Digital Employee Driven Innovation in Construction Engineering

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Digital Employee Driven Innovation in Construction Engineering

Master Thesis submitted to Delft University of Technology in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

in **Management of Technology**

Faculty of Technology, Policy and Management

at the Delft University of Technology

To be defended publicly on Wednesday, 16th August 2023, at 01:00 PM

by

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Project Duration:	April, 2023 - August, 2023
Faculty:	Faculty of Technology, Policy and Management, Delft
Number of credits:	30 ECTS

An electronic version of this thesis is available at https://repository.tudelft.nl/.

TU Delft

Acknowledgements

In front of you lies the master thesis report 'Digital Employee Driven Innovation in Construction Engineering'. The document is a result of my two-year period in the Master of Management of Technology, in which I've combined many skills and knowledge gathered over the two years. Mainly knowledge from courses such as 'Research Methods', 'Leadership and Technology Management', and 'Preparation for the Master Thesis' has been used in order to turn this thesis period into a success.

Even though the thesis document indicates the end of my period within the study of Management of Technology, and therefore ending a period that I enjoyed immensely, I do feel grateful for the fact that this opportunity arose in my life. I've learned about and gained many new insights on technology, and how it can be helpful for us but at the same time something that we should be careful with and take responsibility for in how we handle new technologies. It can drive us to achieve things that before were thought to be unachievable, and thus improve our quality of life. I am thankful for gaining such insights and contributing to managing technology as a whole.

During my master's, I've collaborated with many people with which I've learned a lot and have enjoyed spending time with. I would like to thank Rishika and Aditi for being great team members in many projects throughout the two-year period. I especially see our teamwork within the course of 'Integration Moment' as an example of how I would like to see future teams operate. I would like to thank Aditi specifically for the great support during the Economics and Finance specialization and the thesis period.

Additionally, special thanks go to Dr. Nikos Pachos-Fokialis for the guidance throughout the five-month thesis period and his great enthusiasm on the subject of employee-driven innovation. This enthusiasm has definitely triggered my interest and eagerness to work on the subject and gain more knowledge about it. In the end, this has led to my current enthusiasm about the subject as well, as how it affects current businesses immensely. Also, I would like to thank Dr. Martin Sand as my second supervisor and Dr. Robert Verburg as the chair of the committee. I directly felt included in and enthused by the thesis circle of employee-driven innovation. Overall, I would like to thank everyone who has helped me grow during my two-year period at TU Delft and has supported me along the way.

For now, to anyone who reads this, I hope that you'll enjoy reading the thesis. I hope it gives you more insight into employee-driven innovation and inspires you in learning more about it.

Stefan Uitermarkt
July 2023

Executive Summary

The concept of involving employees in decision-making processes has gained a lot of support in recent years. This increased involvement has led to an increasing amount of innovation initiatives from 'ordinary employees'. This concept is called employee-driven innovation (EDI). In recent decades, by implementing information and communication technology (ICT) in organizations, innovation has been fostered. EDI in relation to ICT implementation has already seen practical applications, mainly among high-tech organizations. In these examples, the concepts of an organizational climate for innovation (OCI) and the individual willingness to work with ICT-based tools are often included for optimal results in EDI. However, these results are not shown in every sector, as ICT adoption and innovation have been stagnating in the construction engineering sector.

From this, a gap has occurred in researching the construction engineering sector in relation to EDI. In this master thesis, a research model is proposed to test whether managing EDI in construction engineering can be done in the same way as it has been done in many other sectors, especially concerning ICT applications. A research model is set up, existing from 5 different hypotheses that are tested. Innovative work behavior (IWB) was used to effectively measure the performance of EDI. The individual behavior towards ICT, ICT usage, and OCI were included in the research model as variables influencing IWB. Additionally, the variables of age and job hierarchy were added as these were expected to be related to certain outcomes of the research, although not specifically indicated how. The testing was done via a survey set out in a large-sized engineering & consultancy firm based in multiple countries in Europe and Asia. Eventually, the survey was distributed in the regions of the Netherlands and Belgium, where the core of the business is run. The employees were selected on their job role and discipline, which had to be directly related to the engineering projects run in the company so that results would be specifically focused on the field of construction engineering.

Based on the final sample of 160 employees, a statistical analysis was performed. From the tested research model, three out of the five tested hypotheses seemed to be significant to stimulate IWB in an organization. Although two hypotheses were rejected, the outcome still showed that the individual behavior towards ICT, the level of ICT usage, and OCI related positively to IWB. Job hierarchy also showed to have a direct positive relationship to IWB.

The findings were reflected on the literature found on digitally-driven EDI, which mostly aligned with the literature gathered. Based on this, a model was proposed for EDI enhancement in construction engineering. However, there were some limitations to the study. These limitations cover the choice of the sample, certain limitations to the survey, the measures used in the research, barriers to innovation in construction engineering, and the overall measurement of innovation. Options for future research are discussed to cover these limitations.

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Nomenclature

Abbreviations

Abbreviation	**Definition**
AECO	Architecture, Engineering and Construction and Operations
DF	Dogfooding
EDI	Employee-driven innovation
HREC	Human Research and Ethics Committee
HRM	Human resource management
IATICT	Individual attitude towards ICT
ICT	Information and communication technologies
ICTU	Usage of ICT-based tools
IWB	Innovative work behavior
NL	Netherlands
OCI	Organizational climate for innovation
OECD	Organisation for Economic Co-operation and Development
OP	Organizational performance
PO fit	Person-organization fit
R&D	Research & development
SMEs	Small and medium-sized enterprises
TU Delft	Delft University of Technology

1

Introduction

Nowadays, we as a society are becoming more and more dependent on new technologies. We use applications of technology on a daily basis, whether it is in our smartphones, pc, or car. Through the ever-growing need for technological products, the technology sector as a whole has seen major growth in the last decades. The technology sector owes its growth primarily to its successes in technological innovation (Van Laar et al., 2017). Especially the manufacturing, computing, and software sectors are affected heavily by an ever-growing amount of innovative applications (Sirilli & Evangelista, 1998). One of the factors influencing the level of innovativeness the most is the use of information and communication technology (ICT) tools. According to Van Riel et al. (2004), *"the likelihood of innovation success is associated with the systemic reduction of decision-making uncertainty, as a result of organizational information gathering, diffusion, and processing activities."* (Van Riel et al., 2004, p.348). This shows that properly managing ICT tools within an organization can lead to innovative outcomes. This, in turn, is crucial for the survival of organizations in the technology sector. In the high-technology sector, often defined as the technology sector that is very R&D intensive, this is even more the case. There are two main reasons for this:

- The high-speed technological developments and related globalization lead high-technology service providers to experience higher levels of competition in their marketplaces (Bogner & Barr, 2000).
- Product life cycles are becoming increasingly shorter, meaning that there is a need for continuous, fast, and effective change and innovation (Boulding et al., 1997).

This need for innovation leads to companies having investments in R&D and software as the main components of their expenditures (Sirilli & Evangelista, 1998). Because of these rising costs, investments have become even more important. In extreme cases, this can lead to an 'all-or-nothing strategy', in which a successful adoption of ICTs and R&D can lead to great profits, but on the other hand, can lead to an enormous risk of failure. According to Van Laar et al. (2017), a mitigation strategy can be implemented by increasing employee involvement in the innovation process. Kesting and Ulhøi (2010) argue that employees have hidden potentials that are often not utilized. Increased employee involvement can play a role in creating innovation driven by employees as a bottom-up process. This concept is called employee-driven innovation (EDI) and is described as:

"The generation and implementation of significant new ideas, products, and processes originating from a single employee or the joint efforts of two or more employees who are not assigned to this task" (Kesting and Ulhøi, 2010, p.66).

Even though these drivers indicate increased participation in organizations, it does not clarify how employees can be involved in the innovation process. Although the premise might seem simple by just letting employees co-decide, there are many barriers to an organization before employee participation in the innovation process can be realized. As human capital is an important factor in this, the organizational climate should be sorted in a way that an employee feels open for idea generation, and besides, the employee should have certain skills in order to create innovative ideas (Kesting & Ulhøi, 2010). Even though this alignment should be in place, many EDI initiatives in relation to ICT adoption have come into practice. The most well-known examples are often initiated by large high-tech multinationals, such as Meta, Apple, and Google (Tirabeni & Soderquist, 2018). However, there is one particular sector that is lagging behind in EDI driven by ICT, which is the sector of construction engineering (Oesterreich & Teuteberg, 2016). Even though the sector accounts for a large portion of the total amount of jobs and is therefore vital for our economies, its level of innovation is stagnating. The sector has not managed to integrate the innovative technologies mentioned to keep up with other comparable sectors such as automotive and mechanical engineering (Hampson et al., 2014). To increase the innovativeness of the sector, it is of essence to research how EDI initiatives in relation to ICT could be implemented for the construction engineering sector.

Thesis outline

This master thesis document will address how employee involvement is managed in an ICT-driven engineering firm and how managing the organizational climate can play a role in this. The thesis starts with an extensive literature review on employee participation in relation to the employee's innovative traits, ICTs adopted in the high-technology sector, and the organizational culture to support innovative behavior in chapter 2. From the literature review, a research model is built, including several hypotheses. This model gives the foundation for the research design in the master thesis. Secondly, the methodology of the quantitative research is described in chapter 3. The research is conducted through a survey of a large-sized engineering firm operating in and with the construction sector in multiple European and Asian countries. The core of the business is found in the Netherlands and Belgium, in which the survey has been distributed. Results of the research are shown in chapter 4. These results have been gathered through a regression analysis, showing possible links in the research. In chapter 5, these results are discussed and reflected upon in the literature. The theoretical and practical implications of the research are mentioned, extended by the limitations of the research including the proposed future research. Finally, in chapter 6, the document ends with a conclusion on how EDI could be managed in the construction engineering sector.

2

Literature Review

2.1. Employee Driven Innovation

In the last couple of decades, human capital has become an even more important production factor. This does not only apply to the top management level but also to the ‘ordinary worker’ (Kesting & Ulhøi, 2010). This trend has been mostly defined by the combination of two factors. The first is that workplaces are becoming more complex as industrial manufacturing and overarching technology develop. This development leads to the automation of many work processes, requiring the employees to have or obtain skills and expertise to handle and understand the more complex equipment related to this automatization. Second, workers increasingly expect their jobs to be satisfying, using their potential to the fullest extent. This includes their talents to be developed and challenged, and that the workers are taken seriously and involved in the decision-making processes (Kesting and Ulhøi, 2010; Stohl and Cheney, 2001).

It has therefore become more important for employees to participate in the organization. Not only in the ordinary work processes but also when it comes to the decisions taken on major innovations in the organization (Bakker & Demerouti, 2008). Worker participation in decisions in the innovation of the organization can simultaneously make the organization more resistant to or even flourish in the global environment with its growing influence on work processes. This is mainly due to the increasing geographical dispersion, cultural diversity, and electronic collaboration (Stohl & Cheney, 2001). The organization, therefore, needs to be more knowledge-intensive, decentralized, adaptive, flexible, efficient, and responsive to rapid changes. Employee participation in innovation can have a positive effect on this. In many cases, instead of involving all employees in the innovation process, they have assigned a small group of people focused on innovation in their daily practices. We often refer to this group as Research & Development (R&D). They focus solely on creating and implementing novel ideas within an organization. Other ‘ordinary’ employees are automatically excluded from these processes (Stohl & Cheney, 2001). This idea of driving innovation in an organization led by R&D is countered by the concept of EDI. Within EDI, the ‘ordinary’ employee is involved in the process of idea generation and idea implementation.

Høyrup (2012) identified three forms of EDI:

1. A bottom-up process in which innovation arises from cultural practice that is performed daily. Besides, innovation can occur from practices that were intentionally not meant to act as or create an innovation.

2. A mixture of both bottom-up and top-down processes. In this mixture, employees receive innovation input, which is subsequently formalized by management.

3. A top-down process from management. Here management initiates the innovation process and involves the necessary employees to support and develop the process.

The first form of EDI, which involves the bottom-up process, is seen as the traditional way of including employees in the innovation process. It is a method in which there is little structure given, as there is no management involved initially. Management is only included in a later stage and can therefore not steer the idea in an early stage. Bäckström and Bengtsson (2019) claim that EDI can be better steered through the last two mentioned forms of EDI, so basically including management to not only direct but also promote EDI in the workplace. According to Tirabeni and Soderquist (2018), *"the challenge for the practice of EDI in organizations is to move away from an essentially unstructured and spontaneous approach to more specific programs, consciously designed and managed to enhance EDI's positive impacts on innovation."* (Tirabeni and Soderquist, 2018, p.6).

2.1.1. Innovative Work Behavior

As concluded from section 2.1, a constant factor of EDI is the involvement of the employee in the innovation process. One of the main contributions to EDI is the employee's innovative work behavior (IWB). IWB is described as: *"The initiation and intentional introduction (within a work role, group or organization) of new and useful ideas, processes, products or procedures"* (De Jong and Hartog, 2010, p.24). This concept is different from employee creativity, as it does not only include the generation of ideas but also the implementation of these ideas. It is therefore a more applied method of innovation within an organization. In some papers, more foundational subcategories or phases of IWB are included, such as idea promotion, idea exploration, and idea championing (Janssen, 2000; De Jong and Hartog, 2010). De Jong and Hartog (2010) also argue that the distinction between the different phases can be hardly measured, let alone distinguished, and are therefore not seen as separate identities of IWB, but rather part of idea generation and idea implementation.

According to Ramamoorthy et al. (2005), job autonomy is one of the key factors when it comes to the influence on IWB. Through the fact that the employees feel more empowered in their job role, they have more incentives to take such a 'risk' of coming up with and implementing a new idea in their work practices. The autonomy or freedom experienced in their job leads to employees engaging in more 'trial and error' processes, which often lead to new ideas and consequently better work practices. This autonomy also lets go of the feeling of having strict rules and regulations surrounding the job or job description, automatically giving the employee more room to explore. These so-called 'empowered employees' often contribute to the organization's performance by providing and implementing ideas that would not have occurred if the job role did not hold any autonomy for the employee (Paul et al., 2000). Another factor that has a positive effect on IWB is the perception of freedom. If employees experience the feeling of being 'free' in their work practices, they may automatically experience greater free will and subsequently take more control of their own ideas and work processes. This enhances their innovativeness, as idea generation and idea implementation become easier for the employee (Si and Wei, 2012; Amabile et al., 1996).

2.1.2. Organizational factors influencing IWB

Organizational climate for innovation

The concepts of autonomy and freedom as discussed are only examples from which the IWB of an employee can be influenced. Besides these examples, the employees can experience multiple factors influencing their IWB. One important factor in promoting IWB in an organization is the creation of an 'organizational climate for innovation' (OCI) (Shanker et al., 2017). The terms 'organizational culture' and 'organizational climate' are sometimes used interchangeably. From the literature, it becomes clear that these terms include several overlapping factors, and sometimes even describe the exact same concept. In many instances, 'organizational climate' describes a more broad concept, involving the concept of 'organizational culture'. For that reason, the term 'organizational climate' is kept as the term to describe both the organizational culture and the organizational climate.

Knowledge among employees is crucial for organizations to maintain or gain a competitive advantage. That is the main reason why it is essential to create an organizational climate that is in line with this need for innovation within the organization (Shanker et al., 2017; Kissi et al., 2012; Isaksen and Ekvall, 2010). As mentioned, the employee must hold a certain level of autonomy to have the incentive to come up with new ideas to improve his or her work processes. Given the fact that an employee's IWB contributes to better overall organizational performance (OP), it is even more important that an organization organizes its climate in such a way that IWB is optimized to the fullest extent (Shanker et al., 2017). Part of this OCI is that the management makes sure that individual creativity is encouraged, nurtured, and enhanced (Hunter et al., 2007; DiLiello and Houghton, 2006; Isaksen and Lauer, 2002). According to DiLiello and Houghton (2006), employees who have innovative traits are more likely to be creative and implement new ideas when they feel supported by the organization. It is therefore that if employees have a positive view of their organization's climate, this is more likely to result in high levels of motivation, commitment, and employee engagement. This, in turn, will lead to an improved OP.

Although the distinction between definitions of OCI cannot be made easily, it is clear that the organizational climate is of the essence for promoting IWB in an organization. Multiple studies have tried to understand and fully explain what OCI holds. Hunter et al. (2007) have tried to map the dimensions related to OCI, and have concluded a total of 14 general taxonomy dimensions based on the literature, to measure the OCI. The dimensions are as follows:

1. **Positive Peer Group:** Employees have the perception that they are supported and intellectually stimulated by their peers. Relationships between the employee and the peer are characterized by trust, humor, openness, and communication (Abbey & Dickson, 1983).
2. **Positive Supervisor Relations:** The employee has the perception that the supervisor is supportive of his or her innovative ideas. Besides, the supervisor operates in a non-controlling way (Oldham & Cummings, 1996).

3. **Resources:** The employee has the perception that the organization has and is willing to use resources to facilitate, encourage and implement innovative ideas (Amabile et al., 1996).
4. **Challenge:** Perception that the job role of the employee is challenging enough, but not overwhelming at the same time (Oldham & Cummings, 1996).
5. **Mission Clarity:** The employee has the perception and awareness of the goals and expectations of creative performance in the organization (Thamhain, 2003).
6. **Autonomy:** Perception that the employees have autonomy and have the freedom to perform their jobs (Ekvall, 1996).
7. **Positive Interpersonal Exchange:** There is a general perception of 'togetherness' in the organization. There is no or almost no conflict occurring (Ayers et al., 1997).
8. **Intellectual Stimulation:** The perfection of an employee that a debate and discussion of ideas in the organization are encouraged and supported (Ekvall, 1996).
9. **Top Management Support:** The employee perceives that creativity is supported and encouraged by the upper levels of the organization (N. Anderson & West, 1998).
10. **Reward Orientation:** The perception that creative performance is rewarded within the organization (Tesluk et al., 1997).
11. **Flexibility and Risk-Taking:** The perception that the organization is willing to take risks. Uncertainty and ambiguity that are associated with creativity, are dealt with (Ayers et al., 1997).
12. **Product Emphasis:** The employee perceives that the organization is committed not only to quality but also to the originality of ideas (Sethi & Nicholson, 2001).
13. **Participation:** The perception that participation of the employee within the organization is encouraged and supported. There is clear and effective communication between peers, supervisors, and subordinates (N. Anderson & West, 1998).
14. **Organizational Integration:** The perception that there is a good integration of both internal and external factors (Thamhain, 2003).

