國立臺灣大學工學院土木工程學系

碩士論文

Department of Civil Engineering
College of Engineering
National Taiwan University

Master Thesis

工程設計公司發展和管理 BIM 人才的組織策略

An Organizational Strategy for Developing and Managing BIM Talents in Design Firms

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中華民國 112 年 7 月

July, 2023

doi:10.6342/NTU202303396

國立臺灣大學碩士學位論文
口試委員會審定書
MASTER'S THESIS ACCEPTANCE CERTIFICATE
NATIONAL TAIWAN UNIVERSITY

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本論文係徐嘉珮 R09521624 在國立臺灣大學土木工程系電腦輔助工程組完成之碩士學位論文，於民國 112 年 7 月 26 日承下列考試委員審查通過及口試及格，特此證明。

The undersigned, appointed by the Department of Civil Engineering, College of Civil Engineering on 26th July 2023 have examined a Master's thesis entitled above presented by Chia-Pei, Hsu R09521624 candidate and hereby certify that it is worthy of acceptance.

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謝尚賢　林祐正　林之謙

（指導教授 Advisor）

系主任/所長 Director: 葛宇甯

Acknowledgements 誌謝

首先，我最想要感謝我的指導教授謝尚賢老師，在兩年多的碩士生涯中給我許多研究上的支持，老師總是以十分精闢及高遠的宏觀讓我開拓思考進行深入的探索，也總是不厭其煩地給我許多意見及指導，在老師的幫助下我學習到用不同的思考角度去面對問題。由衷的感謝老師兩年多來的耐心提點及悉心指教，沒有您的指導我也無法完成研究。

另外要特別感謝兩位口試委員林之謙老師以及林祐正老師，在口試期間提供我許多論文上的珍貴建議，讓這篇研究更加完整。同時感謝當初支持我進行在職進修的公司老闆 CheeWee 先生以及 Alvin 先生，在公司中提供我可以盡情發展的舞台，也給我十足的信任讓我可以實踐我的想法，並且在這篇論文中用學術的角度去解讀研究，啟發良多，兩位是我在職場遇到的貴人導師。

而在工作中，謝謝 Koh 先生給我許多精闢的指導，以及 Gan 女士的理解與支持，兩位的指引是支持我完成研究的動力。另外 Adah、Teoh、Marc、Vyna 和 Ivan，謝謝你們是我最難能可貴的團隊，能與你們一同在辦公室腦力激盪、努力完成專案及許多不可能的任務是我的榮幸。在忙碌的工作中永遠對我伸出援手的 WeiKee、SanJoe、SuetYee、Magdalene、Yoo、Lai、Kenny、KK，謝謝你們，得到的幫助太多了，若有遺漏在此致歉。

在碩班期間，感謝一同打拼的同學沒有因為我的中年入學嫌棄我，感謝佳文一路給我的支持，以及庭儀的情義陪伴，還要當我的紀錄我感激不盡，祝兩位早日完成研究一起畢業！也感謝老師團隊中的所有同學們，謝謝你們拿著不在台灣的我的背板拍畢業照！感謝土木系辦及研究大樓工作人員，辛苦地維持舒適的環境讓我們可以在這努力。謝謝土研 610 從白天陪伴到深夜的苦讀夥伴們，讓中年研究生總有人陪不會獨自挑燈夜戰。

就讀碩班也開啟一條未知的領域；謝謝儒錚學長在專案上給我很多幫助，在學長身上學到許多寶貴的想法，後來甚至也給了我在 SGS 分享的機會；謝謝點構土木事務所的孟政和點點，謝謝你們相信我並給我機會幫你們做教學；謝謝 Podcaster QQ 土木人生的 QQ 學弟給我一個機會錄 Podcast，第一次在空中講 BIM，

doi:10.6342/NTU202303396

開啟了我對於這領域的熱情；謝謝新北市工務局的除除學妹，千辛萬苦隔海邀請我線上分享工作經歷，讓我有這麼有趣又有意義的經驗；謝謝 Autodesk 的阿華田也願意給我機會分享導入 BIM 的觀點；謝謝台大生工系的游教授邀請我去系上與學生做分享，讓他們更了解甚麼是 BIM；謝謝麗明營造的李經理邀請我跟同仁做分享及想法交流；另外特別感謝 Youtuber 城市語言家的 Cytus 總是給我溫暖的鼓勵及獨特見解，希望天才如你工作一切順利；最後要特別謝謝建勳學長，如果當初沒有你的推薦我也不會有機會進入 CAE 組深造。

這邊還要感謝我的高中好朋友品儒、怡君、式瑩、藝珈、耀儀、世涓、昱瑩、婉瑩、郁瑩、佳慧、韋之、學穎、在天上的薰云，一直給我心靈支持與陪伴；感謝大學好朋友及你們的伴侶們紹禎、詩婷、達言、暉涵、伊廷、浩文、宥任、晟暐、兆中、智嘉、杰蔚，謝謝你們總不厭其煩地問我甚麼時候會畢業；謝謝李大師，常常喝酒到一半要跟我討論論文；謝謝凱婷、英文老師 Heather、奕哲、小朱，給我許多信心完成學業。

接著我要感謝我的爸爸，沒有他我不會留在台灣邊工作邊讀碩士，希望在天上的你今天能以我的努力為榮，謝謝我的媽媽容忍女兒總是任性的做出奇怪的人生選擇，謝謝我的妹妹和弟弟，讓不像姐姐的我無後顧之憂，也讓我的生活總是十分有趣。最感謝的是我的男友靖博，時而扮演嚴師鞭策督促進度，時而扮演好友體貼照顧相談煩惱，給我許多支持陪伴，鼓勵我完成研究。

最後，在此向所有關心我、幫助過我的人致上最誠摯的謝意，謝謝你們。沒有想過在畢業近十年後會回到校園進修，就像疫情在我們的人生中莫名插腳，事發突然，只能面對並交出人生的功課。畢業後的未來還有許多挑戰，但相信帶著大家祝福和勉勵，在未來我還能夠繼續勇敢堅定、向前邁進、有所貢獻。

doi:10.6342/NTU202303396

中文摘要

建築資訊塑模 (Building Information Modeling) 是營建產業數位化轉型的關鍵要素，在設計階段，BIM 提供了資訊管理和協調溝通的平台，其強大的 3D 圖形可視化和協作功能有助於提高設計品質。然而， BIM 的應用進展緩慢，主要是因為其導入存在困難，由於缺乏具備相關技能和經驗的專業人員，BIM 的整合設計無法有效進行，從而阻礙了其在設計中的充分應用。而多數的研究基於 BIM 的工作與能力分級、亦或是以 BIM 的導入做討論，而鮮少以 BIM 的人才管理為本去做導入的策略討論。本研究的目標是制定一種組織策略，在工程設計公司內發展和管理 BIM 人才。BIM 工作不應僅僅被視為建模，而應被視為專案中不可或缺的組成部分，可以帶來顯著的效益。本研究制訂一策略為通過從人力資源管理的角度對 BIM 工作能力進行分類，確定適當的 BIM 培訓水平，在本研究中提出新的組織小組結構以涵蓋組織所需的 BIM 功能，培養能成功導入 BIM 的學習文化，還提供一個組織導入 BIM 的指引圖，使工程設計公司能夠建立完善的組織結構，以多方位培養所需之 BIM 人才並充分發揮 BIM 的潛力，提高設計工作的品質。

關鍵字：建築資訊塑模（Building Information Modeling）、BIM 導入、組織策略、人力資源、在職培訓、人才管理、工程設計公司

doi:10.6342/NTU202303396

ABSTRACT

In the digital transformation of the Architecture, Engineering, and Construction (AEC) industry, Building Information Modeling (BIM) plays a crucial role. BIM offers an information management and coordination communication platform during the design stage, with its powerful 3D graphic visualization, enhancing a collaborative project culture that leads to improved design quality. However, the slow adoption of BIM is due to the difficulties encountered in its implementation, the full utilization of BIM in design is hindered by a lack of skilled professionals who can integrate design experience effectively through BIM. This study aims to develop an organizational strategy to manage and develop BIM talents in design engineering firms. BIM work should not be perceived solely as modeling, but rather as an integral part of the project that offers significant benefits. This study formulates a strategy to determine the appropriate level of BIM training by categorizing BIM job competencies from a human resource management perspective. The study proposes a new organizational team structure to cover the organization's required BIM capabilities and foster a learning culture for successfully BIM implementation. Furthermore, a guide map for implementing BIM has been provided to help engineering design companies establish a sound organizational structure, cultivate the required BIM talents in multiple directions, and leverage the potential of BIM to improve the quality of design work.

Keywords: Building Information Modeling (BIM); BIM Implementation; Organizational Strategy; Human Resource; On-Job Training; Talent Management; Design Firm

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Chapter 1 Introduction

1.1 Background and Motivation

The construction industry has undergone a digital transformation for decades by adopting digital technologies such as Building Information Modeling (BIM) (Matarneh & Hamed, 2017). BIM is a powerful tool that allows project teams to manage a project through a model-based collaborative approach and provides data-driven modeling, visualization, analysis, and simulation capabilities (Abubakar et al., 2014).

Using BIM can reduce costs, shorten delivery times, and improve quality. BIM offers the benefits of cost savings, a robust work environment, and convenient and secure collaboration when used in small and medium-sized architectural firms. In addition, BIM can improve the performance of construction companies. The adoption can lead to numerous benefits, such as reduced time delays and costs, better project coordination, increased productivity, and better control over design projects. Ultimately, BIM can revolutionize the construction value chain by bringing technology into the construction process.

In Lu and Xu et al. (2020), longitudinal social network analysis research for BIM projects showed that implementing BIM in an organization changes the organizational structure by making it looser and flatter, also increases communication efficiency in the project, and re-organizes the collaborative process at an earlier stage. Moreover, the experiments by Lee et al. (2016) indicated the limitation of using the drawing-based design review: even experienced professionals could not detect 5% of known errors on drawings.

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However, even if benefits derived from efficient knowledge and process management using BIM are increasingly recognized and technologies are rapidly growing, BIM adoption still needs to grow.

Much research has been conducted on the barriers to implementing BIM. For instance, Siebelink et al. (2021) identified the following obstacles in different organizational levels to BIM implementation within an organization: (1) Lack of top management support; (2) People & culture; (3) Technology; (4) Procedures. The construction industry is intricate and fragmented, where the supply chain plays a crucial role in the success of BIM implementation. The industry's environment affects the implementation outcome, such as the need for more supply chain and institutional support. Depending on the need for clear and practical strategies, the adoption and implementation of BIM vary from developed to developing countries, as observed from the current global status (Matarneh & Hamed, 2017). Implementing BIM can be difficult due to complex technical, organizational, and cultural factors. To use BIM effectively, project teams need to adjust to new processes and tools, like 3D modeling software and cloud-based collaboration platforms (Arayici et al., 2011). Therefore, if the focus is solely on learning a 3D modeling software and the potential risks of organizational change are ignored during implementation, the result of digitalization will likely end in failure.

To successfully integrate BIM, an engineering design firm must first create a detailed plan that addresses the unique challenges faced by various parties during different phases. The progress of BIM integration may involve implementing training programs, developing supportive policies and regulations, and encouraging collaboration and innovation within the construction industry before hiring experienced personnel to execute the process.

doi:10.6342/NTU202303396

To date, several studies have been conducted to determine the benefits of integrating BIM (Hong et al., 2018). While the focus has been on BIM's application, more attention should be given to mapping the inputs required for BIM. Overlooking that BIM encompasses inputs and outputs can potentially result in additional barriers to its implementation and the underestimation of risks associated with this transformative change (Bonanomi et al., 2016). Chien et al. (2014) suggested using BIM technology to reduce financial and legal risks in project management; additionally, common challenges are a lack of project experience and skilled personnel.

Assessments of BIM maturity and capabilities have been studied to assist organizations in customizing their implementation strategies and tracking their advancements (Succar, 2010). Studies have analyzed job acquisitions and positions for BIM to help organizations find suitable employees (Joseph, 2011; Nguyen et al., 2020; Uhm et al., 2017). On the other side, the studies related to the BIM implementation stagey has indicated the importance of competency build and organizational structure changes (Kouch et al., 2018; Siebelink et al., 2021). However, there is a gap in research to guide organizations on building a workable structure to cultivate and develop BIM talents based on these various competencies and positions and to create a balance step to bridge the BIM implementation and the projects execution.

Since the Covid-19 pandemic, the construction industry has faced demands to digitize the workforce. Automation and digitalization have led to advancements in robotics, 3D printing, and improved productivity in construction. BIM provides accurate data for model simulation and machine control in robotic construction (Kouch et al., 2018). In addition to downsizing and the AI era replacing basic skilled labor such as 2D drawings drafting, BIM is not only the solution but also increasing efficiency. A BIM-enabled work environment is a foundation to achieve construction automation

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soon. It is imperative that we establish a framework that amplifies the ongoing development and learning of engineers in the workplace (Nittala et al., 2018). Therefore, talents with knowledge and skills will be critical to realizing the changes; hence, the key to solving the root is how design engineering firms can create the environment to manage and develop BIM talent.

