, but this does not mean that they are leading the approach and process of BIM-oriented projects.(Mirhosseini *et al.*, 2020) It is recognized as the best when BIM adoption can be initiated from top to down or from the center to around, while BIM initiators are standing in the front line of the project. (Succar and Kassem, 2015) BIM initiators often play as leaders in various aspects of BIM projects and may generate new leadership structure which is informal or others. In addition, emerging leadership occurring in the context of BIM-oriented projects, will highlight the connection between leadership and management. (Liu *et al.*, 2017)

BIM-related leadership is braced by three main pillars: structural support, competent BIM leaders, and team member competencies and composition, which are referred to as key of BIM-related leadership. The first pillar, structural support, involves support from organizations and financial reward for BIM application.(Abbasnejad *et al.*, 2021). The second pillar, competent BIM leadership, means BIM-oriented project leaders are expected to be able to motivate and guide their teams through the whole process. The third pillar means identifying, acquiring, and assessing the competencies of individuals by project managers or BIM managers, as well as the composition of teams and groups involved in BIM-oriented projects (Succar *et al.*, 2013).

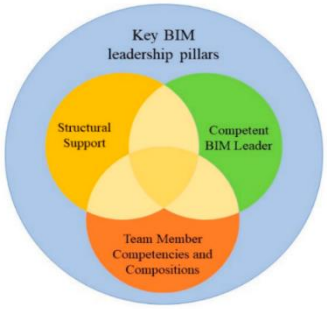

Figure 7: BIM leadership pillars (Mirhosseini et al., 2020)

Yang *et al.*, (2022) has done very meaningful and complete research on summarizing existing knowledge and studies to have a whole a picture of what leadership competencies are important under construction 4.0 and BIM-oriented era. 22 leadership competencies are identified which are categorized into four domains, as shown in *Figure 8* through thematic analysis. The cognitive domain plays foundationally and brings support for 3 other domains.

For instance, according to (Yang *et al.*, 2022), competencies in the cognitive domain, such as Conveying message, provide leaders with essential capabilities that contribute to competencies in other domains like Persuasion in the interpersonal domain, Team building and coordina*tion* in the business domain, and *Visioning* in the strategic domain. Interrelationships exist among the different domains. Interpersonal domain helps project managers and BIM managers to better communicate with team members and influence them. Interpersonal competencies encourage engaging others and promote the application of competencies in business domain. Business domain enables project managers and BIM managers to act more like management role referring to daily works and working structures (Baldwin, 2019), while providing purpose and objectives to practice interpersonal competencies. Simultaneously, implementation of competencies from interpersonal and business domains makes it easier for project managers and BIM managers to overcome complicated challenges environmentally. Strategic domain and its competencies play importantly in helping project managers and BIM managers to have better vision and guide the future development, also parallelly providing support for interpersonal and business domains. (Yang *et al.*, 2022)

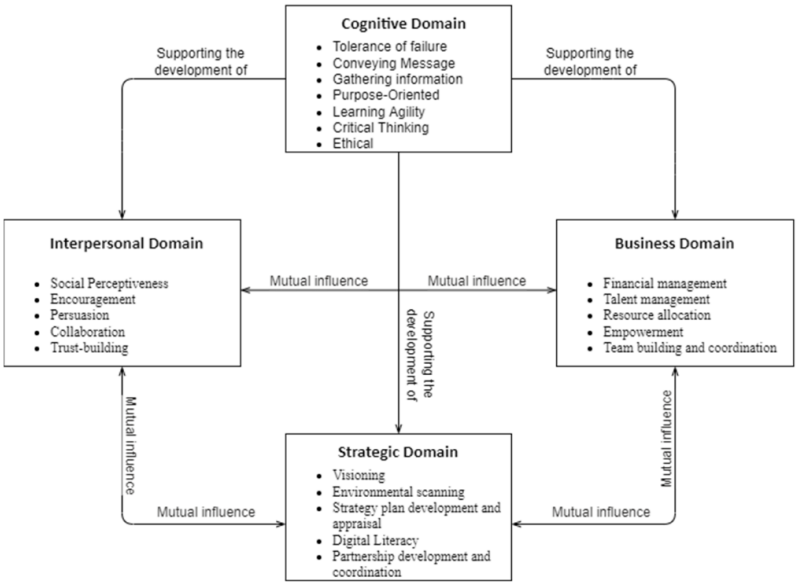

Figure 8: Key competencies in construction 4.0 (Yang et al., 2022)

Omer *et al.*, (2022) has a different perspective on discovering the constructive leadership competencies, who classify leadership competencies into behaviors, skills, and traits when talking about BIM-oriented construction projects. In their research, most common constructive leadership characteristics are *tolerance* (behavior), *communication* (skill), and *reliable* (trait). *Tolerance* refers to the behavior of accepting differing opinions and being able to endure unpleasant situations or overcome difficulties regarding to guiding and mentoring inexperienced individuals, such as newbies or fresh graduates, who lack prior experience within BIM-oriented projects. *Communication* is considered by almost all leaders to be the most important skill, whether it is BIM-oriented project or traditional project. *Reliable* as a trait shows that a leader is expected to be responsible for critical decisions and team performance. This shares the similar results with Dossick and Neff. (2008), who believe that individual leadership of project managers plays an important role for successful projects, especially inspirational leaders. They value 3 leadership characteristics for BIM-oriented projects: *communication, problem solving,* and *inspiring*, while almost same result with Omer *et al.*, (2022)

3 METHODOLOGY

In this paper, we chose interviews as the main approach, which is not limited in Sweden. The interviews are taken in English. This chapter will have an explanation of why such methodology is chosen for collecting the data.

3.1 Research Strategy

Qualitative research involves presenting assumptions and using theoretical frameworks to inform research problems. To enhance existing theories is a key objective that does not fully address the complexity of the subject matter.(Lewis, 2015) Given the lack of empirical research that effectively addresses our research questions and comprehensively captures people's experiences, qualitative research study is chosen to be conducted.

Different and a set of approaches have been studied and suggested for conducting qualitative research interviews by several authors, including Kvale and Brinkmann, (2009). These steps include thematizing, study design, interviewing and transcribing, data analysis, validity verification, and study report. In qualitative research, coding is commonly applied as an analytical approach to break down empirical data and make it more understandable. (Lewis, 2015)

3.2 Research Process

This research starts from studies on previous literatures within this topic in order to investigate the development of BIM and construction 4.0, to find out the best valued competencies within leadership which can match the new working method.

Then 6 interviews are planned after studying literature. BIM-related roles are selected to investigate how leadership is implemented and how they think of the research questions within this topic. Details of the interviewees are shown in chapter 3.3.

3.3 Data Collection

Literature Review

The study's theoretical framework and understanding of relevant theory were informed by a literature review of previous research. The review encompassed topics including the discussion of BIM-based project management, and the differences between management and leadership, following with the reason and significance for studying leadership within construction 4.0 and BIM era, the actors and roles involved in BIM projects and their competencies which is mainly project managers and BIM managers. In the end, the topic of leadership styles and competencies in BIM-oriented projects is discussed by previous research.

Besides, part of secondary data such as leadership competencies evaluation from Mirhosseini *et al.,* (2020) and other sources, including websites, online articles, journals, and books, were applied to do a analysis after.

Interviews

Table 3: Specification of interviews

No.	Role	Location, Company type	Work experience	Setting
1	BIM Manager	Sweden, General contractor (Chinese capital), design dep.	11 years	Video meeting
2	Project Planner (VDC specialist before)	Sweden, Contractor, project team on site	8 years	Video meeting
3	BIM Manager	Sweden, General contractor (Chinese capital), design dep.	9 years	Video meeting
4	Design lead (Project Manager before)	Sweden, General Contractor, design dep.	10+ years	Video meeting
5	Project Manager (Projektledare)	Sweden, Real estate developer also General contractor	10+ years	Video meeting
6	BIM modeler	Algeria, General contractor, design dep.	6 years	Face to face

Interviewee 1 is a *Specialized BIM Project Manager* who is from a contractor company. He finished his study of architecture in 2012 and has been working within the construction industry for 11 years. Since 2014, he started to work within BIM projects for design work, and then within BIM project management until today.