Organizational leadership

What becomes clear from the dimensions mentioned in the study of Hunter et al. (2007), is that all dimensions are based on the perception of the employee towards the organization. Therefore it is argued that it is not only important how the OCI is designed, but also how it is perceived by the employee. On the other hand, Cai et al. (2018) argues that organizational leadership is a major factor in defining the IWB of an employee. Throughout the years, traditional leadership styles are increasingly being questioned (Sendjaya & Sarros, 2002). These leadership styles tend to create a certain distance between a leader and a follower, subsequently leading to the demotivating of the follower in IWB practices. The concept of 'servant leadership' opposes the traditional leadership styles by making sure that employees are facilitated in their needs, instead of commanding them to do certain tasks. In essence, servant leadership can, by flattening the hierarchical structure, nurture the followers' desirable outcomes (Barbuto and Wheeler, 2006; Mayer et al., 2008; Parris and Peachey, 2012). Examples are putting the employees' development as a priority in their work processes, and creating meaningful jobs for employees. In short, a more flattened hierarchical structure may be benefiting the IWB of the employee, as the leader does not only act as someone who gives commands to the subordinate, but rather facilitates them in their innovative practices.

2.1.3. Individual factors influencing IWB

Except for external factors affecting IWB such as the organizational climate and organizational leadership, internal factors are also present, individually identified by factors influencing IWB. Tirabeni and Soderquist (2018) have identified multiple individual competencies that contribute to innovation. These competencies or skills are split between four different categories. These are professional, methodical, social, and personal skills. Subsequently, these are subdivided into different skill sets: explorative *('how well can somebody gain knowledge from outside of the standard boundaries?')*, exploitative *('how well can somebody exploit knowledge and translate this knowledge to improve their work processes?')*, and ambidextrous *('how well can somebody combine both explorative and exploitative skills to improve overall innovativeness?')*. For the four different categories, the following skills are related:

1. Individual professional skills: expanding knowledge (explorative), knowledge concentration (exploitative), and knowledge brokerage and multi-tasking (ambidextrous).
2. Individual methodical skills: coping with complexity in the context of variety enhancement (explorative), simplification and variety narrowing (exploitative), and dialectic and synthesis thinking (ambidextrous).
3. Individual social skills: cooperation in the framework of interaction relationships (explorative), keeping control of work processes (exploitative), and tolerance to ambiguity and mediation capabilities (ambidextrous).
4. Individual personal skills: self-reflection as a personal routine (explorative), authority in the implementation of personal action (exploitative), and the capability to combine alternative logic and control emotional ambivalence (ambidextrous).

This idea of individual skills being the only internal determinant of IWB is countered by the paper of Siregar et al. (2019). They argue that a combination of internal factors exists. These factors do not only include certain skills but also individual characteristics and attitudes. Based on the research, a conceptual model of four different types of factors is set up. These factors are competency, self-efficacy, motivation, and commitment.

Competency is seen as one of the psycho-sociological aspects of an employee's IWB. This is mainly due to the skills related to it, such as cognitive and interpersonal skills, the willingness to discuss, the willingness to solve existing problems, communication skills, and collaboration skills (Janssen et al., 2004). But aside from these cognitive and interpersonal skills, the concept of competence also covers the accumulation of knowledge and experience in their related work field (Vilá et al., 2014). According to Ah et al. (2010), the accumulation of knowledge and experience are determinants of the successful implementations of innovation in organizations. The second factor, self-efficacy, is defined as *"beliefs in one's capabilities to organize and execute the courses of action required to manage prospective situations."* (Bandura and Watts, 1996, p.313). This belief can encourage employees to do a certain activity of which the employee is confident that he or she can carry it out. This can either be a task belonging to the daily routine or an innovative activity. It is even argued that the higher the self-efficacy, the higher the level of IWB is (Hsiao et al., 2011). Self-efficacy can be improved by social persuasion. This, for example, can be done through a leader in an organization. According to Hsiao et al. (2011), the opposite is also true. When self-efficacy is lowered, for example through the employee experiencing anxiety or stress, IWB can be decreased. The third factor mentioned in the article of Siregar et al. (2019) is motivation. Motivation leads to employees being more encouraged to work harder (Anjum et al., 2016). This is relevant to IWB, as motivated people tend to put in the extra effort, which is required for initiating innovative activities. Lastly, commitment is mentioned in the conceptual model. The commitment reflects to what extent an employee is bound to the organization. According to Xerri and Brunetto (2013), a highly committed employee is likely to see him- or herself as a true member of the organization. This often means that the employee is willing to stay in the organization for a longer period, enabling them to more easily participate in innovative processes. Besides, committed employees know how the organization operates and what the goals of the organization are, which can be translated into trying to achieve those goals. From this section, it can be concluded that IWB is decided by many co-deciding factors, both from the individual and the organization, which should be aligned for maximizing IWB.

2.2. Digitally-Driven Innovation

With the fast development of digital technologies, it has become consistently harder for organizations to compete. This is especially due to the rapid change in these digital technologies (Amorim et al., 2018). It forces organizations to switch to a digital work environment. If this is done before others do, a survival strategy could flow out of it, or the organization might even get a competitive advantage over others (Bharadwaj, 2000). ICTs are at the forefront of this fast-changing digital transformation. In recent decades, innovation in the industry has been mostly due to ICT innovation and implementation (Van Laar et al., 2017). But apart from ICT tools being a foundation for innovation in the current age, in itself, it is not sufficient to drive innovation. The factor of human capital is decisive when it comes to innovation (Anderson, 2008). Van Laar et al. (2017) have identified a combination of two factors on how innovation by human capital and the use of ICTs can be optimized:

- The employee should contain a certain skill set surrounding the computer. This is sometimes also referred to as 'computer literacy'. This mostly covers the more basic tasks like how to work with certain files on the computer, how to store them, etc.
- The employee should contain a certain level of 'digital competence'. Digital competence covers the mastering of the skills to manage information, collaborate, communicate and share, create content and knowledge, be ethically responsible, evaluate, solve technical problems and handle technical operations (Ferrari, 2012).

2.2.1. ICT and Employee-Driven Innovation

As mentioned in 2.2, there is a clear relationship between innovation in the 21st century and the use of ICT tools. In the initial phases of innovation, this was very different. The concept of innovation has changed a lot throughout the years. Formerly, innovation was regarded as something that was focused on technology-push (Manolopoulos et al., 2011). So basically innovation was something that had to come from within the organization and subsequently used as a means of output in the form of product or service. With higher costs and increasing rates of failure came a transformation into a more pull-oriented method of innovation (Ulwick, 2005). Multiple kinds of innovation models were created though-out the years. A big change happened when the internet was introduced and foremost became accessible (Chesbrough et al., 2006). This caused the information to be transferred more easily and freely. Technologies driven by information and communication (ICT) flourished, especially because unused ideas some could be used by others. Not only the sharing of ideas but also knowledge sharing, is one of the main contributors to innovation in an organization. The most important reason for this, is that often it does not concern general knowledge, but rather exclusive in-depth and highly context-dependent knowledge (Gressgård et al., 2014; Kesting and Ulhøi, 2010). Managers do not often possess this kind of knowledge and is therefore extra important and simultaneously challenging to be shared within an organization. There are multiple examples of ICT tools used to boost this idea and knowledge sharing within organizations. Examples such as innovation portals, idea submission systems, innovation management software, collaboration software, and social media are used on a frequent base. However, introducing these ICT tools is not sufficient on its own. According to Gressgård et al. (2014), this can only be achieved through the implementation of a supportive OCI, as previously discussed in subsection 2.1.1. Through the relatively easy exchange of information through ICTs, Chesbrough (2003) has introduced the concept of Open Innovation (OI). OI captures all methods of ideas generation and sharing, but also the implementation of these ideas into the organization. This can be achieved through for example inter-organizational collaborations, licensing agreements, and crowd-sourcing (Bogers et al., 2017). One of the key elements of OI is employees' overall engagement in the process. According to Flocco et al. (2022), this is due to a combination of two main drivers:

1. **It is almost impossible to possess all of the knowledge that is required to innovate in the current state of organizations.** Products and processes have become so complex that one single individual is unable to innovate on his own, thus requiring knowledge and idea sharing as a means of creating innovation within an organization (Høyrup, 2010).

2. **Employees increasingly expect their potential to be used within the organization as best as possible (Felstead et al., 2018).** Kesting and Ulhøi (2010) have described human talent as an essential element in organizations, as it is a competition between organizations to constantly attract the best employees with the most valuable talents.

Applications of technology-Assisted EDI

ICT tools can be of great influence on the level of activity of employees regarding innovation. According to Watanabe et al. (2015), who conducted a case study of implementing a communication support system in the health services field, acknowledged that implementing such a system improves EDI in the workplace. This is supported by the research of Laviolette et al. (2016) and Soderquist et al. (2016), which identified that technology can enhance OI via employment engagement. This effect was particularly seen in companies related to the ICT sector. One example of enhancing employee engagement is via dogfooding (DF). This entails that the company makes sure that when it comes to certain ICT-related products which are output-related, employees are forced to work with them through their normal work activities. This way, employees are forced to solve problems in the functioning of these kinds of products, so that the product becomes more efficient and operational (Soderquist et al., 2016). Besides DF, there are other known methods of implementing EDI within an organization. Tirabeni and Soderquist (2018) have identified three frequently used methods:

- **Time Allocation:** a certain amount of time is given to an employee to come up with new ideas and try to work these out. Often the time allocation is a fixed number of hours a week. These hours are not meant to spend on every-day-work processes, but only on creating something novel.
- **Internal Digital Platform:** these platforms are used to share ideas internally. It is meant to be a collaborative process, often aimed to improve internal ways of working (Bäckström & Bengtsson, 2019). Additionally, the internal digital platform is used to uncover hidden ideas within the company. Therefore it is essential that every employee can contribute to the platform with their input.
- **Hackathons:** an internal competition which lasts between 24 to 48 hours. The purpose of a hackathon is to work on an idea, a prototype, a product, or a solution and solely focus on this specific topic. Often the item is thoroughly tested and experimented on in these 24 to 48 hours.

By now we know that technology-assisted EDI has brought many innovative ideas to big tech companies like Meta, Amazon, Google, Apple and Microsoft (Tirabeni and Soderquist, 2018; Soderquist et al., 2016; Bäckström and Bengtsson, 2019). It is one of the reasons why these companies have gained such a competitive advantage.

Technology-assisted innovation in the technology service sector and construction engineering

The applications of technology-assisted EDI mentioned above are mainly based on product innovations. According to some, a significant difference exists between product innovation and service innovation (Edvardsson & Olsson, 1996). This is mainly due to the fact that product innovations are tangible (you can see changes happening to the product and thus measure it more easily) and intangible service innovations (change is not visualized). This principle is opposed by Lusch and Nambisan (2015), who claim that technology service innovation should not be seen differently from product innovation. This is mainly due to the service-dominant (S-D) logic, arguing that the value in service innovation is the *"comparative appreciation of reciprocal skills or services that are exchanged to obtain utility"* (Vargo and Lusch, 2004, p.7). Basically, the theory claims that the value of service innovation is found in every instance and that the growth of skills and knowledge is already a visible innovation. An observed difference in the technology service sector compared to sectors in technology such as manufacturing, is that the network is constructed differently. In the service sector, there is a more 'actor-to-actor' kind of network instead of a more producer-consumer-oriented relation. That means that there is less of an innovation push in the technology service sector, but rather a more dynamic way of innovating (Lusch & Nambisan, 2015). The service sector accounts for two-thirds of all jobs in OECD countries, of which a large extent is in the technology service sector, making it vital to sustain innovation in this sector (Van Laar et al., 2017).

However, the specific sector of construction engineering shows signs of stagnating innovation (Oesterreich & Teuteberg, 2016). A possible explanation for this is that the sector shows low levels of digital technology adoption (Hampson et al., 2014; Oesterreich and Teuteberg, 2016). According to Mannino et al. (2021), the same applies to the whole sector of Architecture, Engineering and Construction and Operations (AECO) sector. Oesterreich and Teuteberg (2016) argue that the sector is different from the sectors where digitally-driven innovation does succeed, based on three factors: (1) the value chain of the construction sector is highly dependent on tight collaborations with customers, subcontractors, and other stakeholders. For the construction process to be managed properly higher levels of specialized knowledge are required, as construction projects are complex and site-based. (2) Additionally, the construction sector consists of many small and medium-sized enterprises (SMEs) that have limited capabilities for investing in new technologies. (3) Lastly, so far, the lack of innovation and technological progress in the sector has gone hand in hand with low investments in R&D.

2.2.2. Challenges faced within digitally-driven EDI

Although EDI has brought some considerable benefits to some organizations, it has become clear from the literature that EDI also has some limitations, as it is still not the standard. Within the boundaries of OI, EDI can have clear benefits as knowledge is easily transferred, being translated to the complete exploration and exploitation of ideas. EDI inherently assumes that employees in the company have or can create ideas that can be beneficial for the organization. The influential role of the 'ordinary employee' is clear, but that does not mean that the importance of leadership should be forgotten. Successful EDI uses the full potential of both employees and leaders within organizations (Amundsen et al., 2014). Although this may sound like something that can be aligned easily, there are some limitations to EDI as a whole, thus restricting EDI in some instances:

- **Lack of knowledge and skills:** the premise of EDI is that involving the ordinary employee in the decision-making processes of the organization will automatically contribute to more innovativeness. This is not always the case, as employees need to contain a minimum amount of knowledge about the topic and contain the required skills for idea generation and implementation (Kesting and Ulhøi, 2010; Amundsen et al., 2014). According to Bjornali and Støren (2012), innovative behavior among higher-educated professionals is an important factor in defining their innovative activity. The paper concluded that *"The probability of being innovative is nearly 10 percent higher among graduates with higher levels of professional and creative competencies compared to those with lower levels."* (Bjornali and Støren, 2012, p.414). The paper suggests that having these competencies is most effective in the fields of Science, Engineering, and Agriculture and veterinary, with the latter being the most affected. This automatically means that innovative behaviour by different types of employees may differ.
- **Lack of resources:** although an organization might be willing to increase its EDI initiatives, it could lack time and resources to facilitate it (Kesting & Ulhøi, 2010). This could lead to the employees feeling unsupported in their ideas, resulting in the failure of EDI initiatives. Especially reflecting on the availability of ICT tools, this could be an issue. If, for example, an organization is not able to provide sufficient ICT related products through which idea sharing can be facilitated, this could lead to EDI initiatives failing.
- **Lack of organizational support:** reflecting back on leadership practices in EDI, it is required that the organization offers organizational climate in which employees feel free to give and develop their ideas (Amundsen et al., 2014). Multiple limitations could exist in the organizational climate. Firstly, employees should have the possibility to cross over ideas and discuss with others, and not be restricted by their day-to-day work activities. Secondly, hierarchical structures should be minimized in order to promote communication between 'top-level' management and 'lower-level' employees. A hierarchical structure promotes top-down initiatives and decreases bottom-up EDI initiatives (Kesting & Ulhøi, 2010). Besides, a hierarchical structure is often increasing resistance to change (Amundsen et al., 2014). Lastly, the fear of failure should be minimized. If employees are 'punished', for example by public shaming, EDI

initiatives might fail. Therefore employees should be able to embrace the willingness to accept failure, supported by the organizational climate (Amundsen et al., 2014).

- **Lack of general acceptance:** the perceived usefulness, perceived ease of use, and user acceptance of information technologies are not always present in organizations. They define the overall willingness to work with (new) information technologies (Davis, 1989). As discussed in subsection 2.2.1, the implementation of ICT tools in an organization can improve the number of EDI initiatives and its overall innovativeness. Thus, by implementing these tools, the general competitiveness of the company can be increased. According to Taherdoost (2018), individual factors, such as self-efficacy and motivation are important factors in defining the overall acceptance of information technologies and willingness to work with these kinds of tools. For both self-efficacy and motivation, it's the case that the higher the presence of the factor, the higher the acceptance of the information technology and the willingness to work with it.

2.2.3. Managing digitally-driven EDI

In order to cope with the challenges mentioned in subsection 2.2.2, EDI should be managed properly. Kesting and Ulhøi (2010) argue that it is the goal to facilitate management support for EDI, instead of managing innovation from a top-down structure. Human Resource Management (HRM) is an important factor in facilitating this support. According to Cooke and Saini (2010), it is important to make sure that strategic management is aligned with the management of human resources. This way, the designed OCI can be supported via HRM to stimulate IWB in the organization. In essence, it is important that these are aligned, so that innovation in the organization is optimized.

HRM practices

It has become more evident that HRM practices can have a determining factor in defining the levels of EDI in an organization (Renkema et al., 2021). Influences of HRM practices can enhance organizational learning, the innovative climate or culture, and human capital. Through this, HRM does not only relate positively to the innovative performance of the organization itself but also to the innovative behavior of individual employees. For long it was thought that organizational-oriented top-down practices, such as training, were best suited to increase the overall innovativeness of an organization. Nowadays this concept is challenged, as factors like job complexity and autonomy influencing the levels of bottom-up innovative practices have gained more attention (Li et al., 2017).

Person-organization fit

Within managing EDI in an organization, the person-organization (PO) fit is important. This indicates how well a person is fitting in an organization and therefore feels “at home” (Saether, 2019). Not only does it influence the employee's emotional state of being, it again influences the level of IWB of the employee. Therefore it is important to make sure that the PO fit is as high as possible. This PO fit is not merely something that is present or not when a new employee joins the company. The PO fit can also be influenced. One of the options for aligning the employee with the organization is through team-building sessions. This can increase the feeling of ‘togetherness’, which is also part of the organizational climate as mentioned in subsection 2.1.1. Except for team-building, training could also be offered to the management and leader positions in the organization, making sure that they know how to align the organizational climate with the employee by supporting creative thinking (Saether, 2019). Aside, recruiting new employees is in the end preferred to be in line with the overall organizational strategy so that IWB is optimized if the employee is put in the right organizational climate. For the digitally-driven organization more specifically, it is also important that the employee is able to operate with ICTs in its daily operations. With the current literature, we can set up a structure of how EDI can be managed in a digitally-driven organization. The structure based on current literature can be seen in Figure 1.