1.2 Research Objective

Developing BIM talent is the fundamental prerequisite for successful BIM implementation. Much research has studied the barriers or success factors of BIM implementation and analysis of the competency of BIM. However, more is needed to provide a strategy for an organization to develop and manage BIM talents. Cultivating an expert requires long-term planning, skill learning, and repeated project practice until one can justify an independent decision. The design stage of a project is crucial as it impacts the project's outcome and the implementation of BIM tools. However, adopting BIM necessitates an implementation strategy and professional guidelines at the operational level. The objective of this study aims to develop an organizational strategy from the perspective of human resources in a practical way that could create an environment for developing and managing BIM talents within the project works; the topic listed as follows:

a. This study collects the previous studies on the implementation strategies of BIM and identifies the main success factors and obstacles. Based on these sources, the critical success factor of implementation is analyzed, and then the basic scope of the strategy is designed.

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b. To develop BIM talents within an organization, this study reviews BIM education from academia to industry, then examines studies on human resource management perspective and uses the findings to define the critical factor that could retain BIM talent.

c. The results of these two topics, illustrated in Figure 1.1, will be used as input for developing the BIM talent training program.

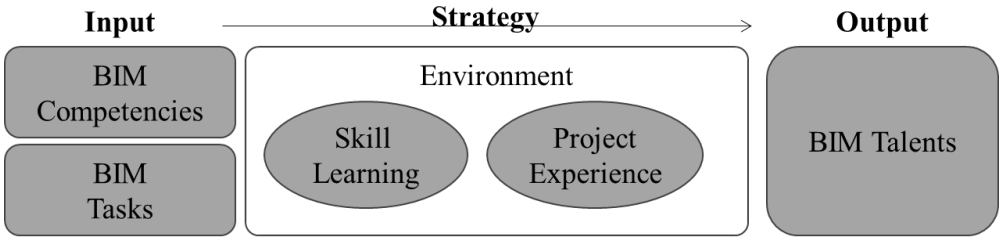

Figure 1.1 Initial Concept of the Strategy to Cultivate BIM Talents

1.3 Organization of Thesis

The structure of this paper is as follows; after reviewing and discussing the literature about implementation strategy, Chapter 2 lists the key factors that form the scope of the strategy and reviews the education and training of BIM and propose the strategy in human resource perspective to setup a career path in BIM. Chapter 3 concludes all and proposes a strategy based on the scope of the talents cultivated and the content of the strategy, which includes setting up the strategy, categorizing the competencies, job design for the role, and on-job training for career development. The paper presents and discusses the results of adopting this approach's case study in Chapter 4. Finally, Chapter 5 includes the conclusion and future work.

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Chapter 2 Literature Review

2.1 A Successful BIM Implementation Structure

Various approaches have examined the obstacles and crucial factors in implementing BIM (Chien et al., 2014; Abbasnejad et al., 2021; Abubakar et al., 2014). Implementation is seen as a dynamic process. Siebelink et al. (2021) have identified various barriers to implementing and using BIM based on existing theories. These barriers can be categorized into management support, people and culture, technology, and defined processes and standards. According to Siebelink et al.'s (2021) research on simplifying organizational levels (illustrated in Figure 2.1), the BIM department can be considered a separate team that works alongside the project and IT departments. Siebelink (2021) has identified the IT department is an isolated department under Top Management which connected with Project Team and BIM department. Since Siebelink's (2021) research also been influenced by the supply chain hence there is an External Facilitator indicated out of the organization in Figure 2.1 .

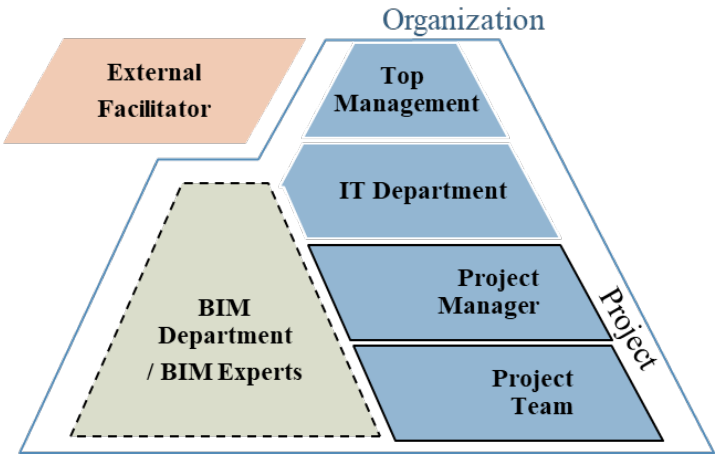

Figure 2.1 Generic Picture of Organizational Levels from Siebelink 's (2021) Research

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Research has shown that the one who overcomes the prevailing organizational obstacles is the one who makes it, which is related to motivation and the ability to change. The barriers are effectively presented in Figure 2.2 recreated from Siebelink S. et al.'s (2021) research result, aligning with the organization's BIM maturity levels. This discussion will thoroughly explore the advancement of BIM maturity levels, starting from the lowest level and moving towards the highest, as clearly indicated by the blue arrow presented in Figure 2.2.

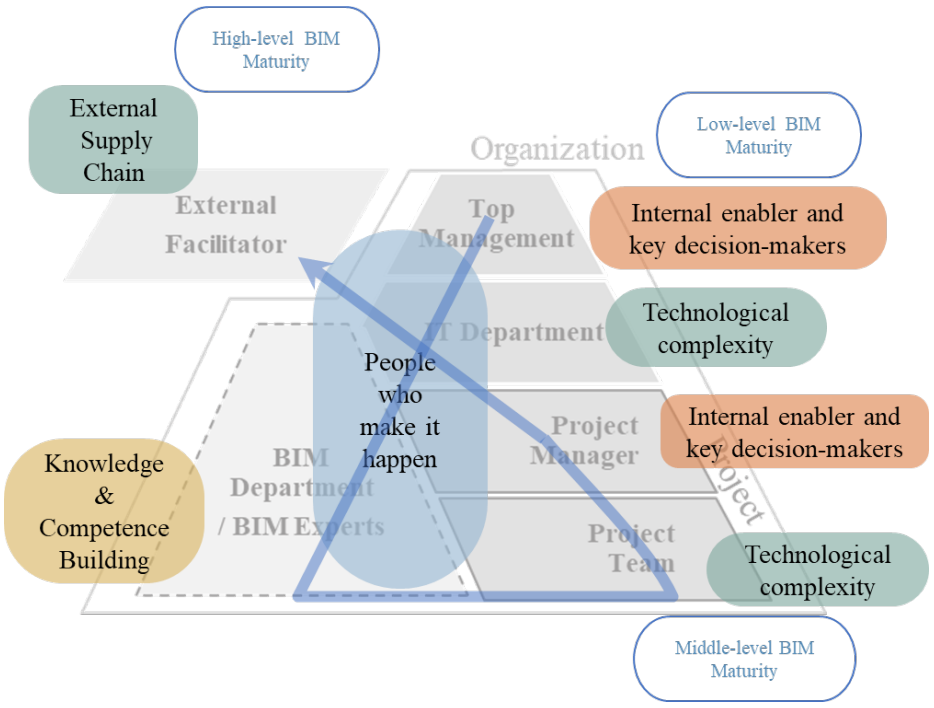

Figure 2.2 Barriers in Organizational Levels Recreated from Siebelink's (2021) Research

Follow the trend of the arrow to evolve the result shown in Figure 2.3, the initial implementation of BIM mainly encounters difficulties due to a lack of top management support and ineffective knowledge. As experience is gained, BIM reaches a medium

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maturity level, but obstacles arise from the diversity of projects and disciplines that hinder standardization. The organizational and project structure must be redesigned to reach a high maturity level, and resistance to project autonomy must be overcome. The final obstacle is the insufficient maturity of the supply chain. It is important to note that people and culture play a significant role in the implementation process.

During the first stage of implementing BIM, the individuals in charge of the process can play a crucial role in promoting a suitable organizational culture that will aid in adopting organizational change resulting from implementing BIM (Abbasnejad et al., 2021). Furthermore, in the middle of the implementation, senior-level executive/project management support is the most crucial dynamic factor for the overall adoption of BIM, which changes the internal workflows (Villena-Manzanares et al., 2021; Siebelink et al., 2021). Start with smaller projects using lower LOD BIM to gain experience before undertaking High-Level BIM or complex applications to avoid risks. (Xu et al., 2021)

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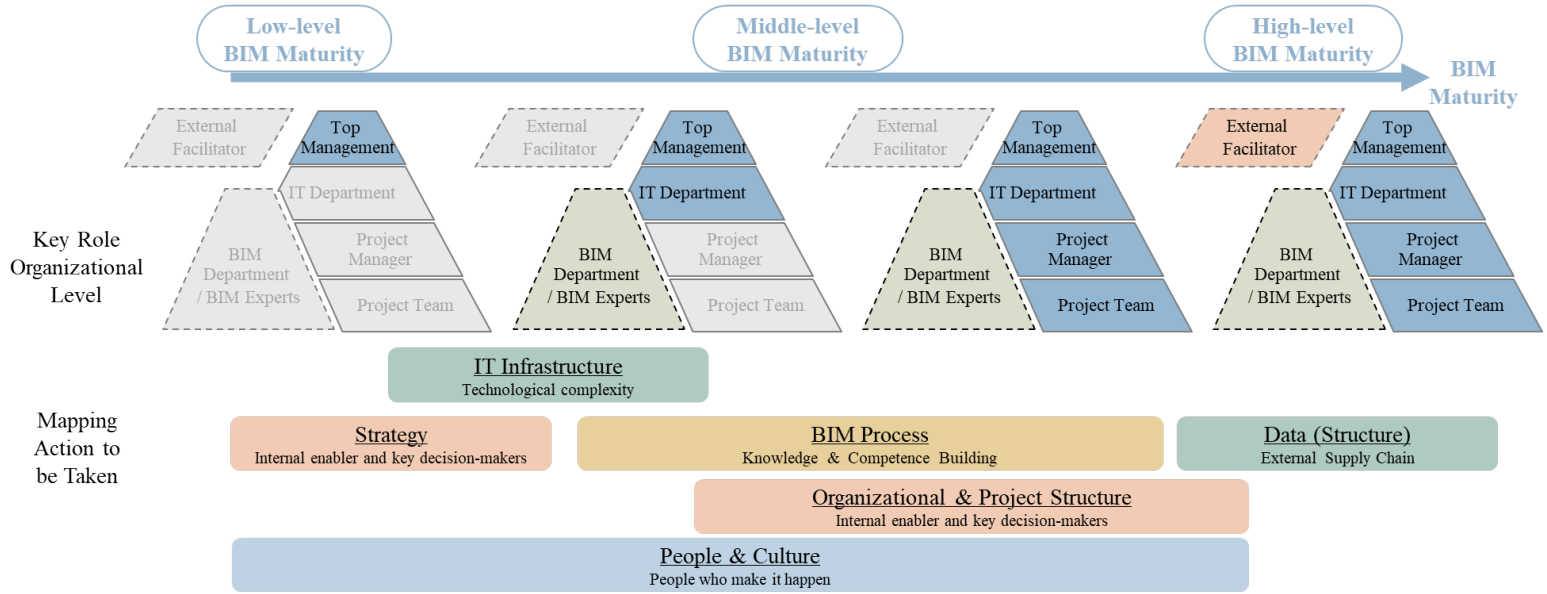

Figure 2.3 Barriers in Organizational Levels with Maturity Levels Recreated from Siebelink's (2021) Research

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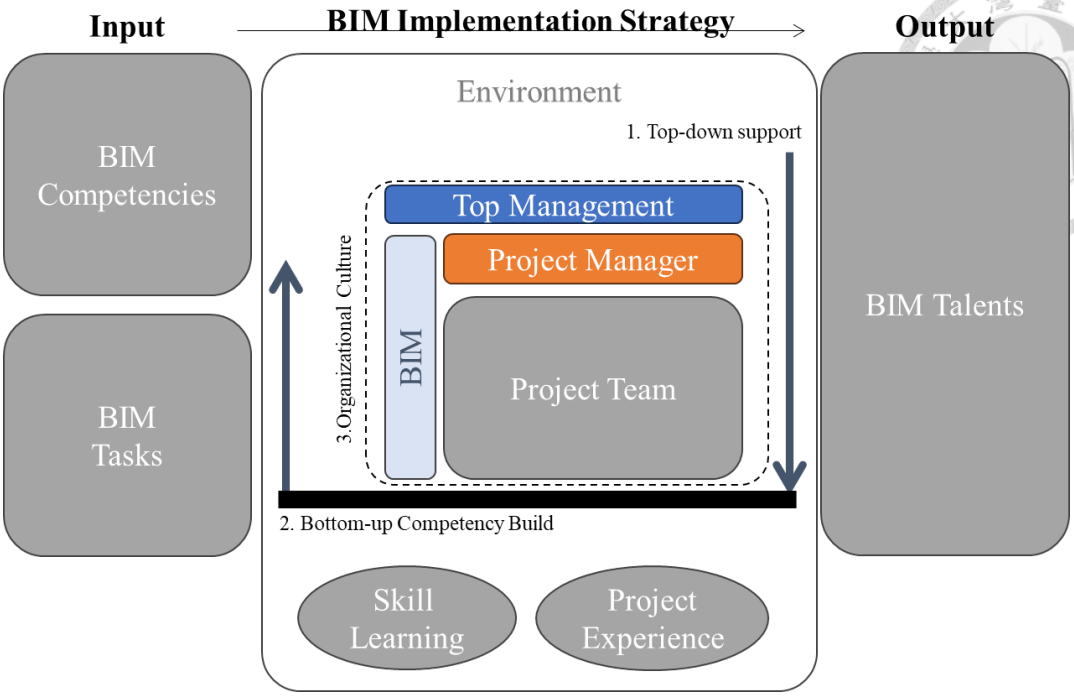

Figure 2.4 Strategy of a Successful BIM Implementation Structure- Key factor

To sum up, the research conclusion from Siebelink et al. (2021), as shown in Figure 2.4, setting up a successful BIM implementation structure from scratch requires:

1. Assign a BIM leader who will execute the strategy with unwavering support from top management.
2. The system must embrace a bottom-up approach that integrates competencies into job descriptions and encourages employees to embrace the BIM role through personalized training programs.
3. Establishing an organizational culture that fosters BIM implementation is imperative to prevent any pushback from middle-level management (project manager) during the implementation stage.

doi:10.6342/NTU202303396

2.2 Organizational Culture and Internal Work Group

Continued from above, the development of organizational culture is a socio-dynamic process and is considered "an emergent property of informal relationships within work groups" (Krackhardt et al., 1990, pp. 142-154). Kissack and Callahan (2010) stated that changing organizational culture and training programs requires multiple intricately linked interventions. In Rasool's research (2017), it was found that most employees are influenced by training in their company culture.