Interviewee 2 is a *Project planner* who is from a contractor company. Two years ago, she worked as BIM coordinator and before as VDC specialist, the main responsibility is related with communication in design stage about the model, report coordination model every week or month and try to find out the main information requirements for the model from a perspective of contractor or other stakeholders. Now she works as a project planner who is in charge of plan management. She has 8 years' experience within the construction industry and has very solid knowledge in BIM project management.

Interviewee 3 is *BIM project manager* who has 9 years' experience within the construction industry. With international experience in Ukraine and Egypt, he has been involved in many projects implemented by BIM and has a strong understanding of the industry.

Interviewee 4 is a *Design lead* (currently, project manager before) who has very solid international experience with more than 10 years within the construction industry. With working in Australia, Canada, Ireland, Mexico, China, Germany and now Sweden, she successfully has herself armed with skills in process thinking, quality management, risk management etc. as a project manager. She has been involved in many complex projects.

Interviewee 5 is a *Project manager* in a Swedish real estate company, they develop their own housing projects and bid for other housing construction projects in Sweden. She is a project manager who has more than 10 years of experience, but only for housing projects instead of complicated infrastructure projects, and they only do prefabricated buildings.

Interviewee 6 is a *BIM modeler* who is working for an international construction company, they do both housing and infrastructure projects. With 6 years' working experience in the design department, he is now experienced in the BIM field.

Culture differences

Except Interviewee 6 from Algeria, the other 5 interviewees are from Sweden, even though Interviewees 1 and 3 are from Chinese-capital companies. So, it is still interesting to notice and discover the culture differences regarding to local Swedish companies.

Both Chinese and Swedish companies in Sweden place a strong emphasis on professionalism, working efficiency, and delivering good project quality within the construction industry. They share a commitment to meeting high standards and delivering projects on time. Additionally, both cultures value communication within teams and exterior long-term relationships, they tend to facilitate collaboration and understanding based on project teams. In terms of communication, Chinese companies may exhibit a preference for indirect and subtle communication, while Swedish companies generally embrace more direct and explicit communication styles. But on the other hand, those companies are based in Sweden, it brings Swedish culture in as well to have a more communicative environment.

The nationality of interviewees is hidden in this research and culture difference is not a study direction of this paper but understanding the culture differences may foster bring acknowledges for future study within project management and leadership areas.

3.4 Data Analysis

There are multiple approaches to data analysis. One method involves utilizing analysis models to organize and evaluate the collected data. Another approach is to employ descriptive statistical analysis to gain fresh insights. Additionally, simulations can be conducted to test the gathered data. In this research, the responses of the interviewees were analyzed and interpreted. Answers are discussed integrate and compared to each other. Also, the data is analyzed based on studies from literature research.

Qualitative research tends to generate a substantial volume of data, this is often considered as a drawback (Becker *et al.*, 2012). Furthermore, it is challenging to analyze qualitative data because it is required to filter and clarify to extract meaningful inputs, unlike quantitative data. Initially, it is essential to do the transcribing work, then following by coding to clarify the gathered data into specific themes. Additionally, when having the interviews, researchers can pay attention to respondents' non-verbal behavior to know if they are nervous or aggressive (Fellows and Liu, 2021).

The six interviewees have been knowing the topic with a small discussion before the interviews, so the author believes they have put valued thinking into it and based on their experiences, the author believes the collected data through their interviews are valuable to be analyzed by the mentioned approaches.

3.5 Ethical Considerations

Broesch *et al.*, (2020) indicated that ethics has significant importance in the report writing, because it is used to examine the concepts of what is right and what is wrong, what is good

and what is bad, what is just and what is unjust. When conducting this study, an ethical framework was diligently followed.

According to Broesch *et al.*, (2020), one of the key ethical considerations was maintaining anonymity. To safeguard the confidentiality and privacy of the company being studied, as well as its employees, measures were taken to anonymize their identities. This ensured that no individual or organization could be identified through the report, fostering a sense of trust and security.

Furthermore, the participants in the study were fully informed about the benefits of their involvement. They were made aware of how their participation would contribute to the development and improvement of their own company. By emphasizing the positive impact their contribution could have, it was ensured that their voluntary participation was based on an informed decision. To address any doubts or apprehensions, the participants were provided with explicit reassurances about their anonymity. This was done to alleviate any concerns they might have had regarding the potential risks associated with their involvement. By explicitly guaranteeing their confidentiality, the researchers aimed to create a safe and supportive environment, encouraging open and honest responses from the participants.

In summary, this study was conducted with a strong ethical foundation. Interviewees were well-informed about the benefits of their participation, and their anonymity was explicitly assured to build trust and alleviate any doubts or concerns they might have had.

3.6 Sustainability

This paper explores how leadership competencies are identified and valued by project managers and BIM managers in BIM-oriented projects, which can influence and promote sustainability in BIM projects. Sustainable leadership in BIM projects involves adopting a holistic approach that integrates environmental, social, and economic dimensions. It requires project managers and BIM managers to prioritize sustainable practices throughout the project lifecycle, from design and construction to facility management. It is indicated that the importance of aligning sustainability goals and metrics with BIM implementation. It is investigated that leadership can leverage BIM's capabilities to optimize energy efficiency, reduce waste, and enhance the life cycle performance of BIM-oriented projects. (Gerard *et al.*, 2017) It is considered in this paper that project managers and BIM managers can effectively integrate sustainable principles into decision-making processes, stakeholder engagement, and project planning. The role of leadership in fostering a sustainability mindset among team members, encouraging innovation, and driving continuous improvement in sustainability performance is also mentioned.

By addressing the intersection of leadership, BIM, and sustainability, this paper contributes to the growing of knowledge on sustainable construction practices. It brings insights and recommendations for project leaders to navigate the complexity of BIM-oriented projects

while integrating sustainability principles, ultimately promoting the development of more environmentally conscious and socially responsible construction practices. (Valdes-Vasquez and Klotz, 2013)

4 EMPIRICAL DATA

The data collected from the interviews are indicated in this chapter and categorized into the following contents.

4.1 BIM as a process

To have a better understanding of BIM project management, it is necessary to have a clear mind to know what it can give you and where you may have difficulties when using this working method.

"What would you consider BIM as for project management?" (Author)

"BIM actually is not only IFC files or something else, if you know the 7 dimensions of BIM, you will definitely realize that, ok, we can do so many things with it." (Interviewee 1)

Almost all the interviewees prefer to consider BIM as a process instead of integrated software. It is already far beyond a model which has limited functions, with managing information related to structure, scheduling, cost etc., it has now become a core of people and information for project management.

Interviewee 1 mentioned that BIM's 7 dimensions through the life cycle of a project, where the information flow via BIM is a critical path from the beginning of the project to the end.

This is emphasized by Interviewee 3 as well, who believe the "I" in the middle of the abbreviation "BIM" is information flow, instead of only information. Working geometry is an interesting point made by him. He defines people as points and activity as lines in his geometry. Information flow goes through the dots and lines and becomes a plane and with the help of BIM, plane becomes solid. When you put information in BIM, not only into the model, but also into the process, the information is defined to be withdrawn in the future and applied in some way. The information flow involved different stakeholders and team actors. It is the link of people and activities. BIM becomes an integrated process on his working geometry for Interviewee 3. Or, in another word from him, an ideology. It is difficult for people who do not understand this ideology to see the positivity. One of the positives of BIM compared to traditional method is reducing time cost from a perspective of the whole project life cycle, even though it may take more time and cost in the beginning. And this, is the blind spot for many leaders.

Interviewee 2 and 6 also indicated that BIM means more like a step-by-step process. If you preferred a better result, you would need it. Actors can benefit from BIM project management to save time and energy. Cloud BIM is frequently used by Interviewee 6 and BIM 360 provides a platform for architects and structure engineers etc. to collaborate together. But it is still not the ultimate solution because it is always on its way to developing. This working method and platform has narrowed the information gap greatly and brings great efficiency for communication.