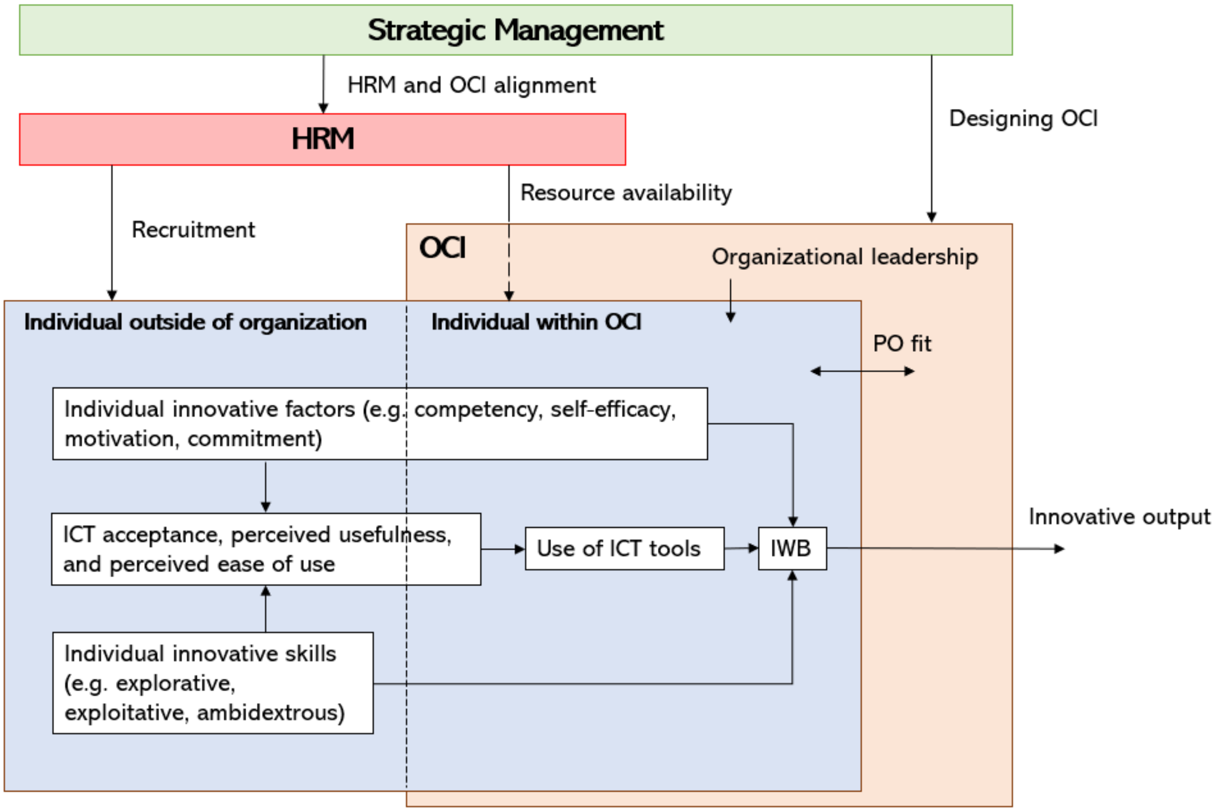

Figure 1: Managing EDI in a digitally-driven organization

Concluded from the figure, we can see multiple dependencies occurring in managing EDI in an organization. Reflecting back on the challenges to digitally-driven EDI mentioned in subsection 2.2.2, the first thing that should be properly defined is strategic management. As mentioned by Kesting and Ulhøi (2010), the goal is eventually to support EDI practices within the organization. In order to do so, the OCI should be designed to support the employee/individual in order to facilitate IWB and eventually innovative output. An important factor in this is creating the PO fit, as argued by Saether (2019). This fit makes sure that the employee is aligned with the organization, boosting mainly the self-efficacy and motivation required for IWB. This alignment is the main responsibility of HRM and can be influenced by recruiting the right individuals. It is therefore important that strategic management takes care of the alignment of HRM and the OCI, so that the right people are recruited for the organization (Cooke & Saini, 2010). For a role in a digitally-driven organization specifically, there should be a general willingness to work with ICT applications. Finally, HRM is responsible for making sure that the availability of resources is sufficient to stimulate the IWB of employees.

2.3. Outlines of the Research

2.3.1. Identification of the Research Gap

EDI is a relatively new concept, and literature is still limited. Although, there are examples of successfully-implemented EDI initiatives. Companies like Apple, Amazon, Meta, and Google have shown that there are possible applications of improvements through EDI initiatives to enhance their output through OI (Tirabeni & Soderquist, 2018). As mentioned in subsection 2.2.1, some examples are the 'Hackathons', 'Time Allocation', 'Internal Digital Platform', and 'Dogfooding'. Some examples of EDI initiatives in other sectors also exist. Such an example has been quantitatively tested by Velu (2022). In this research, the mediating effect of ICT tools on innovative behavior to enhance innovative action was tested. This study was done in universities, where it was shown that some traits of innovative behavior are significantly impacted by the implementation of ICT tools, subsequently enhancing innovative action. According to the literature, more than just one factor is influencing EDI initiatives in organizations. Factors like organizational culture and climate are covered in some papers but in limited cases in relation to ICT tools. In most cases, the innovations that spring from these EDI practices are product innovations.

In the literature, less emphasis is laid upon business-to-business related innovations, which frequently occur in the technology service sector. Reflecting back on the technology-assisted EDI in the technology service sector mentioned in subsection 2.2.1, there is still discussion on how service innovation should be interpreted (Lusch & Nambisan, 2015). However, it is clear that innovation in the technology services sector is required to sustain it. As previously discussed, the sector of construction engineering has seen stagnation in its innovativeness. It is therefore necessary that a way is found through which innovation in this sector can be stimulated. As discussed in subsection 2.2.1, the lack of innovation in this field might have a relationship with the slow adoption of ICT in its innovation processes. It is also discussed that R&D expenses in this field are low, going hand in hand with the low levels of innovation (Oesterreich & Teuteberg, 2016). Although it, therefore, seems likely to see whether R&D can be increased in order to increase innovation in the sector, it is also known that this can bring additional financial risks and can even lead to an 'all-or-nothing' strategy (Sirilli & Evangelista, 1998). It is therefore recommended to also look at alternatives, like the implementation of EDI practices in relation to ICT in order to stimulate innovation in construction engineering firms. Successful implementation of EDI within the construction engineering sector might additionally remove one of the barriers mentioned by Oesterreich and Teuteberg (2016), as it can (partially) replace required R&D practices.

2.3.2. Research Objective

Research in this master thesis mostly focuses on the less extensively researched link between the combination of an OCI and the implementation of ICT tools in order to enhance IWB in construction engineering. In the research, the concept of ICT is tested as the link from which IWB in the context of EDI is enhanced. The research objective, as proposed, will be the following: identify if EDI is enhanced by the implementation of ICT tools within the construction engineering field and make recommendations based on the research, which are generalized for engineering firms.

2.3.3. Research Question

The research question related to the research objective is: ***"Does the use of ICT tools enhance employee-driven innovation in the field of construction engineering?"***

Sub-research Questions

To fully understand and answer the main research question, it is important to split up the question into additional sub-research questions:

1. *Does the use of ICT tools encourage IWB in the domain of ICT-based tools?*

   Although it seems logical, it is not necessarily clear what the driving factor of an individual should be in order to increase his or her use of ICT-based tools. As discussed in subsection 2.2.2, there should be a general acceptance, perceived ease of use, and perceived usefulness of ICT to use these tools within the organization. That goes for both the organization itself and the individual employee within the organization. One known premise is that there should be a general willingness to work with these tools. Answering the question might give insight in the fact whether the increased use of ICT tools leads to more IWB in this domain.

2. *Does the implementation of ICT tools enhance IWB?*

   As described in subsection 2.2.1, ICT in organizations can have a big impact on the activity of employees regarding innovation. It is therefore interesting to see whether implementing ICT tools enhance IWB in general. In this research specifically, the sub-research questions are meant to be answered in the context of construction engineering. Answering the question may lead to an overall recommendation to engineering companies on how to manage ICT implementation in their organization.

3. *Does the organizational climate affect IWB?*

   As mentioned in subsection 2.1.1, organizational climate can be an important factor in promoting IWB in an organization. When an organizational climate is managed properly, this can be referred to as the organizational climate for innovation (OCI). In subsection 2.2.3 it is mentioned that if there is a PO fit between the employee and the OCI, IWB can be optimized. This can in turn lead to competitive advantages for the organization in its domain, as innovative output is likely to increase.

4. *What is the role of an OCI on IWB in the domain of ICT-based tools?*

   Concluding from the literature, both an OCI and the implementation of ICT tools in an organization have a positive effect on overall IWB. Since it is assumed that these will hold a positive relation to IWB, it is automatically interesting to answer the question of what the role of an OCI on IWB is.

2.3.4. Research Model

Based on the research gap, a possibility for more in-depth research has occurred. This in combination with the research objective and related research questions has formed the research model, which acts as a basis for the research in this master thesis. The research model can be seen in Figure 2.

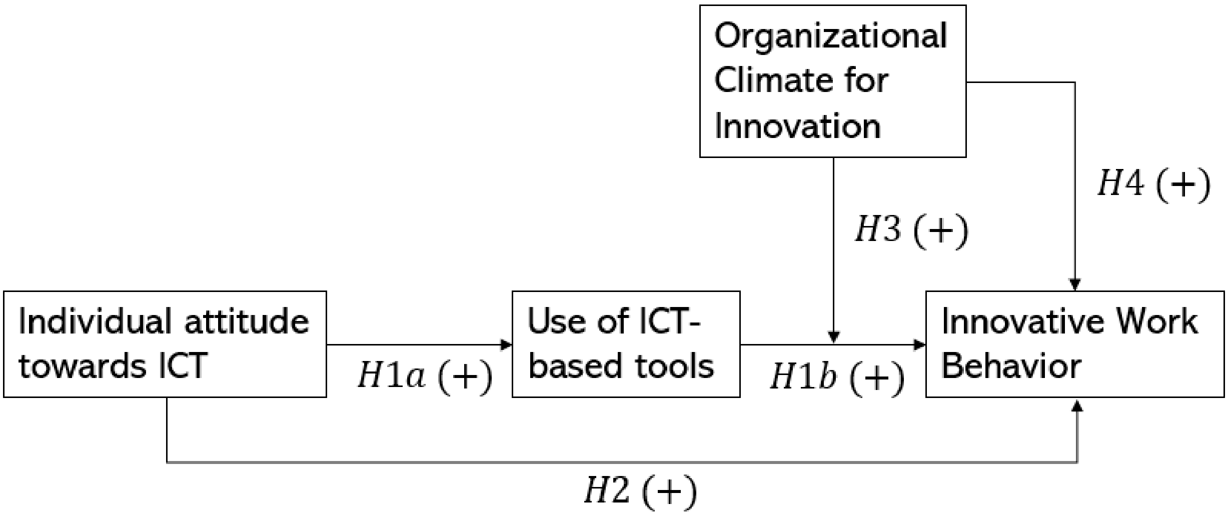

Figure 2: Conceptual research Model

2.3.5. Hypotheses

Based on the research question mentioned in subsection 2.3.3, the sub-research questions mentioned in subsection 2.3.3, and the research model drawn in Figure 2, several hypotheses can be formed. The hypotheses and their relation to the research model are shown in Figure 2 by indicating them with H1 to H4. The hypotheses formed, are:

- ***H1a: A positive attitude towards ICT and the willingness to work with ICT-based tools of individuals increase the overall use of ICT-based tools in an organization.***

  As discussed by Van Laar et al. (2017), the implementation of ICT-based tools can lead to significant benefits for an organization. One of those benefits is that implementing these tools is that it forces the organization to operate in a more digital work environment, making sure that the organization is more competitive when fast digital transformation occurs (Amorim et al., 2018). In subsection 2.2.2 it is argued that for the ICT-based tools to be used, it is required that there is a general acceptance towards ICT and willingness to work with ICT-based tools. This is the case for both the organization and the employees themselves. This hypothesis purely focuses on the attitude of the employee, not the organization. However, it is expected that if there is a general willingness to work with ICT tools and perhaps innovate through these tools, the organization is willing to facilitate the resources required for this (Kesting & Ulhøi, 2010). Davis (1989) quantitively tested whether an overall willingness to work with ICT-based tools increased the overall use of ICT. They found that a significant increase occurred when the attitude towards ICT was positive, therefore acting as a foundation for this hypothesis.

- ***H1b: If the overall use of ICT-based tools in an organization increases, then this will lead to an overall increased IWB of the employee.***

  Following from subsection 2.2.1, The use of ICT in organizations can lead to an increase in the innovative behavior of employees. This is in terms of idea generation, idea promotion, and idea realization/implementation. It, therefore, seems like an increased use of ICT leads to an increase in IWB. This concept is mainly built on the idea that increased use of ICT-based tools leads to more ideas and knowledge being transferred (Gressgård et al., 2014; Kesting and

Ulhøi, 2010). In an article by Velu (2022), a similar hypothesis was tested to be significant for students' employability, mostly in universities. It was seen that if the students communicate more via these ICT platforms or channels, employability increased. This hypothesis is therefore also used as a guideline for this hypothesis, but does not consider limitations to the availability of these tools. Even though, it is expected that increasing use leads to an overall increased IWB. Subsequently, this hypothesis indicates the partial mediation of the relationship of the individual attitude towards ICT on IWB. It is expected that IWB will be partially increased by employees actually using the ICT-based tools as they are more willing to do so.

- ***H2: A positive individual attitude towards ICT-based tools has a direct positive relation to the level of innovative work behavior of the employee.***

  In order for an individual to use ICT, he or she should have some degree of willingness to work with it (Davis, 1989). The ICT acceptance, perceived usefulness, and perceived ease of use are at the foundation of this willingness to work with ICT-based tools. It is expected that certain factors are influencing this willingness, which are also present in IWB. The prerequisite of IWB is that the individual should contain certain innovative skills relating to the individual's explorative, exploitative, and ambidextrous nature (Soderquist et al., 2016). Especially skills relating to the individual being explorative are expected to be pulling the individual towards using ICT-based applications more often. The same applies to individual innovative factors such as self-efficacy and motivation (Taherdoost, 2018). These factors might have a positive influence on both the overall willingness to work with ICT-based tools and IWB, as the higher these factors are, the more eager the individual probably is. Therefore, it is expected that except for a mediating effect of ICT usage, there is also a direct effect present between the two factors.

- ***H3: The relationship between the use of ICT tools and IWB is positively moderated by a supportive OCI.***

  It is assumed that both the use of ICT tools and the 'right' organizational climate lead to increased IWB. The concept of being 'right' is rather vague and depends largely on the PO fit (Saether, 2019), indicating how well an employee aligns with the organizational climate. Hunter et al. (2007) identified 14 dimensions that the organizational climate can have in order to stimulate employees in their innovative behavior. It is assumed that if an organization succeeds in designing such an OCI, innovative behavior is automatically stimulated. However, it does not directly indicate the relation between stimulating IWB through ICT-based tools. Research by Leidner and Kayworth (2006) has indicated that the organizational climate is an influential factor in creating innovation through ICT applications. The organizational climate is able to steer an employee in his or her way of working, thus influencing the innovativeness of the employee through working with ICT-based tools. It can therefore be seen as a foundation to further research this hypothesis, and whether it applies to the field of construction engineering.

- ***H4: A supportive OCI is positively associated with the IWB of employees within the organization.***

  As mentioned in subsection 2.1.1, IWB is influenced by the organizational climate within an organization. Based on the factors mentioned, it seems that a perceived 'positive' organizational climate in which innovation is stimulated, also leads to an increase in IWB. In the article of Shanker et al. (2017), such a hypothesis was tested. In this research specifically, Malaysian companies were tested on their OCI and relation to organizational performance. The relationship seemed to be positive and significant. It is therefore expected that this is also the case for the construction engineering sector and any other sector. For these reasons, the direct influence of OCI on IWB is tested.

3
Research Methodology

In section 2.3, a structure is set in place for the research of this master thesis, mainly based on the research model in Figure 2 and the hypotheses mentioned in subsection 2.3.5. In the research methodology, quantitive research is described. The goal is to analyze whether the elements in the research model are related to each other, and if so, in what direction and to what extent. In the study, the focus is on the traits of individual engineers, and test their innovative behavior and action based on the use of ICT tools in a set organizational climate. Therefore, based on the book of Bougie and Sekaran (2019), the relations in the model are tested with a quantitative analysis, showing relations between the different variables.

3.1. Population and Sampling

3.1.1. Population

The targeted population for this research is all employees in the AECO sector, with an emphasis on organizations in the field of construction engineering. The organizations in which the employees work should either operate their daily business digitally, either fully or partly or have intentions to digitalize their work processes. As discussed in subsection 2.2.1, the service sector, and thus the AECO sector, is highly represented in the OECD countries, through which the research may be more applicable for organizations operating in these countries. However, this does not exclude employees in organizations in the AECO sector in other parts of the world.

3.1.2. Research Sample

For the research, a survey is set out to test the hypotheses in the research model. The survey has been distributed in a large-sized engineering & consultancy firm, operating in multiple countries in Europe and Asia. The company is active in several construction-based industries, such as energy, chemicals, and pharmaceuticals. The core business is located in the Netherlands and Belgium, where the survey has been distributed. For the distribution of the survey, an internal distribution channel has been used so that all recipients received the link to the survey personally. The employees in the sample were collected through communication with the HR department of the company. Employees were differentiated based on a total of three categories:

1. **Job role:** As described in the research objective of subsection 2.3.2, the goal of the study is to identify if EDI is enhanced by the use of ICT tools within the field of construction engineering. For the job role, it was therefore necessary to distinguish the split between employees whose core business is to be involved in the engineering of the organization, or whether it is mainly focused on organizational practices. As the aim is to specifically focus on employees who include engineering in their daily operations. Consultants are also included in the study after discussing with HR, as consultants in the organization often have tight connections to the engineers and are heavily involved in projects run in the organization. For example, employees in the HR and finance departments are excluded for these reasons. Upper management levels are also excluded, as studying EDI is mainly about a bottom-up structure as described by Kesting and Ulhøi (2010), and should therefore be focused on the 'ordinary employee'.