According to Papadonikolaki (2018), innovation is influenced by the networking of various projects. Therefore, it is best to focus on individual project levels. The motivation behind a project network can significantly impact the success of implementing BIM. This includes internal drivers, such as the need for quality assurance, and external factors, like market pressure or client demand. Therefore, working groups could explore how project networks can be used to support the implementation of BIM and address any bottlenecks or concerns that arise. In addition, the capability of existing staff to use BIM tools positively impacts establishing an organizational knowledge-support system, which ultimately determines the decision to adopt BIM. Therefore, staff engagement should be emphasized during the implementation process (Hong et al., 2018), and working groups would be a way to arise employees' participation for BIM implementation.

Consequently, for successful cultural transformation, the strategy shown in Figure 2.5, is vital to begin by creating a training program and securing the backing of the organizational roles working group involved in the project network.

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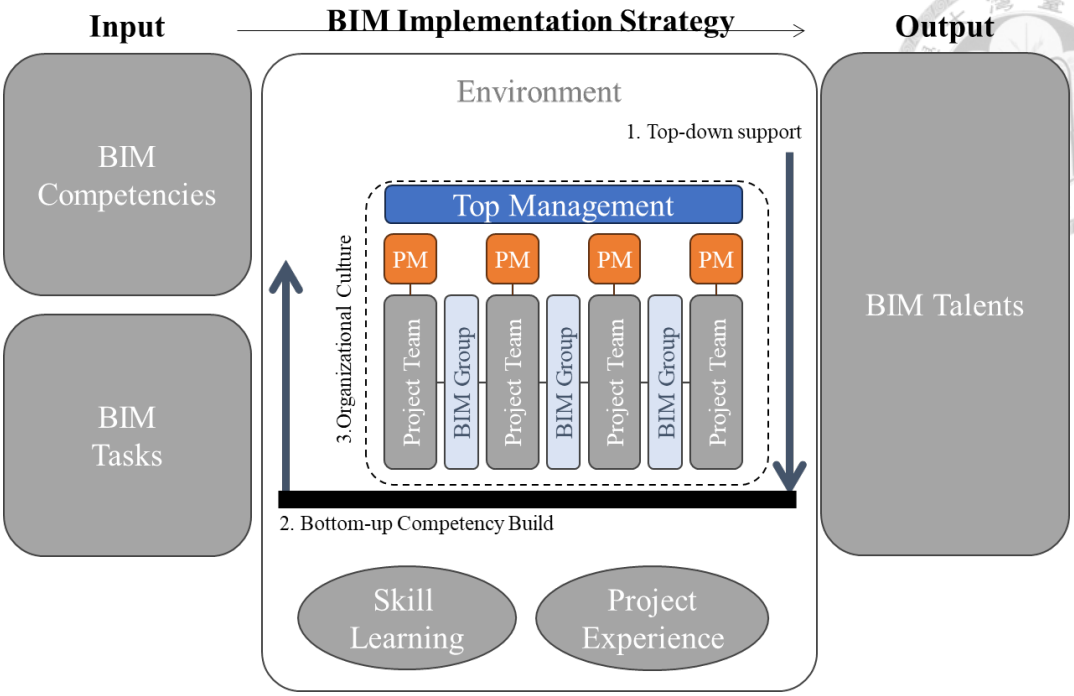

Figure 2.5 Strategy for Successful BIM Implementation- Working Group

2.3 BIM Education and Industry Job Acquisition

As a result of the need for BIM talent, academic education has taken action to provide BIM courses for improving efficiency, collaboration, and decision-making in the construction industry. BIM Educators and researchers have contributed to designing BIM training frameworks, curricula, and courses to face the new generation (Chegu Badrinath et al., 2016). Furthermore, the BIM Body of Knowledge (BOK) was developed by the Academic Interoperability Coalition (AiC) (Mayo et al., 2020) and aimed to create a standard curriculum to bridge the gap between higher education outcomes and industry performance requirements and promote understanding of BIM practices. According to Martek et al. (2021), BIM professionals with T-shaped skills must possess strong communication and teamwork abilities, work efficiently in co-located teams, and apply fundamental engineering, management, and computer skills

doi:10.6342/NTU202303396

in real-world scenarios to keep up with the transformative trend of BIM. One critical challenge in BIM education is transitioning students from novices to professionals and eventually to BIM experts (Wu et al., 2021).

Regardless, from Wu's (2021) survey, college graduates lack knowledge of multidisciplinary model management (45%) and relevant BIM project experience (43%) concerned professionals (Wu et al., 2021). Demand for skilled BIM professionals is increasing as more AECO companies adopt BIM. From Wu et al (2013)'s study, the most popular options for companies to recruit 80% or more of their BIM talent are training and educating employees, followed by hiring free-agent BIM professionals (Wu et al., 2013). Recruiting talent in BIM is challenging due to the market's need for qualified BIM professionals. Uhm et al. (2017) analyzed BIM jobs and competencies of 8 types of jobs and pointed out three competency categories: essential, general, and occupation-specific competencies; according to the research findings, essential competency required the most engineering/technology knowledge and BIM-related work experience. According to Nguyen et al. (2020), the most frequently used keywords in job ads are "experience" and "software." Besides, the job needed by the market can be identified through the job search platform, but the platform cannot provide the background for the BIM maturity level of the company and the reason for recruitment. Although the license of the use of BIM software is often required in job requirements, there is no formal certification process in many regions, making it difficult to certify the efficient use of BIM and guarantee the services provided by AECO industry professionals (Dao et al., 2020).

Although there are many obstacles to hiring from the field, some organizations still employ new team members with specialized BIM expertise to improve an organization's BIM capabilities swiftly; this strategy allows for introducing fresh talent with specific

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training in BIM methodologies and technologies. On the other hand, organizations can expand their BIM capabilities by training and upskilling their current employees, which saves costs and utilizes existing expertise.

2.4 Human Resource Management Strategy to Retain BIM Talents

The key components of practical employee training include clear objectives, relevant materials, diverse training methods, and impactful evaluations. Investing in job promotion and better training programs can improve job performance and boost employee motivation (Haryono et al., 2020). Therefore, providing only in-house on-job training without identifying the employee's BIM role and development direction can reduce their motivation to participate in upskill training. Implementing career ladders within the workplace is essential to recognize and reward employees for their unique skills truly. The career ladder system allows employees to advance based on their skills and knowledge, promoting job enrichment and collaboration. Integrating knowledge, skill, and attribute (KSAs) into job design increases participation and job satisfaction. In order to build a positive workplace culture, it is important for companies to prioritize the growth and development of their employees. This can be achieved by promoting trust, good practices, and leading by example. Additionally, creating an environment that empowers and acknowledges employees is crucial. These strategies can help construction companies improve their recruitment and retention efforts, as employees are more likely to stay and actively contribute to the company's success if they feel valued and supported in their career paths (Bae et al., 2022)

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Joseph's (2011) study classifies BIM job positions into seven categories: BIM manager, BIM Modeler, BIM analyst, BIM application developer, BIM software developer, BIM modeling specialist, BIM facilitator, BIM consultant, and BIM researcher. For categorizing and leveling the BIM competency, Succar (2013) has developed a BIM competency index to measure the skills of individuals (Succar et al., 2013). The competency hierarchy is divided into core, domain, and leadership competencies and subdivided into different BIM domain competency inventories.

When an organization is starting to implement BIM, the primary BIM tasks are focused on meeting project needs such as BIM modeling, coordination, and management. However, it is also important to establish standardized processes and technical support systems within the organization (Kouch et al., 2018). These tasks were not typically included in training programs and can be challenging for new BIM users who are also trying to meet project deadlines. In addition, there may be challenges with the workload for employees as demand for BIM work increases, but the organization is not increasing the size of the BIM team. Alternatively, there may be a lack of knowledge-sharing among employees.

To further develop a clear organizational BIM career path so employees can follow the designed route to climb the career ladder, the organization also needs the non-project functional role to complete the BIM tasks while expanding BIM-related work. The required skillset of the different roles is cultivated from skill learning (training) or experience gaining, which should be indicated by the job and career ladder design. Figure 2.6 depicts a method of categorizing input for the purpose of enhancing organizational culture during the BIM implementation process. By breaking down the input into BIM competencies and tasks, training can be tailored to motivate employee participation. Additionally, offering a clear career ladder leading to promotion in the

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BIM field can help to retain talented individuals and build the organization's overall BIM competency.

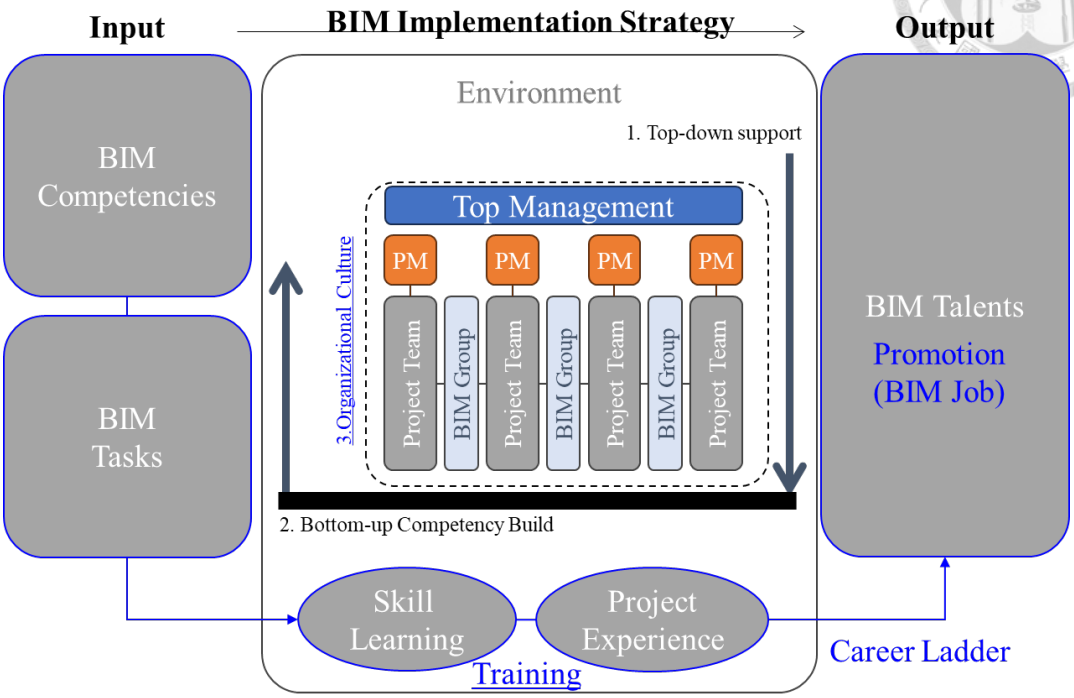

Figure 2.6 Strategy for Successful BIM Implementation- Developing BIM Talents

Additionally, training improves their abilities, knowledge, and new skills while improving employee connections and organizational efficiency (Rasool et al., 2017). Creating and maintaining an environment conducive to increased learning is essential to implementing BIM (Abbasnejad et al., 2021). To take full advantage of BIM, educators and trainers in the industry must provide BIM-enhanced knowledge, skills, and abilities for emerging professionals. In addition, the rapidly evolving BIM technology requires constant training to keep up with the latest developments.