Interviewee 5 is the only one who has used BIM for less than 2 years after a role of project manager in a traditional way. She works mainly with checking BIM models on construction sites and quantity take off. But even though it is not a long period, 2 years still makes it easier for her to better manage the project, especially discussing drawings with clients and construction works.

4.2 BPM advantages

"Now we can talk about, in your project management process, BIM brings what changes." (Author)

"Well, I would say thanks to BIM, now I can have a whole picture of almost everything in the very beginning, and of course, keep the information updated as the project progresses. And this, is very important for a project manager, well, I am a design team lead now, but I did work as project manager on site before in xxx (company name) in Stockholm." (Interviewee 4)

BIM generally helps to build a whole picture for project managers to establish a new working procedure and method to manage the project time and quality efficiently from the planning stage of the project, which can be seen from the quote of Interviewee 4. And it has enhanced the performance of the project management process. Interviewee 4 indicated that it is exciting to have BIM to change the city, and because of BIM, her own way as design lead has changed a lot. The complete picture is of course the most important thing: How far have we thought about everything? How are we with the requirements? How is everything connected to each other? How are the properties set on the different items? Can we use the data for the next stage after design? Can we use it for estimation of time and cost? Etc.

Interviewee 2 could not agree more on this since she works a lot in project planning. For instance, many, maybe more than 1,000 activities are identified in the time schedule which will make the planning very detailed. In this case, a BIM model will connect to the time schedule. When changes are needed from the time schedule, a 4D result will be indicated through BIM with a simulation of how it is in the whole process. Managing a time schedule in a traditional way brings giant challenges, however, BIM provides the possibility of improving efficiency and performance. Through managing meetings with the help of BIM management process, risks are discovered earlier and minimized when doing the planning.

Another change brought about by BIM management is activity management with leadership distributing, which is mentioned by Interviewee 1. For example, the RACI Matrix is used by his team, where R is realization, A is approvement, C is contribution, I is informed. It is more like a process map with accountability distribution, which shows the how stakeholders should be involved in the project, for instance, the owners may be only matched with I which is Informed when talking about the accountability distribution. It is also applicable for project modifications especially when decisions are made to have

changes not just the design, but also construction method, different stakeholders will have different responsibilities to be involved in the project. This is done at the beginning of the project and will be modified through the whole lift cycle of the project.

By applying this Matrix, it is easy to minimize conflict, which is also mentioned by Interviewee 2. BIM cannot erase the conflict in the project, but it can help to identify the conflicts earlier which is so important especially in the construction stage. For example, when you have the model on site and have a detailed time schedule, as a project manager, you will find out the problems and conflicts in the early stage. Otherwise, you may find out after finishing part of the construction. You still can have a chance to remedy but it costs a lot.

Interviewee 1 agreed on this early identifying by using clash detection. Compared to traditional projects, the most significant part is saving time from a long term, and clash detection. Clash detection is complicated when using the traditional construction method, and it is so easy to be hysteresis. This brings rework because many processes are already finished even before some clashes are discovered.

For Interviewee 3, BIM makes it possible to have a more accurate product than before. The product can be the drawings, or project performance. Even if you are very experienced in 2D, you will still be impressed by 3D/4D with the rich information integrated model, which is the reality. But on the other hand, this does not mean that BIM always operates better than the traditional method. It should be admitted that sometimes working approaches like 2D are still a better choice than BIM. So, a leader should have the ability to identify the best applied approach for the project and team.

4.3 Challenges for BPM and leadership execution

"But I do think that you may have faced troubles leading a BIM-oriented project, while someone in the team is always resistant to management under BIM, I mean, they are used to how they have been working." (Author)

"Yes. For me, I had a colleague who is more than 50 years old and very experienced, and he was working as a construction lead in my previous project, every time we show him the 3D model and scheduling information, he just wants it in 2D." (Interviewee 4)

It is understood by Interviewee 4 that there are still some people who prefer to go back to traditional working approach but she also thinks that there is a danger in doing that because even if you have done a detailed design, you still never really know how the site looks like and it is going to be built by a different team who need to see the big picture to avoid risks. People's reluctance is still the biggest obstacle for BIM implementation in her opinion. Education is not the right word she would like to use to overcome this obstacle, maybe stimulation it is. Being able to show people that they themselves can have advantages in using BIM because that is what they want in the end, can help them to see more things for the project.

In traditional projects, it is possible to have visual design and planning also but, you won't see the impact of decisions as fast as in BIM projects. It is still the different type of working ways due to the implementation of BIM. This is deeply understood by Interviewee 5 since it sounds like she uses visual tools in a traditional project instead of BIM. Even though it was easy for her to adapt to new tools, she thinks going further to have everyone in the team is still unrealistic in her company. It is a small construction company, and the top management would not like to spend time and money on changing. Even they can see the necessity, but it is in their future planning not now in the recent 5 years at least. So, lack of support from top management is an issue for her.

Comfort-zone is also mentioned by Interviewee 1. People, especially experienced engineers, or leaders are reluctant to change their working style or method. This is a big problem because it is very often seen in many companies, and it brings more challenges to BIM implementation and communication.

4.4 Leadership seminar within BPM

4.4.1 Leadership and the team

"Now we have talked about what changes you think BIM brings to project management, as a project manager, what do you think you should do to adapt to these changes because of BPM, if we talk about leadership style and competencies here." (Author)

"OK yes, it becomes different after using BIM, as I think, people are more tend to be bureaucratic in traditional projects, because sometimes without an efficient information flow process, people are more like to make up information gap with bureaucratic system." (Interviewee 4)

Most interviewees say that BIM project management has its particularity, because project participants generally have a high degree of acceptance of new things and are generally relatively young. Leadership is considered by most interviewees as facilitator to team management. Interviewee 4 mentioned that due to the BIM implementation, leadership styles should be modified compared to traditional projects. Traditional projects generate more bureaucracy than BIM projects. Since information sharing is not efficient as BIM projects. BIM project makes it possible for the management to be flatter structured instead of tall structured, which she believes will be trend of the future structure of construction project team. In BIM project, it is much more transparent for everyone. Firsthand information is always better than getting information from three or four leaders.

Interviewee 1 indicates that a leader should have the knowledge to see if it is necessary for him to apply new technologies like BIM. Starting with smaller things and taking time to change seems much better to have all the approaches changed. It is more economical. This is also agreed by Interviewee 5. She is in her starting to change and she believes all beginnings are hard and a project manager should be qualified to evaluate the benefit of a solution and see the path to resolution.

Interviewee 4 emphasized that a leader is not a boss. If you are always the one sitting on the information, you are more like a boss then. You are not transparent. A leader is an enabler for others to be able to do their work, sort out all the questions than just managing others. On the contrary, a boss is not. A leader should be team based and project based, this is applied to both traditional projects and BIM-oriented projects. If a leader is too isolated from the team, you get challenged in another way. Leaders, like everyone else, have a role in the big picture, but work is equally important.

Interviewee 1 shares the same opinion on this. In many companies, leaders and team members are in two different boxes. The communication between them is the information flow which is mainly in the form of Command. Coordination is not emphasized in this communication. But for BIM project, the negative effects will be magnified. So, it is important for leaders to jump out from their own box and let team members know they are also in their box. So, when they have problems or challenges, leaders will be there for them.

In this case, Interviewee 1 is more like supportive leadership instead of emphasizing the power or the art of management. He emphasizes communication within the team a lot because it is the link between people and can have a direct impact on work quality.

Interviewee 6 can hardly be treated as a leader if talking about authority, but he is standing in the center of leadership because his role brings model-based BIM project management to life. Supportive leadership is also mentioned by him that a BIM modeler sometimes needs input from different roles, and it is important to have support, and relatively clear information management method. Transforming this information into the model is a first step and the foundation of leadership implementation later. So being supportive as project leaders or actors is even important.

While differently, strong, and powerful leadership is emphasized by Interviewee 3 who believes it can facilitate efficiency, for both traditional project and BIM-oriented project, which is no doubt, especially in the planning stage. A leader should have boldness to make difficult decisions at the beginning. It is also important for project managers to create rules and routines for the team so everyone can follow the same standard and routine to reach the best result. It may bring some problems and conflicts absolutely, but it is essential. With a regular period, the whole team should examine the previous approach to have it best applied, for instance, once per month. A leader should be good at summarizing his and his team's experiences to have better change management for the project and team building.