2. **Area of operation:** As explained in section 3.1, the core of the organization is taking place in The Netherlands and Belgium. The Netherlands is split up into three regions: West, North-East, and South-East. Consultancy is seen as a separate entity and therefore brought up in the sample as a separate area of operation.

3. **Discipline:** The disciplines included in the sample are all disciplines related to engineering activities, as has been explained for the job role.

In total, the survey was sent out to a total of 735 employees within the organization. The initial sample consisted of 253 participants. Eventually, due to missing values and employees not completely finishing the survey, 88 of the responses had to be left out. Therefore the final sample consisted of a total of 165 finished surveys (have answered the last question of the survey). This results in a response rate of 22.4%. The distribution of participants in job role, area of operation, and discipline is shown in Table 1, Table 2, and Table 3. In Table 4 and Table 5, the distribution in gender and age group can be found.

Table 1: Response distribution based on job role

Job role	Recipients	Respondents	% of total	Response rate
BIM Coordinator	5	1	0.6	20.0
Buyer	11	4	2.5	36.4
Construction Manager	14	1	0.6	7.1
Construction Supervisor	26	2	1.2	7.7
Consultant	78	19	11.7	24.4
Discipline Engineer	374	63	38.7	16.8
Estimator	5	1	0.6	20.0
Expeditor	3	0	0.0	0.0
Intern	13	0	0.0	0.0
Lead Engineer	94	45	27.6	47.9
Project Control Engineer	20	4	2.5	20.0
Project Document Controller	16	4	2.5	25.0
Project Manager	76	19	11.7	25.0
Total	**735**	**163**	**100.0**	**22.2**

Table 2: Response distribution based on area of operation

Area of operation	Recipients	Respondents	% of total	Response rate
West region (Netherlands)	267	71	43.0	26.6
North-East region (Netherlands)	188	34	20.6	18.1
South-East region (Netherlands)	141	31	18.8	22.0
Belgium	57	8	4.8	14.0
Consultancy	82	21	12.7	25.6
Total	**735**	**165**	**100.0**	**22.4**

Table 3: Response distribution based on discipline

Discipline	Recipients	Respondents	% of total	Response rate
Architectural	40	5	3.1	12.5
BIM Management	7	0	0.0	0.0
Building Services	27	10	6.1	37.0
Civil and Structural	53	14	8.6	26.4
Construction Management	40	3	1.8	7.5
Electrical	54	16	9.8	29.6
Energy	9	3	1.8	33.3
Environment	25	4	2.5	16.0
Estimating & Cost Control	14	3	1.8	21.4
Infrastructure	4	0	0.0	0.0
Instrumentation & Process Control	49	6	3.7	12.2
Maintenance	4	0	0.0	0.0
Mechanical	118	21	12.9	17.8
Pipelines	43	10	6.1	23.3
Process	78	28	17.2	35.9
Procurement	16	7	4.3	43.8
Project Management	79	21	12.9	26.6
Safety	52	9	5.5	17.3
Scheduling	4	1	0.6	25.0
Technical Administration	19	2	1.2	10.5
Total	**735**	**163**	**100.0**	**22.2**

Table 4: Response distribution based on gender

Gender	Respondents	% of total
Male	134	81.2
Female	28	17.0
Non-binary / third gender	2	1.2
Prefer not to say	1	0.6
Total	**165**	**100.0**

3.2. Measures

Based on the five hypotheses mentioned in subsection 2.3.5, measures are developed in order to properly define whether the hypotheses are true.

Individual attitude towards ICT

As discussed in subsection 2.2.2, the overall perception of ICT of an individual and willingness to use ICT-based tools largely define the overall acceptance of ICT of that specific individual (Davis, 1989). Taherdoost (2018) argue that individual factors such as self-efficacy and motivation also play

Table 5: Response distribution based on age group

Age group	Respondents	% of total
18-24	7	4.6
25-34	52	34.0
35-44	39	25.5
45-54	20	13.1
55 and above	35	22.9
Total	**153**	**100.0**

a big part in the overall acceptance of ICT. The article of Agarwal and Prasad (1998) captures these concepts as 'perceptions about new IT' and combines them with the individuals' intentions to use new IT applications. Since the research model in Figure 2 shows a direct relationship with the use of ICT tools, this link is also present in this study. The variable used in the study is called 'Personal Innovativeness in the Domain of IT' and was shown to be significant for the study (Agarwal & Prasad, 1998). The measure for the variable was originally set up by Goldsmith (1986). It includes a total of four items being rated on a five-point Likert scale, ranging from 'Strongly Disagree' to 'Strongly Agree'.

Use of ICT-based tools

In the research model, the use of ICT-based tools acts as a mediating variable for H1 and H2. In a study of the effects of ICT usage on individual IWB in multinationals in Malaysia's electrical and electronic sector, ICT usage for employees was measured by a 4-item scale (Ibrahim et al., 2020). This scale is adopted from Lin (2007), specifically measuring the degree of employees' ICT usability and capability towards knowledge sharing. Again, items in the scale can be answered through the five-point Likert scale, ranging from 'Strongly Disagree' to 'Strongly Disagree.

Organizational Climate for Innovation

The OCI can be experienced as a relatively intangible term, thus automatically making it harder to measure the concept. In subsection 2.1.1, the 14 general taxonomy dimensions are mentioned (Hunter et al., 2007). Because of the large number of dimensions, this could give a clear view of how well the organization in this case study performs regarding its OCI. However, due to the number of items, the survey would be extended significantly, possibly reducing the number of responses to the survey. For that reason, a more general measure for OCI was used. The study of Scott and Bruce (1994) describes OCI as a combination of two subscales: (1) support for creativity and (2) tolerance of differences. These subscales are rather broad and can be interpreted as overlapping factors when comparing them to the 14 dimensions mentioned by Hunter et al. (2007). From the items mentioned in the study, only the items that turned out to be significant are used in this research. As with the items measuring personal innovativeness in the domain of IT, the items of OCI are also rated on the five-point Likert scale, ranging from 'Strongly Disagree' to 'Strongly Agree'.

Innovative Work Behavior

IWB is considered to be the dependent variable in the study, relating to both H2 and H4 as mentioned in subsection 2.3.5. In the study of Ibrahim et al. (2020), ICT usage was used as a variable influencing individual IWB. The scale of individual IWB is measured by three subscales, adopted from Janssen (2000): (1) idea generation, (2) idea promotion, and (3) idea realization. The items are answered based on the question: "With what frequency do you engage in the behaviors listed below?". Each of the items in the scale is answered by a five-point Likert-scale, with options being (1) 'Never', (2) 'Almost Never', (3) 'Sometimes', (4) 'Often', and (5) 'Very Often'. All above-mentioned measures of the variables, and included items are shown in Table 6.

Apart from the above-mentioned variables, control variables are added to the research. In this research, the variables (1) Job role, (2) Area of operation, (3) discipline, (4) Gender, and (5) Age are included, as these are mentioned in subsection 3.1.2. Age is measured as a continuous variable, indicated by the number of years. In the research, (6) job hierarchy was also added as a control variable. Job hierarchy is estimated by a division of the employees' absolute level through the total levels of the hierarchy of the organization (Dries et al., 2009; Guan et al., 2013).

3.3. Research Procedure

3.3.1. Survey Outlines

The survey required for the quantitative research was designed in Qualtrics. The survey started with an 'Informed Consent' form, informing the participant of all risks associated with the research and giving a short description of risk mitigation and the overall purpose and length of the survey. By pressing on 'next', the participant agreed with the possible risks and officially started the survey.

The first block consisted of personal questions regarding gender and age. This was followed up by work-related questions asking for the area of operation, the discipline, and the job role. After that, the participant was asked to give an indication of the hierarchy through a combination of two questions, as mentioned in section 3.2. The items for measuring the IWB followed thereafter. Here, the participant was asked the question: *"With what frequency do you engage in the behaviors listed below?"*. The next block of items was about the OCI. The participants were asked to indicate to what extent they thought the statements were applicable to the organization. In one of the items, the concept of 'rock the boat' was explained by adding the text: *"read: say or do something to disturb an existing situation and upset people"*. This was to make sure no confusion about the concept could occur. The last page included the items for the measures of 'ICT usage' and 'Individual attitude towards ICT'. An introductory text for ICT usage was used to explain the concept of ICT and what tools are included in this category:

"Work processes in an organization sometimes involve the use of Information and Communications Technology (ICT). ICT is defined as a diverse set of technological tools and resources used to transmit, store, create, share, or exchange information. For example, tools like (company-related tools) can be seen as ICT-related tools. Please indicate to what extent you agree to the following statements for your organization:"

The survey ended with the note: *"We thank you for your time spent taking this survey. Your response has been recorded"*. The complete survey, as shown to the participants, can be found in Appendix A.

3.3.2. Survey Distribution

The survey was distributed to all 735 recipients mentioned in subsection 3.1.2. They were provided an URL link to the survey via an organization-internal email on Monday afternoon. In the email, it was already indicated that filling in the survey only would take about 5 to 10 minutes and that traceability is minimized to protect personal information. The email also indicated that the participants had two work weeks to finish filling in the survey, assuming that some were on leave in the first week, after which the collection of data was closed (Friday evening). The initial email was followed up by a reminder email on the Wednesday before data collection was closed.

3.3.3. Ethics Approval

The data collection method in this study has been formally reviewed and approved by the Human Research and Ethics Committee (HREC) of the Technical University of Delft.

Table 6: Measures of variables included in the research

Measures	Items
Individual attitude towards ICT (Goldsmith, 1986)	If I heard about a new information technology, I would look to experiment with it. In general, I am hesitant to try out new information technologies.* Among my peers, I am usually the first to try out new information technologies. I like to experiment with new information technologies.
OCI (Scott & Bruce, 1994)	**Support for creativity** An individual's ability to function creatively is respected by the leadership of this organization. The main function of members in this organization is to follow orders, which come down through channels.* **Tolerance of differences** A person can't do things that are too different in this organization without provoking anger.* The best way to get along in this organization is to think the way the rest of the group does.* People in this organization are expected to deal with problems in the same way.* This organization is open and responsive to change. The reward system in this organization benefits mainly those who don't rock the boat.*
Use of ICT-based tools (Lin, 2007)	Employees make extensive use of electronic stage (such as online databases) to access knowledge. Employees use knowledge networks (such as groupware, intranet, and virtual communities) to communicate with colleagues. My company uses technology that allows employees to share knowledge with other persons inside the organization. My company uses technology that allows employees to share knowledge with other persons outside the organization.
IWB (Janssen, 2000)	**Idea generation** Creating new ideas for difficult issues. Searching out new working methods, techniques, or instruments. Generating original solutions for problems. **Idea promotion** Mobilizing support for innovative ideas. Getting approval for innovative ideas. Making important organizational members excited about new ideas. **Idea realization** Transforming innovative ideas into useful applications. Introducing innovative ideas into the work environment in a systematic way. Evaluating the utility of innovative ideas.
	*Item was reverse-coded.

4 Results

In this chapter, the results of the quantitative analysis are presented. The analysis has been conducted through the use of SPSS, a data analysis software package provided by the Technical University of Delft. Initially, the descriptive statistics of the participants have been given. After that, all four hypotheses mentioned in subsection 2.3.5 have been tested. From the collected data gathered through the survey, response data is filtered. As mentioned in subsection 3.1.2, 165 finished surveys were collected. However, data fields were left open in some cases, thus not providing a complete response. After filtering, a total of 160 (*N=160*) 'valid' responses were left. First, job hierarchy was calculated, and the six reverse-coded items mentioned in Table 6 regarding Individual Attitude towards ICT (IATICT) and OCI were added as variables to the research sample.

Reliability testing

Before running any analyses, all items collected and used in the research were tested for reliability based on the calculation of Cronbach's Alpha (Cronbach, 1951). For correct analysis, all scales were analyzed separately. All scales seemed to be reliable, with the lowest Cronbach's Alpha of 0.729 for the Usage of ICT-based tools (ICTU), which is above the minimum required score of 0.7 (Cronbach, 1951). The outputs related to the reliability testing can be found in Appendix B. After testing the reliability, the items measured were combined into the overarching scales and subscales, as they are shown in Table 6.

4.1. Descriptive Statistics

Mean comparisons were performed in order to create the descriptive statistics of the control variables of Area of operation, Discipline, Job role and Gender, as shown in Appendix B. In total, data from employees in 11 different job roles was collected. Most participants were working in the job roles of Consultant (12.8%), Discipline Engineer (38.5%), Lead Engineer (27.0%), and Project Manager (10.8%) as shown in Figure B.7. Figure B.5 shows in which areas the employees are operating, of which the West region of the Netherlands is most represented (42.0%). Most participants are operating within the disciplines of Civil and Structural (9.5%), Electrical (8.8%), Mechanical (12.8%), Process (18.2%), and Project Management (12.2%), as presented in Figure B.6. The gender distribution is shown in Figure B.8. The participant group is male-dominated, with a total of 82.0%.

The group of females is relatively small with 16.0%.

Comparing the areas of operation in total, we see most areas scoring low on IWB (*M=2.843, SD=0.672*) as compared to the other variables of IATICT (*M=3.5146, SD=0.812*), ICTU (*M=3.544, SD=3.544*), and OCI (*M=3.546, SD=0.685*). For IWB, we can argue that the level is scored around and just below average or 'Sometimes' in the survey. For the other variables, scores are between 'Neither agree nor disagree' and 'Somewhat agree', indicating a 'better' performance on these variables. When looking at regional differences, Belgium stands out the most. The mean age 54, as compared to 41 for all regions. Simultaneously, Belgium scores considerably higher on IATICT (*M=3.813, SD=0.788*), ICTU (*M=3.6875, SD=0.85304*), and IWB (*M=3.4028, SD=0.58776*), although scoring lower on OCI (*M=3.2875, SD=0.27742*). However, it is important to mention that the scores are only based on the number of 8 employees, whereas 21 is the smallest number in other areas. Overall, large differences are not visible, and regional scores are comparable. A summary of the statistics per area is given in Table 7.

Table 7: Statistics per area

Area of operation		**Age**	**IAICT**	**ICTU**	**OCI**	**IWB**
West region (NL)	**Mean**	38.54	3.588	3.592	3.597	2.833
	Std. Dev.	12.886	0.781	0.765	0.749	0.632
	N	63	68	68	68	68
	% of Total N	42.0%	42.5%	42.5%	42.5%	42.5%
North-East region (NL)	**Mean**	42.96	3.445	3.461	3.483	2.653
	Std. Dev.	13.769	0.798	0.809	0.672	0.606
	N	28	32	32	32	32
	% of Total N	18.7%	20.0%	20.0%	20.0%	20.0%
South-East region (NL)	**Mean**	40.77	3.548	3.629	3.610	2.817
	Std. Dev.	13.025	0.840	0.774	0.724	0.778
	N	31	31	31	31	31
	% of Total N	20.7%	19.4%	19.4%	19.4%	19.4%
Belgium	**Mean**	54.14	3.813	3.688	3.288	3.403
	Std. Dev.	9.974	0.788	0.853	0.277	0.588
	N	7	8	8	8	8
	% of Total N	4.7%	5.0%	5.0%	5.0%	5.0%
Consultancy	**Mean**	40.19	3.218	3.333	3.480	2.989
	Std. Dev.	11.665	0.882	0.903	0.536	0.671
	N	21	21	21	21	21
	% of Total N	14.0%	13.1%	13.1%	13.1%	13.1%
Total	**Mean**	40.79	3.515	3.544	3.546	2.843
	Std. Dev.	13.090	0.812	0.795	0.685	0.672
	N	150	160	160	160	160
	% of Total N	100.0%	100.0%	100.0%	100.0%	100.0%

Subsequently, the disciplines are compared in Figure B.6 of Appendix B. The mean comparison has been conducted for age, IATICT, and IWB. Both the variables ICTU and OCI are not considered, as these variables are more aimed at company-wide (or regional) scoring. This becomes clear from the questions mentioned in Appendix A, as these are specifically asked for 'the organization'. Only taking into account disciplines with a considerable amount of employees (N>5), there is a lot of disparity in age between the disciplines. There are some disciplines with a relatively low average

age like Electrical (*M=36.08, SD=10.492*) and Pipelines (*M=34.25, SD=9.270*), as compared to some disciplines with a relatively high average age like Building Services (*M=46.89, SD=8.937*) and Procurement (*M=51.00, SD=16.155*). However, there is no direct link visible between this observation and the scores on IATICT and IWB. For IATICT we see high outliers in the disciplines of Electrical (*M=3.891, SD=0.780*) and Mechanical (*M=3.803, SD=0.705*. Relatively low scoring are disciplines such as Civil and Structural (*M=3.286, SD=0.848*) and Pipelines (*M=3.250, SD=1.225*). For IWB, considering a considerable sample size (N>5), we see relatively high outliers in the disciplines of Procurement (*M=3.191, SD=0.669*) and Safety (*M=3.012, SD=0.802*), compared to lower outliers in the disciplines of Building Services (*M=2.789, SD=0.829*), Pipelines (*M=2.667, SD=0.596*), and Project Management (*M=2.720, SD=0.638*). Table 8 shows the statistics of the most common disciplines (N>5).