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Chapter 3 Proposed Organizational Strategy for BIM Talent Development and Management

3.1 On-job Training Strategy & Continuous Professional Development

Smith and Tardif (2009) noted that AECO organizations that believed their employees would naturally learn new skills on the job were disadvantaged. To fully utilize BIM technology, companies need a strategy involving all stakeholders, promoting new tech adoption, updating processes, providing support, and encouraging a cultural shift. On the contrary, if the organization does not realize the status, employees may struggle to adapt the software to their specific project requirements and workflows after learning how to use it. Besides, the employees need more direct technical support and guidance from internal experts after external training to fully grasp and fully utilize the software's functionalities for organizational needs. Align BIM training with implementation objectives to integrate software seamlessly; external training hardly matches the organization's strategy for successful integration. In summary, to build solid internal training, the fundamental strategy of on-job training will be:

1. A standardized operation process that conforms to the original corporate culture can be established simultaneously.
2. A system that can plan long-term deepening skills after much basic training.
3. Strategically adjust the organizational culture to integrate with the existing work system and be accepted by the original employees.

Rivera (2019) suggested a parallel and gradual implementation; the combination of training and practice creates a synergistic effect, deepening the capability of BIM.

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Training provides the foundation of knowledge, while practice allows individuals to apply it in practical situations and refine their skills over time. Continuous learning and practice are crucial for staying updated with the latest advancements in BIM technology and maximizing its potential in the construction industry. The implementation process will be in stages, each training for the next. Combine new and traditional techniques for less risk. Master these techniques for future continuous improvement (Rivera et al., 2019).

In this part, a crucial idea that defines a highly efficient approach is shown in Figure 3.1. Competence pertains to the knowledge, abilities, and skills necessary to carry out tasks effectively. Task pertains to the specific duties and obligations that employees are expected to take on in their position. On the other hand, role encompasses the more extensive set of duties, expectations, and conduct linked to a specific job or position. Initially, we will arrange BIM competencies into categories and match them with corresponding tasks. Subsequently, this research develops an all-inclusive group design system that clearly identifies each member's role in the organization based on their abilities and the task at hand.

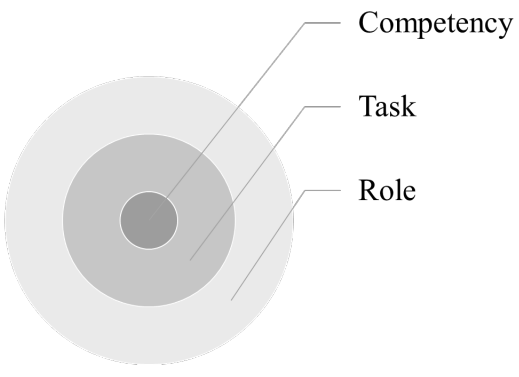

Figure 3.1 Research Workflow from Competency, Task to Role

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3.2 Categorization of BIM Competencies with Project and Organizational Roles

According to Succar's (2013) competency assessment, there are four main competency sets: Managerial, Functional, Technical, and Supportive, and four secondary competency sets include Administration, Operation, Implementation, and Research and Development. This research to further categorize these competency sets based on the function in the company will be three tasks' field: - Organizational, Project Based, and Developing, as shown in

Table 3.1and Figure 3.2, the definition of these three fields is defined below:

- Organizational: Tasks refer to the essential routine activities required for the proper functioning of the organization and are related to the core operations and processes of the organization.
- Project-Based: Tasks are activities with a specific goal or objective and must be completed within a set timeframe. These activities are typically temporary and require collaboration among team members to complete the project successfully.
- Developing: Tasks encompass activities that create or enhance an organization's products, processes, or systems. These activities are commonly related to innovation, research, and development efforts to improve the organization's performance and competitiveness. Hence the tasks of developing are between organizational and project-based.

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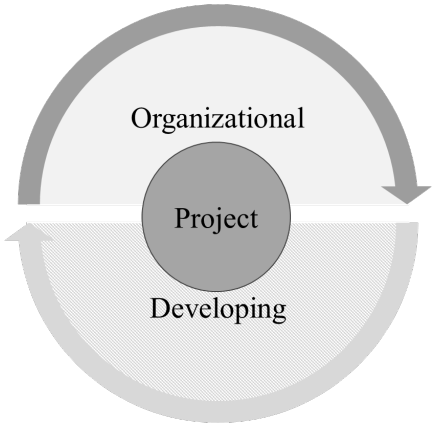

Figure 3.2 Relationship between Fields of Competency Set

For these three competency sets in the Project Based field, including Functional, Operation, and Technical, the output of the work is mainly for project delivery. Moreover, for the field, Organizational included Managerial and Administration, which primarily covered strategic planning work for companywide workflow. Moreover, the last field, Developing, includes Implementation, Supportive, and Research & Development, supporting the Project and enhancing the Organization's strength. The developing approach shown as Figure 3.3.

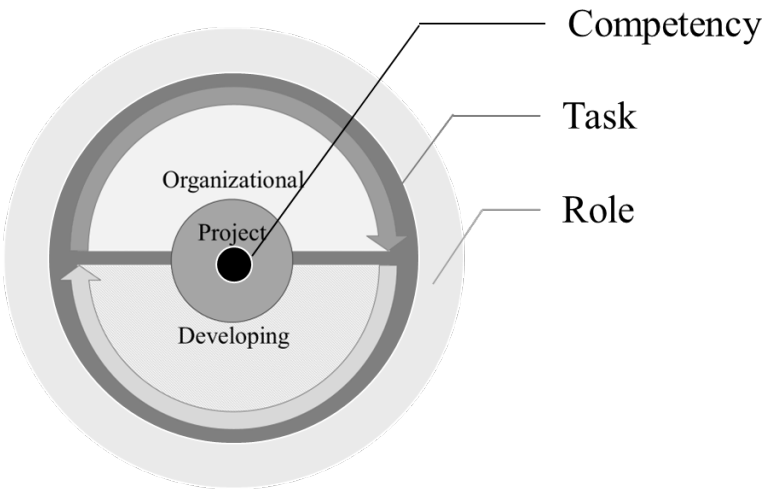

Figure 3.3 Research Workflow from Competency, Fields of Task to Role

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Table 3.1 Categorization Fields in List of Competency Sets from Succar's (2013) Research

Field	Competency Set	Code	Competency Topic
Organizational	Managerial	M1	Leadership
		M2	Strategic Planning
		M3	Organizational Management
	Administration	A1	Administration, Policies, and Procedures
		A2	Finance, Accounting, and Budgeting
		A3	Human Resource Management
Project Based	Functional	F1	Collaboration
		F2	Facilitation
		F3	Team and Workflow Management
	Operation	O1	Designing and Conceptualizing
		O2	Analyzing and Simulating
		O3	Quantifying and Estimating
	Technical	T1	Modeling and Drafting
		T2	Documentation and Detailing
		T3	Model Management
Developing	Implementation	I1	Implementation Fundamentals
		I2	Component Development
		I3	Technical Training
	Supportive	S1	IT Support
		S2	Software and Web Development
		S3	Software-related Troubleshooting
	Research & Development	R1	General R&D
		R2	Teaching and Coaching
		R3	Industry Engagement & Knowledge Sharing

3.3 Organizational BIM Group Design

However, categorizing the competency into fields still needs to be clarified for an organization to understand how to establish its BIM competency, especially in the organizational and developing fields. BIM professionals are problem-solvers (Becerik-Gerber et al., 2012) who align with constructivism learning theory, emphasizing self-reflection and self-experience. (Martek et al., 2021). Hence here to refer Partl et al. (2023) research, a T-shaped BIM professional has deep expertise in a specific discipline (the vertical part of the T) and a broad understanding of other

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disciplines (the horizontal part of the T), as shown in Figure 3.4. The vertically T-shaped skills involve deepening specificity knowledge of BIM; the horizontally T-shaped skills involve acquiring new disciplines' knowledge, making required workflows, and applying them in practice. Here could apply the organizational and developing fields into the T-shaped model. Hence, this research based on this T-shaped BIM professional concept extend the definition of the tasks of competency to developing four organizational BIM group as shown in Figure 3.5.

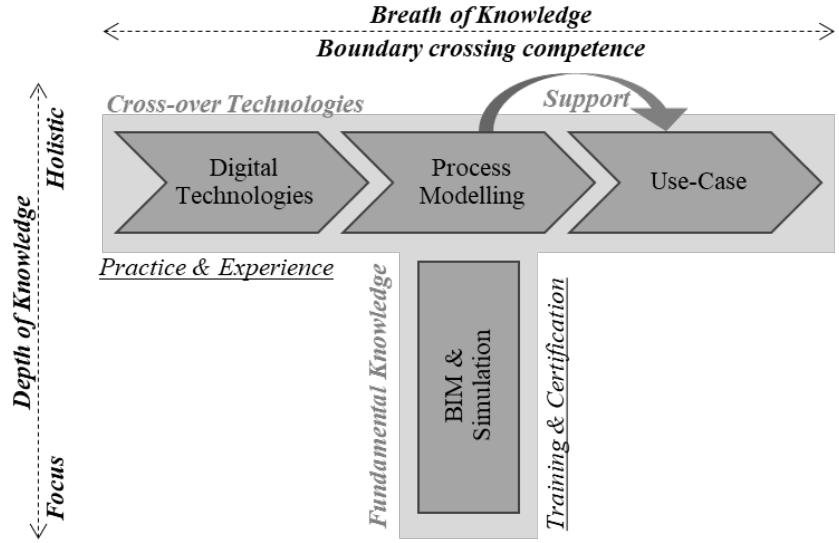

Figure 3.4 Concept of a T-shaped Model for BIM from Partl's (2023) Research

The proposed design for a group involves both horizontal Development and Process Groups working together in order to acquire new technology for proper project practices. Additionally, the Training Group provides continuous learning opportunities, and the Support Group can serve as a driving force for an organization to further deepen its skills and knowledge.

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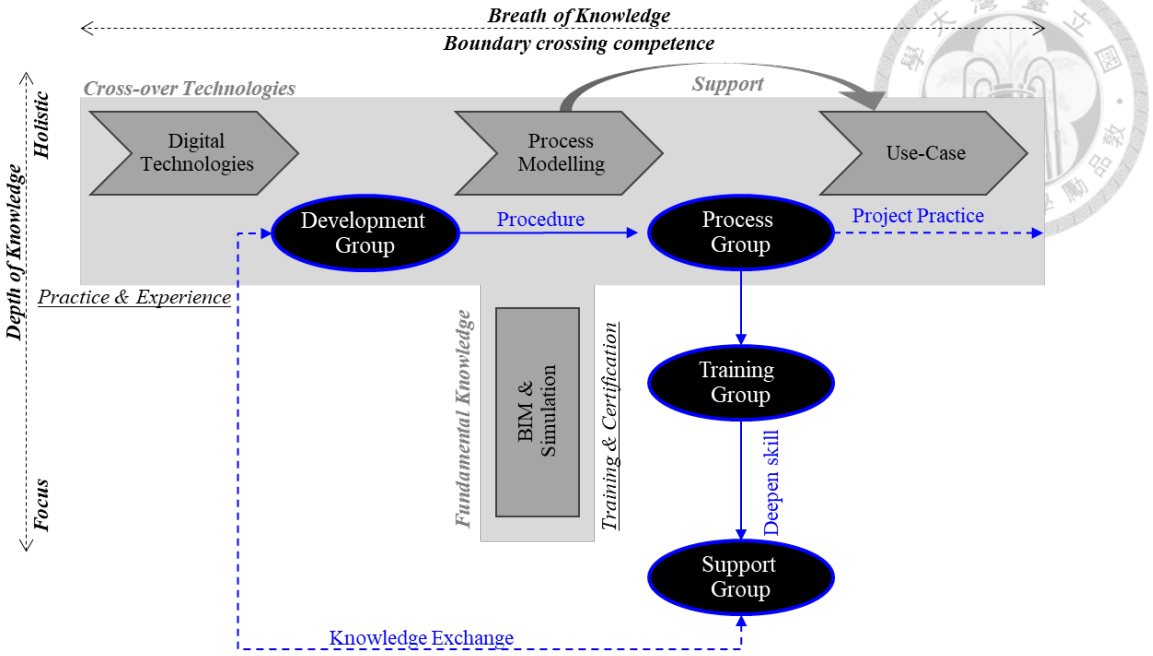

Figure 3.5 Organizational BIM Group Design based on T-shaped Model from Partl's (2023) Research

The arrows depicted in Figure 3.3 indicate the sequential relationship between each group; technologies are explored by the development group and then settled upon for standardized procedures in the process group for project practices. Procedures practiced in a project are then sent to the training group for further development into training material, while the support group works to deepen skills and provide troubleshooting. These steps provide a proper workflow with extensive support, shown by a solid line arrow. The relationship between the development group and support group is denoted by double-direction hidden lines, indicating that the exchange of knowledge here is not related to project or organizational fields but more so focused on exploration and practical discussion to keep the organization competitive.