"It is very important to be able to read people, as a project leader." (Interviewee 1)

Interviewee 1 thinks that as a project manager, it is very important to read people, and he adopts different communication methods and working methods according to the different abilities and personalities of different people, motivates others with different stimulators.

This is also indicated by Interviewee 4 and Interviewee 2. Interviewee 4 suggests that it is important for leaders to have the ability to read, to choose and evaluate team members. The

most considerable aspect is whether the leader can communicate openly with this person or not. Can the leader be him/herself or will he/she have to change? To feel comfortable is important for both the leader and the person. But on the other hand, individual competencies are preferred even sometimes the person may be difficult to work with. Interviewee 2 likens it to that it sounds like that you need to interpret customer's requirements and your own requirements during construction and application, and then to confirm what kind of product can you get, same to leadership. When a leader starts to read people, including clients and team members, then he/she will have more possibility to achieve the common goal.

4.4.2 Listening and Encouraging, Communication

"What leadership competencies do you value most for BIM-oriented project management? You can talk about this in 2 aspects, skill, and behavior." (Author)

"Well, I think this question depends, and you really should act like different persons in front of different people." (Interviewee 4)

For the leader, building a team means to have a mix of all sorts of competencies and also personalities. In Sweden, people say that the similar children play best, it is not believed by Interviewee 4. She thinks it depends. It is important to have a diverse group with a comfortable culture in it. Same logic for being a project leader. Since you have different culture and personalities in the team, a good leader should act like different persons in front of different people.

Interviewee 2 and Interviewee 5 believes that a leader should be able to behaviorally listen to advice no matter if the advice is accepted or not. Listening and giving feedback to them means you are leaving them on board, this means a lot and sometimes brings motivation and stimulation to others. Listening also can indicate some obstacles or emotional resistance hidden in the team, for instance, someone maybe not willing to using BIM compared to old working approach.

Interviewee 1 additionally indicates the importance of encouraging, as well Interviewee 5. Compared to individual competencies and management skills, they think it is more important for emotional skills. This means you can stimulate others to work with more motivation. Encouraging is a very important behavior for him as a leader. In their perspective, it brings more conflicts and disadvantages when you always discourage someone. This will tag someone with bad impression. It is very important to create a comfortable atmosphere and working environment and insert confidence in every team member.

Interviewee 2 talked about a similar aspect but used a different word, penetration. It means similar to stimulation. A leader should have the motivation to modify him/herself first and be willing to change to improve working efficiency and quality. On the other hand, team leaders can infiltrate emotions to others. It is good to create an atmosphere where the team

can see how cool it is to work with your way and with time going by subtle influence, they will be penetrated to change themselves.

For Interviewee 4, It is important for leaders to have openness, trust, and honesty. Support to your team members is so important to team building as it shows carelessness to others. No matter if it is a small project or complex ones, everybody is needed. Every specialty is needed. Every competence is needed. Of course, the leader needs to make decisions where the team absolutely does not agree, but he/she must. And the leader also needs to justify why he/she makes the decision to have everyone on board. It is always better than just telling them that's just the way it is.

Interviewee 5 summarized the mentioned competencies into one which is communication skills. She said it will become more and more important for BIM-oriented projects. Because even with a small implementation of BIM project management, she feels great advantages from the high efficiency of communication. Therefore, she believes when a high level of BIM, after integrating more information into the working approach, the significance of communication will stand out eventually.

4.4.3 Decision making

In a way of listening and encouraging, it shows advantages of involving others on the decision-making board which is important for BIM leaders in a shared box. Creating a coordination path in the shared box for different professionals and actors is significant. Early involvement of others also brings advantages than late. For instance, MEP engineers are always involved in the project in the second half of the project. This is wrong because it may bring many clashes. Early involvement is a path for overcoming clashes among professionals.

According to Interviewee 3, it is not a good idea to have everyone on the decision-making board. It will bring chaos for BIM project management. But suggestions should be encouraged under powerful leadership, otherwise, the high pressure in the working environment will easily cause people to collapse. Powerful leadership does not mean making all decisions by the leader. It is just an emphasis for the courage and vigor of the leader.

Similar description on decision making from Interviewee 2. She believes that the right for decision making should not be distributed too much to the team members especially in the early stage of project since it may bring negative effect on efficiency. But with the project going further, the project team becomes diverse, distributed leadership may bring more benefits instead because it encourages creativity and allows them to have their own way to work. This is important because in such a working environment, people are more willing to share information and experience, which is a huge advantage for coordination and communication. From a perspective of leadership, the improvement of information flow means higher efficiency of the team.

Interviewee 4 thinks this differently in some way. She suggests that a leader cannot be the specialist of everything. Sometimes a leader may make wrong decisions as well. Weekly meetings are taken by interviewee 4 where they go through all decisions which must be made. About changes and prerequisites for the design or contracts or whatever, people can hear different voices, and everyone has the possibility to speak up. An environment where others can feel confident and comfortable makes project management easier and more successful, otherwise you will miss those people who have the knowledge. It is important for letting team members to be themselves. For example, if there is a person who doesn't want to speak up in a big group and it really makes him uncomfortable, then the leader should notice and talk to him one after one after the big meeting. Since many disciplines are defined in the project and everyone is important, you can go further by creating a culture where everybody can be themselves and where they feel safe and are not fear to make mistakes. Interviewee 6 shares the same opinion as Interviewee 4 and Interviewee 6 himself is in this kind of team which makes him confident and comfortable.

On the other hand, Interviewee 5 as a experienced project manager, has a lot of power for decision making in a smaller company structure. This brings higher requirements for project leaders, in her opinion which means you must be experienced enough to do it. But as she said, she is always willing to have others on board about decision making but unfortunately, there are not too many others. But to avoid risks, there are weekly communication meetings for all project managers discussing issues regularly, where they can see the possibilities to be improved.

4.4.4 Educating

"From my position, because I work a lot on educating others and coaching them, so I would say educating others as a behavior, is important for BIM project leader." (Interviewee 1)

As a leader, interviewee 1 emphasizes a favorable competence is the ability of educating others. For him, he prefers young members instead of experienced ones in his team because it is easier and communicating effective when bringing new knowledge and working method to the younger ones. This is a perfect match for a BIM-oriented project since many younger colleagues are involved in BIM management instead those are reluctant to accept new technologies. It does not mean educating elders is less meaningful, instead, if the elders who are more experienced are willing to accept suggestions and renewed working method, they bring more advantages.

4.4.5 Visionary

"BIM makes it easier to have a whole picture since the beginning of the project, which is so important not only for project managers, but also other roles." (Interviewee 4)

Interviewee 2: As a project leader, a very important competency is to be visionary, especially when talking about risk. The ability to find risks earlier and can adapt themselves

to minimize the risks brings more accountability for decision makers of the team. Risk management should be not only emphasized by the leader, but it is for sure one of the biggest responsibilities for the leader.

Interviewee 1 indicates that Sacrifice is much underrepresented in discussions of leadership. From his understanding, sacrifice is worth discussing a lot in leadership. In includes many aspects. For instance, sacrifice some time to gain more time. In the beginning of the project, leaders must emphasize the importance of planning. It may take weeks to clear out but once it is done, workflow will be much more efficient following. Detailed BEPs can bring work disciplines and routines for the whole project as an example.

4.4.6 Leadership as an ever-changing concept

"Leadership is an ever-changing concept through the life cycle of a project." (Interviewee 1)

When talking about leadership, it is an ever-changing concept during the life cycle of the project, said by Interviewee 1. The leadership should always be slightly changed based on tasks, requirements, people etc. So being energetic and quick-minded is a necessity for project leaders.

Interviewee 4 comes up with a similar conclusion for this. Leadership should be slightly modified in different stages of the project. Once getting into construction, it of course depends on what kind of contract it is. Daily work and people are not the same with planning stage and design stage, in construction phase, logistics plays an important role, and work environment also. So, from this perspective, leadership will change more to that a leader has to be a bit more authoritarian actually. If a leader encourages openness too much on construction site and someone doesn't do what they are supposed to do, it can have disastrous consequences. So, leadership does change, but it's still a lot about responsibility for people's tasks in the team. Compared to design, construction seems more needs for stronger leadership and better communication and daily planning ability.