Table 8: Statistics per discipline (N>5)

Discipline		**Age**	**IAICT**	**IWB**
Building Services	**Mean**	46.89	3.350	2.789
	Std. Dev.	8.937	0.530	0.829
	N	9	10	10
Civil and Structural	**Mean**	43.79	3.286	2.937
	Std. Dev.	14.050	0.848	0.678
	N	14	14	14
Electrical	**Mean**	36.08	3.891	2.920
	Std. Dev.	10.492	0.780	0.617
	N	13	16	16
Mechanical	**Mean**	38.11	3.803	2.877
	Std. Dev.	11.813	0.705	0.772
	N	19	19	19
Pipelines	**Mean**	34.25	3.250	2.667
	Std. Dev.	9.270	1.225	0.596
	N	8	9	9
Process	**Mean**	38.56	3.473	2.762
	Std. Dev.	13.060	0.731	0.605
	N	27	28	28
Procurement	**Mean**	51.00	3.714	3.191
	Std. Dev.	16.155	0.668	0.669
	N	7	7	7
Project Management	**Mean**	39.28	3.691	2.720
	Std. Dev.	10.725	0.627	0.638
	N	18	21	21
Safety	**Mean**	41.11	3.389	3.012
	Std. Dev.	15.752	0.885	0.802
	N	9	9	9
Total	**Mean**	40.85	3.524	2.843
	Std. Dev.	13.104	0.804	0.664
	N	148	158	158

Next, in Figure B.7, job roles are compared with the means of Age, Job hierarchy (Hierarchy), IATICT, and IWB. Hierarchy is included as it is expected that certain job roles have a considerably higher score on hierarchy, as most organizations have some degree of hierarchy present. First of, a clear distinction can be made between job roles based on age. Lead Engineers seem to be representing a relatively high age group (*M=45.57, SD=11.626*), as compared to the average age of the employees (*M=40.89, SD=13.113*). The job role with the youngest employee group is the role of Discipline Engineer (*M=35.72, SD=11.848*). Looking at the Hierarchy, the level for Lead Engineers is high as well (*M=0.6166, SD=0.261*), and again relatively low for Discipline Engineers (*M=0.4995, SD=0.293*), as compared to the whole employee group (*M=0.560, SD=0.294*) and more average-aged job roles such as consultancy (*Age: M=40.26, SD=12.201; Hierarchy: M=0.5352, SD=0.308*). Therefore at first glance, it seems that there is a link present between the age of the employee and the Job hierarchy of that same employee. For IATICT, the job role of Consultant has a relatively low score (*M=3.268, SD=0.900*) as compared to higher scores among Lead Engineers (*M=3.597, SD=0.907*) and Project Managers (*M=3.6447, SD=0.642*). Differences in IWB are clearer. The lower-scoring job roles are Discipline Engineer (*M=2.675, SD=0.685*) and Project Manager (*M=2.801, SD=0.608*). The higher-scoring job roles are Consultant (*M=3.012, SD=0.700*) and Lead Engineer (*M=3.000, SD=0.608*). In Table 9 shows a summary of the statistics on all frequent (N>5) job roles.

Table 9: Statistics per job role (N>5)

Job role		Age	Hierarchy	IAICT	IWB
Consultant	**Mean**	40.26	0.535	3.268	3.011
	Std. Dev.	12.201	0.308	0.899	0.670
	N	19	18	18	18
Discipline Engineer	**Mean**	35.72	0.500	3.492	2.675
	Std. Dev.	11.848	0.293	0.742	0.685
	N	57	58	58	58
Lead Engineer	**Mean**	45.57	0.617	3.597	3.000
	Std. Dev.	11.626	0.261	0.907	0.608
	N	40	39	44	44
Project Manager	**Mean**	40.69	0.505	3.645	2.801
	Std. Dev.	10.524	0.290	0.642	0.608
	N	16	18	19	19
Total	**Mean**	40.89	0.560	3.513	2.841
	Std. Dev.	13.113	0.294	0.817	0.676
	N	148	148	158	158

Lastly, scores in the mean comparison of the control variable Gender are shown in Figure B.8. For gender, we look at Age, Hierarchy, IATICT, OCI, and IWB. Here, OCI is included as it can be expected that the perspective of the organizational climate can be different for females and males and subsequently might be more supportive or less supportive depending on gender (King et al., 2009). On average, males in the organization are older (*M=41.55, SD=12.974*) than females (*M=38.23, SD=13.379*). When it comes to job hierarchy, males (*M=0.572, SD=0.286*) score higher than females (*M=0.545, SD=0.343*). Again, the possible link between age and job hierarchy is shown. Subsequently, it can be seen that the standard deviations on the Job hierarchy are relatively high compared to the mean, especially for females. This indicates a large variety in the job hierarchy among both males and females, the last being the most varied group. Again for IATICT, scores for males (*M=3.551, SD=0.822*) are higher than for females (*M=3.324, SD=0.727*). The opposite is true for the perspective of OCI, where males (*M=3.518, SD=0.716*) considerably find the organizational climate less supportive than females (*M=3.709, SD=0.517*). The same is the case when looking at IWB, where again males (*M=2.814, SD=0.651*) indicated lower scores than females (*M=3.002, SD=0.788*). Table 10 shows a summary of the statistics based on gender.

Table 10: Statistics per gender (N>5)

Gender		Age	Hierarchy	IAICT	OCI	IWB
Male	**Mean**	41.55	0.572	3.551	3.518	2.814
	Std. Dev.	12.974	0.286	0.822	0.716	0.651
	N	121	123	130	130	130
Female	**Mean**	38.23	0.545	3.324	3.709	3.002
	Std. Dev.	13.379	0.343	0.727	0.517	0.788
	N	26	24	27	27	27
Total	**Mean**	40.79	0.561	3.515	3.546	2.843
	Std. Dev.	13.090	0.295	0.812	0.685	0.672
	N	150	150	160	160	160

4.2. Variable Testing

4.2.1. Multicollinearity and correlations

Variables in this study were checked for multicollinearity before running any other analyses. This was done by estimating the variance inflation factor (VIF). The highest VIF value was estimated at 1.226, as presented in Figure C.1 in Appendix C, which is below the maximum threshold value of 5 (Hair et al., 1995). To get insight into how the variables relate to each other, a bivariate correlation analysis is conducted. The output of the bivariate correlation analysis is found in Figure C.2. The summary of the output of the analysis with all variables including means, standard deviation, and correlations are shown in Table 11. From the table, it seems that there is a significant low-positive correlation between the variables Age and Job hierarchy (*R=0.411, p<0.001*), meaning that the higher the age, the higher the job hierarchy, as has also been indicated in section 4.1. Subsequently, age seems to have a direct positive link to IWB as well (*R=0.172, p0.035*). Although, this correlation is negligible, as R is a lot smaller than 0.30 (Duncan et al., 1990). For job hierarchy, a significant correlation with IWB is shown (*R=0.272, p<0.01*). Now Pearson's R is relatively close to the value of 0.30, making it harder to identify whether this correlation is negligible (Duncan et al., 1990). IATICT also has a significant correlating effect with IWB (*R=0.311, p<0.01*). The variable of ICTU shows two significant correlations, both with OCI (*R=0.291, p<0.001*) and IWB (*R=0.171, p=0.030*, with the latter being relatively weak. Lastly, the variable OCI shows a significant but weak correlation with IWB (*R=0.210, p=0.08*).

Table 11: Correlation Matrix

Variable	Mean	SD	Age	Hierarchy	IATICT	ICTU	OCI	IWB
Age	40.79	13.090	1	0.411**	-0.109	0.043	-0.049	0.172*
Job hierarchy	0.561	0.295		1	0.000	0.012	0.013	0.272**
IATICT	3.515	0.812			1	0.096	0.043	0.311**
ICTU	3.544	0.795				1	0.291**	0.171*
OCI	3.546	0.685					1	0.210**
IWB	2.843	0.672						1

***p<0.01*
**p<0.05*

4.2.2. Hypotheses Testing

To test the hypotheses, multiple regression analyses are used. The analyses use multiple Two-way repeated measures, following the framework proposed by Hayes (Hayes, 2013; Bolin, 2014). To run the analysis in SPSS, the 'PROCESS v4.2 by Hayes extension' is used, as offered by the University of Calgary. For the hypotheses H1a, H1b, H2 and H3, process model 14 is used (Bolin, 2014). The principle of the model is indicated in Figure 3. H4 is separately analyzed as a direct effect of OCI on IWB.

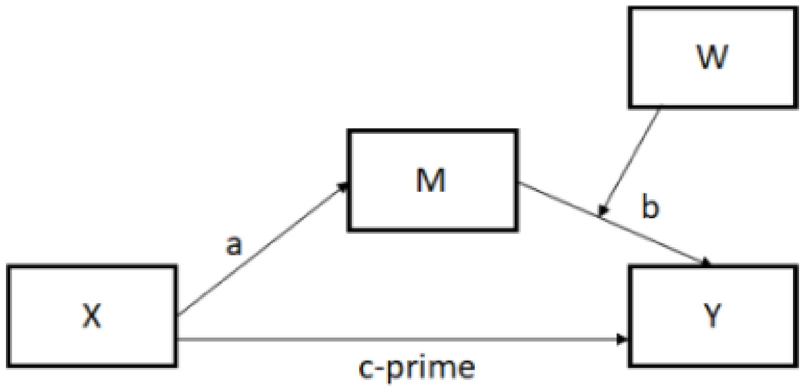

Figure 3: Hayes' process model 14

Source: Bolin, 2014

Effect of Individual Attitude towards ICT on the usage of ICT

Hypothesis 1a argues that within the partial mediation of ICTU, an effect is present in which a positive attitude towards ICT increases the overall use of ICT-based tools in an organization. The relationship indicated in the analysis shows a positive effect (*B=0.094*). However, following from the analysis shown in Figure C.3, this is not the case as the relationship is not significant (*t=1.208, p=0.229*). This indicates that the relationship drawn between IATICT and ICTU as hypothesized by H1a should be rejected and that the null hypothesis (the individual attitude towards ICT does not significantly affect the usage of ICT-based tools in an organization), should be accepted.

Direct effect of Individual Attitude towards ICT on IWB

Next, the direct effect of the individual attitude towards ICT on IWB is analyzed. From the output, it becomes clear that a significant positive effect of IATICT on IWB is present (*B=0.245, t=3.962, p=0.001*), as shown in Figure C.4. This indicates the more positive the attitude towards ICT of an individual, thus increasing the willingness to work with ICT-based tools, the higher the level of IWB of that same employee. This relation was indicated by hypothesis 2, which can therefore be accepted.

Moderating effect of OCI

In Figure C.4, the moderation effect of the OCI is measured on the relation between the usage of ICT-based tools and IWB is tested. From the analysis, it is concluded that the moderation effect is insignificant (*t=0.848, p=0.398*) for the studied case. That means that a positive OCI does not significantly increase the effectiveness of the usage of ICT-based tools in stimulating IWB in the organization. Therefore, hypothesis 3, indicating that there is a positive significant moderating effect in the aforementioned relation, should be rejected. We automatically accept the null hypothesis, indicating that there is no significant moderating effect.

Moderated mediating effect on IWB

The moderated mediating effect on IWB by the usage of ICT-based tools and OCI is shown in Figure C.5. From the analysis, it has become clear that the mediation model of IATICT –> ICTU –> IWB, is insignificant, as 0 falls between the confidence intervals of the bootstrap (Hayes, 2013). An overview of all the relations tested in Hayes' model 14 and the corresponding values are shown in Table 12.

Table 12: Overview of relations tested by Hayes' model 14

Relation tested	Unstand. B	t-value	Sign. (p)
IATICT –> ICTU	0.094	1.208	0.229
IATICT –> IWB	0.245	3.962	0.001
OCI –> ICTU –> IWB (moderation)	0.079	0.848	0.398
	BootSE	**BootLLCI**	**BootULCI**
IATICT –> ICTU –> IWB (mediation)	0.014	-0.014	0.043

However, this does not directly indicate whether hypothesis 1b is significant or not, as it is not separately tested in the model. To test this relationship, which is the positive relationship between the usage of ICT-based tools in the organization and the level of IWB, a separate analysis is conducted. In this analysis, the direct effect of ICTU on IWB is measured using linear regression in order to indicate whether the variable of IWB can be predicted by the variable of ICTU. An overview of the results of the analysis is shown in Figure C.6. The analysis showed a positive significant effect (*B=0.145, t=2.185, p=0.030.* Therefore, it is concluded that we can accept hypothesis 1b, indicating that the effect of the usage of ICT-based tools is positively related to the level of IWB in an organization.

Effect of OCI on IWB

Lastly, for hypothesis 4, the direct effect of OCI on IWB is analyzed. For this direct effect, again linear regression is used to indicate the effect and significance of the relationship. From Figure C.7 it is concluded that OCI has a positive and significant direct effect (*B=0.206, t=2.703, p=0.008*) on the level of IWB in the organization. Therefore, we can accept hypothesis 4, arguing that there is a positive direct effect of OCI on IWB. In Table 13, the research results on all hypotheses are presented.

4.2.3. The influence of age and job hierarchy

From the correlation matrix in Table 11 it has become clear that certain significant correlations are present for the variables Age, Job hierarchy, and IWB. To get an indication of these relationships, three extra linear regression analyses have been performed. Within these relationships, it is obvious that age cannot be defined by any of the other variables, and therefore automatically acts as the independent variable in the linear regression analyses. From Figure C.8 and Figure C.9 it can be concluded that age has a significant positive effect on job hierarchy (*B=0.009, t=5.300, p<0.001*)

Table 13: Research results

Number	Hypothesis	Finding
1a	*A positive attitude towards ICT and the willingness to work with ICT-based tools of individuals increase the overall use of ICT-based tools in an organization.*	Rejected
1b	*If the overall use of ICT-based tools in an organization increases, thus also increasing the use for daily work processes, then this will lead to an overall increased IWB of the employee.*	Accepted
2	*A general acceptance of, and willingness to work with ICT-based tools has a direct positive relation to the level of IWB of the employee, assuming the presence of overlapping factors.*	Accepted
3	*The relationship between the use of ICT tools and IWB is positively moderated by a supportive OCI.*	Rejected
4	*A supportive OCI is positively associated with the IWB of employees within the organization.*	Accepted

and IWB (*B=0.009, t=2.125, p=0.035*). That means that the older the employee, the higher his or her job hierarchy, and the higher level of IWB the employee has. This effect is comparable to the results shown in Figure C.10, where the direct effect of job hierarchy on the level of IWB is summarized. The analysis shows a significant positive relationship for job hierarchy on IWB (*B=0.623, t=3.444, p<0.001*). Therefore it can be concluded that the higher the job hierarchy of the employee, the higher the level of IWB.

Table 14: Overview of relations tested through linear regression analyses

Relation tested	Unstand. B	t-value	Sign. (p)
ICTU –> IWB	0.145	2.185	0.030
OCI –> IWB	0.206	2.703	0.008
Age –> Hierarchy	0.009	5.300	<0.001
Age –> IWB	0.009	2.125	0.035
Hierarchy –> IWB	0.623	3.444	<0.001

5
Discussion

In this chapter, I will go into the research findings brought to light because of the research model that has been analyzed. These findings are then compared to the literature study done before the research was conducted. This way, a clear distinction can be made between certain results that align with the literature and some that are not. After that, the research implications are described that occurred during and after conducting the research. Lastly, this is followed up by an explanation of all the limitations that the study has and for what reasons future research should be done, following the research of this master thesis study.

5.1. Research findings and reflection on the literature

The results have shown a total of 160 (*N=160*) valid responses on which conclusions have been based. When analyzing the results, no issues regarding reliability or multicollinearity have occurred.

In the literature review, one of the first concepts of influence on the level of EDI in an organization mentioned is OCI. A well-organized organizational climate is one of the main factors for increasing IWB, and thus enhancing EDI (Shanker et al., 2017). In the research, OCI has been tested on 7 items, defining the subscales of 'support for creativity' and 'tolerance of differences'. According to the literature, in order for the organizational climate to give support to the employee, his or her individual creativity should be encouraged, nurtured, and enhanced (Hunter et al., 2007; DiLiello and Houghton, 2006; Isaksen and Lauer, 2002). Besides this, the tolerances of differences mentioned in the measure by Scott and Bruce (1994), builds on the concepts of the perception of autonomy, positive interpersonal exchange, intellectual stimulation, and having positive peer and supervisor relations (Abbey and Dickson, 1983; Oldham and Cummings, 1996; Ekvall, 1996; Ayers et al., 1997). From the results, I have concluded that a positive significant effect exists on the performance of OCI on IWB. This indicates that the more supportive the organization is for creativity and differences among employees within the organization, the better it will perform on IWB, and thus enhance EDI. With the comparison of OCI, it was assumed that most employees would base their judgment of the organizational climate on the location they are working in, therefore describing the organizational climate of that specific area. The highest-scoring regions on OCI were the West region (Netherlands) and the South-East region (Netherlands). As discussed, it would be likely that the higher the score on OCI, the higher the score would be on IWB. However, both regions scored below average when it comes to IWB, looking at the complete response group in all regions. As concluded from the results, OCI is not the only influential factor in the research, explaining why regional differences in IWB might vary. We do see a difference in the mean of OCI for the regions in the Netherlands where the mean is between 3.483 and 3.610, as compared to Belgium with a mean of 3.288. We can therefore conclude that on average, the organizational culture is less supportive of creativity and less tolerant of differences among employees.

When comparing the OCI for the difference in gender, a noticeable difference has come to light regarding the scores OCI. Although not tested in the research model, it is seen that scores for OCI are significantly higher for females than for males in the organization. As it is hard to define whether there is a certain ‘truth’ about the organizational climate being supportive or not, the concept of the OCI being mostly defined by perception is put into perspective (Si and Wei, 2012; Amabile et al., 1996). An employee who experiences for freedom and autonomy, and feels more supported by the organizational climate to generate and share ideas, is more likely to do so in the end.

For ICT to be used in an organization, especially for new ICT-based products introduced, there should be an overall willingness to work with ICT-based tools (Davis, 1989). This is based on the assumption that overall perceived ease of use, perceived usefulness, and acceptance of the ICT-based tools are present. According to Taherdoost (2018), these perceptions are again building on other factors, such as self-efficacy and motivation. In the research model, I tried to bundle these factors in one measure, defined by the individual attitude towards ICT (Goldsmith, 1986). The analysis showed a significant direct positive of the individual attitude on IWB, therefore indicating that if the individual is more willing to work with ICT-based tools, his or her IWB is higher. This is supported by literature, as the overall perception is that increased use of ICT in an organization increases EDI (Watanabe et al., 2015; Laviolette et al., 2016; Soderquist et al., 2016; Tirabeni and Soderquist, 2018). Noticeable differences were measured for the individual attitude towards ICT per discipline and job role. Within the disciplines, Electrical and Mechanical stood out with a high mean score. For these disciplines, it makes sense that on average, they are more used to working with ICT-based tools, required for tasks related to designing and 3D-modelling. This is probable to improve self-efficacy as the employees become more familiar with the concept of using ICT-based tools (Taherdoost, 2018). Engagement with newly introduced tools might therefore be easier for these disciplines. This makes sense when we compare the scores to other disciplines Environment and Safety, which have considerably lower mean scores on IATICT, as most employees in these disciplines are consultants. Although it is hard to say for certain, it is expected that consultants less ‘depend’ on ICT-based tools, thus also lessening their dependency on them. This is supported when looking at the division of the mean scores among the job roles. The consultants score considerably lower as compared to other job roles such as discipline engineers, lead engineers, and project managers. ***Again, this might be because as employees become more familiar with using ICT-based tools, they are more likely to adopt those which are newly introduced in the organization.***

The implementation and therefore use of ICT-based tools in an organization, according to the literature, can improve EDI practices (Watanabe et al., 2015; Van Laar et al., 2017). The direct relation between the usage of ICT-based tools and the level of IWB, thus measuring EDI, was tested. I found that the use of ICT-based tools in the organization had a significant positively related effect on the level of IWB among employees, thus supporting the above-mentioned idea. However, I also expected that there were two additional variables related to the usage of ICT-based tools. The first is that I expected that the effect of IATICT on IWB would be partially mediated by the usage of ICT-based tools, assuming that for innovative behavior to occur, the employee should be assigned sufficient resources (Kesting & Ulhøi, 2010). This effect, however, was not significant. This can possibly be explained by the way the measure was set up. The individual attitude towards ICT focuses more on the individual perspective, so how the individual interprets ICT. The ICT usage was more focused on an organization-wide, or at least area-wide perspective. The organizational climate, on the other hand, was expected to moderate the relationship between the usage of ICT-based tools and IWB. This was mainly based on the foundation explained by Leidner and Kayworth (2006), who argued that a supportive organizational climate can improve ICT usage, as employees feel free to do so. However, I also found out that this effect was insignificant, thus indicating that there is no moderation effect.