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The definition of these four organizational BIM working group as listed below:

a. Development Group:

   To routinely explore or assist in developing new techniques required from the project team, evaluate its potential, and provide the implementation plan for the organization to adopt the new techniques.

b. Process Group:

   Control and define the standardized operation procedure and assure the quality of the model in the project team. Reliable BIM data is crucial for effective decision-making and collaboration in construction projects.

c. Training Group:

   Provide assistance in developing training programs, create customized training programs, and oversee the management of employee competency and individual talent growth. Deliver the company's core value to the employee through the training program.

d. Support Group:

   Technical assistance is being sought to support the ongoing project and enhance the project deliverables. Furthermore, new tools are being sought to be developed that can further improve the quality of the project outcomes.

As mentioned, the project is the core task for design firm, shown in Figure 3.6 could be a process surrounding the projects. The input and output for these groups are all related, and the objective of these groups is to enhance the project's performance while raising the organization's capability and exploring the new market with a higher skill set.

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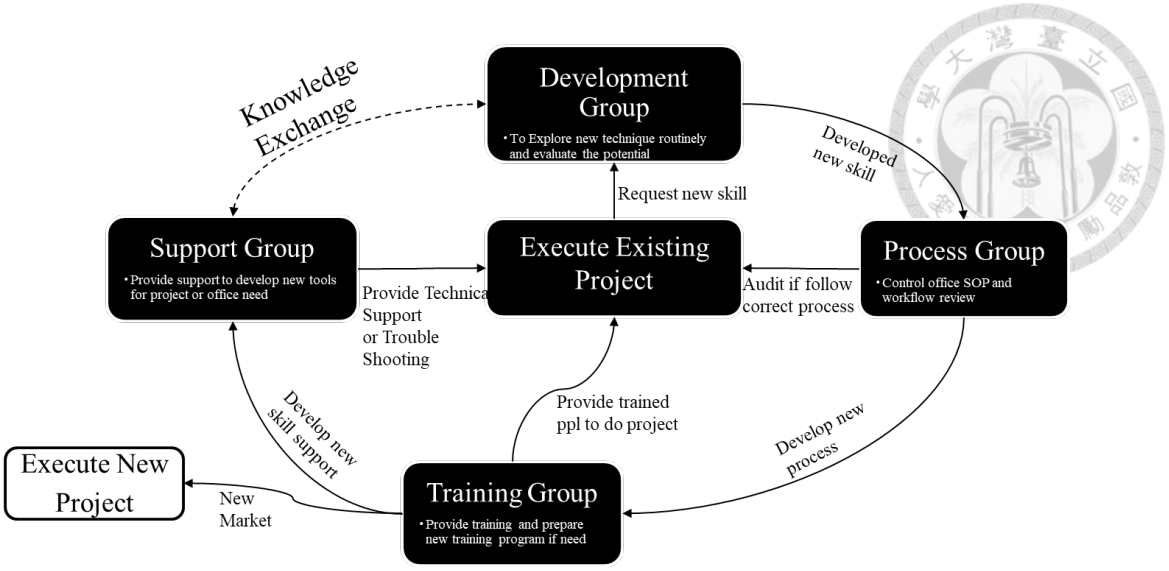

Figure 3.6 Organizational Project-Based Group Design

In the realm of organizational and developmental fields, Table 3.2 provides a comprehensive overview of the different functional groups, each with a distinct definition and desired outcome. The four types of functional groups identified are categorized based on the specific results they aim to achieve in their respective fields. It is important to note that each group is uniquely defined and plays a crucial role in the overall success of the organization or developmental initiative. The developing approach shown as Figure 3.7.

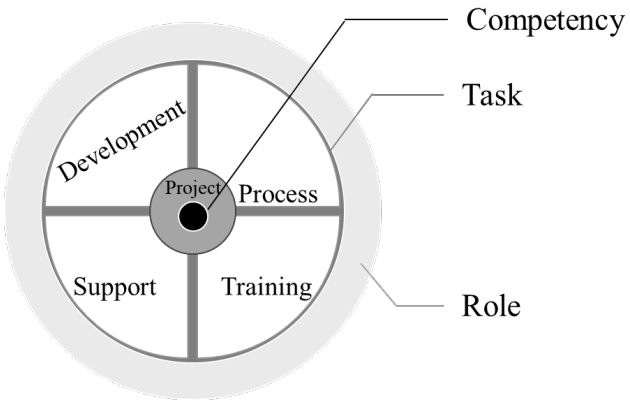

Figure 3.7 Research Workflow from Competency, Group/Project of Task to Role

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Table 3.2 List of Competency Sets from Succar's (2013) Research Mapping to Group

Competency Set	Code	Individual BIM Competency Item	Mapping to Functional Group
Managerial	M1	Generate an overall mission statement covering BIM Implementation within an organization.	Development Group
	M2	Define the strategic objectives for implementing BIM software tools and model-based workflows.	Support Group
	M3	Identify changes to organizational processes as necessary to benefit from model-based workflows.	Process Group
Administration	A1	Organize initiatives to encourage staff to adopt BIM software tools and workflows within the organization.	Process Group
	A2	Establish the necessary metrics to measure the financial performance of BIM projects.	Process Group
	A3	Identify the responsibilities of a BIM manager, a model manager, and similar BIM roles.	Training Group
Implementation	I1	Compare different BIM software tools and select the most suitable for an organization.	Development Group
	I2	Generate basic model components which comply with the organization's modeling standards.	Support Group
	I3	Develop a skill register, a training log, or similar to track existing and newly acquired skills.	Training Group
Supportive	S1	Conduct tests to establish whether IT systems are running at the required levels of performance and stability.	Support Group
	S2	Develop tools/extensions to improve the project deliverables of off-the-shelf BIM software tools.	Support Group
	S3	Manage the relationship between an organization and its BIM software tool vendor/reseller.	Support Group
Research & Development	R1	Generate a BIM-specific R&D plan for an organization.	Support Group
	R2	Develop a well-defined approach to identify change resistance or saturation during the BIM implementation process.	Training Group
	R3	Develop non-technical educational material to assist staff in understanding BIM's business and process requirements.	Development Group

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3.4 Levels of BIM Competency

The UK AEC BIM Protocol outlines the responsibilities of the BIM Manager, BIM Coordinator, and BIM Modeler in Table 3.3 (Nguyen et al., 2020). These guidelines are based on three main functions:

- Strategic:

  This is a firm-wide role, not a project role, which impacts each project.

- Management:

  This is a project-focused role and BIM-specific. Each project needs an individual (or multiple individuals) to help set up the project, audit the model, and coordinate with all collaborators.

- Production:

  This is a project-focused role, primary responsibility being the production of information.

Table 3.3 The Responsibilities of Project BIM Role developed from Nguyen's (2020) Research

Role	Strategic						Management				Production		Under Training
	Corporate Objective	Research	Process + Workflow	Standards	Implementation	Training	Execution Plan	Model Audit	Model Coordination	Content Creation	Modeling	Drawing Production	
BIM Manage	Y	Y	Y	Y	Y	Y	Y	N	N	N	N	N	-
Coordination	N	N	N	N	N	Y	Y	Y	Y	Y	Y	N	-
Modeling	N	N	N	N	N	N	N	N	N	Y	Y	Y	-
Bloom's Taxonomy	Create←						Evaluate← Analyze				Apply← Understand← Remember		

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The original responsibilities table in Table 3.3 does not differentiate between organizational and project roles, but here can utilize the Strategic, Management, and Production concepts for competency leveling. Succar (2013) used tier taxonomy to classify the level of competency; Wu (2021) introduced the revised Bloom's Taxonomy in the BIM Body Knowledge (BOK), which is from the level of Remember, Understand, Apply, Analyze, Evaluate, and Create. To integrate Bloom's Taxonomy into the three guidelines above, Production presents as the status of remembering, understanding, and applying knowledge, hence could say it means an employee has been through training to obtain the technical skill and use it to practice after the practice the employee can prove to be capable deliver the model output as the standard. Meanwhile, Management requires expertise to analyze and evaluate the model. It is crucial to have an experienced employee conduct audits to identify any logical or rule-based errors. Finally, the Strategic type of work involves utilizing one's unique knowledge and experience to create something original.

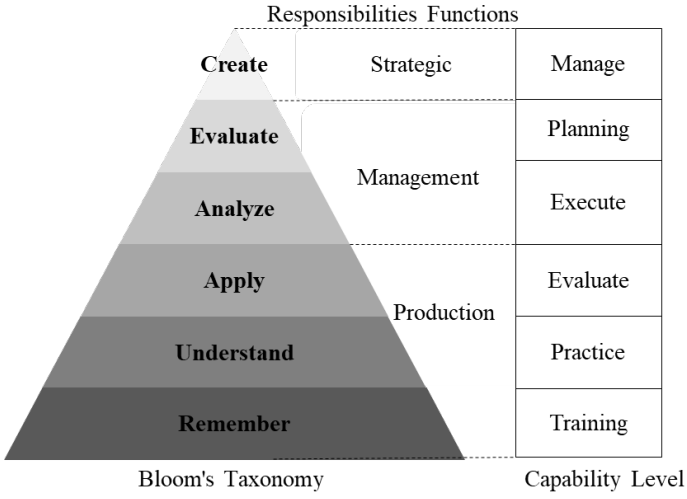

Figure 3.8 Competency Level to Capability Level

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As shown in Figure 3.8, here we could say that to reach the Production function level individual should go through training, practice, and been evaluate if it can apply as a standard. Then up to the Management function level, an individual should be capable of conducting a project with the upgraded or additional responsibility. The action of planning is to produce the content to be verified; till the individual can control the work, which is achieved at the Strategic function level.

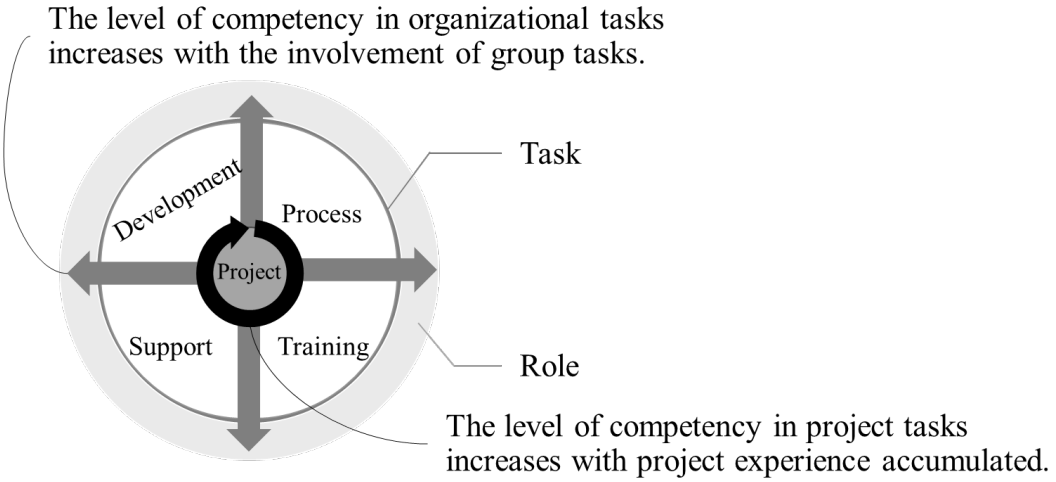

Figure 3.9 Level of Competency map with Group/Project of Task to Role

As shown in Figure 3.9, the level of competency gains differently from project tasks to organizational group tasks. According to

Table 3.1, here could say the competency in project task is only gain from project involvement, increase with project experience accumulated. But for the competency of organizational group, since tasks is contributed to project and organization, hence the competency is gain from participating in the different level of tasks which will be clarify in next section.

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3.5 BIM Roles in Project and Organizational Side

3.5.1 BIM Roles in Project

In Nguyen et al. (2020)'s research, there are three indispensable positions in a BIM project: BIM Manager, BIM Coordinator, and BIM Modeler (Modeling Technician BIM). The characteristics of the BIM role have been defined in many research (Rivera et al., 2019; Joseph J., 2011) and here to simplify the job description as listed below:

a. BIM Manager:

   BIM Managers must understand the business thoroughly to manage the process of virtually constructing a building and documenting the design contract documents accurately. They would encompass managing a team of production professionals, designers, and technicians of multiple disciplines. They lead model management, planning, collaboration, and coordination on leading projects and verify design intent during the CD phase.

b. BIM Coordinator:

   Articulator of the BIM process in the organization, responsible for model validation and coordination. Serves as a point of contact among different modelers and specialties—must comply with the BEP and be fully aware of BIM standards and regulations.

c. BIM Project Engineer:

   Professional who performs modeling, analysis, and structural design but has acquired skills to develop such work partially or totally under BIM methodology and computational platforms.

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d. BIM Modeller:

In charge of developing BIM models, including 3D visualizations and information associated with the elements. Must have a broad mastery of the related computational tools and knowledge of the discipline modeled.