Interviewee 3 thinks this additionally. He believes since there will be more changes and challenges in the future such as AI integrated within BIM, even though now it is mostly in the design phase, but still, it will be developed revolutionarily. As project managers, it is important to have a learning heart and never being reluctant to try new things, otherwise, it will be difficult to adapt to this era.

An interesting hypothesis is made for Interviewee 4 which is: If the leader has one month work off, do you think the project team can still have the high working efficiency and performance same as when having the leader with them? Interviewee 4 said it does. She usually documents on what basis is done. For everyone, she leads the team with a system where they log everything and those visual meetings they have. She didn't plan them herself. She is willing to have everyone dedicated and on board. Coordination meetings are

planned in advance and the topics. So, it will bring routine even if the leader is off for a period.

5 DISCUSSION

In the discussion chapter, the author will analyze the empirical data collected from the interviews while being supported by arguments of previous research indicated in literature review chapter. The following question which also shown in chapter 1 will be detailed discussed:

1）Question 1: What has construction 4.0 and BIM brought to project management?

2）Question 2: What leadership competencies are valued in a BIM-oriented project?

3）Question 3: How to find out if a manager has these competencies or not? What are the indicators of the mentioned leadership competencies?

5.1 BIM management vs. project management

Chan *et al.*, (2018) has ever studied on project management while considering the integration of BIM, which offers extensive capabilities to enhance project management, particularly in terms of information management and collaborative work. This is why Ma *et al.*, (2018) proposed a new concept which is called "BIM-based project management (BPM)". BPM is a concept where the functional applying of BIM is enriched by project management requirements at different stages of the project, aiming to achieve efficient project management with BIM implementation.

Previously, the question confused someone by whether it is logical to separate project management and BIM management. Experience overseeing BIM management in numerous projects indicates that certain tasks typically associated with project management are, in fact, led by the BIM managers involved in the project. (Gómez, 2021) This is also what is found by the author that accountability is intersected within different roles in BIM-oriented projects. The fundamental idea from the author is that BIM management should never be treated as a separate entity running parallel to the project management. Instead, we should strive for the project to be primarily managed using BIM, and this consistency must be maintained. Regrettably, there are many project managers who remain unaware of this fact.

Resource planning and financial control of the project are not typically included in scope of work as BIM Managers, but companies should always consult an internal or external BIM Manager to estimate the resources and timelines required to successfully execute a project according to agreed terms. These estimates have a direct impact on costs. (The author is specifically referring to BIM projects, although fortunately, in the AEC industry, the need to specify "BIM" for projects is becoming less necessary.)

The author thinks that the ideal scenario is for the project manager to be knowledgeable about BIM or at least open to learning and receiving guidance. It is highly recommended for the project manager to undergo BIM training appropriate to their role, ensuring that

project management and BIM management are fully aligned and can maximize their synergies.

In a less favorable scenario, the project manager may lack awareness of the fundamental principles of BIM methodology and either disregard its importance or remain oblivious to it, running the project in parallel until they realize that the final outcome does not meet the client's expectations. For example, Interviewee 5. In any case, conflicts arising from the overlapping responsibilities should be avoided. Collaboration among all parties involved should prevail, aiming to enhance the overall project management, whether it is labeled as a BIM project or not. It is worth noting that intermediate positions, such as BIM coordinators or BIM planners or modelers, are crucial, depending on the project's size and complexity. These roles ensure that BIM management can maintain a holistic view of the project, as the BIM manager often gets entangled in resolving minor issues, affecting BIM planning.

George Lucas, director of Star Wars, has mentioned during an interview that *"Technology is not going to save us. Our computers, our tools, our machines are not enough. We have to rely on our intuition, our true being."*

Similarly, the author believes that BIM alone is not enough. The expertise and magic of a BIM manager and their team are required to assess, plan, implement, manage, and fully leverage its potential.

This comprehensive range of tasks constitutes a significant part of any project. Therefore, when you engage a BIM management service for your project, it is crucial to recognize that you are also enlisting a substantial portion of its overall management.

5.2 Manager or leader?

Similarities and differences have been discussed in previous chapters even though many or most of the researchers emphasized their differences. For example, Madsen, (2019) has indicated that *Manage tasks and Lead people.* According to her research, management is more task-oriented and leadership is more people-oriented. The author partly agrees with this, only partly. It is indeed leadership has been studied that it sets directions for change, goals and motivating the team toward this new direction. It is totally agreed. But on the other hand, it should be mentioned that without the following management, which focuses on supervising the impact and implementation performance of that motivation or stimulation, leadership dies in the beginning.

This shares the same logic with management-to-leadership. It is not possible to separate them easily because *Tasks are executed by People*. Of course, the author thinks that previous research is not intended to take them as two opposing concepts and it is essential to consider their focuses. But still, the author would prefer to emphasize their intersections, because for most practical cases, what the author means is, for most project-based teams, the leader is exactly the same individual as the project manager. You cannot expect the top

management or the CEO to show up on the site every day stimulating the team with big words and boosting morale with rewards, punishment, and charisma. Mostly, it is the project manager who plays both roles for daily management of routine work and leading them with future expectations and charisma. So, it is much important to emphasize both management and leadership at the same time and try to study their intersection. Bennis and Nanus, (1985) ever said *"Leaders do the right things; managers do things right"*. But you know what, the author says, do the right things AND do things right, because the project needs you as both. And it is agreed by Madsen, (2019) who believes project managers must effectively manage tasks and lead people both. As she said, to build a team with good performance, and strengthen the relationships with clients, it is not possible to accomplish that by only logic. As project managers and BIM managers, one needs to be creative, empathic, willing to take risks, visionary and importantly, able to connect with others from a personal level. When BIM is integrated into project management, more attention should be paid to leadership while at the same time daily management by project managers and BIM managers are executed, as we discussed in chapter 5.1, management based on technology is not enough, we should definitely consider the intuition and people. Because even though BIM is not a new thing for the industry, the effect BIM implementation of BIM is still under discussion especially regarding the management performance, and many people still have not formed the habit and effective experience of using BIM or even simple visualization to manage projects. Of course, as project managers and BIM managers, you need to face this, just as Interviewee 5 does.

One of the characteristics of BIM-oriented projects is that real-time project changes will appear in the model or work process in the form of timely information, at the same time, will be known to project managers and BIM managers. Therefore, when managers deal with such real-time changes in daily project management, there is a greater need for managers to possess some of the characteristics of leadership, because when we study the difference between management and leadership, it is shown that dealing with changes is an advantage of leadership since management skills are more related with routine tasks and "leaders" tend to be more risk-taken and creative.

Based on previous research and discussion above, the author would like to generally consider leadership as a subset concept of management in this paper, or in other words, the dynamic side of management. This is why during the interviews, most of them would also like to dilute the concept of *"leader"*. They think that leadership is inserted in management already. It is more like dynamic facilitators that they applied for project management. Interviewee 4 indicated that a leader is not BOSS, so she said. She believes the project manager should definitely be focusing on activities and individuals, soft management skills are integrated in daily management instead of being BOSS's stimulation occasionally. So, when project management is discussed in this paper, leadership is also considered in some way.

5.3 Shared leadership box within roles

In this paper, 4 main roles are interviewed which are project manager, BIM manager, project planner, and BIM modeler. Many of them are intersected, almost all the interviewees have experience from at least two related roles in their career, except Interviewee 6. This is corresponding to the research from Beckley, (2020), where we can know that employees positioned as project managers or other individuals between top management and staff members share the similar significant portion of their time and effort to daily work, for instance, scheduling, meetings, coordination, communication etc. For BIM-oriented projects, it is a good thing because everyone is in the same shared box, and this makes them leaders and followers. The accountability of different actors within BIM projects may sometimes be unclear, resulting in them acting as their own decision-makers to negotiate their roles and responsibilities when working on different projects, or the client may define them.