It is argued that flattening the hierarchical structures of an organization can nurture the followers' (in a leader-follower relation) creative thinking and feeling the freedom to do so, leading to more idea generation and idea implementation (Barbuto and Wheeler, 2006; Mayer et al., 2008; Parris and Peachey, 2012). In current structures, traditional leadership is being questioned (Sendjaya & Sarros, 2002). Instead, according to Sendjaya and Sarros (2002), leadership should be more focussed on 'servant leadership', making sure that the employee is not commanded to perform certain tasks, but is rather supported by the leader with the necessary resources (Barbuto & Wheeler, 2006). Again, this builds on the idea of flattening the hierarchical structure. Just as with the organizational culture, it is sometimes more important what the perception of the hierarchy in the organization is, rather than the actual hierarchy present (Hunter et al., 2007).

In this research, I have tried to indicate this perspective on hierarchy, by letting the employees give an indication of their job hierarchy (Dries et al., 2009; Guan et al., 2013). Again, the measure is mainly focused on the perception of the hierarchy in the organization, rather than the factual hierarchy present. Although not initially indicated in the research model, I ran an extra analysis on the influence of job hierarchy on IWB because of the significant correlation between the two variables.

I found that job hierarchy has a significant positive relationship with IWB, thus indicating that the higher the employees' job hierarchy, the higher the level of IWB. This would indicate that some sense of hierarchy should be present in order to stimulate the IWB of the employee. Although this does not directly counter the proposed enhancing factor on EDI of flattening the hierarchical structure (Barbuto and Wheeler, 2006; Mayer et al., 2008; Parris and Peachey, 2012), ***it does indicate that constantly flattening the hierarchical structure or at least the perception of this, does not automatically contribute to increasing EDI.*** This could be explained by the fact that an employee perceives a feeling of being more free or autonomous within the organization, therefore feeling less insecure which contributes to taking more risks. Related to this is the possible lessening feeling of the employee being 'punished' for taking risks (Amundsen et al., 2014).

Because it was expected that job hierarchy in the control variables of Area of operation and Discipline would be messy because of the wide range of job roles and according to ranks within the areas and disciplines, hierarchy was only compared for the variables Job roles and Gender in relation to IWB. Hierarchy levels were shown to be high for consultants, but especially for Lead Engineers. This makes sense, as the name of the role already gives a descriptive perception of the Lead Engineer 'leading' other engineers. For consultancy, it might be an explanation that it is included as a separate entity among the areas of operation, giving the feeling of having a higher hierarchical position. For both disciplines, levels of IWB were significantly higher than the mean, supporting the idea that a higher job hierarchy leads to more IWB. However, I expected the job hierarchy for the project managers to also be high as it makes sense that project managers in general have a leading position, but this was not the case. The job hierarchy was significantly lower than the mean. IWB among project managers was also lower than the mean.

I included age in the research as a control variable, assuming that however not specifically stated as an influential factor, it could give insights on the distribution in the area, discipline, and job roles and perhaps even relate to other variables in the study. It was found that age had a significant positive relation to job hierarchy. This makes sense, as is likely that the older employees are, the more experience they have, and the more likely it is that they have higher positions in the organization such as leadership positions.

5.2. Research Implications

The main contribution of this master thesis is advice on how EDI could be enhanced in the field of construction engineering. By enhancing EDI initiatives, organizational performance can be improved significantly, thus contributing to the survivability of the organization.

5.2.1. Theoretical Implications

This study has shown that the principle of EDI, as described by Kesting and Ulhøi (2010), which is measured by the level of IWB in this specific research, is also applicable to the field of construction engineering. It is shown that employees do show innovative behavior and therefore generate, promote, and implement new ideas in the organization. However, there are differences when it comes to certain areas in which the employees operate, the discipline they are working in, or the job role that they have. However, on average, the levels of IWB are not very high (*M=2.843*), basically meaning that the average answer to the frequency of innovative behaviors was 'sometimes', indicating that there is still a lot of room for improvement. The study does show that more than just one factor can improve the level of innovative behavior, thus giving the organization multiple options to choose from in its strategic decision-making.

This research has shown that the form of EDI applicable to the field of construction engineering is a combined process of both bottom-up and top-down processes (Høyrup, 2012). This is indicated by the fact that influence on IWB can be retraced to both practices led by the organization and the employees themselves:

- It is shown that the 'right' OCI should be in place. This indicates that the organizational climate should be supporting creativity and have a level of tolerance towards differences among employees. If this leads to the overall positive perception of the employee that he or she has towards the organizational climate, creative thinking of the employee will be stimulated (Hunter et al., 2007; DiLiello and Houghton, 2006; Isaksen and Lauer, 2002). This will lead to a required PO fit, indicating that the organizational climate and the employees' perception of this are aligned (Saether, 2019).

- In the research, it was shown that increased use of ICT-based tools by the employee can enhance IWB in construction engineering. Providing these tools is therefore necessary, as it can increase knowledge sharing within the organization, which except exchanging tacit and implicit knowledge, also contributes to idea sharing (Høyrup, 2010).
- Employees in the organization should have a positive stance towards using ICT-based applications. They should be willing to work with it and perceive a certain usefulness and ease of use of ICT (Davis, 1989).

5.2.2. Practical implications

Aside from the theoretical implications of the study, practical implications are summarized. These give a general indication of how organizations in the construction engineering sector could manage their EDI:

- As discussed in subsection 5.2.1, a supportive OCI should be in place. One example of how OCI can be significantly improved is via improving the organizational leadership (Cai et al., 2018). This can be achieved through management or leadership training, directed from the strategic management level. Besides, the PO-fit can be simultaneously influenced, by having team-building sessions to create a better connection between leaders and followers in the organization (Saether, 2019).
- The organization should provide the employee with sufficient ICT-based tools. This is indicated in subsection 5.2.1 as the increased use of ICT-based tools by the employees increases their level of IWB. Examples of these tools are groupware, intranet, and virtual communities, but also only databases so that knowledge can be stored.
- Apart from assigning the resources in the form of ICT-based tools, the individuals should in the end actually operate their daily business with these tools to increase their IWB. This is where I suggest that HRM should be involved. Current employees can be trained to get familiar with using these tools, improving perceptions of these tools. However, there should be at least some willingness to work with ICT. This process should be guided via the recruitment process in the organization (Renkema et al., 2021). This has some practical limitations though, as it is unlikely that it can be easily figured out who has this overall willingness and who doesn't. However, individual factors such as self-efficacy and motivation are indications that a person is willing to work with new things, and therefore also ICT-based applications (Taherdoost, 2018). In the recruitment process, therefore, it can be checked or investigated whether the individual contains these characteristics. Training can thereafter lead to an overall increased perceived use and perceived usefulness of ICT so that in the end, the employee will interact with these tools. Additionally, recruitment could target individuals containing factors such as commitment and competency, as this directly contributes to IWB (Siregar et al., 2019).

Proposed model for EDI enhancement

With all the theoretical and practical implications mentioned above, I propose that digitally-driven engineering companies in related fields implement the model shown in Figure 4 to enhance EDI in their organization. This model shows a combination of how EDI can be managed concluded from the literature study as shown in Figure 1, extended with the findings that occurred from this research. The implementation of the model can contribute to lowering two out of the three barriers mentioned by Oesterreich and Teuteberg (2016). The first barrier, related to the required specialized knowledge because of the complexity of the projects, can be shared more easily through the implementation of ICT-based tools. The second barrier that can be lowered is the lack of R%D investment in the field of construction engineering. Enhancing EDI can either fully or partially, replace R&D initiatives, thus requiring less risky investments (Van Laar et al., 2017).

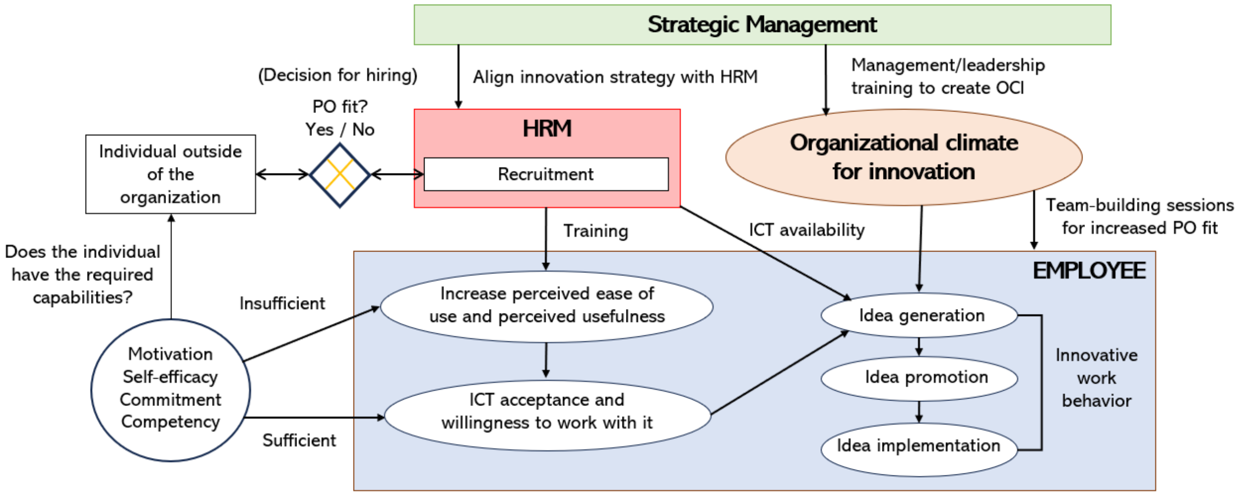

Figure 4: Proposed model for EDI enhancement in construction engineering

5.3. Limitations and future research

The research conducted in this master thesis does not go without its limitations. It is important to acknowledge these limitations, as they may be the foundation for further research in the field of EDI and related fields of study.

- **Choice of the sample:** the sample chosen in this research is a single case. Although the chosen firm (almost) fully drives its processes digitally, it is merely one organization that is analyzed. This in itself gives some issues regarding the generalizability of EDI enhancement in digitally-driven engineering companies, let alone organizations in the more extensive AECO sector. Subsequently, the organization is only analyzed for the Netherlands and Belgium, which only cover some parts of all the countries that the company is active. Even though some differences in the organizational climate were found between the Netherlands and Belgium, it is expected that if other countries from Europe would be included in the study, the differences in organizational climate are much bigger, let alone if countries from Asia were included in the research. Therefore, this research only specifically indicated the situation in the Netherlands and Belgium. A sample collected from more countries could give more insight into the differences in organizational climate and how this influences innovative work behavior in the organization.

  Additionally, I chose a sample based on several disciplines and job roles as these employees had a direct involvement with the engineering projects in the organization. I think this way of sampling is sufficient to show differences between the disciplines and job roles, but it does not cover the organization as a whole. Certain departments like human resource management, finance, and strategic management are excluded from the research. Future research could give indications on how EDI is managed in those departments of the same type of organization.

- **Sample size:** the survey was distributed to a total of 735 employees, of which 253 filled in the survey either partially or fully. Unfortunately, 88 of the employees clicked on the survey but did not finish the complete survey. 5 Employees also did not fill in the important fields of how IWB was measured and were therefore also filtered out. This led to a total of 160 responses for the final analysis. This gave issues in some descriptive statistics, as some disciplines and job roles were only represented by a small number of employees, or were not even represented at all. There are many possible explanations for why certain employees did not finish the complete survey. One possibility is that employees found the nature of the questions too sensitive to fill in. Another possibility is that the survey simply took too long to fill in. Therefore it is recommended that in future research, either the distribution is set out for more possible respondents, or the data collection period is extended. In this research, the collection period was set to two work weeks.

- **Subjective answers:** the nature of the survey is subjective. That means that the answers to the questions in the survey are mostly based on the perception of the employee. This could lead to employees being optimistic, generally scoring higher on for example IWB, even though in reality it's less. The same can occur in the opposite situation, where the employee is more pessimistic. Employees might also feel pressurized to fill in answers higher than they actually think is true, just because they think it's in the company's favor to do so (Dellarocas, 2003).

- **Limitations in the measures used:** the measures that are used in this research have some limitations. From the concepts discussed in the literature review, like OCI and the individual attitude towards ICT, I have tried to find certain measures that include items to fully describe the concept. However, at the same time, I wanted the response rate of the survey to be as high as possible. Therefore I decided not to include measures that included too many items. This way, a limitation has occurred of the concept not being fully represented in the items, but merely an estimation of it. This is especially the case for trying to measure the organizational climate. Preferably, all 14 general taxonomy dimensions by Hunter et al. (2007) were included in the research. My recommendation would be that quantitative research is performed in which a questionnaire is filled out in the presence of a guiding researcher. This would require a much more intensive kind of research, through which it was not possible to perform this kind of research in the limited time space given. By guiding this process, employees could be approached personally and asked to make some time free for answering the questions, which can then be extended in the number of items asked.

  Besides, many measures in the study have underlying factors co-deciding the scores on those measures. For example, the individual attitude towards ICT is measured through a four-item scale, but underlying factors such as motivation and self-efficacy, that co-decide the willingness to work with these tools, are not directly included. Future research is suggested to measure these characteristics and factors specifically. The same goes for the measure of job hierarchy. From the research, it's concluded that the higher the employees' perspective of their job hierarchy, the higher the level of IWB. Underlying job hierarchy could be factors such as experience (the more experience a person has, the more likely it is that his or her job hierarchy is within the company) and education level (the higher the education level, the more likely that the employee has a higher position). I recommend adding such factors in future research so that more explanatory hypotheses can be formed.

- **Barriers in the field of construction engineering:** in subsection 2.2.1, three barriers were mentioned on innovation in the field of construction engineering. The first is the high dependency on collaborations with customers, subcontractors, and stakeholders in the value chain. The second mentioned barrier is the high complexity of the construction projects, thus requiring higher levels of specialized knowledge. The last barrier mentioned is the lack of R&D investment. Although the implementation of the proposed model in Figure 4 can lower the second and third barrier, as knowledge can be shared more easily through ICT-based applications and EDI can simultaneously act as a replacement for R&D practices, it cannot lower the dependency on collaborations. Future research is required to investigate which options are viable to reduce this dependency so that innovation in construction engineering can be optimized. I propose that this is done through an explorative study, as multiple options should be considered and possibly developed.

- **Innovation measurement:** this research has tried to explain the concept of employee-driven innovation in the field of construction engineering. In order to measure this, innovative work behavior is used in the research. However, this does not take into account that after idea implementation, these ideas are actually perceived to be useful and put into practice. Measuring innovation is inherently hard, and therefore it is attempted to measure something that is highly related to the concept. In order to get a better view of actual innovations put into practice through employee-driven incentives, I suggest the following for future research: a longitudinal quantitative study and a qualitative study. The longitudinal quantitative study could identify the percentage of ideas that are implemented, eventually will lead to innovations being put into practice. By conducting a qualitative study, the researcher could ask the respondent to what extent ideas generated and implemented actually lead to innovative action.

6 Conclusion

Employee involvement has shown to be an increasingly important factor in innovation (Kesting & Ulhøi, 2010). Nowadays, many organizations are driven on digital work processes, and so is its related innovation processes (Van Laar et al., 2017). The combination of implementing EDI in digital innovation processes has seen to be a good way of innovating while having employee involvement as the main factor. This digitally-driven innovation process, however, cannot be fully utilized if the innovation process is not fully supported by the organizational climate set in place. Therefore, for an organization, it is necessary to make sure that employees have access to ICT in order to share knowledge and ideas and simultaneously support the process from its organizational culture (Van Laar et al., 2017; Si and Wei, 2012; Amabile et al., 1996; Hunter et al., 2007; Shanker et al., 2017). Aside from the organizational perspective, the employee should be willing to work with ICT-based tools, thus meaning that he or she accepts the overall use of ICT and perceives the ease of use and usefulness of its applications (Davis, 1989). For this, individual factors such as motivation, competency, self-efficacy and commitment are helpful in creating this general willingness to work with ICT (Siregar et al., 2019). Organizing such a structure where the above-mentioned concepts are combined has led to many EDI initiatives being successfully implemented. Especially large high-tech companies like Apple, Amazon, Facebook, and Google have shown real-life examples (Tirabeni & Soderquist, 2018). A research gap was identified for applying the same model to the field of construction engineering. To test whether the same, multiple hypotheses relating the individual attitude towards ICT, ICT usage, OCI and IWB were tested. It is concluded that the research model is partially true. The concepts mentioned of individual attitude towards ICT, the usage of ICT-based tools, and the organizational climate for innovation all showed to be significantly related to innovative work behavior. However, the moderated mediation was found to be insignificant.