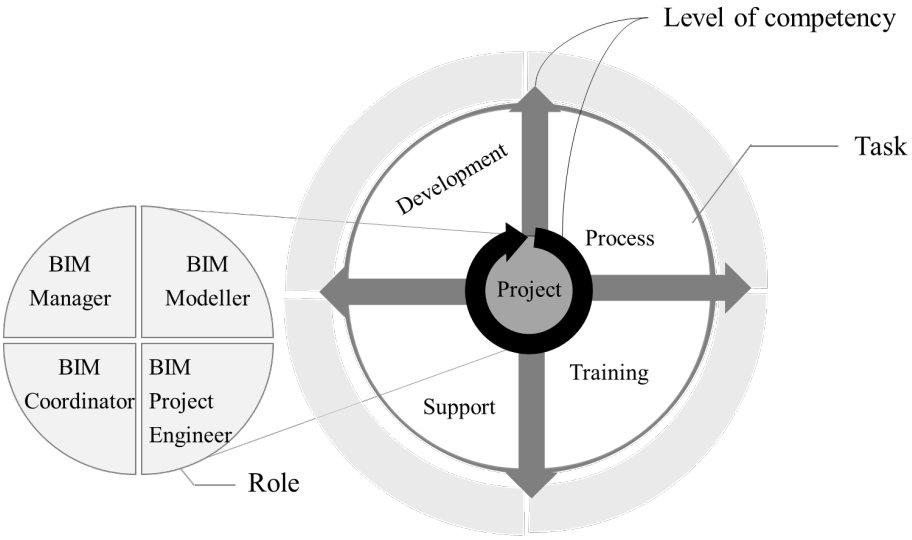

Figure 3.10 Project Task to Project Role

According to the job description here to mapping back to the individual competency set as shown in

Table 3.4, BIM Manager links to the Functional competency set of F1-Collaboration and F3-Team and Workflow Management to lead the model management and the project planning; BIM Coordinator and BIM Project Engineer related to the Operation competency set, former focus on the coordination between other consultant or contractor, another more on responsible to modeling and the analysis the output from the model; BIM Modeller is mapping to the Technical competency set to complete the model, generated drawing and model management.

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Table 3.4 Competency Mapping to Project Role

Competency Set	Code	Individual BIM Competency Item	Mapping to Project Functional Role
Project Based	F1	Develop model ownership protocols with other project participants at/before the start of collaborative BIM projects.	BIM Manager
	F2	Act as the project team's BIM facilitator while delivering collaborative BIM projects.	BIM Coordinator
	F3	Use a content management system or a document management system to manage information storage and sharing.	BIM Manager
	O1	Use a BIM software tool to generate a rough representation of space through basic geometry and identify spatial relationships.	BIM Project Engineer
	O2	Use specialized software tools to generate a thermal study from a data-rich 3D model.	BIM Coordinator
	O3	Prepare a BIM model for the purpose of linking it to a construction schedule.	BIM Coordinator
	T1	Generate BIM Models using a pre-defined set of standards and guidelines.	BIM Modeller
	T2	Generate 2D Drawings of accuracy suitable for construction documentation and submittal for Tender/Bid.	BIM Modeller
	T3	Maintain a BIM model according to modeling standards set by the organization or project team.	BIM Modeller

3.5.2 Organizational BIM Roles in Working Group

According to the previous conclusion, here to set up four types of roles from the organizational working group, which are listed below to clarify the job description for the functional group:

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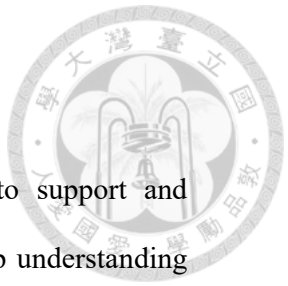

- BIM Developer (Development Group):

  BIM Developer is responsible for using BIM technology to support and improve the design and construction process; they need a deep understanding of BIM concepts and specific BIM tools. Additionally, the BIM Developer is the pioneer in the organization to explore and research the applicability of the new software for the organization.

- BIM Auditor (Process Group):

  BIM Auditors ensure BIM models meet quality standards, identify errors, and provide improvement recommendations; they review project documentation and work with stakeholders to address issues and provide guidance on BIM implementation.

- BIM Trainer (Training Group):

  BIM Trainers is to educate and train professionals in BIM; they equip employees with the necessary skills for BIM adoption, including computing, cost modeling, computer-aided design, construction technology, and coordination skills, through organizing workshops and providing on-the-job training to enhance BIM competencies.

- BIM Technical Support (Support Group):

  The BIM Technical Support assists with technical issues and supports BIM processes and software applications. They ensure that BIM tools and systems are functioning properly and work on developing new tools. Their expertise helps troubleshoot technical problems and assist users with software usage. Additionally, these professionals collaborate with IT technicians and BIM teams to address technical challenges and find practical solutions.

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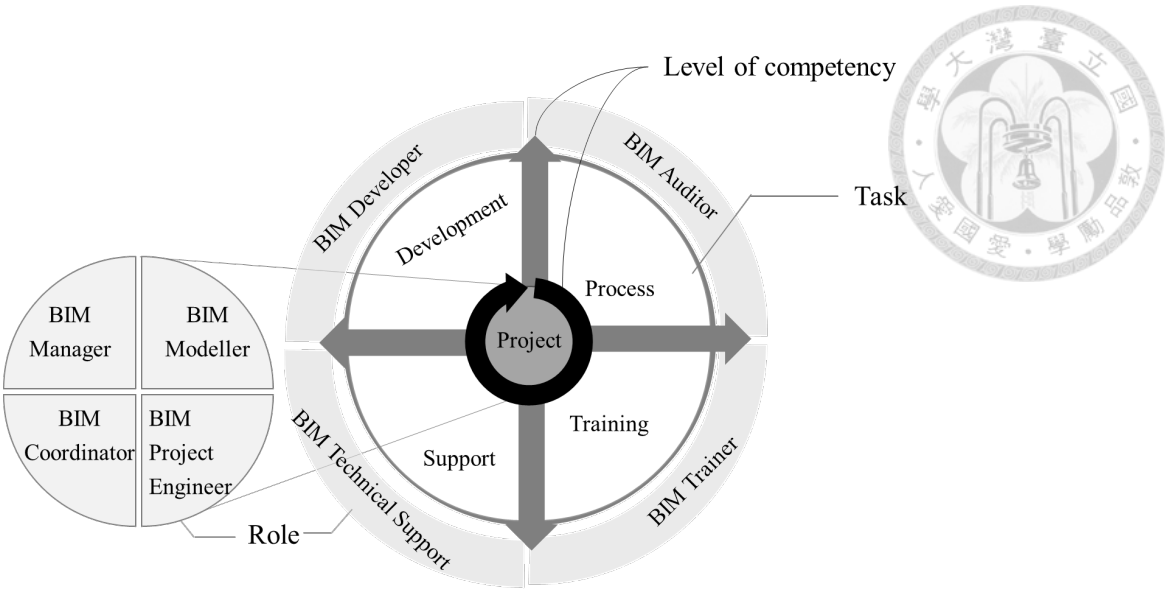

Figure 3.11 Group and Project Task to Group and Project Role

Figure 3.11 demonstrates the integration of project and organizational group roles and the different competency levels, which provides a comprehensive view of the organization's structure. The project side has BIM modelers, coordinators, and managers responsible for handling BIM tasks. The BIM project engineer acts as a bridge between BIM tasks and project managers to ensure a seamless transition between BIM and design work. On the organizational group side, there are four roles: BIM developers, auditors, trainers, and technical support. Within an organization, employees could take part in group tasks that match their career interests, leading to a well-defined path for professional advancement. This approach benefits the organization by ensuring that staff are allocated efficiently to complete all necessary tasks for successful BIM implementation, and establishing a clear structure for different task functions. Project managers can use this structure to evaluate project requirements and improve the quality of BIM submission, ultimately enhancing communication between project leaders and BIM implementation leaders.

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Table 3.5 BIM Role Function and Levelling

Level \ Role	Basic BIM Project Usage		Organizational Group			
			Process	Training	Support	Development
	Graduated Engineer	Experienced Engineer	BIM Auditor	BIM Trainer	Technical Support	BIM Developer
Production	BIM Modeller	BIM Project Engineer	Self QA/QC	Training Assistant	Project Troubleshoot	Software Exploring
			Model Reviewer	Coaching	Technical Support	
Management	N/A	BIM Coordinator	Yearly Audit	Trainer	General R&D	Evaluate Workaround
			Process Audit	Material Preparation	Software Development	
			Setup Process	Training Planning	Software Vendor	
Strategic	N/A	BIM Manager	Project Management	Talent Management	Issue board Management	Implement Fundamental

Table 3.5BIM Role Function and Levelling illustrate the roles in three levels to summarize the project and organization roles. For the project side, four positions are allocated based on the employee's work experience, from the graduate to the professional level. The organization groups' four roles are listed with different levels of tasks; details of the task are described in Table 3.6.

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Table 3.6 Levelling Task of Organizational Role

Group	Task	Task Description
Process	Self QA/QC	Capable of conducting own project's modeling quality assured and quality check complies with the standard.
	Model Reviewer	Work as a model reviewer to routinely conduct other's project model reviews.
	Yearly Audit	Can conduct a detailed level of model audit as an experienced model reviewer for the annual office audit.
	Process Audit	Based on the developed workflow to review and upgrade to best practice.
	Setup Process	To develop a new workflow and plan to adopt to original workflow.
	Project Management	Manage and monitor the office-wide BIM work quality with correct workflow and ensure the project's process has been appropriately conducted.
Training	Training Assistant	To assist in-office training sessions in administrate way and also be able to solve part of trainee's questions.
	Coaching	To elevate the result of training, monitor the progress of the trainee's learning status to ensure the outcome of the training.
	Trainer	Provide the lecture in the office with existing training material to provide the required project workforce.
	Material Preparation	Based on the completed workflow done by Process Group to create training material.
	Training Planning	Analyze the need for the workforce for the new workflow or software to plan a yearly training, decide the target of the train number and the outline of the content, and execute the training after planning.
	Talent Management	To evaluate the office and employees' BIM competency from a human resource perspective, provide employees with a yearly professional development plan for career development.
Support	Project Troubleshoot	To help projects with technical problems and assist users with software usage.
	Technical Support	To provide troubleshooting or BIM component custom creation for companywide projects.
	General R&D	Based on the used BIM software to deepen the skill to explore or develop the tools for practical solutions
	Software Development	Capable of developing a custom workaround for office use as an in-house developer.
	Software Vendor	To deal with the software vendors to solve multi-discipline or high-level software problems. Keep track of the upgrade of the software version.
	Issue board Management	To monitor and manage the issue-solving status on the project and organizational sides. Develop and review the best practice for the office technically.

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Table 3.6 Levelling Task of Organizational Role (Continued)

Group	Task	Task Description
Development	Software Exploring	Assist the request from the project and organization to study the potential of the new software or workaround.
	Evaluate Workaround	Choose a pilot project to do a test run and evaluate the outcome.
	Implement Fundamental	Develop and design the implementation strategy for the new software and workflow. Attend the industry knowledge event to equip the office with the latest technology.

3.6 On-job Training & Career Development Plan

To achieve organizational capability, as in Table 3.6Table 3.6, fostering a supportive learning environment is vital through mentorship programs, peer collaboration, and recognition of achievements can help boost motivation and engagement in learning BIM. As the promote BIM implementation perspective, organizations should provide relevant skill and knowledge training to employees to upskill solutions. The Basic BIM Project role include BIM Modeller, BIM Coordinator, and BIM Manager are essential roles to conduct a BIM project; these are suggested based on the job functional outcome and provide in-house training. Following listed the outline of the training topic for reference:

- Basic BIM Model Training (BIM Modeller)
  - Fundamental Knowledge of BIM
  - Modeling
  - Coordinate & Collaborate
  - Model Check and Review
  - View Setup
  - Sheet Creation and Export

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- BIM Coordinator Training (BIM Coordinator)
  - Basic Knowledge of the BIM Model
  - Coordinate in Design
  - Clash Analysis
  - Coordination Meeting
- BIM Manager Training (BIM Manager)
  - Project management
  - BIM Execution Plan
  - BIM Contract Review

Graduated employees without project experience could acquire BIM skills from Basic BIM Training and gain expertise from practice; after evaluation, the employees could decide the direction of their professional development. To make an example as Example 1 in Figure 3.12, an employee chooses to have the professional development to be a BIM manager; one should go through the relevant training, practice, and evaluation. Within the record of the professional development, as shown in Figure 3.13, in the way to cultivate the talent, the project experience and the level of competency also accumulated relatively.