Shared leadership box within roles means a high degree of intersection of information flow, this is a big difference compared to traditional projects. BIM-oriented projects make it possible for project managers, BIM managers, project planners, and BIM modelers to work in the same information flow, which is updated lively.

5.4 Leadership challenges under construction 4.0 and BIM

After discussion of BIM management turning into BPM under construction 4.0, and leadership as a dynamic facilitator of management and the necessity for managers possessing leadership competencies, it is essential to know if there are obstacles or challenges for doing so.

Many interviewees have mentioned the development of BIM from 3D to *n*D, and its consistent challenges in different stages. Because change from lower level to higher requires leadership mandate and willingness, industrially, organizationally, and projectly. (Interviewee 1) What is *n*D? BIM beyond the third dimensions can refer to be used for planning (4D) and costing (5D) and sustainability (6D) and facility management (7D) and safety (8D) and maybe *n*D.(Charef *et al.*, 2018) According to their study, initially, the 3D BIM model was insufficient, and to expedite project completion, the "time" aspect swiftly became the fourth dimension of BIM. However, numerous other dimensions must be incorporated for BIM to realize its potential, including sustainability, asset management, accessibility, safety management, energy efficiency, acoustics, and others. The integration of these dimensions with the 3D BIM model has resulted in the development of n-dimensional extensions. The *n*D model expands on the 3D BIM model by incorporating "multiple aspects of design information required at each stage of a building facility's lifecycle". The model will bring dataset which can be easily searched from the model and facilitate their workflow during the project. (Park and Cai, 2017) While the industry has seen significant benefits from the third dimension, for instance improved design quality,

communication, and time and cost savings, the fourth and fifth dimensions, even the sixth and seventh dimensions have also gained attention. (Chen and Luo, 2014)

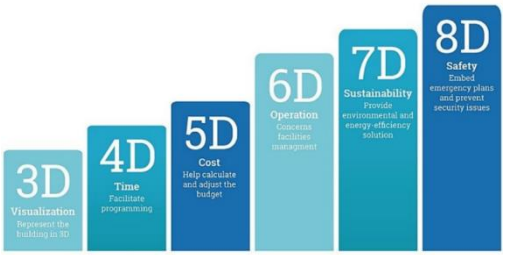

Figure 8: BIM dimensions (Charef et al., 2018)

Pan and Zhang, (2021) has indicated that in traditional projects, information exchange within project actors and processes is always disorganized, which results ineffective sharing and information flow. In contrast, BIM-based projects promote more flexible and cross-interaction, with information being collected and distributed transparently between different stakeholders. BIM project management, especially the application of Cloud BIM has greatly facilitated the collaboration. Shared working platform is provided for gathering information, managing for a same project (Sinenko et al., 2020),which is already used by Interviewee 6. The exchange and flow of information within BIM process involves multiple departments and participants, starting from the design phase all the way to the operation phase. Throughout this journey, information within the BIM system constantly circulates and updates.(Xu *et al.*, 2014) Interviewee 1 shows that information distribution and accountability mapping is integrated in the BIM process through the whole project lift span. It is a mapping tool for implementing leadership on different activities and stakeholders. It can be traced through the information tag. Activity-based leadership acts when activity is planned and executed, it is done when it is done. Information of the activity will partly flow to the next activity since activity itself is the core.

But does this mean it will be easier for project managers and BIM managers to execute management and leadership? Not really.

The first challenge is to deal with mass information from BIM for project leaders, what the author means here is project managers and BIM managers. Interviewee 2 has mentioned that since mass information is generated in BIM-oriented projects, it becomes more challenging for project leaders to pay attention to what information is delivered to the next activity and to whom, to maximize the flow efficiency and activity performance. Sometimes you do not need to accept information which is not your responsibility because it may make you confused for accountability intersection. The author would like to define this challenge as turning to information-oriented leadership, from tasks-oriented management and people-oriented leadership. Loss of information and overload of information is also mentioned by Sundquist *et al.*, (2020). This is quite new and as project managers and BIM managers, they need to be familiar with the management map to better distributing the facilitators.

The second challenge is to deal with lacking. According to Sundquist *et al.*, (2020)'s table about the challenges for BIM implementation, it is recognized that many things are lacking, for instance, lack of education, knowledge transfer and support on BIM, lack of template system for organizing the data, lack of dedicated time to drive BIM etc. Interviewee 5 feels the same way since almost everything is lacking in the beginning.

Role's accountability confusion could be seen as the third challenge, it is difficult to agree on a suitable criterion for the information box and model, sometimes even from a project level. For project managers, how to deal with stakeholders about the confusion is a science.

Significantly, gaining acceptance is the fourth key challenge for project leaders since they have to consider how to have everyone onboard. Resistance to change is always an issue in project management.(Chan *et al.*, 2019) Interviewee 4 must know this well especially when she needs to educate a colleague who refused to use BIM all the time. The good news is that she made it. So at least from this aspect, she is a qualified leader.

5.5 Leadership styles

It is interesting to identify that different interviewees have emphasized different leadership styles, and sometimes similar.

Because of the differences between BIM-oriented projects and non-BIM projects, leadership approaches are not the same. Project manager plays a more important role in non-BIM projects. With a working environment filled with more fragmental information and activities, leadership tends to be more hierarchical.

As traditional projects become increasingly complex, team players involved in the project branch out into specialized areas of expertise. This complexity necessitates a strong and powerful leadership for controlling communication, collaboration, and coordination among project management. (Dossick and Neff, 2008) A tall structure team is preferred by project leaders. Interviewee 4 has given an expression which is bureaucracy is easier to be generated in traditional projects than BIM-based projects. Lower efficiency for information sharing could be one reason. On the contrary, BIM-oriented projects tend to be inserted in a team which is flat structure because of the transparency, open data access, and efficient information sharing.

By studying previous research of Liphadzi *et al.*, (2015), different leadership styles are identified as autocratic, democratic, transformational, transactional, and laissez-faire. Both transformational and transactional factors are important for effective leadership, including charisma, inspirational motivation, intellectual stimulation, individualized consideration, contingent reward, management-by-exception, active and passive management. Interviewee 1 described him as a supportive leadership which shares part of the same characteristics with transformational and transactional leadership. Communication is the most important thing Interviewee 1 suggested, and this is agreed by the author and most of other interviewees. Interviewee 3 thinks powerful leadership promotes efficiency

sometimes. The author does not think that this means Interviewee 3 underrates the importance of communication cause he and Interviewee 2 both indicated that it is suggested in planning stage.

Liphadzi *et al.*, (2015) also indicate that effective managers are expected to have the ability of realizing what leadership style is necessary and finding the best option for a given situation, while relying on previous studied successful characteristics. This corresponds to that leadership is an ever-changing concept through the life cycle of a project. When Interviewee 1 said this, the author believes that a good leader should be able to adapt him/herself to the changes of the project. In a BIM-oriented project, the changes and information are managed in a more structured way. This brings convenience for project leaders to identify. On the other hand, being energetic and quick-minded is a necessity for project leaders.

Toor and Ofori, (2008) suggested that project leaders are culture builders for teams, constructor of environment of trust, cooperation, transparency, and happiness. This is also mentioned by Interviewee 4 who thinks that leaders should have openness, trust, and honesty. Making everyone in the team feel needed will promote productivity.

For Interviewee 4, It is important for leaders to have openness, trust, and honesty. Support to your team members is so important to team building as it shows care to others. No matter if it is a small project or complex ones, everybody is needed. Every specialty is needed. Every competence is needed. Of course, sometimes the leader needs to make decisions where the team absolutely does not agree, but he/she must. And the leader also needs to justify why he/she makes the decision to have everyone on board. It is always better than just telling them that's just the way it is.

Ozorhon and Karahan, (2017) and Alwan *et al.*, (2017) believes that strategic leadership plays a critical role. Strategic leadership refers to the project manager's ability to express a long-term vision for the organization or a specific area of it, and to inspire and motivate others to adopt and work towards that vision. Effective implementation of strategies to manage employees and the ability to influence and facilitate organizational change are also key aspects of strategic leadership. This is expressed by Interviewee 1 and 2. Visionary is related to risk management because in many cases, being visionary means a leader is more likely to identify the risk earlier. BIM provides convenience for risk management since shared working platform makes it easier for early involvement of roles and risk identification.