Based on the research findings, a model was proposed to manage EDI in the field of construction engineering. This model is mainly based on EDI being managed through a hybrid version of top-down and bottom-up processes. In this model, a structure is given where strategic management, HRM, leaders, and the employee are aligned. Strategic management should align its innovation strategy with both HRM and leaders in the organization (Renkema et al., 2021). HRM, through, recruitment, should find the correct candidates to drive innovation in the company based on found competencies such as motivation, self-efficacy, commitment, and competency (Cooke and Saini, 2010; Siregar et al., 2019). If the individual contains these competencies, he or she should some foundation for the willingness to operate with ICT-based tools. If this is not sufficient, training could be used to increase the perceived ease of use and perceived usefulness of ICT, subsequently leading to ICT acceptance (Davis, 1989). This, in turn, can lead to idea generation, based on two assumptions: the employee is provided with the right amount of ICT-based tools to share both knowledge and ideas, and an OCI should be in place. The strategic management of an organization can create an OCI by improving the support for creativity and creating tolerance for differences among employees (Hunter et al., 2007; Scott and Bruce, 1994). This can be done through training leaders in the organization. For an optimal result, the PO fit should be optimized (Saether, 2019). Team-building sessions can improve relations between leaders and followers in the organization and additionally lead to an optimized PO fit.

In short, based on this case study, managing EDI in the field of construction engineering can, to a certain extent, be done according to current literature. Additionally, the implementation of the model can contribute to reducing the barriers on sharing specialized knowledge (through the increase in ICT usage) and the lack of R&D investments (by EDI being a replacing factor), so that innovation is optimized. However, to fully understand the concept of managing EDI in construction engineering, future research is required. This should mainly contribute to a better understanding of job hierarchy in the organization, differences in organizational climates, and the outcomes of implementing ideas for innovating, through which innovation can be measured.

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A

Survey Questions

Dear Participant,

You are being invited to participate in a research study titled ‘Digital Employee-Driven Innovation in Engineering: A Case Study’. This study is being conducted by Stefan Uitermarkt, student from the Technical University of Delft. The purpose of this research study is to measure the effects of using ICT tools on employee-driven innovation (EDI) and innovative behavior in the field of engineering. The study consists of a survey of 10 questions (sometimes including multiple items) and will approximately take 5 to 10 minutes to complete. The data collected will be used for an analysis to seek relationships and make conclusions in order to contribute to the research of innovation management. You will be asked questions about EDI and how your organization plans and implements EDI initiatives.

As with any online activity, the risk of a breach is always possible. To the best of our ability, your answers in this study will remain confidential. We will minimize any risks by the following: only the master student researcher and supervisor conducting the survey will have access to personal information during the study, which will be stored on TU Delft's Onedrive. Besides, the data will be deleted at the latest 2 years after the end of the project (but may be deleted sooner). The data may be used as supporting material for future scientific publications and presentations. Non-personal information may be shared anonymously for scientific publications and presentations. Participants may withdraw from the study at any time without providing any reason. Feel free to contact us if there are any concerns. By clicking on the arrow below and filling in the survey questions, you automatically comply with the statement above.

Your participation in this study is entirely voluntary and you can withdraw at any time. You are free to send any questions to:

Stefan Uitermarkt
Msc Management of Technology
Delft University of Technology
s.uitermarkt@student.tudelft.nl

Figure A.1: Informed consent

How would you describe yourself?

- Male
- Female
- Non-binary / third gender
- Prefer not to say

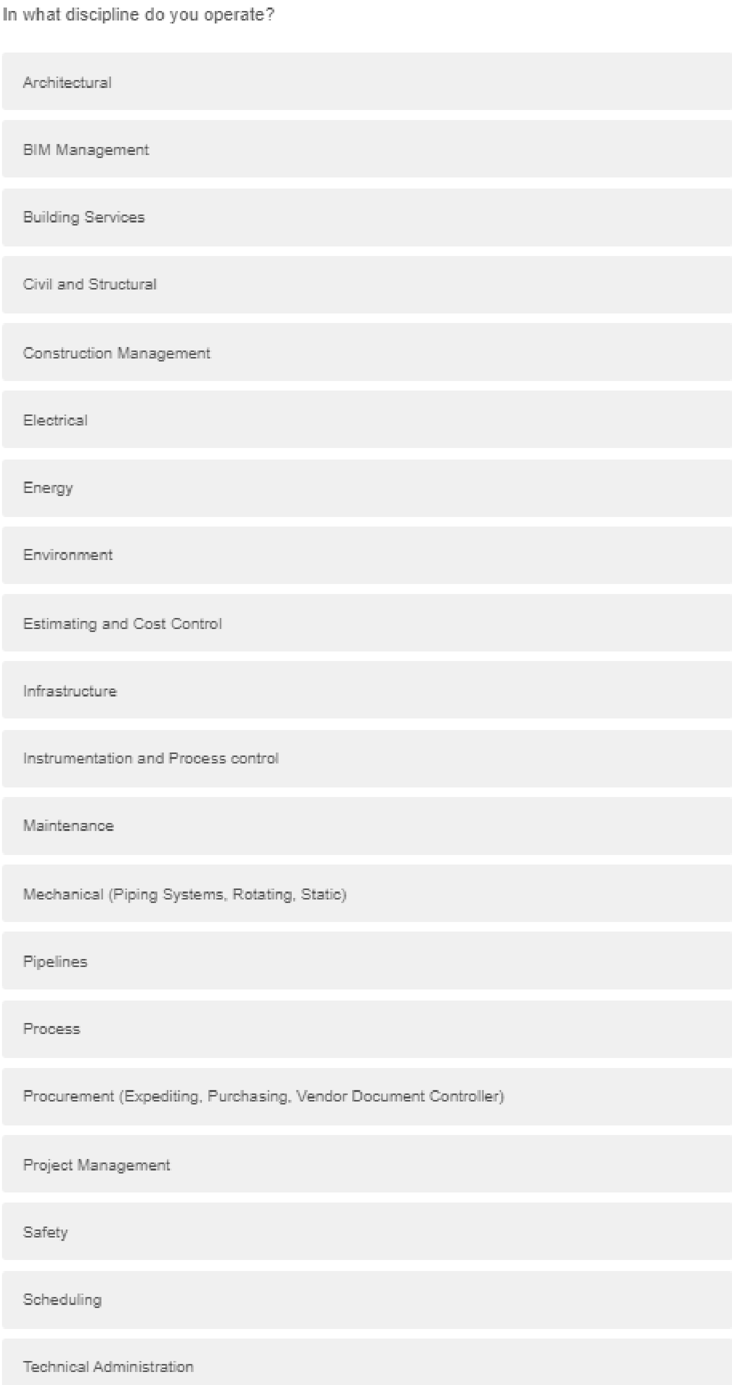
Please indicate your age in number of years.

Figure A.2: Personal questions

In what region do you operate?

- West region (Netherlands)
- North-East region (Netherlands)
- South-East region (Netherlands)
- Belgium
- Consultancy

Figure A.3: Area of operation


In what discipline do you operate?

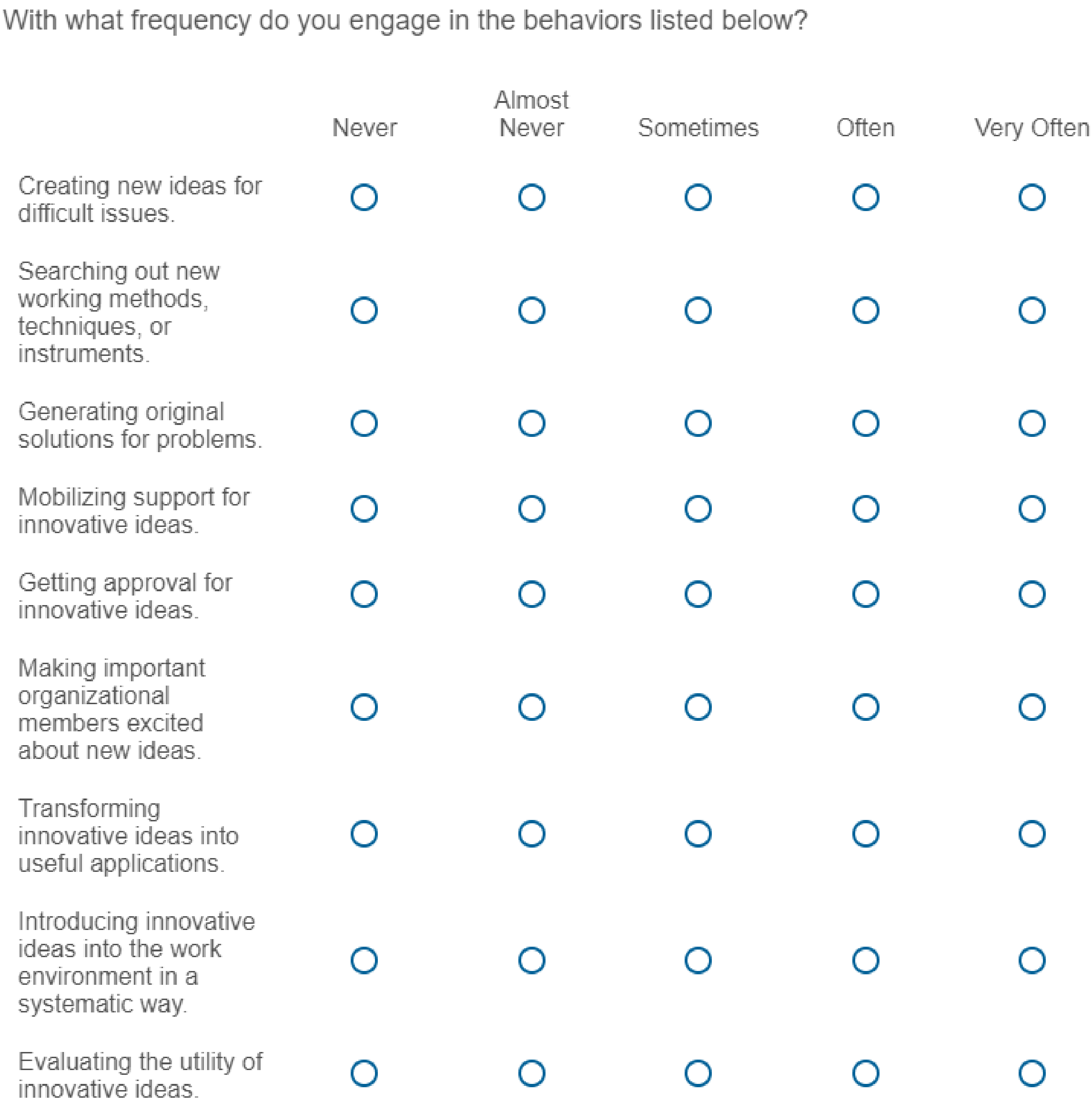
Architectural
BIM Management
Building Services
Civil and Structural
Construction Management
Electrical
Energy
Environment
Estimating and Cost Control
Infrastructure
Instrumentation and Process control
Maintenance
Mechanical (Piping Systems, Rotating, Static)
Pipelines
Process
Procurement (Expediting, Purchasing, Vendor Document Controller)
Project Management
Safety
Scheduling
Technical Administration

Figure A.4: Discipline of operation

How would you describe your job role?

- BIM Coordinator
- Buyer
- Construction Manager
- Construction Supervisor
- Consultant
- Discipline Engineer
- Estimator
- Expeditor
- Intern
- Lead Engineer
- Project Control Engineer
- Project Document Controller
- Project Manager

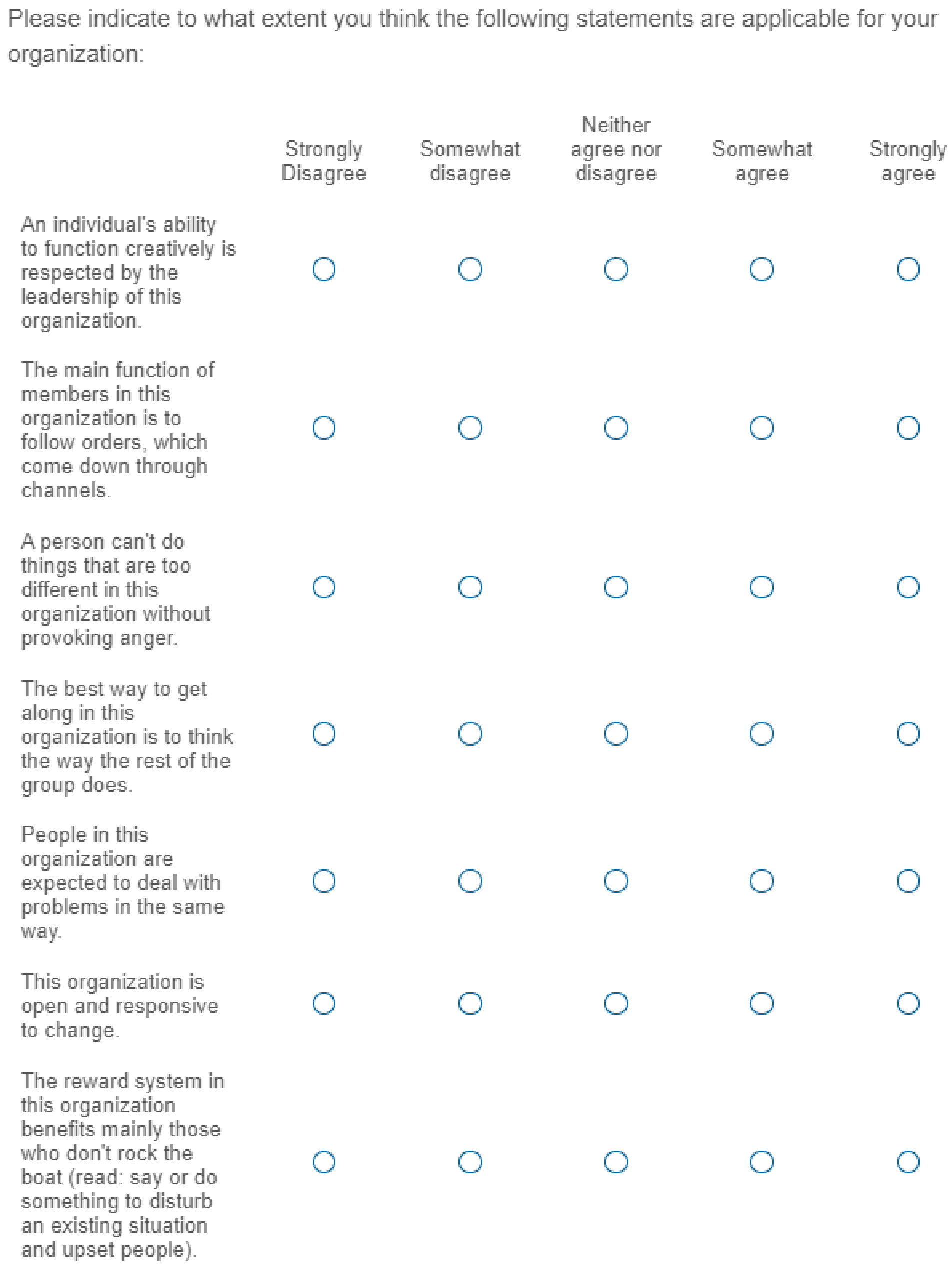
Figure A.5: Job role



With what frequency do you engage in the behaviors listed below?

	Never	Almost Never	Sometimes	Often	Very Often
Creating new ideas for difficult issues.	○	○	○	○	○
Searching out new working methods, techniques, or instruments.	○	○	○	○	○
Generating original solutions for problems.	○	○	○	○	○
Mobilizing support for innovative ideas.	○	○	○	○	○
Getting approval for innovative ideas.	○	○	○	○	○
Making important organizational members excited about new ideas.	○	○	○	○	○
Transforming innovative ideas into useful applications.	○	○	○	○	○
Introducing innovative ideas into the work environment in a systematic way.	○	○	○	○	○
Evaluating the utility of innovative ideas.	○	○	○	○	○

Figure A.6: Innovative Work Behavior



Please indicate to what extent you think the following statements are applicable for your organization:

	Strongly Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
An individual's ability to function creatively is respected by the leadership of this organization.	○	○	○	○	○
The main function of members in this organization is to follow orders, which come down through channels.	○	○	○	○	○
A person can't do things that are too different in this organization without provoking anger.	○	○	○	○	○
The best way to get along in this organization is to think the way the rest of the group does.	○	○	○	○	○
People in this organization are expected to deal with problems in the same way.	○	○	○	○	○
This organization is open and responsive to change.	○	○	○	○	○
The reward system in this organization benefits mainly those who don't rock the boat (read: say or do something to disturb an existing situation and upset people).	○	○	○	○	○

Figure A.7: Organizational Climate for Innovation

Work processes in an organization sometimes involve the use of Information and Communications Technology (ICT). ICT is defined as a diverse set of technological tools and resources used to transmit, store, create, share, or exchange information. For example, tools like **(company-related tools)** can be seen as ICT-related tools. Please indicate to what extent you agree to the following statements for your organization:

	Strongly Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
Employees make extensive use of electronic stage (such as online databases) to access knowledge.	○	○	○	○	○
Employees use knowledge networks (such as groupware, intranet, virtual communities) to communicate with colleagues.	○	○	○	○	○
My company uses technology that allows employees to share knowledge with other persons inside the organization.	○	○	○	○	○
My company uses technology that allows employees to share knowledge with other persons outside the organization.	○	○	○	○	○

Figure A.8: ICT usage

Please also indicate the following for you personally:

	Strongly Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
If I heard about a new information technology, I would look to experiment with it.					
In general, I am hesitant to try out new information technologies.					
Among my peers, I am usually the first to try out new information technologies.					
I like to experiment with new information technologies.					

Figure A.9: Individual attitude towards ICT

We thank you for your time spent taking this survey.
Your response has been recorded.