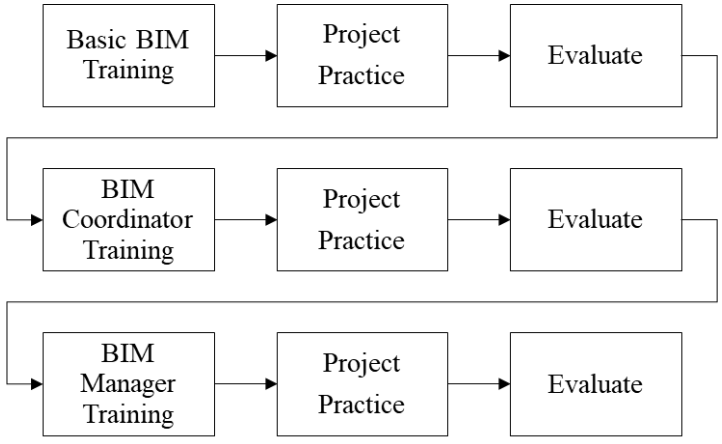

Figure 3.12 Example1 Professional Development Path

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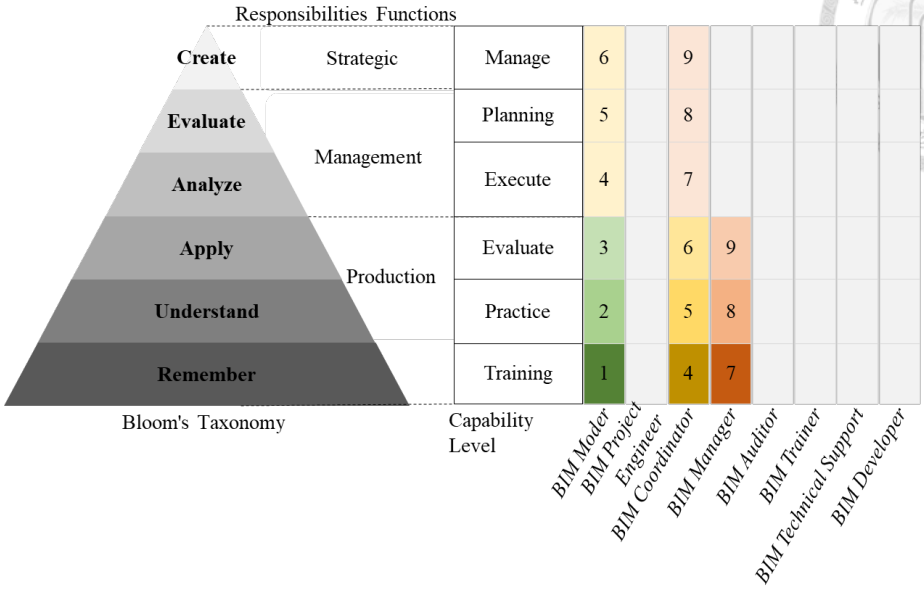

Figure 3.13 Example 1 Outcome of Competency Record

On the other hand, as Example 2 shown in Figure 3.14 and Figure 3.15, an employee could also choose to develop their technical support competency as an organizational group support team member. Meanwhile, the project is also beneficial; the support role could help solve technical problems within the growth capability of this employee's support competency; the group also could provide troubleshooting or BIM component custom creation.

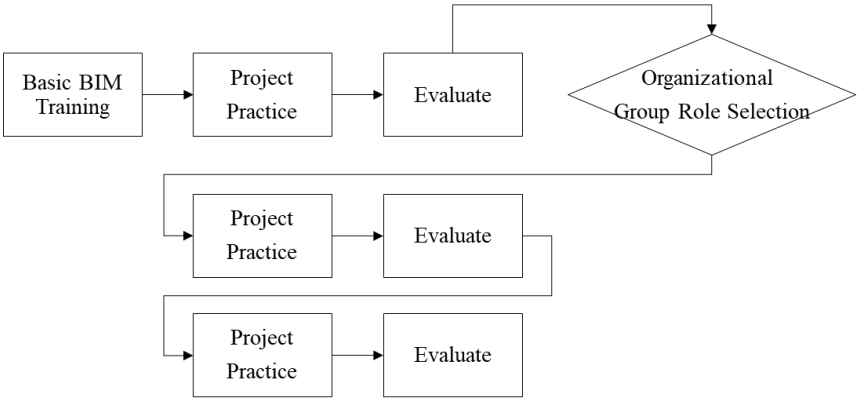

Figure 3.14 Example2 Professional Development Path

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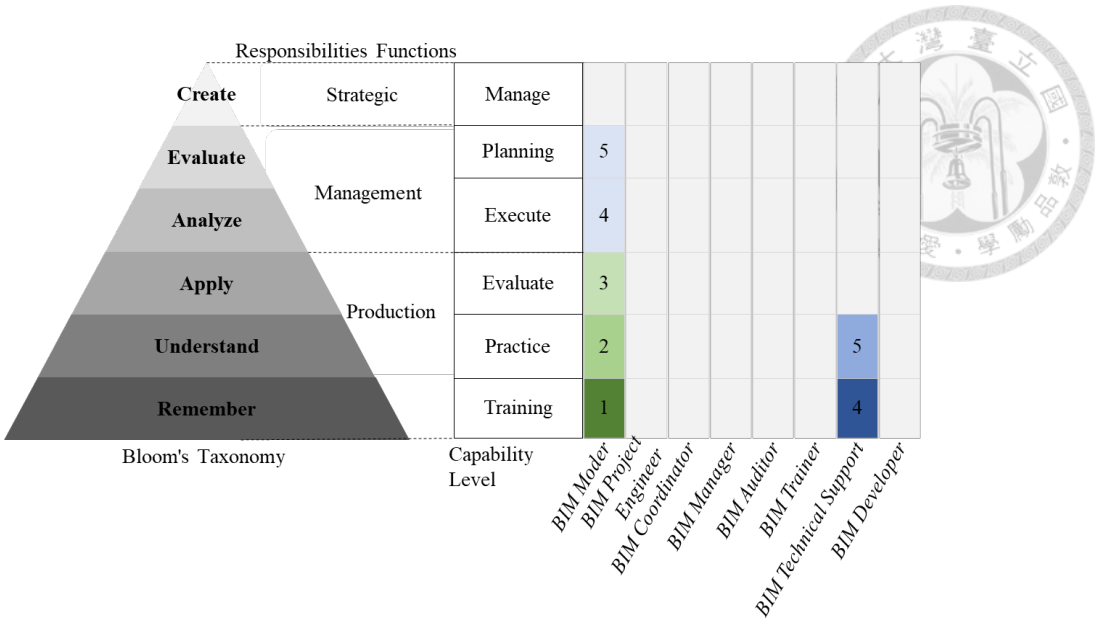

Figure 3.15 Example 2 Outcome of Competency Record

3.7 Workflow of the BIM Implementation Strategy

This section will give an explanation step by step for adopt this strategy to the organization. As mentioned in the content, this strategy proposes a strategy with organizational group to work with project, hence here suggest to have a long-term planning at least two to three years. To achieve the result of the new organization structure, here to sort the steps into three stages as listed below:

- Stage 1: Planning

  During the initial stage, assessing the organization's resources and establishing a three-year target is crucial. The first step is to evaluate the anticipated future requirements for BIM projects based on the organization's current status. As BIM modeling is the foundation of BIM tasks, this approach recommends standardizing the organization's workflow through a pilot project and estimating the necessary BIM workforce based on the

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project's BIM execution status. Subsequently, the number of essential BIM modeling training participants can be determined. Whether an organization is using in-house or outsourced BIM training, the most critical issue is establishing the organization's standardized workflow and adjusting the training material's content further based on the setting. Hence after first round of on-job BIM modeling training, here could assign the key person to review the process and the training material.

- Stage 2: Evaluation

  Once the first round of training is complete, the organization can begin executing projects. This increases the competency of BIM in project tasks. However, as more projects arise, it is important to assign a key contact to develop technical support competency to ensure the timely completion of the project. Additionally, beyond basic BIM modeling training, BIM coordination and management training should be included to further enhance the project's BIM function. As the number of employees involved in BIM tasks increases, they can be assigned to training and process groups with an annual target set to fully utilize the group's function.

- Stage 3: Optimization

  During the final stage, the training and process group needs to be well-structured so that the organization can customize and optimize its procedures. The support group may need to increase the number of its members to handle higher-level problems. Additionally, part of the talented members of the support group may be split into development groups to address the new technical needs of the project or to expand the BIM delivery outcomes for the project. The organization should be well-constructed with

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the BIM project team and functional group at this stage. As such, it is recommended that the management level of group competency be applied in the organization, such as the talent management of the training group and the project management of the process group. Employees' training and project participation records can help the organization evaluate its BIM capacity and the professional development history of its employees in BIM.

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Chapter 4 Case Study

4.1 Start of the Strategy

The proposed strategy has been formulated due to the increasing demand for BIM talents in various projects. After thorough discussions with the top management of the case study, the most effective approach would be to provide in-house on-job BIM training. By delivering the skills of the existing employees, the company can ensure it has the necessary expertise from past project experience and BIM knowledge to meet the market's BIM project needs. This firm does not follow the organizational structure of having a separate BIM department. Instead, they have a hybrid function for employees, allowing them to gain design experience while developing their BIM skills. Hence, plenty amount and routine of training programs are executed in the firm to upskill numerous employees in a BIM capacity. The ultimate goal of this BIM implementation strategy is to establish a learning culture and equip every employee with basic BIM capacity.

4.2 Organizational Background

The above approach is experienced progressively in the engineering design firm in Malaysia. The company has approximately one hundred and seventy employees, as illustrated in Figure 4.1, including building structural engineers, bridge structural engineers, infrastructure engineers, and drafters. The organization started BIM implementation in 2019 using this approach to establish the company's BIM capacity.

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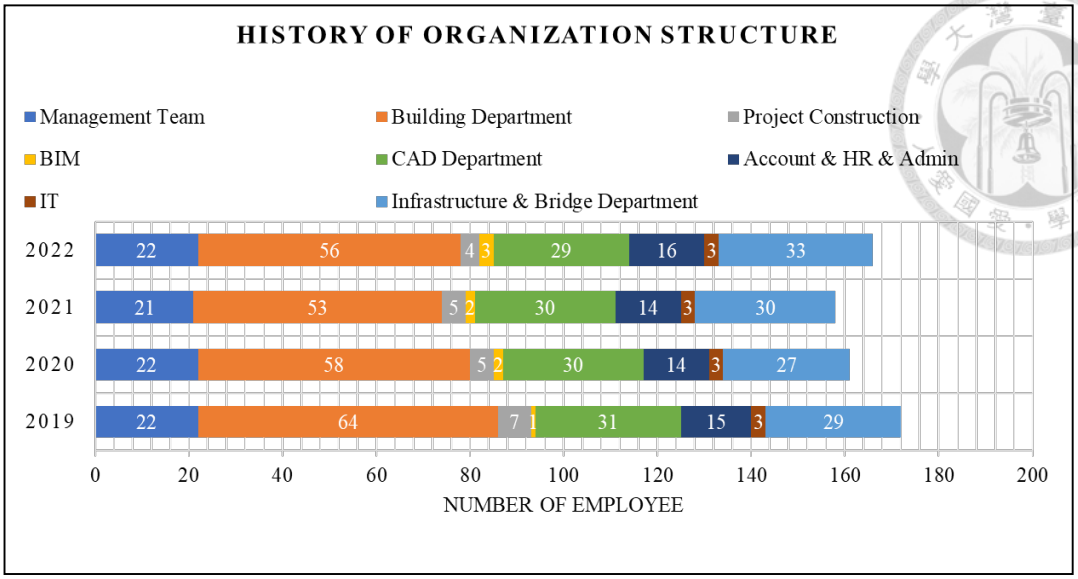

Figure 4.1 History of Organization Structure

4.3 History of BIM Implementation

The BIM implementation begins with the pilot project 2018 in the building department and sets up a standard BIM workflow from the pioneer project. Then in 2019, this firm has performed in-house on-job training in basic BIM modeling skills for 15 employees, including building structural engineers and CAD drafters. This design engineering firm used the outcome of training in 2019 to optimize the firm's standard workflow and adjust the training material. The basic BIM training has been conducted yearly from 2019 to 2022, as shown in Figure 4.2 and Figure 4.3; during this period, an average of 32% of building engineers are capable of using BIM as a 3D visualize coordination tool to improve the design quality; average 45% of the drafters are capable of handling a BIM model for the project and generate the drawing from the model. The company has gained the strength of BIM, and the number of projects requiring BIM is increasing; most important, the employees' BIM competency is built within the accumulated project experience.