Even though authentic leadership is not exactly mentioned by interviewee 1, interviewee 2 and interviewee 4, they have still expressed some similar competencies with authentic leadership which they value much. Interviewee 1 indicated that he values support and communication a lot within teams and hopes to have shared box between leaders and team members. The ability to stimulate others with better motivation is another point he emphasizes. Interviewee 2 is a very classic democratic and authentic leader. She defines

herself as a leader good at listening and having everyone onboard and encouraging creativity. This is very authentic. Penetration is another word she used to show that she is willing to influence others with her own actions to motivate changes. Same with interviewee 2, interviewee 4 also said that it is important to be supportive as a leader. Interviewee 4 has been working on creating a comfortable working environment where everyone can be themselves. A leader is not BOSS, so she said. A leader should be team based and project based.

Even though authentic leadership seems well implemented in construction based on our interviews, it is still being questioned according to research in recent years. Alvesson and Einola, (2019) also indicated that the concept of authentic leadership is often viewed as a fixed and unchanging quality, which demonstrates a narrow understanding of this phenomenon in relation to workplace dynamics, social contingencies, and diverse interpretations of authenticity. Additionally, authentic leadership theory largely neglects the role of leadership itself, offering little guidance on how authentic leaders should behave. While it is valuable for individuals to strive for self-awareness, transparency, and consistency, this perspective diverges significantly from the active management of meaning, which involves motivating individuals to exert greater effort, creativity, and enthusiasm to achieve positive outcomes.

Interviewee 3 talked about the future which seems still far, but not that far. According to studies from Yang *et al.,* (2022), the development in other industries under digital era brings plenty engine power for construction 4.0 and this will enhance greatly to the development of leadership studies. Interviewee 3 does think this way. He believes BIM will AI-ized soon and this will bring new challenges and opportunities for project leaders, or even bring new roles. So, leadership implementers should keep learning and never being reluctant to try new things under a new era.

5.6 Leadership competencies

Since we have discussed the difference between management and leadership, and their intersection, and also the challenges in front of leaders under BIM application and construction 4.0, now it becomes our last step to reach our research goal which is to find out what are the valued leadership competencies then to step over those challenges and how can we know if a project manager or BIM manager is qualified enough to have these competencies? And what are the indicators of a good leader?

Leadership competency is a previously mentioned concept which is better discovered by a framework first. So, what competency framework should be used in this paper? Breaking down the components of competency can provide insight into its workings, said Succar *et al.,* (2013).

The purpose of a leadership competency framework is to outline the criteria for achieving performance excellence among project/BIM managers within project team and

organization. Each competency within the framework provides a general description of the exemplary working behaviors (or not only behaviors) expected from project managers. These descriptions serve as a reference for discovering what leadership competencies are valued for good project/BIM managers and as standard against which project managers' leadership is evaluated. Moreover, a leadership competency framework serves as a communication tool for project teams to convey the behaviors that are necessary, appreciated, acknowledged, and rewarded in relation to managers, and even all team members. It ensures clarity by clearly stating the expected behaviors (or not only behaviors) and helps in establishing a common understanding of performance expectations among project/BIM managers.

The author would like to establish the framework including the following 3 aspects after studying the previous research: skills, behaviors, and traits as 3 main classifications of leadership competencies for BIM-oriented projects. Omer *et al.*, (2022) share the same framework, but according to their research, they found that the most common constructive leadership characteristics are *tolerance* (behavior), *communication* (skill), and *reliable* (trait). This is not exactly the same as the author's result which will be clarified in the following. Succar *et al.*, (2013)'s research direction is similar who have a framework including knowledge, skill, and personal traits. Yang *et al.*, (2022) have a different idea about the framework. They classified the leadership competencies into 4 domains which are cognitive domain, interpersonal domain, business domain, and strategic domain. The author thinks it is a good way to know leadership competencies from a higher picture but on the other hand, it may dilute managers' view of priorities if many criteria are emphasized.

5.6.1 Skills: communication skills

Similar to the opinion of Omer *et al.*, (2022), communication is a most valued skill as well after summarizing the interview results. The author would like to say that communication skills of leadership include listening and encouraging in this paper. Interviewee 4 ever said that a good leader means to have a mix of almost all sorts of competencies and personalities, where communication skills are one of the most important ones. A team is founded with a shared aim but different cultures and personalities, different roles accounted for various work, this requires a leader can prescribe the right medicine for different people and adapt to the situation.

Interviewees 2 and 1 separately emphasize the significance of listening and encouraging. They both agree that this means a lot for project actors and will motivate productivity by making them feel needed. Listening also can indicate some obstacles or emotional resistance hidden in the team, for instance, someone maybe not willing to using BIM compared to old working approach. Interviewee 5 indicated that by creating a comfortable atmosphere and working environment will insert confidence in every team member.

The author agrees with Interviewee 5 who believes communication skills play a unique significant role in leadership for BIM-oriented projects. With a higher-level

implementation of BIM, after integrating more information into management approach, the significance of communication will stand out.

Then how do we know if a project/BIM manager has good communication skills or not? Or what are the indicators of communication skills? Is it just listening and encouraging? Or course not.

The author has summarized the following indicators of communication skills based on research and interviews, if a project/BIM manager has the signs of doing so, then it means he or she has good communication skills.

1）Being a good listener. This is first identified by the interviewees. It means you talk with your team instead of talking towards them. You should be acting like that you are thinking what they are saying and trying to absorb their input and ideas.

2）Being honest. It is important to tell the truth all the time and unnecessary to hide your real thoughts.

3）Ask questions. To be supportive a project manager should ask questions within your team to find out what is needed by your team and let them know you care about the individuals and processes.

4）Being clear and straightforward. You are not expected to talk too much no matter in what kind of meetings or discussions. Making your mind clear and wording your sayings precisely is a basic for being a good communicator.

5）*Being willing to take criticism.* A leader cannot be perfect all the time, when communicating with others, being willing to take criticism can always make your team performance better.

6）*Encouraging.* It is also mentioned by many interviewees that many people have different levels of skills and no doubt that everyone is improving all the time. If you wish them to be better tomorrow than today, encourage them with your practical support since this will make them confident.

7）*Quickly praise.* This is significantly mentioned by interviewee 5 who has established a big rolling paper wall to show every achievement from her team. This motivates the team a lot and tells them they are doing things right.

By doing so, it becomes easier to find out if a project leader is good at communicating or not. Of course, there are some signs as well which show the opposite. For example, never give feedback, shut down ideas from others, no public praise and so on, which for sure a good leader should not do.

5.6.2 Behaviors: decision making

The author would like to define decision-making as a critical behavior of leadership after studying papers and summarizing the interviews. Even though the interviewees share

different opinions on decision making. Some of them, for example, Interviewee 4 prefer to have everyone for decision making to reach the best result while Interviewee 2 thinks differently, especially in the planning stage. She believes sometimes it brings chaos.

Yang *et al.*, (2022) has summarized 22 leadership competencies are categorized into four domains where we can see critical thinking and purpose-oriented in cognitive domain which plays a fundamental role. Those are required for decision making competence for leadership.

Why is decision making emphasized by the author? Because it is indeed significant.

Project/BIM managers must possess the ability to make a diverse range of decisions, and effective decision-making often yields the following outcomes:

1）Problem-solving. Smooth business operations rely on leaders making decisions in a timely manner, effectively addressing problems and preventing delays.

2）Motivational impact. Effective decision-making fosters a culture of discretionary effort, communication, and collaboration among team members.

3）Timesaving. Clear and well-founded decisions provide a sense of direction, reducing the need for employees to hesitate or waste time pondering what to do.

4）Enhanced productivity. Many professionals have experienced frustration when a task stalls due to a lack of decision-making from management. This impedes progress and leads to inefficiency. However, when leaders can evaluate the pros and cons of a task and make decisions promptly, it allows employees to initiate work more quickly, facilitating a productive workflow.