Figure A.10: Thank you note

B

Descriptive Statistics of the Study

Reliability Statistics

Cronbach's Alpha	N of Items
.794	4

Item Statistics

	Mean	Std. Deviation	N
IATICT_1	3.7044	.97145	159
IATICT_2	3.7358	1.02162	159
IATICT_3	3.0692	1.05614	159
IATICT_4	3.5535	1.08877	159

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
IATICT_1	10.3585	6.396	.664	.716
IATICT_2	10.3270	7.437	.381	.846
IATICT_3	10.9937	6.221	.620	.735
IATICT_4	10.5094	5.441	.783	.645

Figure B.1: Reliability test Individual Attitude towards ICT

Reliability Statistics

Cronbach's Alpha	N of Items
.729	4

Item Statistics

	Mean	Std. Deviation	N
ICTU_1	3.64	1.021	159
ICTU_2	3.72	1.109	159
ICTU_3	3.82	.978	159
ICTU_4	2.99	1.175	159

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
ICTU_1	10.53	7.175	.355	.755
ICTU_2	10.45	6.021	.535	.658
ICTU_3	10.34	6.011	.667	.588
ICTU_4	11.18	5.728	.543	.654

Figure B.2: Reliability test Usage of ICT-based Tools

Reliability Statistics

Cronbach's Alpha	N of Items
.797	7

Item Statistics

	Mean	Std. Deviation	N
OCI_1	3.9367	.92167	158
OCI_2	3.3671	1.07877	158
OCI_3	3.7658	.98503	158
OCI_4	3.4177	1.12423	158
OCI_5	3.2342	1.03547	158
OCI_6	3.5380	1.06260	158
OCI_7	3.3101	.93005	158

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
OCI_1	20.6329	18.731	.443	.786
OCI_2	21.2025	17.513	.491	.779
OCI_3	20.8038	18.235	.464	.783
OCI_4	21.1519	15.735	.686	.739
OCI_5	21.3354	17.498	.524	.772
OCI_6	21.0316	16.986	.571	.763
OCI_7	21.2595	18.181	.513	.774

Figure B.3: Reliability test Organizational Climate for Innovation.png

Reliability Statistics

Cronbach's Alpha	N of Items
.889	9

Item Statistics

	Mean	Std. Deviation	N
IWB_1	3.36	.733	158
IWB_2	3.13	.882	158
IWB_3	3.49	.804	158
IWB_4	2.79	.984	158
IWB_5	2.70	.949	158
IWB_6	2.58	.960	158
IWB_7	2.49	.936	158
IWB_8	2.43	.898	158
IWB_9	2.47	.982	158

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
IWB_1	22.08	30.415	.540	.885
IWB_2	22.30	29.143	.567	.883
IWB_3	21.95	30.622	.455	.891
IWB_4	22.65	26.880	.732	.869
IWB_5	22.74	27.722	.670	.875
IWB_6	22.86	27.522	.683	.874
IWB_7	22.94	27.774	.676	.874
IWB_8	23.01	27.331	.764	.867
IWB_9	22.97	27.216	.697	.873

Figure B.4: Reliability test Innovative Work Behavior

Report

Area of operation		Age	IATICT	ICTU	OCI	IWB
West region (Netherlands)	Mean	38.54	3.5882	3.5919	3.5967	2.8325
	Std. Deviation	12.886	.78079	.76527	.74903	.63186
	N	63	68	68	68	68
	% of Total N	42.0%	42.5%	42.5%	42.5%	42.5%
North-East region (Netherlands)	Mean	42.96	3.4453	3.4609	3.4828	2.6528
	Std. Deviation	13.769	.79751	.80850	.67245	.60579
	N	28	32	32	32	32
	% of Total N	18.7%	20.0%	20.0%	20.0%	20.0%
South-East region (Netherlands)	Mean	40.77	3.5484	3.6290	3.6097	2.8172
	Std. Deviation	13.025	.84019	.77425	.72404	.77807
	N	31	31	31	31	31
	% of Total N	20.7%	19.4%	19.4%	19.4%	19.4%
Belgium	Mean	54.14	3.8125	3.6875	3.2875	3.4028
	Std. Deviation	9.974	.78774	.85304	.27742	.58776
	N	7	8	8	8	8
	% of Total N	4.7%	5.0%	5.0%	5.0%	5.0%
Consultancy	Mean	40.19	3.2183	3.3333	3.4798	2.9894
	Std. Deviation	11.665	.88171	.90254	.53617	.67119
	N	21	21	21	21	21
	% of Total N	14.0%	13.1%	13.1%	13.1%	13.1%
Total	Mean	40.79	3.5146	3.5437	3.5456	2.8427
	Std. Deviation	13.090	.81164	.79530	.68533	.67227
	N	150	160	160	160	160
	% of Total N	100.0%	100.0%	100.0%	100.0%	100.0%

Figure B.5: Area of operation mean comparison

Report

Discipline		Age	IATICT	IWB
Architectural	Mean	42.80	3.3000	3.0667
	N	5	5	5
	Std. Deviation	16.131	.99058	.82627
Building Services	Mean	46.89	3.3500	2.7889
	N	9	10	10
	Std. Deviation	8.937	.52967	.82892
Civil and Structural	Mean	43.79	3.2857	2.9365
	N	14	14	14
	Std. Deviation	14.050	.84840	.67757
Construction Management	Mean	53.67	3.7778	3.4074
	N	3	3	3
	Std. Deviation	20.502	1.07152	.33945
Electrical	Mean	36.08	3.8906	2.9201
	N	13	16	16
	Std. Deviation	10.492	.77979	.61663
Energy	Mean	35.00	3.0833	2.8519
	N	3	3	3
	Std. Deviation	8.660	.94648	.12830
Environment	Mean	42.25	2.8750	3.0833
	N	4	4	4
	Std. Deviation	4.924	.85391	.48326
Estimating and Cost Control	Mean	30.33	3.5000	2.3704
	N	3	3	3
	Std. Deviation	8.083	1.32288	.32075
Instrumentation and Process control	Mean	50.75	3.4000	2.5556
	N	4	5	5
	Std. Deviation	17.802	.80234	.46481
Mechanical (Piping Systems, Rotating, Static)	Mean	38.11	3.8026	2.8772
	N	19	19	19
	Std. Deviation	11.813	.70504	.77238
Pipelines	Mean	34.25	3.2500	2.6667
	N	8	9	9
	Std. Deviation	9.270	1.22474	.59577
Process	Mean	38.56	3.4732	2.7619
	N	27	28	28
	Std. Deviation	13.060	.73074	.60460
Procurement (Expediting, Purchasing, Vendor Document Controller)	Mean	51.00	3.7143	3.1905
	N	7	7	7
	Std. Deviation	16.155	.66815	.66887
Project Management	Mean	39.28	3.6905	2.7196
	N	18	21	21
	Std. Deviation	10.725	.62702	.63792
Safety	Mean	41.11	3.3889	3.0123
	N	9	9	9
	Std. Deviation	15.752	.88487	.80209
Scheduling	Mean	64.00	4.2500	3.2222
	N	1	1	1
	Std. Deviation	.	.	.
Technical Administration	Mean	62.00	2.0000	1.3333
	N	1	1	1
	Std. Deviation	.	.	.
Total	Mean	40.85	3.5243	2.8428
	N	148	158	158
	Std. Deviation	13.104	.80429	.66360

Figure B.6: Discipline mean comparison

Report

Job role		Age	Hierarchy	IATICT	IWB
BIM Coordinator	Mean	35.00	1.0000	3.2500	3.0000
	Std. Deviation	.	.	.	.
	N	1	1	1	1
	% of Total N	0.7%	0.7%	0.6%	0.6%
Buyer	Mean	52.50	.8167	3.4375	3.2222
	Std. Deviation	13.077	.16073	.74652	.62854
	N	4	3	4	4
	% of Total N	2.7%	2.0%	2.5%	2.5%
Construction Manager	Mean	65.00	1.0000	5.0000	3.7778
	Std. Deviation	.	.	.	.
	N	1	1	1	1
	% of Total N	0.7%	0.7%	0.6%	0.6%
Construction Supervisor	Mean	66.00	.8333	2.6250	3.1667
	Std. Deviation	.000	.23570	.53033	.07857
	N	2	2	2	2
	% of Total N	1.4%	1.4%	1.3%	1.3%
Consultant	Mean	40.26	.5352	3.2675	3.0117
	Std. Deviation	12.201	.30779	.89949	.69969
	N	19	18	19	19
	% of Total N	12.8%	12.2%	12.0%	12.0%
Discipline Engineer	Mean	35.72	.4995	3.4917	2.6750
	Std. Deviation	11.848	.29253	.74214	.68507
	N	57	58	60	60
	% of Total N	38.5%	39.2%	38.0%	38.0%
Estimator	Mean	39.00	.2000	2.0000	2.0000
	Std. Deviation	.	.	.	.
	N	1	1	1	1
	% of Total N	0.7%	0.7%	0.6%	0.6%
Lead Engineer	Mean	45.57	.6166	3.5966	3.0000
	Std. Deviation	11.626	.26086	.90736	.60764
	N	40	39	44	44
	% of Total N	27.0%	26.4%	27.8%	27.8%
Project Control Engineer	Mean	36.50	.6792	4.2500	2.5000
	Std. Deviation	18.592	.24847	.20412	.63828
	N	4	4	4	4
	% of Total N	2.7%	2.7%	2.5%	2.5%
Project Document Controller	Mean	50.00	.7143	3.2500	2.6296
	Std. Deviation	23.431	.49487	1.08972	1.39812
	N	3	3	3	3
	% of Total N	2.0%	2.0%	1.9%	1.9%
Project Manager	Mean	40.69	.5054	3.6447	2.8012
	Std. Deviation	10.524	.29034	.64181	.60811
	N	16	18	19	19
	% of Total N	10.8%	12.2%	12.0%	12.0%
Total	Mean	40.89	.5603	3.5132	2.8407
	Std. Deviation	13.113	.29373	.81658	.67584
	N	148	148	158	158
	% of Total N	100.0%	100.0%	100.0%	100.0%

Figure B.7: Job role mean comparison

Report

Gender		Age	Hierarchy	IATICT	OCI	IWB
Male	Mean	41.55	.5716	3.5506	3.5181	2.8137
	N	121	123	130	130	130
	Std. Deviation	12.974	.28619	.82244	.71583	.65086
Female	Mean	38.23	.5445	3.3241	3.7093	3.0021
	N	26	24	27	27	27
	Std. Deviation	13.379	.34253	.72661	.51740	.78816
Non-binary / third gender	Mean	24.00	.2500	4.2500	3.2250	2.5000
	N	2	2	2	2	2
	Std. Deviation	.000	.07071	.70711	.74246	.07857
Prefer not to say	Mean	48.00	.2500	2.5000	3.3500	3.0000
	N	1	1	1	1	1
	Std. Deviation	.	.	.	.	.
Total	Mean	40.79	.5608	3.5146	3.5456	2.8427
	N	150	150	160	160	160
	Std. Deviation	13.090	.29545	.81164	.68533	.67227

Figure B.8: Gender mean comparison

C

SPSS Outputs on Variable Testing

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	Collinearity Statistics Tolerance	Collinearity Statistics VIF
1	(Constant)	.533	.410		1.299	.196		
	Age	.006	.004	.122	1.447	.150	.816	1.226
	Hierarchy	.460	.187	.205	2.453	.015	.829	1.206
	IATICT	.238	.062	.297	3.843	<.001	.972	1.028
	ICTU	.103	.068	.123	1.520	.131	.886	1.129
	OCI	.164	.078	.169	2.098	.038	.897	1.115

a. Dependent Variable: IWB

Figure C.1: VIF-test for multicollinearity

Descriptive Statistics

	Mean	Std. Deviation	N
Age	40.79	13.090	150
Hierarchy	.5608	.29545	150
IATICT	3.5146	.81164	160
ICTU	3.5438	.79530	160
OCI	3.5456	.68533	160
IWB	2.8427	.67227	160

Correlations

		Age	Hierarchy	IATICT	ICTU	OCI	IWB
Age	Pearson Correlation	1	.411**	-.109	.043	-.049	.172*
	Sig. (2-tailed)		<.001	.186	.600	.552	.035
	N	150	140	150	150	150	150
Hierarchy	Pearson Correlation	.411**	1	.000	.012	.013	.272**
	Sig. (2-tailed)	<.001		1.000	.885	.876	<.001
	N	140	150	150	150	150	150
IATICT	Pearson Correlation	-.109	.000	1	.096	.043	.311**
	Sig. (2-tailed)	.186	1.000		.229	.587	<.001
	N	150	150	160	160	160	160
ICTU	Pearson Correlation	.043	.012	.096	1	.291**	.171*
	Sig. (2-tailed)	.600	.885	.229		<.001	.030
	N	150	150	160	160	160	160
OCI	Pearson Correlation	-.049	.013	.043	.291**	1	.210**
	Sig. (2-tailed)	.552	.876	.587	<.001		.008
	N	150	150	160	160	160	160
IWB	Pearson Correlation	.172*	.272**	.311**	.171*	.210**	1
	Sig. (2-tailed)	.035	<.001	<.001	.030	.008	
	N	150	150	160	160	160	160

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Figure C.2: Correlation analysis

```
**************************************************************************
Model  : 14
    Y  : IWB
    X  : IATICT
    M  : ICTU
    W  : OCI

Sample
Size:  160

**************************************************************************
OUTCOME VARIABLE:
 ICTU

Model Summary
          R       R-sq        MSE          F        df1        df2          p
      .0956      .0091      .6307     1.4581     1.0000   158.0000      .2290

Model
              coeff         se          t          p       LLCI       ULCI
constant     -.3293      .2799    -1.1768      .2411     -.8821      .2234
IATICT        .0937      .0776     1.2075      .2290     -.0596      .2470

**************************************************************************
```

Figure C.3: Measuring the effect of IATICT on ICTU

```
OUTCOME VARIABLE:
 IWB

Model Summary
          R       R-sq        MSE          F        df1        df2          p
      .3843      .1477      .3951     6.7134     4.0000   155.0000      .0001

Model
              coeff         se          t          p       LLCI       ULCI
constant     1.9710      .2230     8.8386      .0000     1.5305     2.4115
IATICT        .2445      .0617     3.9616      .0001      .1226      .3664
ICTU          .0744      .0660     1.1269      .2615     -.0560      .2047
OCI           .1787      .0773     2.3118      .0221      .0260      .3313
Int_1         .0790      .0931      .8479      .3978     -.1050      .2629

Product terms key:
 Int_1    :        ICTU     x        OCI

Test(s) of highest order unconditional interaction(s):
       R2-chng          F        df1        df2          p
M*W      .0040      .7190     1.0000   155.0000      .3978
----------
    Focal predict: ICTU     (M)
          Mod var: OCI      (W)

Data for visualizing the conditional effect of the focal predictor:
Paste text below into a SPSS syntax window and execute to produce plot.

DATA LIST FREE/
   ICTU       OCI        IWB        .
BEGIN DATA.
     -.7953     -.6853     2.6917
      .0000     -.6853     2.7078
      .7953     -.6853     2.7239
     -.7953      .0000     2.7711
      .0000      .0000     2.8303
      .7953      .0000     2.8894
     -.7953      .6853     2.8505
      .0000      .6853     2.9527
      .7953      .6853     3.0549
END DATA.
GRAPH/SCATTERPLOT=
 ICTU     WITH     IWB      BY       OCI      .
```

Figure C.4: Measuring the direct effect of IATICT and moderating effect of OCI

```
****************** DIRECT AND INDIRECT EFFECTS OF X ON Y *****************

Direct effect of X on Y
     Effect         se          t          p       LLCI       ULCI
      .2445      .0617     3.9616      .0001      .1226      .3664

Conditional indirect effects of X on Y:

INDIRECT EFFECT:
 IATICT      ->     ICTU       ->     IWB

        OCI     Effect     BootSE   BootLLCI   BootULCI
     -.6853      .0019      .0131     -.0262      .0302
      .0000      .0070      .0101     -.0098      .0306
      .6853      .0120      .0145     -.0106      .0466

      Index of moderated mediation:
         Index     BootSE   BootLLCI   BootULCI
OCI      .0074      .0138     -.0141      .0430

 Pairwise contrasts between conditional indirect effects (Effect1 minus Effect2)
    Effect1    Effect2   Contrast     BootSE   BootLLCI   BootULCI
      .0070      .0019      .0051      .0095     -.0096      .0295
      .0120      .0019      .0101      .0190     -.0193      .0589
      .0120      .0070      .0051      .0095     -.0096      .0295

*********************** ANALYSIS NOTES AND ERRORS ************************

Level of confidence for all confidence intervals in output:
  95.0000

Number of bootstrap samples for percentile bootstrap confidence intervals:
  5000
```

Figure C.5: Measuring the moderated mediation effect

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.171[a]	.029	.023	.66443

a. Predictors: (Constant), ICTU

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.108	1	2.108	4.774	.030[b]
	Residual	69.752	158	.441		
	Total	71.859	159			

a. Dependent Variable: IWB

b. Predictors: (Constant), ICTU

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.330	.241		9.683	<.001
	ICTU	.145	.066	.171	2.185	.030

a. Dependent Variable: IWB

Figure C.6: Measuring the effect of ICTU on IWB

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.210[a]	.044	.038	.65933

a. Predictors: (Constant), OCI

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3.175	1	3.175	7.304	.008[b]
	Residual	68.684	158	.435		
	Total	71.859	159			

a. Dependent Variable: IWB

b. Predictors: (Constant), OCI

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.112	.275		7.665	<.001
	OCI	.206	.076	.210	2.703	.008

a. Dependent Variable: IWB

Figure C.7: Measuring the effect of OCI on IWB

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.411[a]	.169	.163	.27277

a. Predictors: (Constant), Age

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.090	1	2.090	28.089	<.001[b]
	Residual	10.268	138	.074		
	Total	12.357	139			

a. Dependent Variable: Hierarchy

b. Predictors: (Constant), Age

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.193	.075		2.582	.011
	Age	.009	.002	.411	5.300	<.001

a. Dependent Variable: Hierarchy

Figure C.8: Measuring the effect of age on job hierarchy

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.172[a]	.030	.023	.65590

a. Predictors: (Constant), Age

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1.943	1	1.943	4.515	.035[b]
	Residual	63.670	148	.430		
	Total	65.613	149			

a. Dependent Variable: IWB

b. Predictors: (Constant), Age

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	2.501	.176		14.227	<.001
	Age	.009	.004	.172	2.125	.035

a. Dependent Variable: IWB

Figure C.9: Measuring the effect of age on IWB

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.272[a]	.074	.068	.65236

a. Predictors: (Constant), Hierarchy

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	5.047	1	5.047	11.859	<.001[b]
	Residual	62.985	148	.426		
	Total	68.032	149			

a. Dependent Variable: IWB

b. Predictors: (Constant), Hierarchy

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	2.464	.115		21.507	<.001
	Hierarchy	.623	.181	.272	3.444	<.001

a. Dependent Variable: IWB

Figure C.10: Measuring the effect of job hierarchy on IWB