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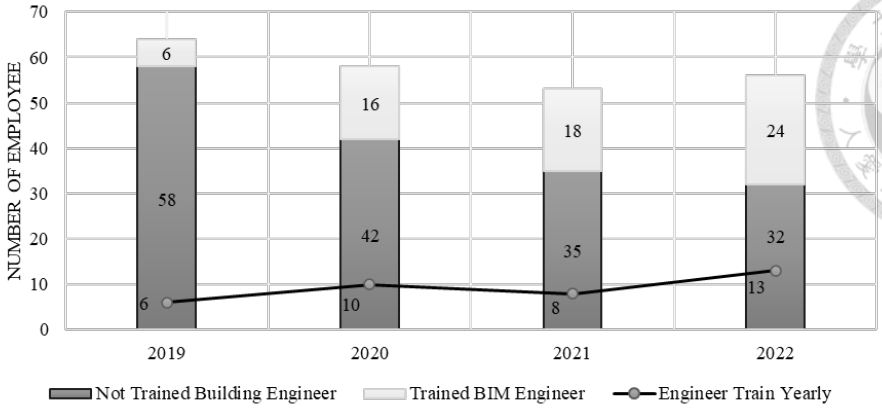

Figure 4.2 Number of Trained BIM Building Engineers

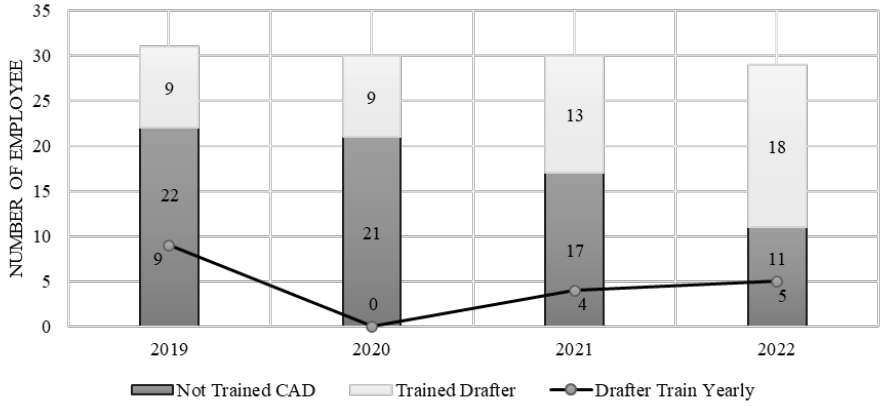

Figure 4.3 Number of Trained BIM Drafter

Besides the competency gained from projects, some diligent employees who contributed more to organizational work are recognized individually for their advanced BIM skills, as shown in Figure 4.4. From the training side, six of the employees can be BIM trainers for basic BIM modeling; five of the employees can prepare training material; they also perform the ability to study and organize basic BIM training for MEP (mechanical, electrical, and piping). Four employees could set up a new workflow for the process side, and six can do model audits. For the support and development side, four employees can assist with the project troubleshooting and establishing new software usage.

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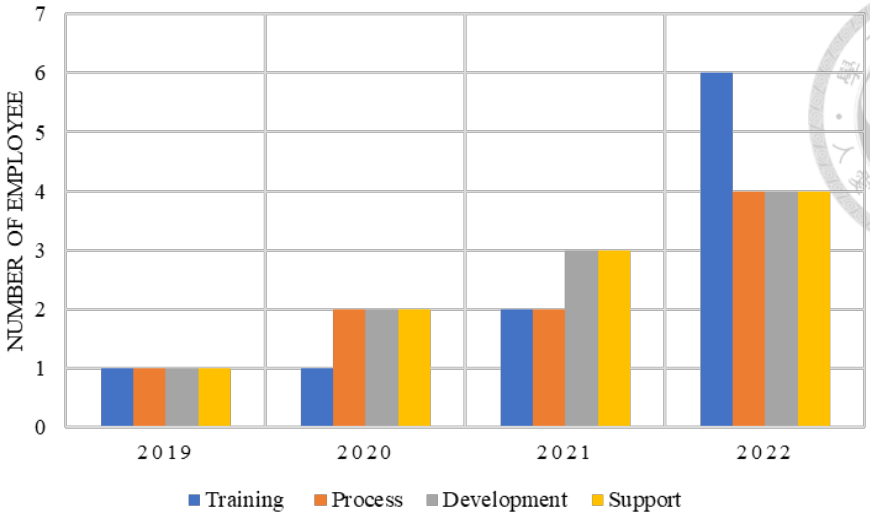

Figure 4.4 Status of Employee's Competency Development

4.4 Challenge

The company has faced three main challenges in adopting this approach:

1. The lack of consistent BIM expertise in project supply chains can lead to some projects relying on CAD/2D drawings, which makes them less motivated to use BIM. Additionally, coordination failures can occur if other consultants need help updating their BIM models with design.
2. Middle-level management (so-called project manager level) needs to understand the importance of BIM to adopt it. If they are still determining their team's proficiency in BIM, they may stick with 2D drawings to ensure that to complete the project on time. Moreover, they might face challenges transitioning to a BIM-based approach for workforce allocation.

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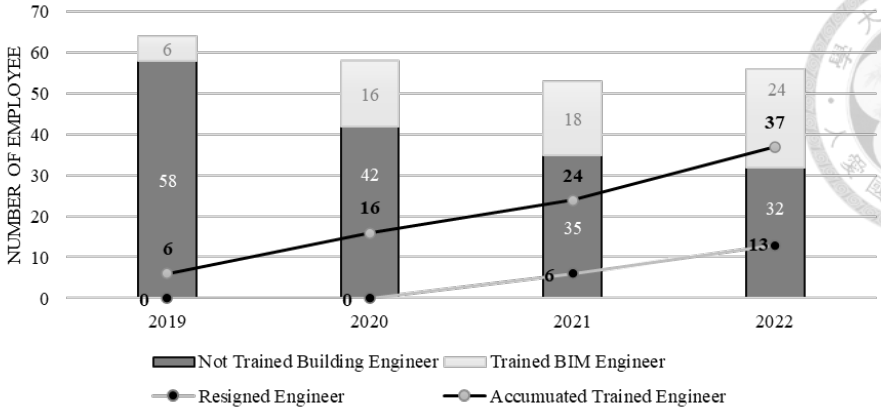

Figure 4.5 Retain Status of Trained Engineer

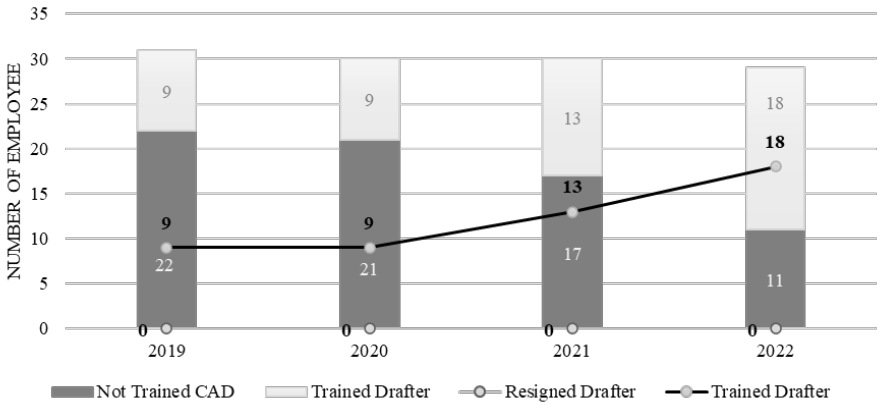

Figure 4.6 Retain Status of Trained Drafter

3. Figure 4.5 and Figure 4.6 reveal that there have been challenges in retaining trained engineers, with an average retention rate of 77% from 2019 to 2022. In contrast, trained drafters have had a 100% retention rate. The demand for BIM talent in the market has increased, particularly among engineers with design experience, BIM capacity, and BIM project experience simultaneously. Such employees have more opportunities to switch employers. It is also indispensable to recognize that the COVID-19 pandemic in Malaysia between 2020 and 2022 may have contributed to higher resignation rates.

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4.5 Result

Even though there are obstacles to implementing BIM that can reduce its effectiveness and make it difficult to appreciate its benefits, the company has successfully developed considerable BIM talent employees to meet project requirements through this approach. Within an organizational working group structure, employees can gain the necessary skills and competencies to participate in projects as project members or functional support roles alternatively, allowing them to develop their abilities further and contribute to the project's success at the same time.

The system can enhance the benefits of BIM in projects and create a conducive learning environment for employees. On the other hand, the organizational manager could evaluate and track the progress of employees' professional development within the system, which is more accessible and could be non-influenced during project changes. For Middle-level managers, the assessment makes it easier to understand the new system; besides, it could work as a tool to establish and evaluate their project team's BIM competency.

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Chapter 5 Conclusions and Future Work

5.1 Conclusion

The objective of this study aims to provide a comprehensive framework to assist design engineering firms in establishing and enhancing their BIM competency. It is imperative to note that various factors, such as organizational growth and individual job roles, significantly influence achieving expertise in this area. Nevertheless, developing a well-thought-out strategy and a long-term plan is crucial to ensure the successful implementation of BIM.

This study presents a fresh outlook on implementing BIM from a human resource management standpoint; the suggested strategy can serve as a foundation for companies looking to put BIM into practice. Different from the research to classify BIM competencies or identify BIM job descriptions, this research provides a further system to assist organization's BIM implementation from:

1. Define the BIM Tasks into Project Side and Organization Side

   Much of the research focused on categorizing BIM competency or job titles, but separating the functional tasks into the organization and project sides is uncommon. Design engineering firms place utmost importance on projects, as projects form the core of their work submissions. Typically, employees could acquire BIM competency in modeling, coordinating, and managing through project participation. However, the implementation strategy should also include developing the capability to enhance an organization's BIM competencies, like setting up standardized processes, providing technical support, exploring new technic, and offering internal training. An organization needs to develop

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non-project-related skills to maintain the quality of project outcomes due to a need for more skilled professionals or adequate support during execution. For example, the project BIM model's quality is dependent on the use of standardized processes, which ensures consistency and accuracy in the creation and management of the BIM model, leading to improved quality and reliability; by providing technical support that BIM users have access to the necessary expertise and guidance to navigate and utilize the BIM model effectively, the support can help users troubleshoot any technical issues they may encounter, improving their overall experience and productivity; developing team could expand the possibility of BIM delivery while not interrupt the continue of project; internal training promotes consistency and standardization in the use of the BIM model across the organization, training employees on best practices and standardized processes ensure everyone follows the same protocols and workflows which leads to improved collaboration, reduced errors, and increased efficiency in project delivery. Completing functional tasks while adhering to a project delivery schedule can be challenging. Therefore, categorize these tasks as either project-related or organizational.

2. Organizational BIM Working Group

   This study suggests a new way of organizing BIM working groups based on different functional competencies to define various tasks and roles better. To successfully implement BIM, it is essential to restructure the organizational culture. This research proposes a hybrid approach that combines on-the-job training with enhanced project network interaction within the working group. Four organizational BIM working groups are presented based on competency sets: Process group, Training group, Support group, and Development group.

doi:10.6342/NTU202303396

Assigning employees to these BIM working groups can help establish a comprehensive system in the initial stages of BIM implementation. These four groups operate on a skill development cycle, beginning with setting up processes, training relevant employees, deepening skillsets to solve high-level problems, and exploring further before returning to a continuous loop. From another perspective, establishing BIM working groups can aid in maintaining BIM project quality and minimizing the likelihood of project failure. This would help middle-level senior management build trust in completing the BIM project and reduce resistance towards BIM, increasing the potential for digital transformation. Forming an organizational BIM working group is the solution to overcome BIM implementation challenges.

3. Provide a Clear Road Map to Cultivate BIM Talents

   One way to encourage employees to reach their potential and advance in their careers is to clearly define their roles and responsibilities within the organization, which can involve participating in projects or contributing as working group members. In addition, having a broad knowledge of BIM competency, which extends beyond just 3D modeling ability, is crucial. To help organizations evaluate their employees' knowledge statuses, this research proposes a BIM competency leveling system adapted from Bloom's Taxonomy from training, practice, evaluating, executing, planning, and managing. Training for new skill sets is essential, and employees should be provided with opportunities to practice and receive evaluations to ensure their work is of high quality. This assessment can serve as an in-house career plan to help employees determine their development direction. Employees can become experts in managing and performing strategic thinking by learning from experience and executing

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projects with careful planning. Ultimately, employees with expertise in their field will be better equipped to contribute to the organization's success. Eventually, employees with expertise can present an excellent ability to manage and perform strategic thinking. Creating a work environment that promotes ongoing learning is vital to retaining talented employees and unlocking their full potential.

5.2 Future Work

This study proposes a new organizational structure for cultivating and supervising BIM skills. Validate the efficacy of this system in enhancing employee growth, it requires precise monitoring of individual progress for analysis. However, identifying the underlying reasons for changes in work status for each person can be complicated. This research is solely focused on the progress and growth of the company, using it as a case study to develop a system that monitors the relationship between individual development and the organization's structure. Further study in this area can be explored in the future.

On the organizational side, the support of top management is crucial for achieving positive results and fostering a company culture during the experiment. While each organization is unique, the employees play a vital role in successfully implementing organizational change and company culture recreation. This research and case study can serve as a guide for other organizations struggling with implementing BIM. Additional case studies of how individual employees influence organizational change should be conducted to enhance its effectiveness and validate its persuasiveness.

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According to research, implementing a project management system that tracks employees' professional growth can benefit companies. As businesses expand, managing talent becomes increasingly important. To facilitate development, companies may consider establishing appropriate procedures or enlisting the help of a consultant specializing in talent management.

In this research has proposed that the interaction of project networking with the organizational working group could be enhance the reformation of organizational culture. This perspective could be proved in further study as an examination.

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