Many researchers take decision-making into consideration as a part of management, even though it is emphasized by the author that leadership is dynamic management, it is still needed to say by the author that decision-making needs to be creative and decisive to show its feasibility and dynamic. It is no doubt that an important competency of leadership.

The author has a similar opinion with Interviewee 4 about involving others into decision making because it makes it possible for more input, of course, the decision maker is the project manager and BIM manager, so with a good communicating skill mentioned before, they will facilitate the decision-making process without any doubt. And importantly, with the help of BIM management, the decision-making process will be enhanced for leadership implementation.

Similar question with communication skills, as a project/BIM manager, what should be considered to be a good decision maker? Or what are the indicators of it?

There are many aspects which shows a project/BIM manager is acting well in decision-making, for instance:

1） *Be well-informed.* It is easier for managers to make decisions if they have enough, and detailed information collected. So, they can know what factors are involved in the decision-making process and have a big picture of all the risks at hand.

2） *Avoid emotional mistakes.* A symbol of a good decision maker is that he or she must avoid emotional decisions which will lead to impulsiveness and poor choices. Main facts and factors should be considered instead of feelings. Of course, as a leader you need to be instinctive, but this does not mean that you don't need to ask for more time to be clear-headed.

3） *Resolute under pressure.* Many managers choose procrastination when having stress or anxiety, and this is a huge threat for decision making. Smooth leadership relies on leaders making decisions in a timely manner, effectively addressing problems, and preventing delays.

5.6.3 Traits: visionary

Being visionary is a leadership trait valued by most interviewees as well, it corresponds to the ability of identifying risks and being good at planning. This can also be related to strategic leadership. By studying the concept of BIM, it is known as working method beyond 3D which is not model based, but information based (Charef *et al.*, 2018). Ozorhon and Karahan, (2017) and Alwan *et al.*, (2017) have both indicated it is important to have strategic vision in BIM-oriented projects. Being visionary is the ability of a project/BIM manager to articulate a long-term direction for the team or a specific area of the organization, and to inspire and stimulate others to share and pursue that vision. Additionally, it involves effectively implementing strategies to manage the team, and the capacity to influence organizational members and facilitate organizational change. (Davies and Davies *, 2004)

The author believes that the first thing for a visionary leader to do is to jump out from their own box since people in the box cannot realize that they are having obstacles. They also should be the ones who can see the big picture of the whole project, which brings much significance in planning stage. During construction phase, to have better workflow and performance, it is necessary for the project leader to have everyone on board and make sure they are engaged in the team. On the contrary, or maybe not on the contrary, a strong and powerful leadership for controlling communication, collaboration, and coordination among project management is preferred instead.

While individuals like Steve Jobs and Elon Musk are often associated with the label of "visionary leader", it's important to note that visionary leadership doesn't necessarily have to be grandiose or exaggerated. It can be cultivated at any level of leadership, whether you hold the position of a project manager or the CEO.

So, how can you embody visionary leadership qualities and ensure your team's success without succumbing to the pitfalls and clichés often associated with the term "visionary"? Or, how to define whether an individual is visionary?

Instead of focusing on extravagant displays or unrealistic promises, a visionary leadership style emphasizes several key aspects:

1）Having a clear and inspiring picture for the future. This picture should be grounded in practicality and feasibility, serving as a guide for your team's actions and goals. Communicating this vision effectively to your team is crucial, ensuring that everyone is aligned and working towards a shared objective.

2）Actively involving others in vision-building process. By encouraging collaboration, valuing diverse perspectives, and fostering a sense of ownership among team members, you can create a more inclusive and sustainable vision. This not only enhances team engagement but also encourages innovation and creativity.

3）*Leading by example.* Your actions should align with the vision you've set forth, demonstrating integrity and authenticity. By consistently embodying the values and principles you promote, you establish trust and credibility among your team members.

4）*Remain adaptable and open to change.* A visionary leader recognizes that circumstances and priorities may evolve, requiring adjustments to the original vision. Embracing flexibility and embracing new ideas allows for continuous growth and improvement.

5）Stay grounded and realistic. Foster a culture of accountability and emphasize the importance of measurable goals and milestones. Encourage constructive feedback and remain open to different perspectives, ensuring that your vision remains relevant and adaptable.

In summary, visionary leadership can be practiced at any level of leadership. By cultivating a clear and inspiring vision, involving your team in the process, leading by example, remaining adaptable, and staying grounded, you can effectively implement visionary leadership qualities and drive the project team towards success without succumbing to common pitfalls.

6 CONCLUSIONS

BIM is well developed after its first presentation by the industry, in both theory and reality. The construction industry benefits a lot from BIM implementation, especially in the design phase of the project. Many designers are working with 3D/4D models, even 5D now instead of 2D drawings and nowadays, some countries have announced that some specific projects must be tender submitted by BIM, which accelerates the BIM implementation greatly. However, there are still obstacles and hinders such as lack of soft skills of leadership which has a great impact on BIM project performance but still under study.

This leads to our study in this topic which aims to take research on previous literatures and the real world to see the significance of studying valued leadership styles and competencies for BIM-oriented projects and find a better performed leadership style and what competencies should a project manager have for accomplishing a BIM project.

Before concluding, the author would like to clear the research path of this paper. It follows from a path which is: *What has construction 4.0 and BIM brought to project management? Then when we talk about project management, there is usually soft side of management which is not routine or task-oriented, so that is leadership, how to identify or define leadership within project management? Then it is realized that leadership plays an important role especially under construction 4.0 and BIM, why is that and what are the obstacles? Then what kind of leadership styles and competencies are valued for what kind of roles in a BIM-oriented project? How are those leadership competencies implemented in practice? How to find out if a manager has these competencies or not?*

By following this research path, the author has discovered that 3 most valued leadership competencies as a result and am able to address the 3 research questions in chapter 1.

Question 1: What has construction 4.0 and BIM brought to project management?

Answer 1: BIM provides a wide range of capabilities that can significantly enhance project management and the dynamic shadow of it, leadership, particularly in the areas of information management and collaborative work. Building upon this a concept known as "BIM-based project management (BPM)" is introduced. BPM is a concept where the functional applying of BIM is enriched by project management requirements at different stages of the project, aiming to achieve efficient project management with BIM implementation.

Also, challenges are indicated for leadership as well because of BPM which are dealing with mass information from BIM for project/BIM managers, dealing with lacking education and support etc., roles' accountability confusion and resistance to change.

Question 2: What leadership competencies are valued in a BIM-oriented project?

Answer 2: This question is studied by a classification of leadership competencies for 3 main aspects: skills, behaviors, and traits. For skills, the most valuable BIM-oriented

leadership competence is communication skills which is agreed by all the interviews and our previous study. Decision making plays an important role as leadership behavior as it is related directly with the project performance and project efficiency by project/BIM manager. A significant trait for BIM-oriented leadership is visionary, which brings advantages for minimizing risks and forms a whole picture for project leaders through the whole project lift span.

Question 3: How to find out if a manager has these competencies or not? What are the indicators of the mentioned leadership competencies?

Answer 3: The author summarized different indicators for implementing those leadership competencies in practice which are:

Skills: Communication skills

Being a good listener; Being honest; Ask questions; Being clear and straightforward; Being willing to take criticism; Encouraging; Quickly praise.

Behaviors: Decision making

Be well-informed; Avoid emotional mistakes; Resolute under pressure. Many.

Traits: Being visionary

Having a clear and inspiring vision for the future; Actively involving others in vision-building process; Leading by example; Remain adaptable and open to change; Stay grounded and realistic.

7 RECOMMENDATIONS

This research is possible for further discovery in the construction industry since the development of BIM implementation. The following directions are suggested by the author for future research:

Exploring how those leadership competencies are implemented on site regarding to BIM-oriented projects and how to evaluate leadership performance by creating a framework or metric. Also, how BIM-ized leadership helps with change management could help with project performance is a further direction for future research.

Research about new technologies like AI-ized BIM would be an interesting path which the author believes not far away.

By addressing these research directions, the construction industry can better understand and optimize the role of leadership in BIM projects, leading to improved project outcomes, enhanced collaboration, and sustainable development in the built environment.

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